Name

领科教育上海校区

Ulink Education-Shanghai

CAIE iGCSE Chemistry

PreA Physical Chemistry workbook and past exam questions 2020-21

The world's first Chemistry textbook, written by a Babylonian woman called Tapputi 3300 years ago, to learn more, click here.

NAME: _____ English Name: _____

Class: _____ Teacher: _____

iGCSE Physical Chemistry Workbook

Contents

1 Introduction to the Course and the Course Materials

1.1 FUNDAMENTAL – What the 4 different levels used here mean

There are 4 different levels that each activity has been labelled as within this this workbook. Learning about these 4 categories of activities is considered FUNDAMNTAL, so everyone is expected to read this :o)

FUNDAMENTAL – This is the most basic ideas and most important things to do before you try to do anything else. If you are struggling in this subject these FUNDAMENTAL activities are the most important things to concentrate on to allow you to progress on towards the higher grades. If you only do the fundamental parts of the course you are unlikely to get above a C grade.

ESSENTAIL – This refers to activities that you should do if you are aiming for a B or an A grade. These are the kinds of things that you should be doing before you attempt any of the harder activities.

EXTENSION – Anything that is marked with this is considered to be really important for those students who are on track for getting an A* and who intend to stay on track.

EXCEPTIONAL – These are things that you can do that are unlikely to have much impact on your final grade, so only the ablest students who regularly achieve over 90% in assessed activities should attempt these. They are important because they will help broaden your mind and give you a depth of understanding that will be particularly important if you are finding the work extremely easy and would like to stretch and challenge yourself. These kinds of experiences and ideas are especially important to help make a good application for the best universities.

1.2 FUNDAMENTAL – How to use this workbook

Each chapter of this book will have a Keyword list, or Glossary, a Classroom activities section, a Past Exam questions section, a Mark Scheme section, Assessed Activity section and a Stretch and Challenge Section. It is recommended that you read ahead in the textbook so that you already have answers, but most importantly, questions about the topic we are studying. This is what your textbook is for. **The Classroom Activities and the Assessed Activities SHOULD NOT be completed in advance,** but you can read through them if you would like. The Past Exam questions should only be attempted when you feel able to do them successfully, which may be after you have read through the textbook and already worked through the activities there, but often it will only be after you have been taught the material in class. It is better that you answer the questions well on your the first attempt and put all of your energy into doing as well as you can on the current topic, especially before the end of topic test. Only a very small number of students will benefit from getting too far ahead of the class, most will simply have covered more material less well and this will be reflected in disappointing grades and test scores.

1.3 For Parents Section of Smashing Science

There si a page dedicated to explaining the iGCSE course and the resources which is specifically to help your parents better understand what you are learning. You will need to get them to scan the QR codes below and then sign this page to show that they have seen this page and are aware of the additional online resources that have been created specifically for you.

Name of Parent or Guardian:_____ Signature: _____

Date: _____

1.4 FUNDAMENTAL – Explaining the different sections of each chapter

Section title	What is in it	How and why it can help you
Keywords	Keywords for the topic auto translated into Chinese. These words are essential to be able to understand and answer questions about the the science of the topic	If you are struggling with the language this is the most important section, you will not be able to do well in much else if you don't understand the keywords in English. For **exceptional students** I would be very appreciative of a better electronic translation.
Extension keywords	Keywords that are at the edges of the syllabus.	These are not essential to get an A grade, but they will help you to better understand where the syllabus ends. They are also useful in expanding your academic vocabulary and particularly useful for **exceptional students.**
Essential Exam Questions	Past exam questions from previous exam papers that assess the topic.	Understanding the science is only a part of being a successful science student, you also need to be able to read and answer exam questions in a way that will allow you to get enough marks. The best practice for anything nearly always is doing the thing you hope to become good at. The difference between and A* student and an A grade student often has very little to do with how much science they understand, but A* students understand very deeply good exam technique and the patterns in exam questions. This understanding takes a great deal of practice. Some students may not finash all of these questions.**Exceptional students** will not only finish these questions but will also go on the websites shown here and download and work on the additional exam questions.
Mark Schemes	The answers to the exam questions. This is not the mark scheme actually used by examiners when these questions were in real exams, however, but a simplified version.	Understanding the difference between a correct, but incomplete answer and a correct and complete answer is at the heart of excellent exam technique. Looking at how mark schemes change over time (they always get harder!) is also a useful exercise in understanding what the examiners think is the most important aspect of an idea. Exceptional students will make notes of the marks they have lost and work on other questions until the number of marks they lose in a given topic is reduced to a very small number, ideally 0.
Fundamental Assessed Activities	Test on the keywords for the course	These should only be attempted by those students who are struggling with the topic and the course. Most students are not expected to try these, but it is up to you to decide which assessed activity you try based on how you feel about the topic.
Essential Assessed Activities	Straightforward activities that test your progress in the course.	These are not going towards your GPA. You have access to all of them, but it is in your best interest to give them a fair go in class because the score is important: if you get very high scores on these, but very low scores on your End of Topic tests than it is obvious that you are not properly preparing for those tests because you have shown an ability already in this topic. It is far better to score badly in these, learn from those poor scores and revise properly for the end of topic tests, which sometimes will go towards your GPA.
Extension Assessed Activities	These are harder questions and there ar a lot more of them.	These will test your ability to work to tight timelines, which is essential for a good A*. You will complete these after you have completed the Essential Assessed Activities.
Stretch and Challenge Activities and Additional Reading	Questions, further reading and links to additional resources that go beyond the syllabus	You can use the advice and information in here to better understand the topic, but also there is an optional activity where you are able to give a presentation to the class about something loosely connected to this topic .

1.5 FUNDAMENTAL Student Survey Introducing yourself

Please complete this brief introduction to yourself and your background and what you hope to study later on and why.

Name, English and Chinese (in pinyin): _____Class:_____

Email address: _____

iGCSE Subject	Target grade

iGCSE Subject	Target grade

Top 5's – What are your goals for the following

Rank	University course	University (& country it is in)	Career	How you want to be remembered by others
1				
2				
3				
4				
5				

Goals for your time at Ulink

Which activities (at school or outside of school, like music or sport) have you done before?

_____

_____

Which co-curricular activities do you intend to do, or would like to do?

_____

_____

What are your targets for the first few weeks of term?

_____

_____

Academic Targets for this term (and how will you achieve them?):

_____

Life (non-academic) targets for this term (and how will you achieve them?):

_____

_____

If you have studied chemistry before, what do you think is easiest and hardest about the subject?

Easiest: _____

Hardest: _____

Most interesting: _____

Least interesting: _____

Can you think of anything that has happened in science recently in the news that you thought was amazing?

_____

_____

_____

1.6 FUNDAMENTAL – Electronic Resources Available

An electronic version of this book is available by scanning the QR code below:

This book contains some past exam questions, but for even more practice go to one of the websites below, the larger of the two is the first one, but is only accessible through a VPN. Either website offers thousands of pages of resources to help you practice and learn about this subject as well as other subjects.

There is also advice on things you can do to Expand your Mind which will help broaden your horizons and give you ideas on things that might be of interest, especially to the ablest students. In addition, there is advice and guidance on applying to university and the kinds of things that the best universities tend to look for in students that they offer places to.

Videos explaining the science in the course in English can be found on this webpage here:

https://www.smashingsciencecn.org/igcse-chem-videos,

1.7 FUNDAMENTAL – How Your Course Will be Assessed at Ulink College Shanghai

For each topic you will have 2 Assessed Activities that will be carried out in the classroom. These **WILL NOT** go towards your Grade Point Average, but they will help you learn how you are progressing within the topic before the End of Topic Test. Some of your End of Topic Tests will go towards your GPA. This will be explained in advance. You will also have an End of Semester Exam in January, an End of Year Exam and your external iGCSE Exams in May.

1.8 Fundamental Command Terms used in CAIE iGCSE Chemistry (and all other CAIE subjects

Command word	Meaning
Define	(the term(s) …) is intended literally, only a formal statement or the same idea in slightly different language is acceptable. Often these questions lose marks over time, so the same answer is expected, but will carry fewer marks making it more difficult to get full marks.
What do you understand by/ What is meant by	(the term(s) …) normally suggests that a definition should be given, together with some relevant comment on the significance or context of the term(s) concerned, especially where two or more terms are included in the question. The amount of supplementary comment intended should be interpreted in the light of the indicated mark value.
State	implies a short and complete answer with little or no supporting information (e.g. a numerical answer that can readily be obtained 'by looking at it').
List	requires a number of points, generally each of one word, with no further information. Where a given number of points is specified only that number of points should be given, so don't give more answers than is required or they may not be counted, or they may, if they are incorrect, be used to deduct marks from your total.
Explain	may require reasoning or some reference to theory, depending on the context. It is another way of asking candidates to give reasons. The candidate needs to leave the examiner in no doubt why something happens. **These questions will usually include the hardest mark, which is normally the 2nd or 3rd mark that will differentiate between A and A* students.**
Give a reason/Give reasons	is another way of asking candidates to explain why something happens.
Describe	requires the candidate to state in words (using diagrams where appropriate) the main points. *Describe* and *explain* may be given in the same command, as may *state* and *explain*. Usually much easier than the Explain aspect of the question.
Discuss	requires the candidate to give the essential information of the points involved.
Outline	implies brevity, so a short response (i.e. limiting the answer to giving just the essentials).
Predict	implies that the candidate is expected to make a prediction not by remembering a fact (recall) but by making a logical connection between other pieces of information. For instance, predict the properties of a compound with unfamiliar elements, based on understanding lighter elements in the same group in the periodic table.
Deduce	implies that the candidate is not expected to produce the required answer by recall but by making a logical connection between other pieces of information. Normally in chemistry this involves being shown a compound that contains unfamiliar elements, but which belong to a group of familiar elements, e.g. Deduce the formula of hydrogen selenide. Answer: Selenium is in the same group as oxygen, and hydrogen oxide is H_2O, so H_2Se is the expected response.
Suggest	is used in two main contexts, i.e. either to imply that there is no unique answer (e.g. in chemistry, two or more substances may satisfy the given conditions describing an 'unknown'), or to imply that candidates are expected to apply their general knowledge of the subject to a 'novel' situation, one that may be formally 'not in the syllabus' – many data response (for instance where information is given in a table about different substances) and problem solving questions are of this type.
Find	is a general term that may interpreted as *calculate, measure, determine*, etc.
Calculate	is used when a numerical answer is required. In general, working should be shown and clearly labelled especially where more than one step is involved.
Measure	implies that the quantity concerned can be directly obtained from a suitable measuring instrument (e.g. length using a rule, or mass using a balance).
Determine	often implies that the quantity concerned cannot be measured directly but can be worked out from a graph or by calculation.
Estimate	suggests that a statement that is only very roughly close to the real value (within a factor of 10) or calculation of the quantity concerned. Normally assumptions will need to be made based on points of principle and values of amounts not given in the question.
Sketch	when applied to graph work, implies that the shape and/or position of the curve need only be roughly (or qualitatively) correct, but candidates should be aware that, depending on the context, some quantitative aspects may be looked for (e.g. passing through the origin, having an intercept). In diagrams, *sketch* implies that simple, freehand drawing is acceptable; nevertheless, care should be taken over proportions and the clear labelling of important details or equipment.

1.9 ESSENTIAL How the iGCSE Course Will be Assessed

All candidates take three exam papers in May. These will be created by Cambridge Assessment International Education. , which is a part of the University of Cambridge.

Candidates who have studied the Core subject content, or who are expected to achieve a grade D or below should be entered for Paper 1, Paper 3 and either Paper 5 or Paper 6. These candidates will be eligible for grades C to G. ***None of the students in my class will be taking this exam.***

Candidates who have studied the Extended subject content (Core and Supplement), and who are expected to achieve a grade C or above should be entered for **Paper 2, Paper 4** and either Paper 5 or **Paper 6**. These candidates will be eligible for grades A* to G. Only these 3 exams will go towards your iGCSE grade (normally). UK universities will often only know this grade, but US universities will require your GPA for usually your 4 last years of High School.

The exams are held in May, usually on different days.

Extended candidates take:		and Extended candidates take:		or:	
Paper 2	45 minutes	**Paper 4**	1 hour 15 minutes	**Paper 6**	1 hour
Multiple Choice	30%	Theory	50%	Alternative to Practical	20%
40 marks		80 marks		40 marks	
40 four-choice multiple-choice questions		Short-answer and structured questions		Questions will be based on the experimental skills in Section 4	
Questions will be based on the Extended subject content (Core and Supplement)		Questions will be based on the Extended subject content (Core and Supplement)		Assessing grades A*–G	
Assessing grades A*–G		Assessing grades A*–G		Externally assessed	
Externally assessed		Externally assessed			

DATA SHEET
The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H Hydrogen 1										4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98				No Nobelium 102	Lr Lawrencium 103

*58-71 Lanthanoid series
†90-103 Actinoid series

Key: a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

www.SmashingScienceCN.Org

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

1.11 FUNDAMENTAL Recording your scores and keeping track of your performance

Target grade:_____ Target Score_____%

Test name	Topic #	Mark (out of)	% Score
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
Average of the first 10 assessed activities		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
Average of the first 20 assessed activities		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
Average of the first 30 assessed activities		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%

	Topic #	Mark (out of)	% Score
		/	%
Average of the first 40 assessed activities		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
Average of the first 50 assessed activities		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
Average of the first 60 assessed activities		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%
		/	%

1.12 FUNDAMENTAL School Calendar

Week #	Monday starting	Contents	Your Notes
	10-Aug	Mon 10 to 14 G1 & PreA Students Orientation Week **Tue 11th All teachers back in office** Fri 14th Full staff meeting/Department meeting Welcome Buffet Sun 16th C6 AS & A2 students registration **Sun 16th UCS Opening Ceremony All Staff am: G1, G2 & PreA, pm AS, A2 & IB1/2**	
1	17-Aug	Mon 17th Teaching Begins	
2	24-Aug	**Fri 28th Dead Line for G1, ASD and IB1 to change options** Tue 26th Activities Fair Wed 26th-30th Student Union Elections	
3	31-Aug		
4	7-Sep	Fri 11th G1 and PreA Parents consultation day **Fri 11th Dead Line for A2 Students to drop options**	
5	14-Sep	**Fri 18th Dead Line for A2 Predicted grades** Fri 18th IB2 Parents' consultation day Fri 11th Open day for G1 and PreA parents	
6	21-Sep	**Sat 26th Make up day (Tuesday)**	
7	28-Sep	Thur 1st Oct First day of National Holiday	
	5-Oct	10th Oct Last day of National Holiday **Sun 11th Make-up Day (Friday's timetable)**	
8	12-Oct	**SAT 17 Make-up Day (Sports Day) (or Wednesday if weather is bad)**	
9	19-Oct	Fri 23rd International Mole day	
10	26-Oct	Wed 28th Alternative sports day 26th-30th Art Week	
11	2-Nov	**Fri 6th Deadline for 1st observation for returning teachers**	
12	9-Nov	Mon 9th to Fri 13th IB2 MS EXAMS Wed 11th Physics Day Fri 13th CAIE Winter Session Begins **Fri 13th DeadLine for inputting marks for Mid Sememster Reports**	
13	16-Nov		
14	23-Nov	Mon 23rd G1,2 PreA, AS and A2 Reports Fri 27th AS, A2 and IB1 Parents Consultation Fri 27th Completion of the first Student Survey **Sat 28th Makeup day G1, G2, PreA and Pre IB Parents Consultation day**	
15	30-Nov		
16	7-Dec		
17	14-Dec	13th CAIE Winter session ends	
18	21-Dec		
	28-Dec		

Week #	Monday starting	Contents	Your Notes
19	4-Jan	Sun 3rd Jan Last day of Xmas holiday Mon 4th to Sat 9th End of Semester Exams **Sat 9th Jan make up day**	
20	11-Jan		
21	18-Jan	Mon 18th Deadline for input of all makrs in SIMS for EOS Reports Fri 22nd Annual Party & Long Service Awards Celebration	
22	25-Jan	Mon 25th G1,2, PreA, AS and A2 reports issued Thur 28th IB1, AS and A2 Parents Consultation Day (PM only) Fri 29th G1,2 PreA, PreIB Parents Consulation Day (Whole day) Sat 30th Spring Festival Holiday begins	
	1-Feb	Chinese New Year Holiday	
	8-Feb	Chinese New Year Holiday	
	15-Feb	Chinese New Year Holiday Sat 20th Winter Holiday ends **Sun 21st AM All students and form tutors in school for registration** **Sun 21st PM Students Assembly**	
23	22-Feb	Mon 22nd Semester 2 Teaching begins Sun 28th New spring classes in school for registration	
24	1-Mar	Tue 2nd to Fri 12th IB2 Mock Exam Wed 3rd Graduation Picture Day (Weather permitting)	
25	8-Mar	Fri 12th End of IB2 Mock Fri 12th G2 and preA Optional Course Information Day Fri 12th Completion of 2nd Student survey	
26	15-Mar	Mon 15th Deadline for G2, PreA, AS and A2 End of Year Exam Papers to AAO for printing	
27	22-Mar	Mon 22nd Guided Revision Starts Wed 24 UCS Spring Concert Fri 26th Teaching of G2, PreA AS, A2 syllabi completed Fri 26th Deadline for all Observations	
28	29-Mar	Mon 29th- Thur 1st April CAIE Oral English Exam Thur 1st Guided Revision Ends **Fri 2nd April QingMing Holiday Begins** (3 days) Wed 31st Drama Class End of Year Performance	
29	5-Apr	Mon 5th EOY (G2, PreA, AS & A2) begins	
30	12-Apr	Fri 16th EOY ends	
31	19-Apr		
32	26-Apr	Thur 29th IB External Exams Begin	

Week #	Monday starting	Contents	Your Notes
33	3-May	Mon 3rd CAIE Summer Session Begins Deadline All marks G3, PreA, AS and A2 into SIMS	
34	10-May	Fri 14th G1 Syllabus Completed	
35	17-May	Mon 17th to Fri 21st PreIB EoY exams Fri 21st IB External Exams End	
36	24-May	Mon 24th to Fri 28thy G1 EoY Exams	
37	31-May	Mon 31st Deadline for payment of student tuition and dormitory fees Fri 4th G2, PreA, AS and A2 reports issued Fri 4th Deadline for inputting G1 marks into SIMS Fri 4th PreIB Parents consultation day	
38	7-Jun	Wed 9th IB Parents Consultation Day Fri 11th CAIE summer session ends Sat 12th A2 & IB2 Graduation Ceremony Mon 7th-9th G1 Students Social Studies Wed 9th G1 Reports issues Fri 11th G1 Parents Consultation Day	
39	14-Jun	Mon 14th-16th EoY Reflection Days (All staff must attend) Thur 17th Ulink Family Day Fri 18th -20th Annual Summer Trip Mon 21st Summer Holiday Begins	

1.13 ESSENTIAL Teaching order

This is the approximate order that these topics will be taught and if they are going to be taught by your Organic or Physical Chemistry teacher. There may be changes depending on special events or lessons that are missed for other reasons.

Notice that the textbook that is used, Complete Chemistry for Cambridge IGCSE (3rd Edition, Oxford 2014) follows a different order than the CAIE topic order and the teaching order is again different as a result of the split of the class for 2 different teachers. **Exceptional students** will not only be following the topic being taught outside of class but also preparing for the next topic.

CAIE Topic ID	My topic ID	Textbook Chapter	PhysC OrgC?	Teaching Week #	CAIE Topic Name
2.1	2.1&2	19	PhysC	1	Measurement
3.1	3.1	3	OrgC	1	Atomic structure and the Periodic Table
2.2.1	2.2.1&2	2	PhysC	2	Criteria of purity
2.2.2	2.2.1&2	2	PhysC	2	Methods of purification
3.2.1	3.2.1&2	4	OrgC	3	Bonding: the structure of matter
7.1	7.1&2	4	OrgC	3	Physical and chemical changes
3.2.2	3.2.1&2	4	OrgC	4	Ions and ionic bonds
3.2.3	3.2.3&4	4	OrgC	4	Molecules and covalent bonds
1.1	1.1	1	OrgC	5	The particulate nature of matter
7.4	7.4	7	PhysC	5	Redox
3.2.4		4	OrgC	7	Macromolecules
3.2.5	3.2.5	4	OrgC	7	Metallic bonding
5.1	5.1	8	PhysC	7	Electricity and chemistry
4.1	4.1	5	PhysC	9	Stoichiometry
6.1	6.1&2	9	PhysC	9	Energetics of a reaction

CAIE Topic ID	My topic ID	Textbook Chapter	PhysC OrgC?	Teaching Week #	CAIE Topic Name
4.2	4.2	6	OrgC	10	The mole concept
6.2	6.1&2	9	PhysC	10	Energy transfer
7.2	7.1&2	10	PhysC	11	Rate (speed) of reaction
9.1	9.1&2	12	OrgC	12	The Periodic Table
9.2	9.1&2	12	OrgC	12	Periodic trends
7.3	7.3	9	PhysC	13	Reversible reactions
9.3	9.3	12	OrgC	13	Group properties
9.4	9.4	12	OrgC	14	Transition elements
9.5	9.5	12	OrgC	14	Noble gases
12.1	12.1	16	PhysC	14	Sulfur
11.4	11.4	16	OrgC	15	Carbon dioxide and methane
13.1	13.1	16	OrgC	15	Carbonates
8.1	8.1&2	11	PhysC	16	The characteristic properties of acids and bases
8.2	8.1&2	11	PhysC	16	Types of oxides
11.1	11.1	15	OrgC	16	Water
8.3	8.3	11	PhysC	17	Preparation of salts
11.2	11.2	15	OrgC	17	Air
8.4	8.4	19	PhysC	20	Identification of ions and gases
11.3	11.3	16	OrgC	20	Nitrogen and fertilisers
10.1	10.1	13	PhysC	21	Properties of metals
14.1	14.1&2	17	OrgC	21	Names of compounds
14.2	14.1&2	17	OrgC	21	Fuels
10.2	10.2	13	PhysC	22	Reactivity series
14.3	14.3&4	17	OrgC	22	Homologous series
14.4	14.3&4	17	OrgC	22	Alkanes
10.3	10.3	14	PhysC	23	Extraction of metals
14.5	14.5	17	OrgC	23	Alkenes
14.6	14.6	17	OrgC	23	Alcohols
14.7	14.7	17	OrgC	23	Carboxylic acids
10.4	10.4	14	PhysC	24	Uses of metals
14.8.1	14.8.1&2	18	OrgC	24	Polymers
14.8.2	14.8.1&2	18	OrgC	25	Synthetic polymers
14.8.3	14.8.3	18	OrgC	26	Natural polymers

Assessment Structure

1.14 2020-2021 weekly scheme of work for PreA Physical Chemistry_

Pre Chemistry Semester1		
No	Column heading	%
1	PT1(Ch7&8)	30%
2	PT2(Ch9&10)	
3	PT3(Ch9(9.5,9.6)&Ch16(16.1-5))	
4	OT1	
5	OT2	
6	OT3	
7	PHW1(lab report)	20%
8	PHW2(Ch7&8)	
9	PHW3(Ch9&10)	
10	Cumulative HW (org)	
13	EOS	50%

Pre Chemistry Semester2		
No	Column heading	%
1	PT1(Ch11)	20%
2	PT2(Ch13&14)	
3	PT3(Paper6)	
4	OT3(Ch17)	
5	PHW1(Ch11,13,14)	
6	PHW2(lab report)	20%
7	Cumulative HW (org)	
8	EOY	60%
9		
10		
11		

Resources: There is a 400 side book (200 pages) that accompanies this course that is being finished off now which include all exercises, past exam questions and formative assessment activities

Lab protocols and tests will be printed as they are needed throughout the year.

Weeks	Chapter [CAIE Topic #]	Sub-topics	Assessment/ HW	Practical work	School events/ key dates
1 (17-21 Aug)	Laboratory Induction (inc. Ch19.1 & 19.2) **[T2.1]**	Intro to lab Intro to resources, including the workbook and online resources Health and safety	Revise	Find the equipment	16th: opening ceremony (all staff)
2 (24-28 Aug)		Naming Equipment	Assessed activity 1 T2	Separating mixtures Sand and salt	
3 (31-4 Sept)	Ch2 Separating Substances **[T2.2]**	Separating techniques	Assessed Activity 2 T2	Separating mixtures Chromatography	4th Teacher's day dinner
4 (7-11 Sept)	Ch5 (5.1-5.2) Chemical Equations **[T4.1*]**	Naming chemicals, balanced chemical equations with state symbols	End of Topic 2 Test	How much Na2CO3 in a mixture with NaCl	9th 1st PRM 11th 1st NT Ob.
5 (14-18 Sept)	Ch7 Redox Reactions **[T7.4]**	Ionic half equations	End of Topic 4.1 Test Assessed Activity 1 T7	IDemo Intro redox reactions – Lollipops & KMnO4	18th DL A2 PG, G1/Pre Open Day
6 (21-25 Sept)		Oxidation and reduction	End of Topic Test Assessed Activity 2 T7	Burning a candle	26th Tuesday timetable
7 (28-2Oct)	Ch8 Electricity & Chemical Change **[T5.1]**	Electrolysis	Assessed Activity 2 T5	Electrolysis of NaCl with universal indicator	1-10 Oct National Holiday 11th Friday timetable
(5-9 Oct) National Holiday					
8 (12-16 Oct)	Ch8 Electricity & Chemical Change **[T5.1]**	Electroplating Galvanic cells	Assessed Activity 1 T5	1.Electroplating 2. Galvanic cells	16th 2nd NT Ob. 17th Sports Day
9(19-23 Oct)	Ch9 (9.1-9.4) Energy Changes **[T6.1&6.2]**	Enthalpy, Endo & Exo	End of Topic 5 Test	Endo thermic and Exothermic reactions	21st 2nd PRM
10 (26- 30 Oct)		Calculating enthalpy changes from bond energies	Assessed Activity 1 T6	Drawing graphs for P6	
11 (2-6 Nov)	Ch10 Speed of a Reaction **[T7.2]**	How to measure rate of reaction	End of Topic 6 Test	Measuring the volume of gas produced against time changing temperature	6th DL RT Ob.
12 (9-13 Nov)		Rate of reaction curves and collision theory	Long answer questions on rate	Measuring the rate	11th 3rd PRM 13th DL SIMS
13 (16-20 Nov)	Ch9 (9.5-9.6) Reversible Reactions **[T7.3]**	Reversible reactions including tests for water CuSO4 and CoCl2	Assessed Activity 1 T7	Demo of CoCl2 (aq) Dehydrating Copper Sulfate & testing 2 liquids (ethanol and water)	

Weeks	Chapter [CAIE Topic #]	Sub-topics	Assessment/ HW	Practical work	School events/ key dates
14 (23-27 Nov)	Ch16 (16.1-16.5)* Haber Process & Contact Process **[T11.3][T12.1]**	Le Chatelier's principle Haber process	End of Topic Test	Video demonstrations of equilibria from the RSC	25th EOS to AAO 27th (PM) &28th Parents consultation 27th 1st Student survey
15 (30-4 Dec)		Contact process	Assessed Activity 1 T11		
16 (7-11 Dec)	Ch11 Acids, Bases & Salts **[T8.1&8.2]**	Definitions, strong and weak acids and bases	End of Topic Test	Making salts 1 (CuSO4 from CuO, BaSO4 by precipitation)	9th 4th PRM
17 (13-18 Dec)		Making salts	Revise	Making salts 2 NaCl by Titration	
18 (20-25 Dec)	Mock EoS Exam	Mock EoS Exam Going through the exam	Mock EoS Exam		24 Dec- 3 Jan Christmas Holiday
(27-1 Jan) Christmas Holiday					
19 (4-8 Jan)	EOS (excluding acids and bases)				9 Jan make up day
20 (11-15 Jan)	Ch19 Identification of Gases & Ions (19.3-19.5) **[T8.4]**	Flame test, Test for anions	Assessed Activity 1 T8	Flame tests Tests for ions	
21 (18-22Jan)		Test for cations	Assessed Activity 2 T8	Test for ions	18th DL SIMS 22nd annual Party
22 (25-29 Jan)	Ch13 Behavior of Metals **[10.1&10.2]**	Reactivity series of metals and displacement	End of T8 test	Displacement of Cu from CuSO4 and Zn	28th (PM) & 29th Parent consultation
(1-5 Feb) CNY					
(8-12 Feb) CNY					
(15-19 Feb) CNY					
23 (22-26 Feb)	Ch13 Behavior of Metals **[10.1&10.2]**	Etraction of iron and Zinc	Assessed Activity 1	Thermite	28th New Spring
24 (1-5 Mar)	Ch14 Making use of Metals **[10.3&10.4]**	Extraction of copper and its purification	Assessed Activity 2	Electroplating using copper sulfate	
25 (8-12 Mar)		Uses of metals and sacrificial protection	End of T10 test	Galvanic cells	12th Course info. Day 12th 2nd student survey
26 (15-19 Mar)	Paper6 **[8.3]**	Q1 and Q2 Focus		Preparing salts	15th EOY to AAO

Weeks	Chapter [CAIE Topic #]	Sub-topics	Assessment/ HW	Practical work	School events/ key dates
27 (22-26 Mar)		Q3 and Q4		Advanced lab techniques	26th complete teaching syllabi DL ALL OB.
28 (29-2 Apr)	Guided Revision Starts				2nd QingMing
29 (5-9 Apr)	EOY				
30 (12-16 Apr)					
31 (19-23 Apr)		Going through the EoY exam			
32 (26-30Apr)					30th completion of self-reflection
33 (3-7 May)		CAIE EXAMS			CAIE starts 5th DL SIMS
34 (10-14 May)					12th G1 EOY to AAO
35 (17-21 May)					
36 (24-28 May)					G1 EOY
37 (31-4 June)					
38 (7-11 June)					
39 (14-18 June)					

EXCEPTIONAL Stretch and Challenge - Basics to delivering an effective presentation

At the end of each topic there will be a chance for the most interested students to give a presentation about anything they found particularly interesting. It can be about anything, but it will help develop your public speaking skills, your confidence and allow you to demonstrate subject passion, which is the most important quality that the best universities in the UK are interested in.

This exercise is voluntary but open to all students.

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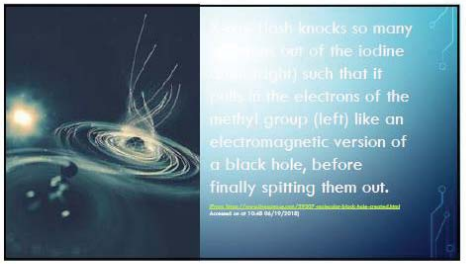

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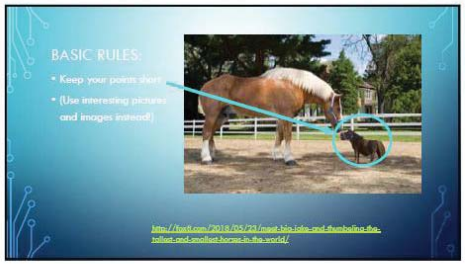

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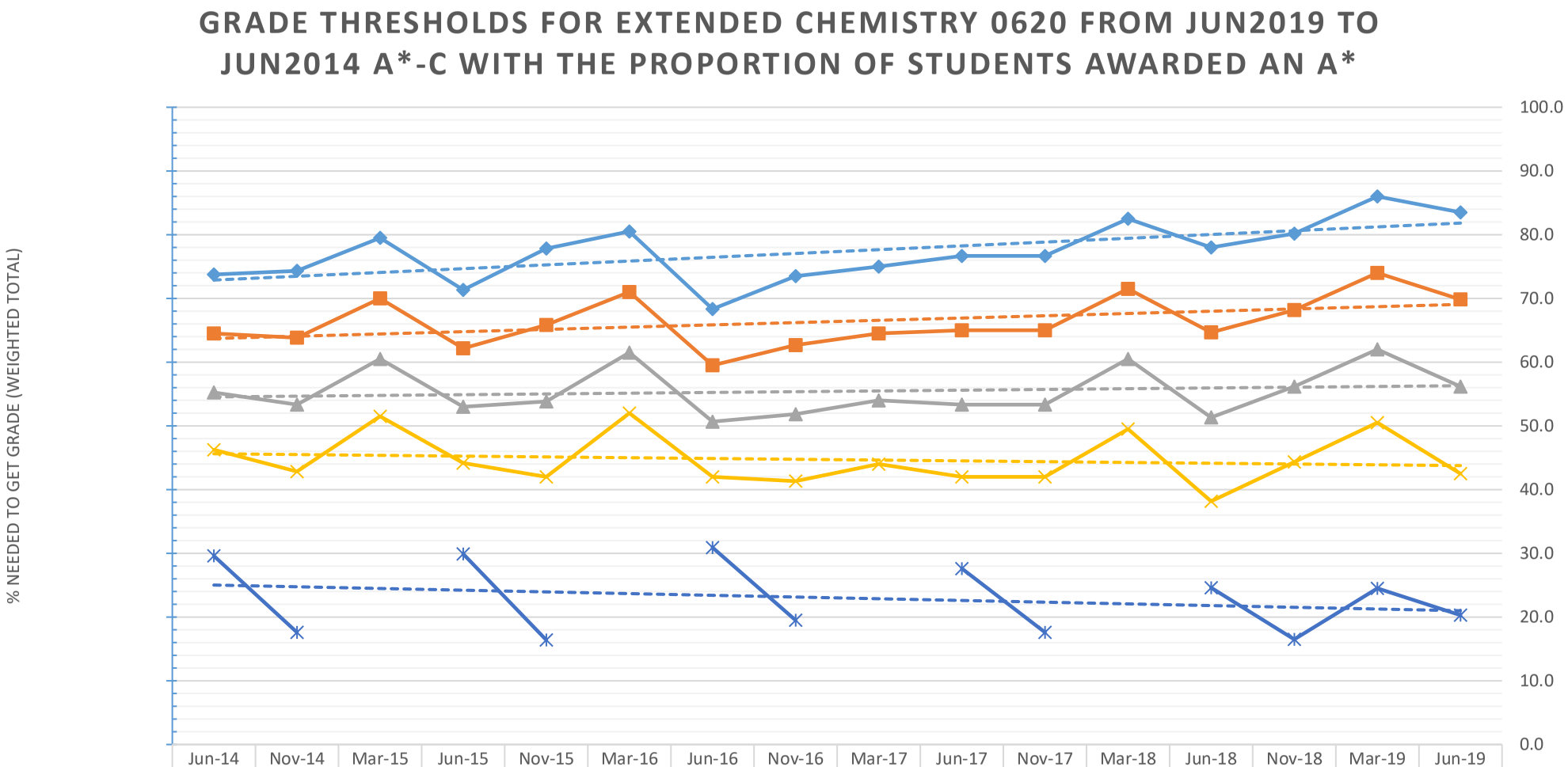
1.15 EXTENSION How grade thresholds have changed across the years



	Jun-14	Nov-14	Mar-15	Jun-15	Nov-15	Mar-16	Jun-16	Nov-16	Mar-17	Jun-17	Nov-17	Mar-18	Jun-18	Nov-18	Mar-19	Jun-19
A*	73.8	74.3	79.5	71.3	77.8	80.5	68.3	73.5	75.0	76.7	76.7	82.5	78.0	80.2	86.0	83.5
A	64.5	63.8	70.0	62.2	65.8	71.0	59.5	62.7	64.5	65.0	65.0	71.5	64.7	68.2	74.0	69.8
B	55.3	53.3	60.5	53.0	53.8	61.5	50.7	51.8	54.0	53.3	53.3	60.5	51.3	56.2	62.0	56.2
C	46.3	42.8	51.5	44.2	42.0	52.0	42.0	41.3	44.0	42.0	42.0	49.5	38.2	44.3	50.5	42.5
% Stds w/ A*	29.6	17.6		29.9	16.4		30.9	19.5		27.6	17.6		24.6	16.5	24.5	20.3

1.15.1 Reflection:

What do you think this graph shows? How can you use this information to make sure you achieve the A*?

1.16 ESSENTIAL Study Timetable – Use this to assign blocks of time to different subjects and regular activities

Period	Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
	5:00 AM							
	5:30 AM							
	6:00 AM							
	6:30 AM							
	7:00 AM							
Regstn	7:45 AM							
1	8:00 AM							
2	8:50 AM							
Break	9:35 AM							
3	9:45 AM							
4	10:35 AM							
Lunch 5	11:25 AM							
Lunch 6	12:10 PM							
7	1:00 PM							
8	1:55 PM							
9	2:45 PM							
10	3:30 PM							
	4:20 PM							
	5:00 PM							
	5:30 PM							
	6:00 PM							
	6:30 PM							
	7:00 PM							
	7:30 PM							
	8:00 PM							
	8:30 PM							
	9:00 PM							
	9:30 PM							
	10:00 PM							
	10:30 PM							

1.17 ESSENTIAL Revision Timetable –Use this to help you start to organise your revision time

Period	Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
	5:00 AM							
	5:30 AM							
	6:00 AM							
	6:30 AM							
	7:00 AM							
Regstn	7:45 AM							
1	8:00 AM							
2	8:50 AM							
Break	9:35 AM							
3	9:45 AM							
4	10:35 AM							
Lunch 5	11:25 AM							
Lunch 6	12:10 PM							
7	1:00 PM							
8	1:55 PM							
9	2:45 PM							
10	3:30 PM							
	4:20 PM							
	5:00 PM							
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	9:00 PM							
	9:30 PM							
	10:00 PM							
	10:30 PM							

2 Learning to learn

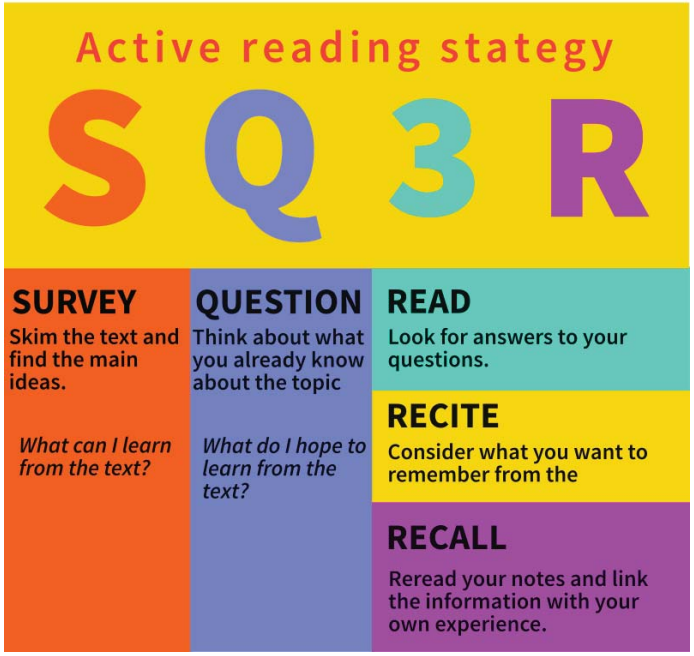
2.1 ESSENTIAL Critical reading techniques

Active reading simply means reading something with a determination to understand and evaluate it for its relevance to your needs.

Simply reading and re-reading the material isn't an effective way to understand and learn. Actively and critically engaging with the content can save you time. Most OU study books and websites include in-text questions and self-assessed questions. Use these as built-in cues to make your study active.[1]

[1] https://help.open.ac.uk/active-reading

2.2 FUNDAMENTAL Active Reading Advice



2.3 EXTENSION Active Reading Advice

From: https://mcgraw.princeton.edu/sites/mcgraw/files/media/active-reading-strategies.pdf

THE McGRAW CENTER TEACHING & LEARNING
328 Frist Campus Center
Princeton University, Princeton, NJ

Active Reading Strategies

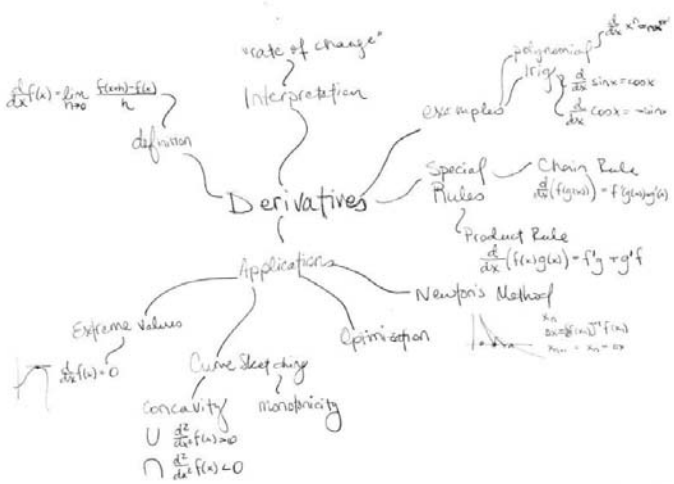
Choose the strategies that work best for you or that best suit your purpose.

- **Ask yourself pre-reading questions.** For example: What is the topic, and what do you already know about it? Why has the instructor assigned this reading at this point in the semester?
- **Identify and define any unfamiliar terms.**
- **Bracket the main idea or thesis of the reading, and put an asterisk next to it.** Pay particular attention to the introduction or opening paragraphs to locate this information.
- **Put down your highlighter. Make marginal notes or comments instead.** Every time you feel the urge to highlight something, write instead. You can summarize the text, ask questions, give assent, protest vehemently. You can also write down key words to help you recall where important points are discussed. Above all, strive to enter into a dialogue with the author.

- **Write questions in the margins, and then answer the questions in a reading journal or on a separate piece of paper.** If you're reading a textbook, try changing all the titles, subtitles, sections and paragraph headings into questions. For example, the section heading "The Gas Laws of Boyle, Charles, and Avogadro" might become "What are the gas laws of Boyle, Charles, and Avogadro?"
- **Make outlines, flow charts, or diagrams that help you to map and to understand ideas visually.** See the reverse side for examples.
- **Read each paragraph carefully and then determine "what it says" and "what it does." Answer "what it says" in only one sentence.** Represent the main idea of the paragraph in your own words. To answer "what it does," describe the paragraph's purpose within the text, such as "provides evidence for the author's first main reason" or "introduces an opposing view."
- **Write a summary of an essay or chapter in your own words.** Do this in less than a page. Capture the essential ideas and perhaps one or two key examples. This approach offers a great way to be sure that you know what the reading really says or is about.
- **Write your own exam question based on the reading.**
- **Teach what you have learned to someone else!** Research clearly shows that teaching is one of the most effective ways to learn. If you try to explain aloud what you have been studying, (1) you'll transfer the information from short-term to long-term memory, and (2) you'll quickly discover what you understand — and what you don't.

See other side of page for sample diagrams →

Sample diagrams:



Sketch of a reading's argumentative structure:

Open with specific example → Generalize to larger problem → Diagnosis of problem → Tentative solution → Objection → Reply and final position

2.4 How to get the most from your textbook

The best way to learn most efficiently is the most important thing that you will learn about yourself and about learning. To discover better ways of learning will need you to try them out. Hopefully you have already started to notice certain patterns in all textbooks, like the way they are set out. Normally one idea or concept is covered in either a single page or a double page spread, helping to break down a larger topic into smaller parts which are easier to manage. They will also have questions after idea has been explained which are designed to reinforce your learning and require you to think about the ideas and make use of what you have just learnt. This is a part of a process known as Active Learning[2]. Solving past exam questions is another way to learn by activity. Also effective is teaching another student who is struggling with a particlar part of the course.

Active reading[3] requires you to really think about what you are reading and make notes, underline and refloect on the ideas. If you follow the instructions that follow when you are workign through the textbook, especially if you are reading ahead of the classes (use the calender and ask your teacher to find out which topic or Chapter is next)

2.4.1 Important points to note about the textbook

Like any textbook it will contain information that is relevant, but not always necessary for the topic it covers. For instance, some of the uses of chemicals it lists are accurate, they really are used in those processes, but they are not always included in mark schemes for CAIE iGCSE Chemistry, which in addition to valuing what is true, also requires from it's A* students what is most relevant. E.g. if you got hit by a car walking across the street there are lots of things that you might notice like it's colour, shape, size and the direction it was travelling, but really only it's speed would matter if you hoped to survive. Not all things that are accurate (close to being the "true"[4] value) are equally relevant, and this exam board sometimes requires you to understand and list the most relevant factors, properties or characteristics first.

Activity	What you should do	Why it helps	When you should do it
FUNDAMENTAL 1. Translation	Translate **ALL** new words, especially the ones in **bold**, ideally next to the text. Use the glossary at the back to help you.	The most important words to translate are the non-scientific words you already know in Chinese.	As you are reading.
FUNDAMENTAL 2. Underlining	Underline, highlight circle, put a *star or symbol 😉 next to the biggest new ideas. But remember, if you highlight everything, you've actually highlighted nothing ☹.	Completing the in the Key Points task becomes quicker but most importantly, it is a form of ACTIVE READING.	As you are reading.
FUNDAMENTAL 3. Answers	Answer the Summary Questions about the material at the end of the double page spread.	Here you are shown what is most important about the ideas of this 2-page spread and forced to think about it in a new way.	After you have finished reading both pages
FUNDAMENTAL 4. Checking Answers	Check your answers with the answers provided at the end the textbook (pages 286 to 301	Any major misunderstandings or confusions you have are likely to be discovered doing this.	After you've finished your answers
ESSENTIAL 5. Key Points	Main ideas, equations and diagrams for both pages. It's the idea that you are trying to describe to your self, so try to make it as visual and colourful as possible! Make sure whatever you write is in your own words!!! Include any notes you have from lessons here!	At this point you are now starting to own the information you are processing. This task will force your brain to think about what is most important because space is limited and writing is work. After you have thought about it in a new way, you'll need to remember your thoughts long enough to write them out, helping your long-term memory. This will also help to write out better que questions.	After you have finished the going through the questions and answers, but before you start the next two pages.

[2] https://teachingcommons.stanford.edu/resources/learning-resources/promoting-active-learning & https://www.smartsparrow.com/what-is-active-learning/
[3] https://help.open.ac.uk/active-reading
[4]

Activity	What you should do	Why it helps	When you should do it
ESSENTIAL 6. Cue Questions v1.0	Write out, in your own words, questions and bullet points that will force you to think about the essential ideas. Links to other parts of the topic and syllabus should also be included (e.g. half-equations are also covered in Topic 5 (Electrochemistry), so a note like: **T5** $2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$ **[conc only!]** Might be a good idea if you've missed a mark on this before.	If you covered up the notes section of the page, answering these questions should allow you revise the whole page simply by answering a few questions and thinking about a few core ideas. If this is done carefully and thoughtfully not only will it make revision quicker later on, but also because it helps long term memories form, it'll mean less revision is needed to get the highest grade.	After you've finished the next 2-page spread.
ESSENTIAL 7. Summary	Write one or two sentences, in your own words that contain only the most important ideas.	Another way of thinking about it is: what's the least useful or important 80% content here? Give a thoughtful person 2 tasks and the first thing they'll do is create a third task which they'll do first and prioritize which of the two is most important.	After you've finished the section
EXCEPTIONAL 8. Cue Questions v2.0	Write out, in a different colour, or in any other way to identify it, any new questions or details that you've discovered are important to getting full marks on questions assessing material covered in this 2 page spread. After you've worked on the past exam questions you should understand this section as well as the quality of the work you have put in deserves. You should also know in detail which marks are the hardest and this information needs to go into your Cue section so the work you've put in to discover this information isn't abandoned or forgotten.	The tricky marks and the slippery explanations (especially that 2nd or 3rd mark) are most obvious now, but unless you make a decent effort to write them down, not only will you have lost the value of the work you have done because you'll be less likely to remember them, you'll also have no record to use later on. This is essentially saving your hard work for later when you'll nee it most.	After you've finished the past exam questions
EXCEPTIONAL 9. Top tips	Any new tough mark or detail that you have overlooked.	This level of attention to detail will help you become a person who is far less likely to make a mistake, but if you do, is far more likely to learn from it. It's your capacity to learn effectively and efficiently that will get you into a good university in the short term; in the long term it will allow you to do more interesting things with your work and your life.	Any time after you've finished the topic, but before the iGCSE exam

2.5 EXTENSION Examples of active reading

Feel free to tape additional pieces of paper onto the edges of your textbook to increase the space you have for making additional notes while you are reading. Another option is to digitise your textbook as has been done below.

A6 (&A8). Cue questions
Fill this in AFTER finishing the section

Alkali metals are metals with low densities, melting and boiling points, and all with very high reactivity. They are generally soft and can be cut with a knife to reveal a silvery white section.

13.5 Thermal decomposition

Extension

LEARNING OUTCOMES

- Describe the action of heat on selected hydroxides and nitrates
- Link the thermal decomposition of nitrates to the reactivity of the metals

When we heat some carbonates, nitrates and hydroxides, they break down to form two or more different products. We call this type of reaction **thermal decomposition**. For example, the equation:

$$CaCO_3(s) \xrightarrow{heat} CaO(s) + CO_2(g)$$

represents the thermal decomposition of calcium carbonate.

Thermal decomposition of metal hydroxides

Most metal hydroxides decompose when heated. A metal oxide and water are formed. For example:

$$Zn(OH)_2(s) \xrightarrow{heat} ZnO(s) + H_2O(g)$$
zinc hydroxide → zinc oxide + water

All Group II hydroxides decompose in a similar way. Most alkali metal hydroxides, however, do not decompose. They are stable to heat. There is one exception to this: lithium hydroxide:

$$2LiOH(s) \xrightarrow{heat} Li_2O(s) + H_2O(g)$$
lithium hydroxide → lithium oxide + water

Lithium is the least reactive of the alkali metals. So does thermal decomposition depend on the reactivity of the metal? We shall look at the decomposition of nitrates and carbonates to answer this question.

Nitrates can decompose explosively to cause a large amount of damage, as shown by the remains of this fertiliser factory.

Thermal decomposition of nitrates

All nitrates decompose when heated. But there are some differences in how they decompose. The alkali metal nitrates decompose to form a nitrite and oxygen. You can see that the nitrite ion is similar to the nitrate ion but has one fewer oxygen atom:

$$2KNO_3(s) \xrightarrow{heat} 2KNO_2(s) + O_2(g)$$
potassium nitrate → potassium nitrite + oxygen

Nitrates of other metals decompose on heating to form an oxide, nitrogen dioxide and oxygen. For example:

$$2Mg(NO_3)_2(s) \xrightarrow{heat} 2MgO(s) + 4NO_2(g) + O_2(g)$$
magnesium nitrate → magnesium oxide + nitrogen dioxide + oxygen

Lithium nitrate, a compound of the least reactive alkali metal, decomposes in this way too.

Activities To Do
(complete as you are reading)
A1. Translating - 翻译
A2. Underlining
A5. Key Points
(in space below)

EXAMINER SAYS...
You need to remember the products from the thermal decomposition of nitrates. If you don't know these, you won't be able to write equations for thermal decomposition.

☆Thermal decomposition means the breakdown of a compound into two or more different products by heat.
☆The more reactive the metal, the more stable its nitrate, hydroxide or carbonate
☆Metal hydroxides decompose to oxides and water
☆Most nitrates decompose to either nitrites and oxygen or to oxides, nitrogen dioxide and oxygen.
☆We could observe how long does the compound need to be decomposed to deduce how stable the compound is.

A7. Summary Section- *Do this a after you have answered the past exam questions* and write, in your own words, only one or two sentences that sums up the important points on this page

The more reactive the metal, the more stable its nitrate, carbonate or hydroxide is.

A6 (&A8). Cue questions part 2
Fill this in AFTER finishing the section

When alkali metal hydroxide is heated strongly, it will melt, but not nothing.
When metal nitrate (except alkali metal) is heated. Brown gas will form. (NO_2)
When copper nitrate is heated, blue solid will turn into black, and brown gas will form.

Extension

Nitrates of very unreactive metals, such as silver, decompose to form the metal when they are heated:

$$2AgNO_3(s) \xrightarrow{heat} 2Ag(s) + 2NO_2(s) + O_2(g)$$
silver nitrate → silver + nitrogen dioxide + oxygen

DEMONSTRATION

The decomposition of Group II nitrates

This experiment is demonstrated using a fume cupboard because nitrogen dioxide is poisonous.

We start a stopclock when we begin to heat the magnesium nitrate. The nitrate is heated until we see dark brown fumes of nitrogen dioxide in the tube. We record the time taken to see these fumes. Then we repeat the experiment using other nitrates. In this experiment we must keep the amount of nitrate and the rate of heating the same.

The longer it takes for the nitrate to decompose, the more stable the nitrate is.

Figure 13.5.1

Magnesium nitrate decomposes at 402 °C but barium nitrate decomposes at 865 °C. So it appears that barium nitrate is more stable than magnesium nitrate. Barium is more reactive than magnesium. So the more reactive the metal, the more stable to thermal decomposition its compound is. This is well demonstrated if we look at the temperatures at which carbonates decompose when heated.

Thermal decomposition of carbonates

The table shows the temperatures at which the Group II carbonates decompose.

Reactivity →

Group II carbonate	magnesium carbonate	calcium carbonate	strontium carbonate	barium carbonate
decomposition temperature/°C	540	900	1280	1360

The reactivity of the Group II metals increases down the group. You can see from the table that as you go down the group it gets more difficult to decompose the carbonates. So the more reactive the metal, the more stable its nitrate, carbonate or hydroxide is.

KEY POINTS

1. Thermal decomposition is the breakdown of a compound into two or more different products by heat.
2. The more reactive the metal, the more stable its nitrate, hydroxide or carbonate.
3. Metal hydroxides decompose to oxides and water when heated.
4. Most nitrates decompose to either nitrites and oxygen or to oxides, nitrogen dioxide and oxygen when heated.

SUMMARY QUESTIONS

1. Copy and complete using the words below:
   alkali dioxide heated less nitrite oxygen
   Nitrates of the _____ metals decompose when _____ to form the metal _____ and oxygen. Nitrates of _____ reactive metals form metal oxides, nitrogen _____ and _____ when heated.
2. Write equations for the thermal decomposition of:
   a copper(II) hydroxide, $Cu(OH)_2$
   b calcium nitrate, $Ca(NO_3)_2$.
3. Suggest why lithium nitrate decomposes in a similar way to a Group II nitrate rather than a Group I nitrate.

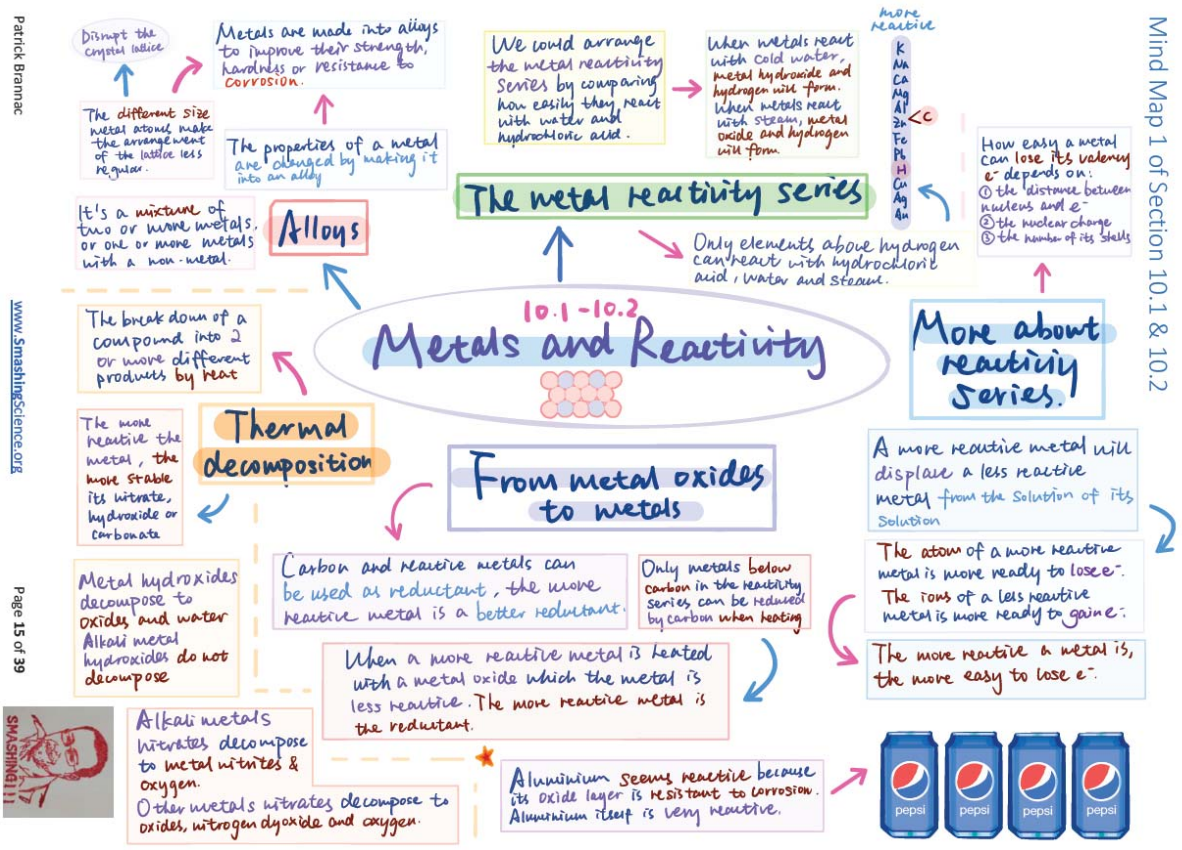
A3. Answers to Summary Questions (& Activity 4 Checking answers)

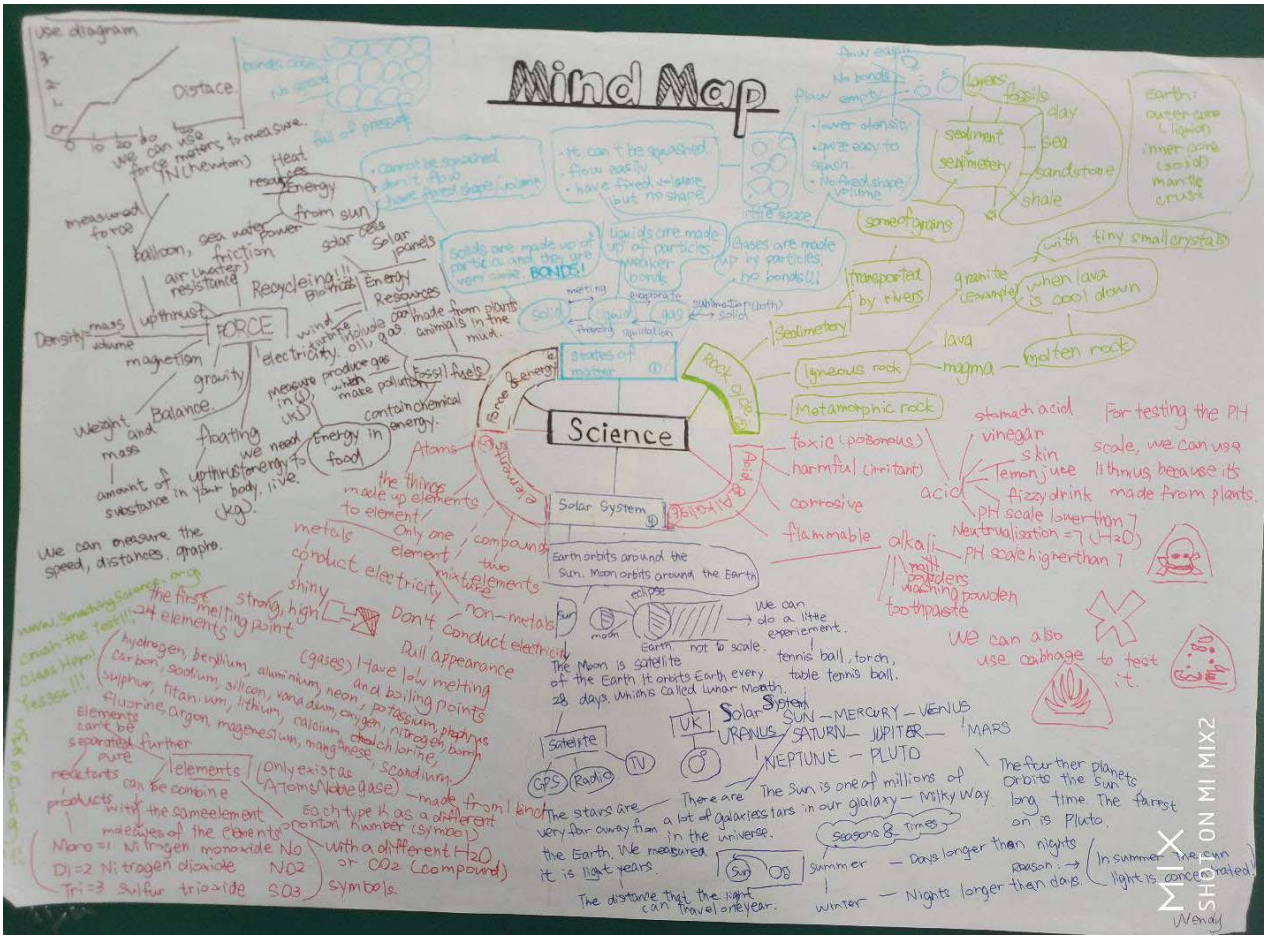
1. alkali, heated, nitrite, less, dioxide, oxygen ✓
2. a) $Cu(OH)_2 \rightarrow CuO + H_2O$ ✓
   b) $2Ca(NO_3)_2 \rightarrow 2CaO + 4NO_2 + O_2$ ✓
3. Because it's the least reactive reactive alkali metal. ✗ Lithium has a much smaller ion than the other group I metals so has a higher charge density. The charge density is more similar to those of group II metals

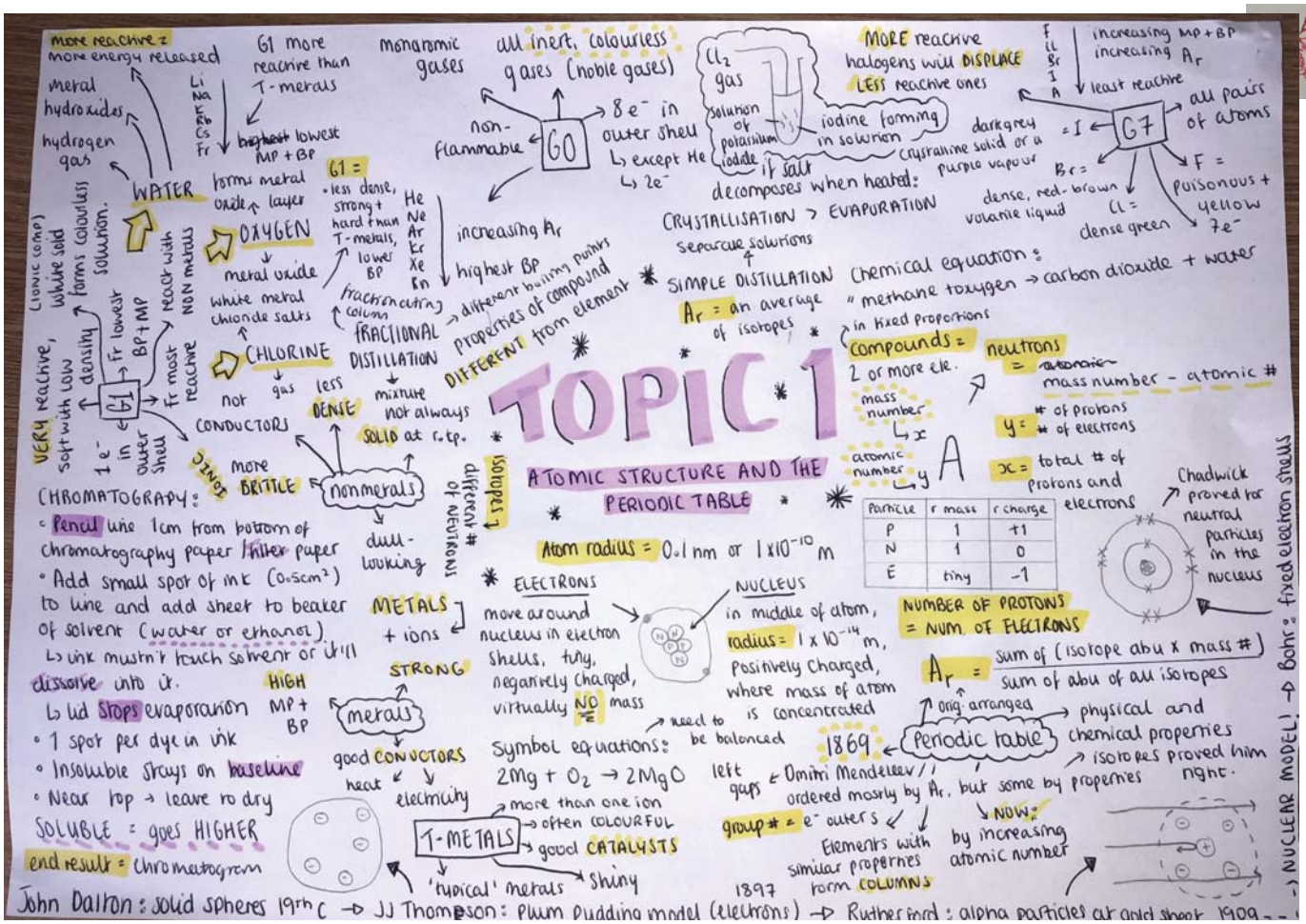
A9 Top Tips - *Do this after you've taken the end of topic test*. Write any difficult, odd or unexpected marks you come across from your tests and revision and especially from working through past exam questions

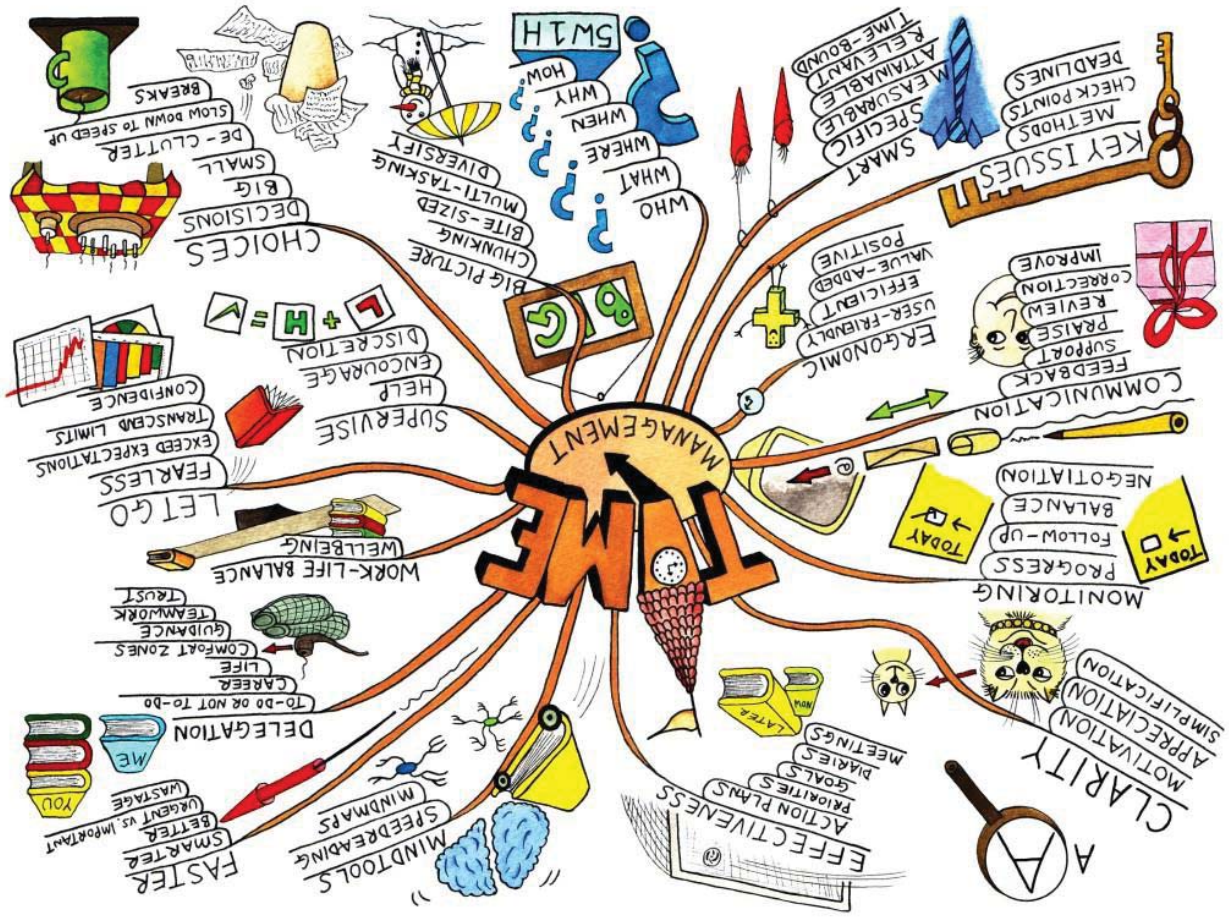
☆ Only alkali metal nitrates decomposed to form metal nitrites and oxygen. Other metals don't.
☆ Most of the alkali metal hydroxide (except LiOH) don't decompose.

2.6 ESSENTIAL Examples of Mind Maps






TOPIC 1
ATOMIC STRUCTURE AND THE PERIODIC TABLE
G0
non-flammable
8 e⁻ in outer shell
except He → 2e⁻
monatomic gases
all inert, colourless gases (noble gases)
He Ne Ar Kr Xe Rn
increasing Ar
highest BP
different boiling points
properties of compound DIFFERENT from element
G1
G1 more reactive than T-metals
Li Na K Rb Cs Fr
lowest MP + BP
forms metal oxide layer
G1 =
less dense, strong + hard than T-metals, lower BP
More reactive = more energy released
metal hydroxides
hydrogen gas
WATER
OXYGEN
metal oxide
white metal chloride salts
CHLORINE
gas
not CONDUCTORS
T1
Fr lowest BP + MP
Fr most reactive
VERY reactive, soft with low density
1 e⁻ in outer shell
forms coloured solution.
(ionic comp) white solid
react with NON metals
fractionating column
FRACTIONAL DISTILLATION
mixture not always SOLID at r.t.p.
less DENSE
nonmetals
dull-looking
more BRITTLE
IONIC
isotopes
different # of NEUTRONS
CHROMATOGRAPHY:
• Pencil line 1cm from bottom of chromatography paper / filter paper
• Add small spot of ink (0.5cm²) to line and add sheet to beaker of solvent (water or ethanol)
↳ ink mustn't touch solvent or it'll dissolve into it.
↳ lid stops evaporation
• 1 spot per dye in ink
• Insoluble stays on baseline
• Near top → leave to dry
SOLUBLE = goes HIGHER
end result = chromatogram
METALS + ions
STRONG
HIGH MP + BP
metals
good CONDUCTORS heat electricity
T-METALS
more than one ion
often COLOURFUL
good CATALYSTS
'typical' metals
shiny
Symbol equations:
2Mg + O₂ → 2MgO
Atom radius = 0.1 nm or 1x10⁻¹⁰ m
ELECTRONS
move around nucleus in electron shells, tiny, negatively charged, virtually NO mass
NUCLEUS
in middle of atom, radius = 1 x 10⁻¹⁴ m, positively charged, where mass of atom is concentrated
need to be balanced
Cl₂ gas
solution of potassium iodide
iodine forming in solution
MORE reactive halogens will DISPLACE LESS reactive ones
F Cl Br I A
increasing MP + BP
increasing Ar
least reactive
G7
all pairs of atoms
F = poisonous + yellow 7e⁻
Cl = dense green
Br = dense, red-brown volatile liquid
I = dark grey crystalline solid or a purple vapour
if salt decomposes when heated:
CRYSTALLISATION > EVAPORATION
separate solutions
SIMPLE DISTILLATION
Ar = an average of isotopes
Chemical equation:
" methane + oxygen → carbon dioxide + water
in fixed proportions
compounds = 2 or more ele.
neutrons = mass number - atomic #
mass number → x
atomic number → y
A
y = # of protons = # of electrons
x = total # of protons and electrons
Chadwick proved for neutral particles in the nucleus
NUMBER OF PROTONS = NUM. OF ELECTRONS
Ar = sum of (isotope abu x mass #) / sum of abu of all isotopes
orig. arranged
Periodic table
physical and chemical properties
isotopes proved him right.
1869
Dmitri Mendeleev
ordered mostly by Ar, but some by properties
left gaps
group # = e⁻ outers
Elements with similar properties form COLUMNS
NOW: by increasing atomic number
1897
→ NUCLEAR MODEL → Bohr: fixed electron shells
John Dalton: solid spheres 19th C → JJ Thompson: Plum Pudding model (electrons) → Rutherford: alpha particles at gold sheet 1909


TIME
MANAGEMENT
CLARITY
MOTIVATION
APPRECIATION
SIMPLIFICATION
MONITORING
PROGRESS
FOLLOW-UP
BALANCE
NEGOTIATION
TODAY
COMMUNICATION
FEEDBACK
SUPPORT
PRAISE
REVIEW
CORRECTION
IMPROVE
KEY ISSUES
METHODS
CHECK POINTS
DEADLINES
SMART
SPECIFIC
MEASURABLE
ATTAINABLE
RELEVANT
TIME-BOUND
ERGONOMIC
USER-FRIENDLY
EFFICIENT
VALUE-ADDED
POSITIVE
EFFECTIVENESS
ACTION PLANS
PRIORITIES
GOALS
DIARIES
MEETINGS
LATER
NOW
5WH
WHO
WHAT
WHERE
WHEN
WHY
HOW
BIG PICTURE
CHUNKING
BITE-SIZED
MULTI-TASKING
DIVERSIFY
CHOICES
DECISIONS
BIG
SMALL
DE-CLUTTER
SLOW DOWN TO SPEED UP
BREAKS
SUPERVISE
HELP
ENCOURAGE
DISCRETION
L + H = V
LET GO
FEARLESS
EXCEED EXPECTATIONS
TRANSCEND LIMITS
CONFIDENCE
WORK-LIFE BALANCE
WELLBEING
DELEGATION
TO-DO OR NOT TO-DO
CAREER
LIFE
COMFORT ZONES
GUIDANCE
TEAMWORK
TRUST
FASTER
SMARTER
BETTER
URGENT VS IMPORTANT
WASTAGE
YOU
ME
MINDTOOLS
SPEEDREADING
MINDMAPS

2.7 FUNDAMENTAL Glossary of Quizlet Library of Weblinks

. If you are struggling with the vocabulary and English in this course here's a whole library of resources including games, puzzles and tests that are based on the Quizlet website that will help you get up to speed with the keywords.

Note: Words from Topic 1 and 2 are combined and found in Topic 1. The same is also true for words from 12 and 13 which are both in Topic 13.

Topic Quizlet word list hyperlink

1. English word to English definition: https://quizlet.com/_4lta54
   English word & translation to Chinese google translate https://quizlet.com/_4ltg2p
2. **This topics word list is grouped with topic 1**
3. English word to English definition: https://quizlet.com/_4ltaf5
   English word & translation to Chinese google translate https://quizlet.com/_4ltgdp
4. English word to English definition: https://quizlet.com/_4ltdjc
   English word & translation to Chinese google translate https://quizlet.com/_4ltggk
5. English word to English definition: https://quizlet.com/_4ltdnw
   English word & translation to Chinese google translate https://quizlet.com/_4ltgl9
6. English word to English definition: https://quizlet.com/_4ltdqq
   English word & translation to Chinese google translate https://quizlet.com/_4ltgnd
7. English word to English definition: https://quizlet.com/_4lteab
   English word & translation to Chinese google translate https://quizlet.com/_4ltgph
8. English word to English definition: https://quizlet.com/_4ltede
   English word & translation to Chinese google translate https://quizlet.com/_4ltgr8
9. English word to English definition: https://quizlet.com/_4ltejh
   English word & translation to Chinese google translate https://quizlet.com/_4ltgsv
10. English word to English definition: https://quizlet.com/_4ltem0
    English word & translation to Chinese google translate https://quizlet.com/_4ltgux
11. English word to English definition: https://quizlet.com/_4lteoy
    English word & translation to Chinese google translate https://quizlet.com/_4ltgwq
12. **This topics word list is grouped with topic 13**
13. English word to English definition: https://quizlet.com/_4lterb
    English word & translation to Chinese google translate https://quizlet.com/_4ltgy5
14. English word to English definition: https://quizlet.com/_4lt3b5
    English word & translation to Chinese google translate https://quizlet.com/_4lth0u

All my English to Chinese by topic word lists:
https://quizlet.com/Patrick_Brannac4/folders/igcse-chemistry-cie-0620-glossary

All my English keyword to English meaning by topic word lists:
https://quizlet.com/Patrick_Brannac4/folders/igcse-chemistry-cie-0620-glossary-english-words-by-topic

3 The Cornel Note-Taking System

3.1 Introduction

The main task your brain does is forgetting things. It is constantly, quietly and relentlessly erasing everything you see, hear and feel during both your conscious and unconscious (e.g. whilst sleeping) sense of being, including the single moment it takes for you look at this next full stop.

But if you have ever fallen off a bike or had an accident your brain stops deleting everything and instead stores as much of the information as it is able. Time slows down and your memory becomes almost photographic. Some things are therefore more memorable than others. The trick with learning is to make your brain think that what you are trying to learn maters to your brain.

It is designed to only remember the things that it is programmed to think are important. It's programming comes from culture, but some is also hard-wired into the system itself, like our shared interest in learning a language when we are babies, or our ability to process visual images or our ability to control our body temperature. This hard wiring is created by our genes, which we inherit from our parents. Our genes were created and adapted to survive and persist tens f thousands of years ago in a totally different world to the one your brain finds itself in a classroom.

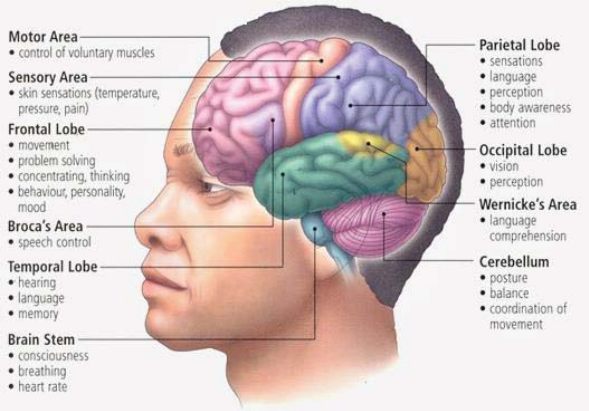


Figure 1 The brain as a biological organ

Current understanding of the human brain is extremely basic, no-one knows what the smallest part of an idea might be in terms of brain cells. But we do know that brain cells make connections and we think that those connections are where the mind, and memory, is created. We also know that the brain is more likely to make connections, and therefore memories, from events we are emotionally attached to, like an accident or a totally awesome movie. If we feel emotions about something, either good or bad, than our brain thinks that thing is something it needs to keep for later.

If you keep returning to the same idea over time, but you make your brain think about it differently, for instance by taking notes using your own words, or making a summary, or writing out key questions raised by that idea, forces it to make new connections in order to enable this different kind of thinking. Not only will the brain be better able to use this new idea in a new situation, like in an exam, but these connections make the memory more stable. If the brain really thinks something is important, like your name or where you live, it will store these essential bits of information into what is called the Long Term Memory.

The goal of learning is not only to make as many interesting and important connections within the brain as possible, but also to put as much information into the long term storage area as possible. The goal of education, especially in the better universities is not fill a student's brain with specific facts and ideas, or to test how intelligent someone is, but to train a students brain with skills and techniques to learn faster, better and longer. The more you know, for instance about the Avengers and the MCU, the more interesting and exciting watching Avengers Endgame for the first time was as a movie. But it was still kinda disappointing, unfortunately.

Learning how to learn better than before is the most valuable and important thing you will take away from any lesson. Luckily, you are not the first person to ever be taught. There are thousands of years of history and tens of thousands of years of culture that you can use to your advantage. Some systems of learning work better than others.

In the 1940s a professor of law at Cornell University called Walter Paulk realised his students, who were supposed to be some of the best of their generation, weren't that good and he wondered what they could do to learn better. He invented the Cornell Notetaking system, which is widely considered to be the best way to learn difficult things in any subject.

If you imagine using this system gives you a token that allows you to have to revise less later. If you follow this system properly, that token has tremendous value and will not only allow you to aim for the highest grade, but allow you to do so with much less stress, challenge and negativity that often surrounds big exams for disorganised students. You are effectively being kinder to your future self by putting the work in earlier when it matters more. If you skip this, and just wait until the end of year exam you'll more likely be learning instead of revising, which takes much longer and produces much poorer results. Even if you end up with the exact same grade, you'll have failed to progress as a student, and that lack of progress eventually, maybe not even at A Level, but at a world leading university, will cause all kinds of calamities and challenges. You may even be so disappointed in how little you learnt about learning that you decide to become a teacher. It happens.

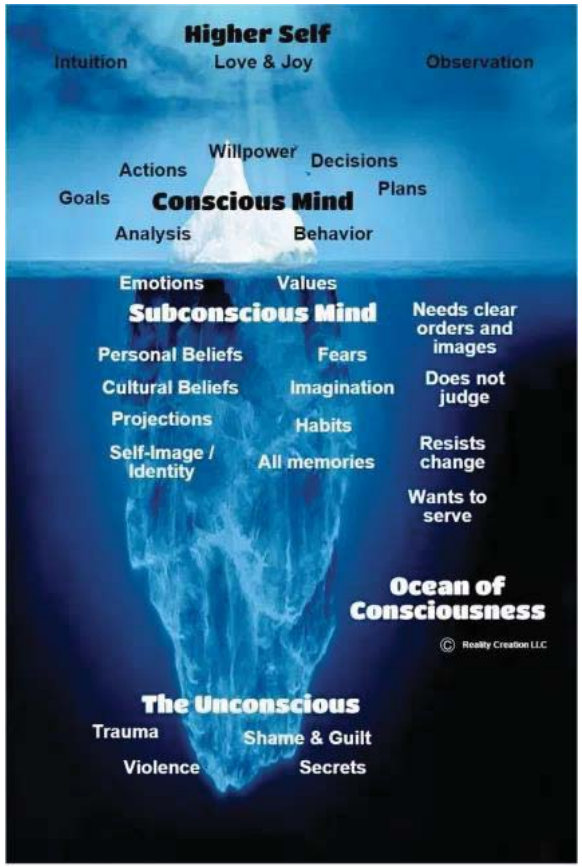
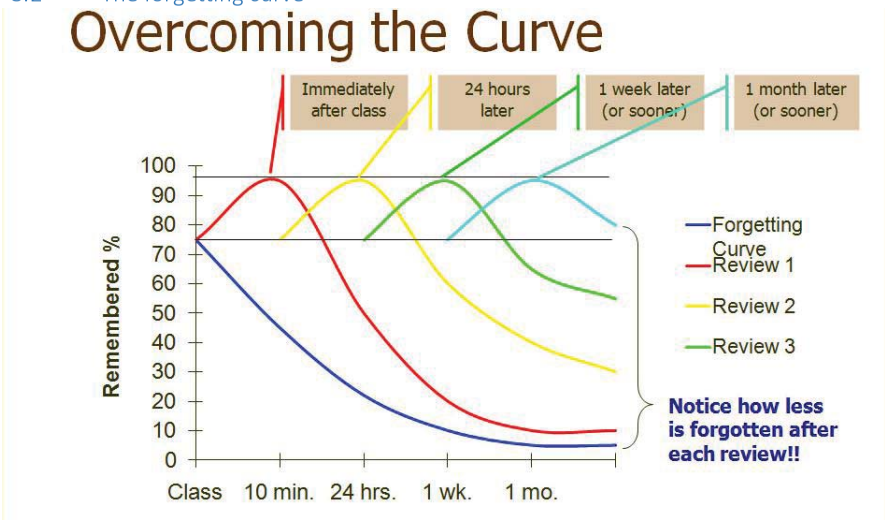
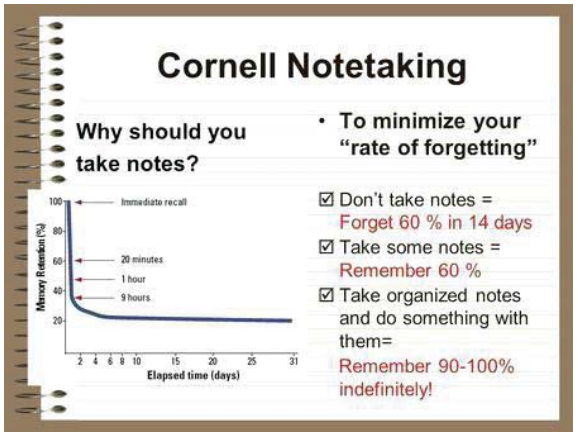


Figure 2 One way of thinking about the mind. Most of it involves aspects of the self that are hard to understand and even harder to change, but with enough work it is possible for anyone to nurture and grow the habits of an outstanding student, but it takes time and especially commitment.

3.2 The forgetting curve

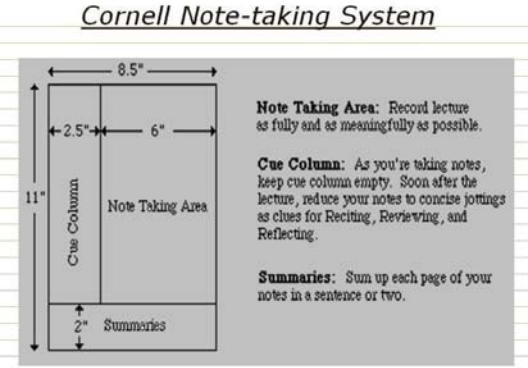


https://psychology.stackexchange.com/questions/8377/how-are-these-review-forgetting-curve-calculated



The quicker you return to a lesson to review it, the less time you will need to gently nudge it into your long term memory, so 5 minutes within 24 hours can be as effective as an hour or more a month later. Remember, your brain does not understand what you are trying to do, but if you try to work with it, and help it along, remind it that this stuff matters to you (and it), it will be more likely respond in the way that you want and learn what you need it to.

3.3 Fundamental Cornell Notetaking Basics



3.3.1 Essential Cornell Notetaking for More Able Students

Cornell University
Learning Strategies Center

420 CCC
Garden Ave Extension
Ithaca, New York 14853-4203
t. 607.255.6310
f. 607.255.1562
www.lsc.cornell.edu

The Cornell Note-taking System

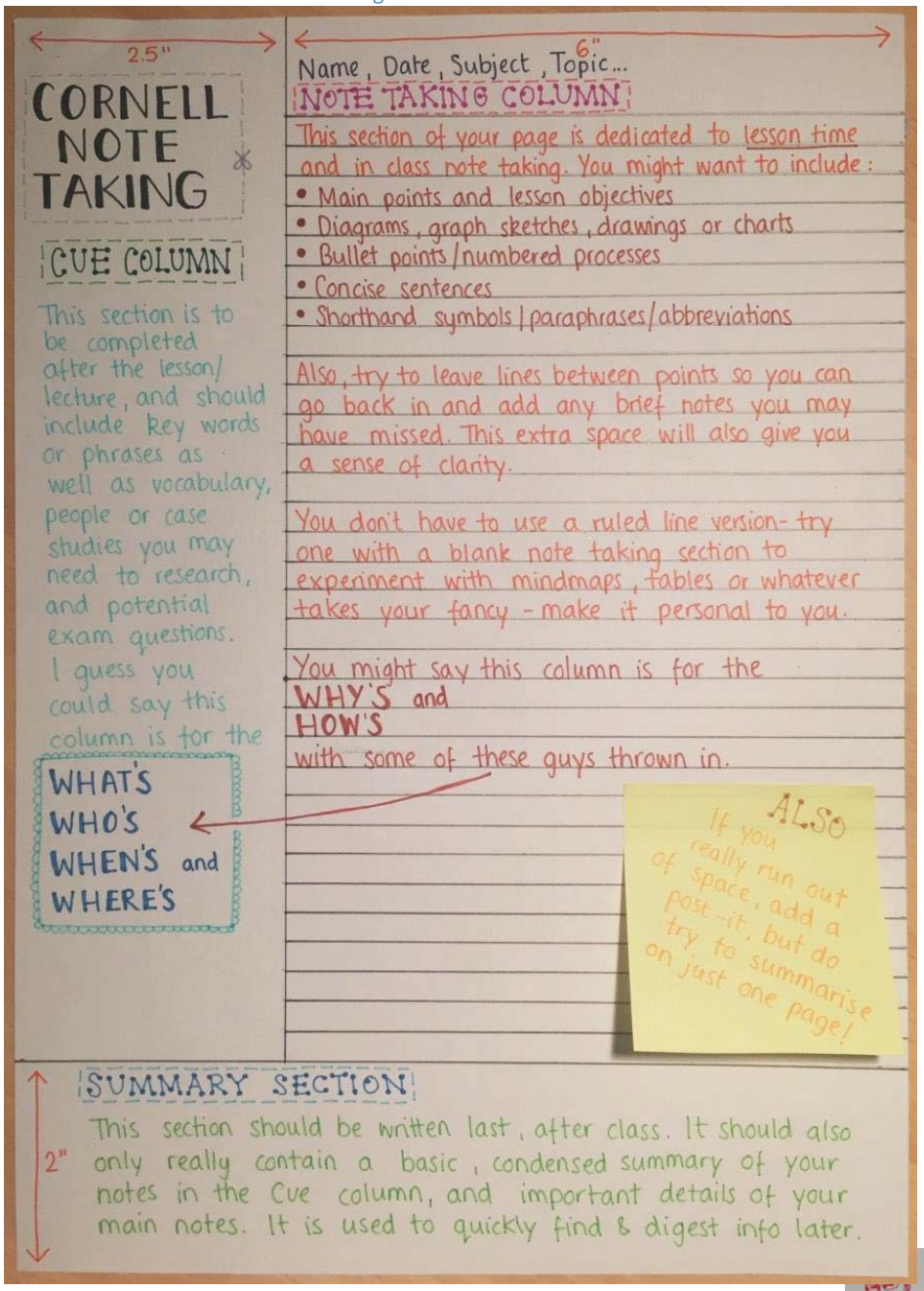
2 1/2"	6"
Cue Column	Note-taking Column

1. **Record**: During the lecture, use the note-taking column to record the lecture using telegraphic sentences.
2. **Questions**: As soon after class as possible, formulate questions based on the notes in the right-hand column. Writing questions helps to clarify meanings, reveal relationships, establish continuity, and strengthen memory. Also, the writing of questions sets up a perfect stage for exam-studying later.
3. **Recite**: Cover the note-taking column with a sheet of paper. Then, looking at the questions or cue-words in the question and cue column only, say aloud, in your own words, the answers to the questions, facts, or ideas indicated by the cue-words.
4. **Reflect**: Reflect on the material by asking yourself questions, for example: "What's the significance of these facts? What principle are they based on? How can I apply them? How do they fit in with what I already know? What's beyond them?
5. **Review**: Spend at least ten minutes every week reviewing all your previous notes. If you do, you'll retain a great deal for current use, as well as, for the exam.

Summary

2" After class, use this space at the bottom of each page to summarize the notes on that page.

3.4 Extension Cornell Notetaking for Better Students



3.5 Exceptional Cornell Notetaking for the Best Students

The advice and ideas here are not needed for most students but include further ideas that can help develop your notetaking skills, which is at the heart of the most successful students (and intellectuals).

The Five R's:

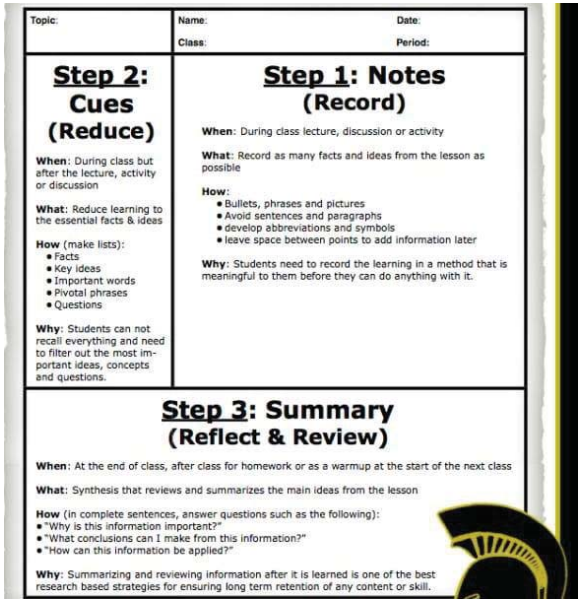
1.RECORD your notes in the right-hand column.

2.REDUCE your notes into the recall column on the left

3.RECITE out loud from the recall column.

4.REFLECT on the information that you are studying.

5.REVIEW your notes immediately and regularly



Step 1: Record

Write main ideas and supporting material in the right column
Use signals from the lecture
Titles & keywords= topics
main ideas
Use abbreviations to get the full idea.
Leave spaces between ideas so you can fill in more later. see how ideas relate to one another

Step 2: Reduce

Write the topics and vocabulary words, in the left column of your notes Write questions to quiz yourself on the material.
–Write a question for each new topic, main idea, or significant detail.
–Write questions on the material which you think your teacher will test you.

Step 3: Recite

This will help transfer ideas to your long-term memory!
Study the information by answering your questions in the left column.
–Cover the Record Column.

–Read your vocabulary words and questions in the left Column
–Using your own words, define the words and answer your questions out loud.
–You can also define the words and answer your questions on the paper you are using to cover the Record Column.
–Uncover your notes and check what you have said against the facts.

Step 4: Reflect

After the lecture, write a summary at the bottom of your notes.

–Use complete sentences in the summary.
–Choose the key points.
–Organize ideas.
–Link ideas together.

Step 5: Review

Improve your memory.
–If you spend 10 minutes after every class in a quick review of your notes, you will retain most of what you have studied you won't have to cram during an "all-nighter" you will relate the facts and ideas to present lectures or readings.

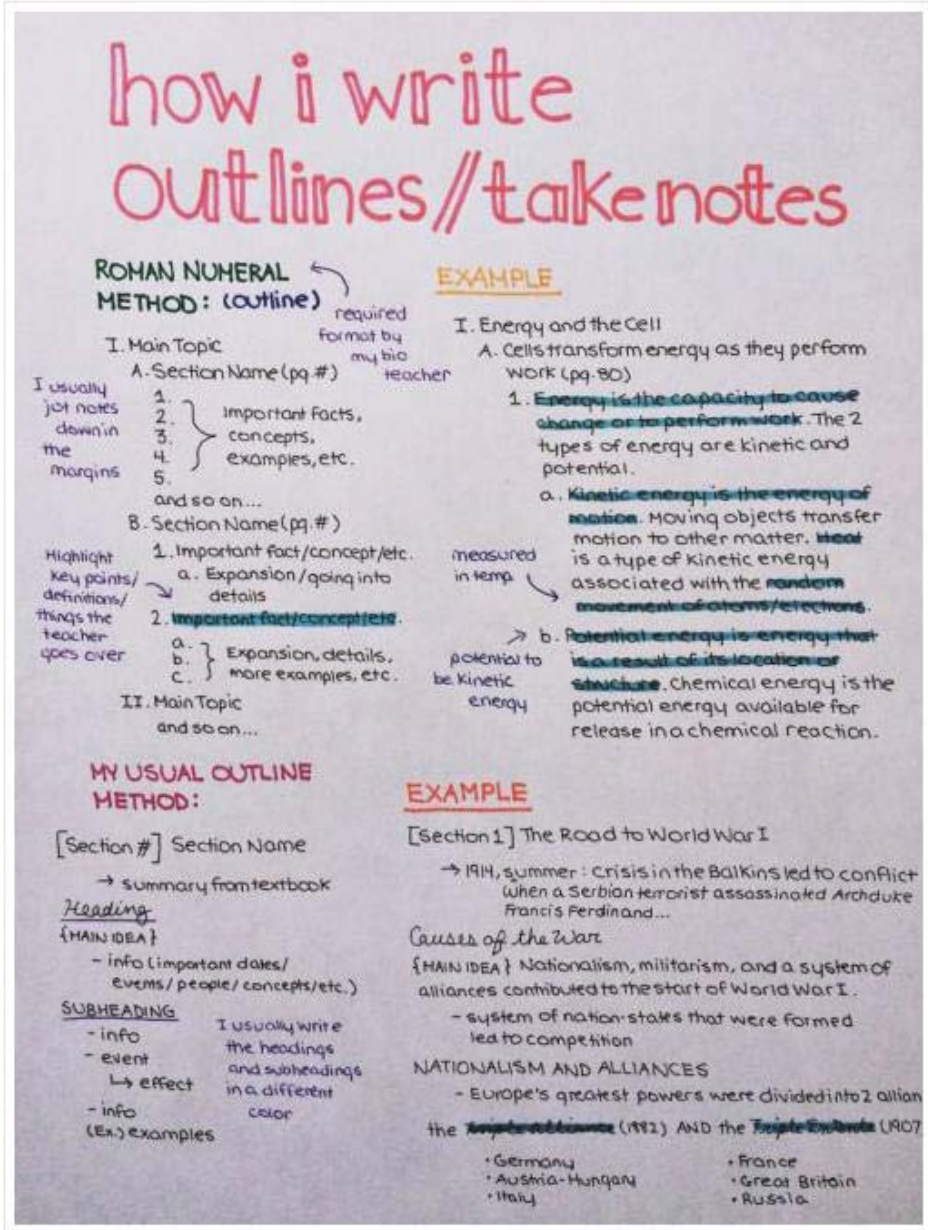
3.6 Essential Note-Taking Tips and Examples

Develop a code system of note-marking to indicate questions, comments, important points …for example,

- Mark unfamiliar vocabulary & unclear ideas in unique ways, such as with a star or asterisk.
- Highlight vocabulary terms and important people.
- Circle ideas that are still unclear.
- Make sure you can understand what you have written and if needed, make corrections.
- Use drawings, arrows or other organizers to help you see concepts and relationships between them.
- Use abbreviations and symbols wherever possible in the notes portion (but try to keep your abbreviations simple to understand, if you forget later your system then your notes lose their mea
- If you completely don't understand an idea, leave a blank space and ask your teacher for help on

For a more detailed and involved exploration and explanation of notetaking download documen attached to this QR code (30 pages):


How To Illustrate Your Notes
By Revise or Die
YOU CAN DO IT!
YES, I CAN DO IT!
IT'S ALL ABOUT PIC N' MIX Y'KNOW
① CHOOSE YOUR 'BAG'... (TYPE OF NOTES)
MINDMAP? POSTER? THE CORNELL METHOD?
THE OUTLINING METHOD? THE CHARTING METHOD?
② CHOOSE YOUR 'SCOOP'... (FONTS/TOOLS/COLOURS)
THERE are SO MANY kinds OF FONTS TO choose FROM
to find inspo go to dafont.com!
TOOLS
PENS
PENCILS
BIRO
GEL
FINELINER
FELT TIP
HIGHLIGHTER
Colours - if you're feeling really snazzy, choose a colour palette for your work! Here's some suggested ones I use...
A) B) C) D) E)
③ CHOOSE YOUR 'SWEETS'... (TWIDDLY BITS)
CLOUDS
BANGS
Mounds
PINS
FLAGS
STARS
RIBBONS
DASHED LINES
ARROWS...
LOTS OF ARROWS
STEP-BY-STEPS! HA!
LITTLE DRAWINGS OF WHO YOU'RE STUDYING
TABLES.
graphs
COGS
anything specific to the subject - don't be afraid to draw it!


how i write outlines//take notes
ROMAN NUMERAL METHOD: (outline)
required format by my bio teacher
I. Main Topic
A. Section Name (pg. #)
I usually jot notes down in the margins
1. 2. 3. 4. 5. Important facts, concepts, examples, etc.
and so on...
B. Section Name (pg. #)
1. Important fact/concept/etc.
a. Expansion/going into details
Highlight key points/definitions/things the teacher goes over
2. Important fact/concept/etc.
a. b. c. Expansion, details, more examples, etc.
II. Main Topic
and so on...
EXAMPLE
I. Energy and the Cell
A. Cells transform energy as they perform work (pg. 80)
1. Energy is the capacity to cause change or to perform work. The 2 types of energy are kinetic and potential.
a. Kinetic energy is the energy of motion. Moving objects transfer motion to other matter. Heat is a type of kinetic energy associated with the random movement of atoms/etc. measured in temp
b. Potential energy is energy that is a result of its location or structure. potential to be kinetic energy. Chemical energy is the potential energy available for release in a chemical reaction.
MY USUAL OUTLINE METHOD:
[Section #] Section Name
→ summary from textbook
Heading
{MAIN IDEA}
- info (important dates/events/people/concepts/etc.)
SUBHEADING
- info
- event
↳ effect
- info
(Ex.) examples
I usually write the headings and subheadings in a different color
EXAMPLE
[Section 1] The Road to World War I
→ 1914, summer: Crisis in the Balkans led to conflict when a Serbian terrorist assassinated Archduke Francis Ferdinand...
Causes of the War
{MAIN IDEA} Nationalism, militarism, and a system of alliances contributed to the start of World War I.
- system of nation-states that were formed led to competition
NATIONALISM AND ALLIANCES
- Europe's greatest powers were divided into 2 allian
the Triple Alliance (1882) AND the Triple Entente (1907)
• Germany
• Austria-Hungary
• Italy
• France
• Great Britain
• Russia

3.7 Cornel Notetaking Note Paper

Questions & Translations *Fill this in AFTER lesson*	**Date:**

Summary Section- *Do this a week later* and write, in your own words, only one or two sentences that sums up the important points on this page

Questions & Translations
Fill this in AFTER lesson

Date:

Summary Section- *Do this a week later* and write, in your own words, only one or two sentences that sums up the important points on this page

For a whole variety of different formats and types of paper: https://incompetech.com/graphpaper/cornelllined/

Questions & Translations *Fill this in AFTER lesson*	**Date:**

Pa

Questions & Translations *Fill this in AFTER lesson*	**Date:**

Questions & Translations *Fill this in AFTER lesson*	**Date:**

Questions & Translations *Fill this in AFTER lesson*	**Date:**

Questions & Translations *Fill this in AFTER lesson*	**Date:**

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Summary Section- *Do this a week later* and write, in your own words, only one or two sentences that sums up the important points on this page

Questions & Translations
Fill this in AFTER lesson

Date:

Summary Section- *Do this a week later* and write, in your own words, only one or two sentences that sums up the important points on this page

For a whole variety of different formats and types of paper: https://incompetech.com/graphpaper/cornelllined/

Questions & Translations *Fill this in AFTER lesson*	**Date:**

Pa

Questions & Translations *Fill this in AFTER lesson*	**Date:**

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Questions & Translations *Fill this in AFTER lesson*	**Date:**

Questions & Translations *Fill this in AFTER lesson*	**Date:**

Questions & Translations *Fill this in AFTER lesson*	**Date:**

Questions & Translations *Fill this in AFTER lesson*	**Date:**

3.8 Top Tips for Smashing! your Exams

Idea	Why it matters
Adding to your answers at the end	**For most students.** The harder explain questions, or other multi-mark questions often will require details that may not be the first ones you include. After you have given the question roughly the right amount of time per mark, MOVE ON to the next part of the exam. Return later if you have made the time to do so, after you have checked through the exam and add whatever else you can think might be relevant AND correct. If you are not sure if it's relevant, but you are sure that it is correct, then add it anyways, **but only if you have the time!**
Annotating your multiple-choice questions	**For ALL students!** Although the examiner will not see you question paper for multiple choice questions, you should still make notes on the question paper itself. This will help you break the question down, which will often require you to have one idea that follows another, if this is written down inside the question you are more likely to see this second step. Also important, at the end you can see your own thinking when you check through your exam at the end, which will make checking your work easier and more effective
Annotating your questions	**For ALL students!** You should be writing out what you know about the compounds and ideas as you are reading the question. Underline numbers, these are usually only ever given to you because they are necessary in a calculation. For questions involving unknowns, try to write what X is if that is possible. This way you break down a larger problem in to more manageable parts helping you see more clearly the answer.
Checking your exam paper	**For most students** try to allow at least 10% of the exam time to check your exam paper at the end, for Paper 2 this is about 5 minutes, Paper 4 it is 8 minutes, for Paper 6 it is 6 minutes. As you move through the paper, you should have already marked the hardest questions with a star or other symbol, these should be checked the most carefully. **For the most able students** who are aiming for a good A* you ought to have about 20 to 30% of the time left at the end for checking which will allow you to thoroughly check all of the exam and locate every mark. For less able students you may need to ignore the later parts of a tough topic to ensure you are able to check through the easiest questions at the end to correct any easy mistakes you may have made.
Chemical equations	For most students. A good answer ought to try to include at least one balanced chemical equation, even if you feel you have just explained the same thing in words, because you may have missed something out or not explained properly the idea that you had in your mind which the chemical equation will provide evidence to the examiner that will allow you to get the mark. It is an example of **REDUNDENCY** or a **FAIL-SAFE**
Crossing out mistakes	Never cross out work that you think is a mistake unless you have already provided another answer, so draw a box around what you intend to replace, then write your new answer, THEN write a neat cross through that box. Your crossed-out work should always be readable to the examiner. If it contradicts your new work, it will not be considered, but if it helps to clarify your new answer, than it ought to be considered by the examiner. For instance, in a recent exam students were expected to describe a difference and explain it; many students simply explained the difference, without saying if the value would be larger or smaller, one student suggested that it would be smaller in their crossed out work, but only different in their final answer, but they had shown they understood how it would be different and got the mark.
Diagrams	**For ALL students!** A picture is worth a 1000 words. A good **LABELLED** diagram even if there is not there is no blank space for a diagram, can sometimes be acceptable and can help give a fuller answer to allow you to pick up the hardest marks or prevent silly mistakes where you have accidentally not included enough information.
Drawing graphs	**In pencil!!!** If you make a mistake in the real exam in pen it your answer may not be clear enough for you to be awarded really easy marks, you cannot ask for another exam paper, so mistakes that are made in pen are permanent! **For ALL students!**
Eliminating the wrong answers in multiple choice questions	**For ALL students!** Usually two of the 4 answers are more easily seen as incorrect. Finding these two will give you a 50/50 chance of getting the right answer with less understanding, so even though you don't fully understand the question, you have at least managed to increase your odds of guessing correctly. If you can't easily and quickly find these 2 answers, mark the question, make a guess IN PENCIL, then move on, this question is obviously a difficult question therefore.
Exam Questions	**For ALL students!** Almost none of the marks are awarded for answering actual questions (you will almost never see a question mark!?!). What are commonly referred to as exam questions, even by Mr Paddy, are in fact commands: calculate this, or explain that or state how etc. This is to reduce confusion so that you know exactly what is expected from the language of the command (which is why the command terms exist and why they are so important to properly understand!!!

Idea	Why it matters
FAIL SAFE or **REDUNDENCY**	For most students. If you really want to make sure you pick up every single mark you should be aiming to include additional information in a slightly different format, including labelled diagrams and balanced chemical equations with state symbols. This level of attention to detail means that if your first attempt at the hardest marks in the exam paper fails, it fails into a safe position, because you have a backup plan. This is an essential idea in engineering and research science.
Give *some* properties/etc	**For the most able students.** Give about 40 to 100% more properties or conditions than there are marks: irrelevant answers, or incomplete answers will not go against you, so to ensure you include all of the answers that the examiner requires you need to be very cautious. Answers acceptable one year may not be acceptable in another exam session, they are not incorrect, just not enough to get a mark. **This is essential for a candidate to hope for a good A*!!!** **For the least able students.** Make sure that you are at least giving as many answers as there are marks, if you are not sure, give your best guess, never leave an answer blank!
Give x# properties/conditions/etc	**For ALL Students!** Give exactly and only x number of properties, any more will either not be marked, so if one of your answers is irrelevant, and you are supposed to give 3 answers, but you give 4 and the 4th is correct, you could lose the mark. If one of the answers is wrong, then you will most likely lose the mark. They do not reward candidates who try to use ambiguity to increase their score, and in fact actively penalise it.
Name	**For most students.** Give the name, in English, for the chemical compound, ion or element. Only the name is acceptable, and if you misspell it, especially if it is a negative ion, like chloride, you will not be awarded the mark.
Plurals	**For ALL students!** If a question requires more than one answer, it will have ALWAYS indicated this with the use of plurals. If only one answer is needed than again, the statement will indicate this grammatically. PAY ATTENTION TO THIS!!!
Showing your working in calculations	**For ALL students!** The space given for your working for a calculation should not be considered as 'rough paper' or include incomplete numbers or ideas. The space for your response should be considered as a place for you to communicate with the examiner what you are doing, and especially thinking, in each step, even if it seems obvious to you what you are doing, each step should be clearly labelled and written in a way that can be easily followed. Sometimes the final answer is only worth one mark, and the other marks can only be achieved with carefully laid out working. Another important reason for good, systematic working, even for easy questions that involve more than one step is that they allow you at the end of the exam to check your thinking quickly, efficiently and effectively.
Spelling	**For ALL students!** It is only really in the naming of a specific process or compound that spelling is vital. Otherwise anything that is spelt well enough for the word to be clear and the meaning to be understood is acceptable. Your written response is used by the exam board to measure you level of understanding, some students with certain disabilities may not be able to write, but they could still get an A* in this subject if they could shown, e.g. through speech, that they are able to understand the ideas. If you think of Stephen Hawking, a world famous scientist, who was also a professor at the University of Cambridge, he could not write, but he was still extremely well respected.
State or identify	**For ALL Students!** In this case you can use either the chemical formula or the full English name of the compound, ion or element. If you give the formula and the name and one of them is incorrect, you will lose the mark, so you are better off only identifying the substance by the way you are most confident in. For instance, if you say that it is "Bromine (Br)" when it is in fact Br_2, you will likely lose the mark. Or "Bromine (Br^-)" when it is the bromide ion, you will also lose the mark.
State symbols	For most students. Always include these in your diagrams where you can, even if you are not able to include all of them for the whole equation (e.g. the electrolysis of aluminium). This is another example of a **FAIL SAFE.**
The order you answer questions	**For ALL students!** This should be organised at the start of the exam. Take 2 minutes to skim through the exam paper and find the hardest questions and the easiest ones. The hardest questions should be answered last, these are the least efficient use of your time (in terms of marks achieved versus time spent). The easiest questions are the most efficient use of your time, unless you have run out of time and are forced to leave them unanswered, or poorly answered. **DON'T' ANSWER EXAM QUESTIONS IN THE ORDER THEY APPEAR ON THE EXAM PAPER!!!**

Idea	Why it matters
Time management in exams	**For ALL students!** You should know how long you have for each mark (normally it is around 1 mark a minute). You should also have a watch that you are familiar with that is not a smart watch or a smart band. A simple, cheap classic Casio watch would be best, and you can use this same watch throughout your academic career making sure to replace the battery before every exam session. Some questions you should be able to make time up on, others will take considerably longer, for those harder questions, stop after about 1 minute a mark and return to them at the end to ensure the easiest marks have been answered fully and carefully.
Understanding the distracter answer in a multiple-choice question	**For the most able students.** After you have eliminated the 2 easily incorrect answers there will be two very similar answers that will differ in a fundamental way, hopefully, that will allow you to find the correct answer. Sometimes, however, neither will be easily identified as correct, so you will need to find the most incorrect answer and chose the other one. These questions tend to be the hardest marks in the exam.
Units	**For ALL students!** Always include units in your answer! Often, they will not be enough to allow you to get a mark, but if they are not there you will lose a mark.
Writing in the mathematics formula booklets	**For ALL maths students.** Nothing to do with chemistry, but I find it really unnecessary. **DO NOT TO THIS!** At best rough work which should have been included in your answer booklet, then neatly crossed out, will not be seen by an examiner, so you could very pointlessly drop marks. At worst the handwriting is yours in this booklet, so you could be accused of writing the answers in there before the exam and therefore cheating. It is CAIE policy (and all exam boards, actually) that everything a candidate does in the exam is sent to them, which is again related to exam security which they take extremely seriously. Most likely however, the booklets are just thrown away for no good reason which is a waste of paper.
Wrong answer + Right Answer	= No marks! If you are unsure go with your best guess, but don't give two answers if only one answer is acceptable. **For ALL Students!**

4 Topic 2 Experimental Techniques

4.1 End of Topic 2 Goals Checklist

For each topic you ought to try to do as many of the following things to get the most out of your time, the resources available to you and to help you grow as a student. Tick each goal off as you complete it. Growth is difficult and uncomfortable, but you should choose to do these things, and the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win!

Aspect	What you should have done	Yes/No	Level
Interacted with your teacher	Ask your teacher 1 question, about anything, once a week		FUNDAMENTAL
	Try to answer one question asked by your teacher at least once a week		ESSENTIAL
	Ask your teacher one question about something you do not understand in science once a week		ESSENTIAL
	Ask your teacher one question about something to do with science every lesson		EXTENSION
Notes and follow up notes	Complete set of class note		FUNDAMENTAL
	Cornell Notetaking Attempted		ESSENTIAL
	Cornell Notetaking Completed		EXTENSION
	Cornell Notetaking Completed to an exemplary standard		EXCEPTIONAL
	Attempted the Mind Map for this topic		ESSENTIAL
	Completed the Mind Map for this topic		EXTENSION
Textbook	Read ahead before the topic has been started		EXTESNION
	Highlighted key ideas and translate new words		FUNDAMENTAL
	Completed the questions at the end of each 2 page spread in your exercise book		EXTENSION
	Added to your class notes ideas and important information from the textbook that you learnt		EXTENSION
Past Exam Questions	Worked on at least 25% of the exam questions in this workbook		FUNDAMENTAL
	Attempted more than 25% of the questions and those questions you have completed you have marked in a different colour pen		ESSENTIAL
	Completed and marked all questions here		EXTENSION
	Completed, marked and additional key ideas where you have located the most difficult marks added to your notebook		EXCEPTIONAL
	Used the resources available online to answer additional questions not found in this workbook on the current topic.		EXCEPTIONAL
	Ask your teacher about an exam question that they cannot answer		EXCEPTIONALLY SMASHING!!!
Assessed Activities	Complete the word list activity using the word list at the front of each topic as little as possible		FUNDAMENTAL
	Complete 2 assessed activities, either in class or as homework		ESSENTIAL
	Complete 2 assessed activities and scored over 70% on average		ESSENTIAL
	Complete 2 assessed activities and scored over 80% on average		EXTENSION
	Complete 2 assessed activities and scored over 90% on average		EXCEPTIONAL
End of Topic Test	Revised sufficiently well to improve upon your score from the previous test (except if you are scoring over 90%, then just write Y for this goal)		ESSENTIAL
	Scored 10% higher than your current average		EXTENSION
	Scored 15% or more than your previous end of topic average		EXCEPTIONAL
	Scored over 90%		EXTESNION
	Scored over 95%		SMASHING!!!
Reading	Spend more than 1 hour a week reading a book **you enjoy** (in any language) about anything.		ESSENTIAL

Aspect	What you should have done	Yes/No	Level
	Spend more than 3 hours a week reading a book **you enjoy** (in any language) about anything.		EXTENSION
	Spend more than 5 hours a week reading a book **you enjoy** (in any language) about anything.		EXCEPTIONAL
	Spend at least one hour a week reading a book **you enjoy** in English about anything.		EXTENSION
	Spend more than 3 hours a week reading a book **you enjoy** in English about anything.		EXCEPTIONAL
Reflection	You completed this goal setting table		FUNDAMENTAL
	You have looked at the goals you have achieved and the ones you have not and added them up and entered them into the table in the Review and Reflection section		ESSENTIAL
	You have given an answer for every question in the Review and Reflection section at the end of this topic		EXTENSION
	You have Given good and thoughtful answers for every question in the Review and Reflection section at the end of this topic		EXCEPTIONAL

4.2 Topic 2 Syllabus

2 Experimental techniques

2.1 Measurement

Core

- Name appropriate apparatus for the measurement of time, temperature, mass and volume, including burettes, pipettes and measuring cylinders

2.2 Purity

2.2.1 Criteria of purity

Core

- Demonstrate knowledge and understanding of paper chromatography
- Interpret simple chromatograms
- Identify substances and assess their purity from melting point and boiling point information
- Understand the importance of purity in substances in everyday life, e.g. foodstuffs and drugs

Supplement

- Interpret simple chromatograms, including the use of R_f values
- Outline how chromatography techniques can be applied to colourless substances by exposing chromatograms to substances called locating agents. (Knowledge of *specific* locating agents is **not** required.)

2.2.2 Methods of purification

Core

- Describe and explain methods of purification by the use of a suitable solvent, filtration, crystallisation and distillation (including use of a fractionating column). (Refer to the fractional distillation of petroleum in section 14.2 and products of fermentation in section 14.6.)
- Suggest suitable purification techniques, given information about the substances involved

4.3 ESSENTIAL Glossary for Keywords for this topic

Many words used in science have a meaning that is slightly different to their common everyday English meaning, for instance a salt is the product of an acid and base reacting together in chemistry, but normally thought of as table salt (NaCl) in common use.

The keywords have been auto translated into Chinese, so the translations will not be perfect but they should hopefully make sense. If there is a better translation you can simply write it out yourself on a Post-it note and stick it over the printed one.

English	Chinese
chromatogram the result of a paper chromatography run, showing where the spots of the samples have moved to	纸质色谱分析结果的色谱图，显示了样品斑点移至的位置
chromatography a technique employed for the separation of mixtures of dissolved substances, which was originally used to separate coloured dyes	色谱法一种用于分离溶解物质混合物的技术，该技术最初用于分离有色染料
crystallisation the process of forming crystals from a saturated solution	结晶从饱和溶液中形成晶体的过程
decanting the process of removing a liquid from a solid which has settled or from an immiscible heavier liquid by careful pouring	通过仔细倾倒，倾析从沉降的固体或不混溶的较重液体中除去液体的过程
distillation the process of boiling a liquid and then condensing the vapour produced back into a liquid: used to purify liquids and to separate liquids from solutions	蒸馏过程：将液体煮沸，然后将产生的蒸气冷凝回液体中：用于纯化液体并将液体与溶液分离
downward delivery a method of collecting a gas which is denser than air by passing it downwards into a gas jar	向下输送一种向下收集气体的方法，该方法将比空气更浓的气体向下传送到一个煤气罐中
filtrate the liquid that passes through the filter paper during filtration	过滤在过滤过程中通过滤纸的液体
filtration the separation of a solid from a liquid, using a fi ne filter paper which does not allow the solid to pass through	使用不允许固体通过的细滤纸过滤从液体中分离出的固体
fractional distillation a method of distillation using a fractionating column, used to separate liquids with different boiling points	分馏通过分馏塔进行蒸馏的方法，用于分离沸点不同的液体
insoluble term that describes a substance that does not dissolve in a solvent	不溶性术语，描述了不溶于溶剂的物质
locating agent a compound that reacts with invisible, colourless spots separated by chromatography to produce a coloured product which can be seen	定位剂一种化合物，它与色谱分离的无色无色斑点反应，生成有色产物，可以看到
mixture a system of two or more substances that can be separated by physical means	混合两种或多种可以通过物理方式分离的物质的系统
pure substance a single chemical element or compound – it melts and boils at definite temperatures	纯物质是一种化学元素或化合物–在一定温度下会熔化并沸腾
residue the solid left behind in the filter paper after **filtration** has taken place	过滤后残留在滤纸中的固体残留物
R_f value in chromatography, the ratio of the distance travelled by the solute to the distance travelled by the solvent front	色谱中的Rf值，溶质行进距离与溶剂前沿行进距离之比
risk assessment an evaluation of the methods and chemical substances used in a particular experiment to see what safety issues may be involved	风险评估：对特定实验中使用的方法和化学物质的评估，以了解可能涉及的安全问题
saturated solution a solution which contains as much dissolved solute as possible at a particular temperature	饱和溶液在特定温度下包含尽可能多的溶解溶质的溶液

English	Chinese
solubility a measure of how much of a solute dissolves in a solvent at a particular temperature	溶解度，用于衡量在特定温度下有多少溶质溶解在溶剂中
soluble term that describes a solute that dissolves in a particular solvent	可溶术语，描述了溶解在特定溶剂中的溶质
solute the solid substance that has dissolved in a liquid (the solvent) to form a solution	溶解溶解在液体（溶剂）中的固体物质以形成溶液
solution formed when a substance (solute) dissolves into another substance (solvent)	当一种物质（溶质）溶于另一种物质（溶剂）时形成的溶液
solvent front the moving boundary of the liquid solvent that moves up the paper during chromatography	溶剂在色谱分析过程中沿纸向上移动的液体溶剂的移动边界的前面
solvent the liquid that dissolves the solid solute to form a solution; water is the most common solvent but liquids in organic chemistry that can act as solvents are called **organic solvents**	溶解溶解固体溶质形成溶液的液体；水是最常见的溶剂，但有机化学中可以用作溶剂的液体称为有机溶剂
upward delivery a method of collecting a gas that is lighter than air by passing it upwards into an inverted gas jar	向上输送一种向上收集气体的方法，该方法是将比空气轻的气体向上传递到倒置的煤气罐中

4.4 EXTENSION Keywords

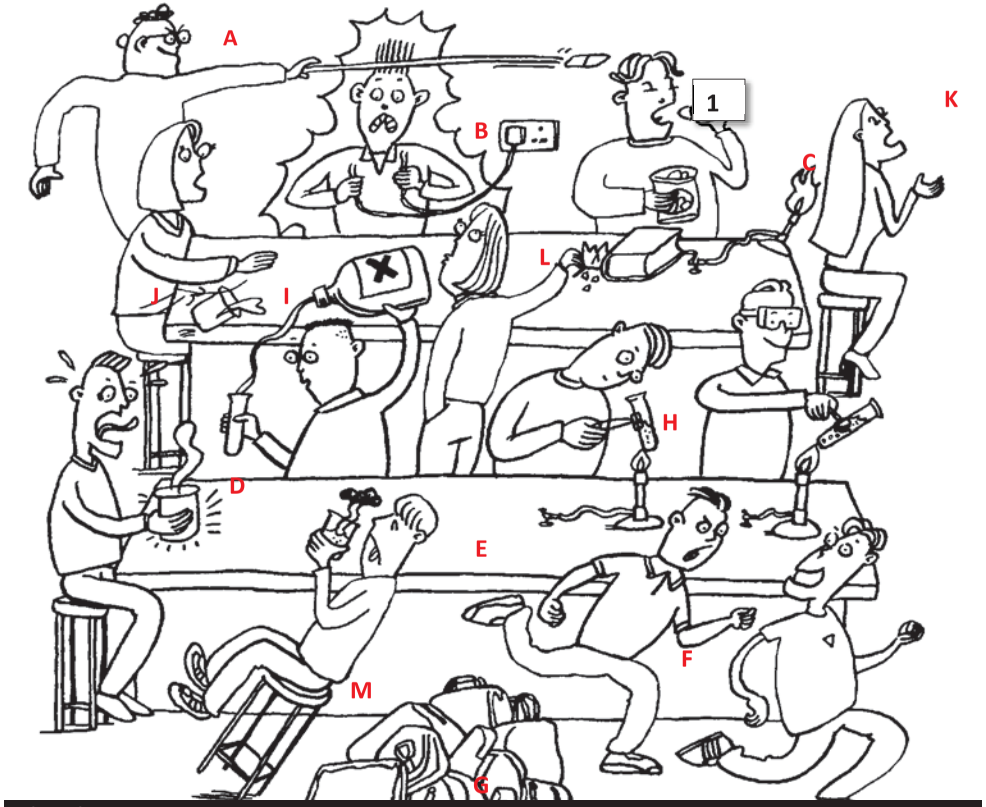
Using your textbook find out what each of these words means and write it in English, then give an example and translate

Topic #	English	Example	Chinese Translation
2	**Hazard** any situation or practical that includes risks that need to be carefully managed to perform that experiment safely for you and your classmates		
2	**Corrosive**		
2	**Irritant**		
2	**Harmful**		
2	**Flammable**		
2	**Poisonous**		
2	**Explosive**		

Extension activity: State and explain which of these hazards is most dangerous in the space below

4.5 EXTENSION Activity 1 WS Safety in the Lab

Find the danger and create a rule to stop it



Where the problem is	What could happen as a result?	Write a rule to prevent this danger from causing harm
1	Student could transfer harmful chemicals on the bench to his food with his hands	Never eat or drink in a lab!
A		
B		
C		
D		
E		
F		
G		
H		
I		
J		
K		
L		
M		

4.6 ESSENTIAL Activity 2 Hazard Symbols

Hazard symbols are used across the world as a way to keep everyone safer. They use pictures instead of words so they can be understood by everyone, but **before you can be safe in a lab you MUST learn these.**

Link the hazard symbols to the correct label and description.

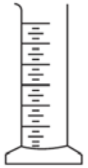
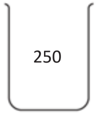
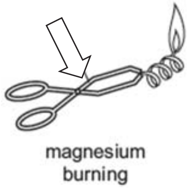
	Old hazard symbol	**New hazard symbol**
1		
2		
3		
4		
5		
6		

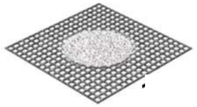
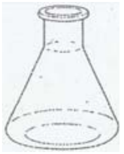
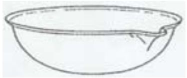
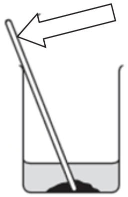
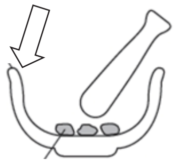
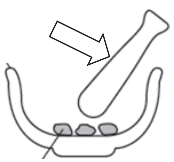
Name
Corrosive
Health hazard (Harmful)
Explosive
Flammable
Toxic
Caution (Irritant)

Description
This may dissolve or burn materials, including skin
This includes irritants, harmful substances, and some low-hazard substances
This contains dangerous organisms such as bacteria
This can be poisonous and possibly deadly
This may explode
This can catch fire easily

4.7 ESSENTIAL Activity 3 Laboratory apparatus

Apparatus is a scientific name for equipment. Use the list below to label this equipment.

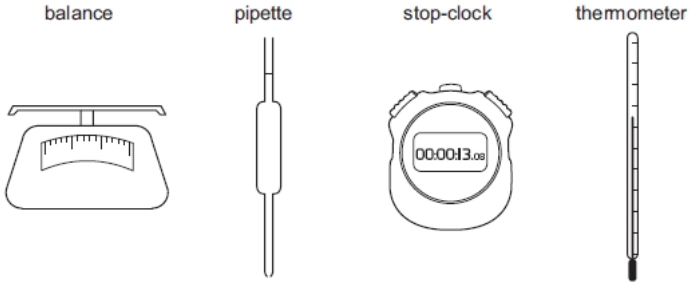
			
			
			
			

(Round bottom) flask
Burette
Clamp stand
Conical flask
Evaporating basin
Funnel
Glass beaker
Heat proof gauze
Measuring cylinder
Mortar
Pistil
Spatula
Stirring rod
Teat pipette
Test tube brush
Test tube holder
Test tube rack
Thermometer
Tongs
Tripod and Bunsen burner
Volumetric flask
Volumetric pipette
Wash bottle (filled with distilled water)

4.8 ESSENTIAL EXAM QUESTIONS Paper 2 Topic 2 11marks

Q# 1/ iGCSE Chemistry/2018/w/Paper 21/

2 The diagrams show four pieces of laboratory equipment.



Which equipment is essential to find out if dissolving a salt in water is an exothermic process?

	balance	pipette	stop-clock	thermometer
A	✗	✗	✗	✓
B	✓	✗	✗	✓
C	✗	✓	✗	✓
D	✓	✗	✓	✗

Q# 2/ iGCSE Chemistry/2018/s/Paper 23/

2 Paper chromatography is done in the same way with three different mixtures of dyes. Each mixture contains at least one of the dyes W, X, Y and Z.

The R_f values of the dyes in the three mixtures are shown.

dye	R_f values from mixture 1	R_f values from mixture 2	R_f values from mixture 3
W	0.15	0.15	0.15
X	0.00	0.00	0.00
Y	0.50	0.50	0.50
Z	0.00	0.91	0.91

Which conclusion is correct?

A Dye W is nearest the solvent front and is present only in mixture 1 and mixture 3.

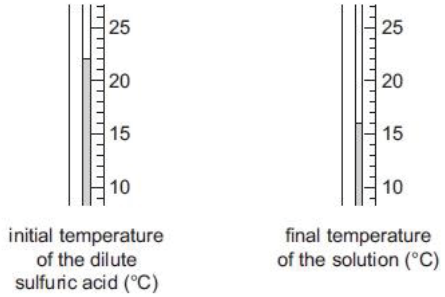
B Dye X has travelled furthest up the chromatography paper.

C Dye Y is the only dye present in all three mixtures.

D Dye Z is nearest the solvent front and is found in only two of the mixtures.

3 Solid R reacted with dilute sulfuric acid.

The initial temperature of the dilute sulfuric acid and the final temperature of the solution are shown.



What was the change in temperature in °C?

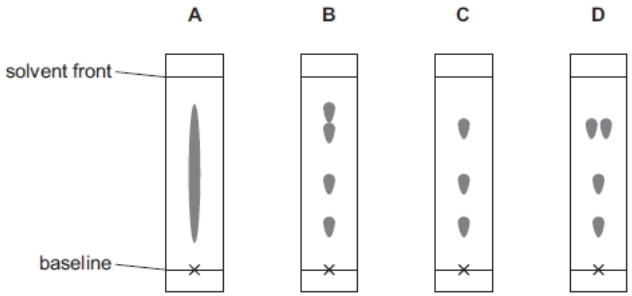
A −6 **B** −4 **C** 4 **D** 6

Q# 3/ iGCSE Chemistry/2018/s/Paper 22/

2 A chromatography experiment was done to separate a mixture of four substances.

The R_f values measured for these substances were 0.3, 0.5, 0.8 and 0.8.

Which diagram shows the chromatogram obtained?



3 Which piece of apparatus **cannot** be used to collect and measure the volume of gas produced in an experiment?

A burette

B gas syringe

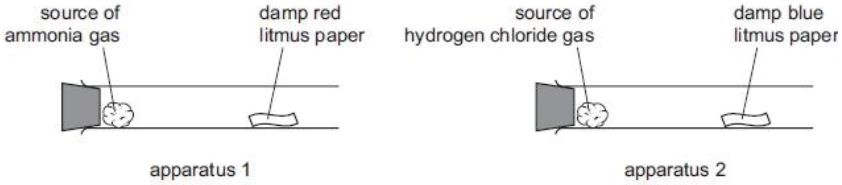
C measuring cylinder

D pipette

Q# 4/ iGCSE Chemistry/2018/s/Paper 21/

1 A student investigated the diffusion of ammonia gas, NH_3, and hydrogen chloride gas, HCl.

Two sets of apparatus were set up as shown at room temperature and pressure.



The damp red litmus paper in apparatus 1 changed colour after 30 seconds.

How long does it take for the damp blue litmus paper to change colour in apparatus 2?

A 64 seconds

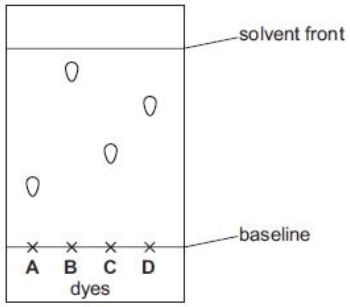
B 30 seconds

C 21 seconds

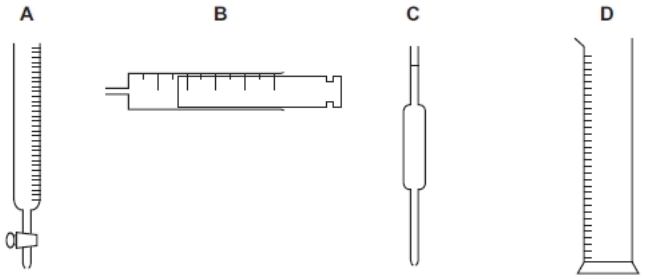
D The blue litmus paper would not change colour.

2 Chromatography is a technique used to separate coloured dyes.

Which dye has an R_f value of 0.7?



3 Which piece of apparatus is used to measure exactly 26.3 cm^3 of a liquid?



Q# 5/ iGCSE Chemistry/2018/m/Paper 22/

2 Which method should be used to separate a mixture of two liquids?

A crystallisation

B electrolysis

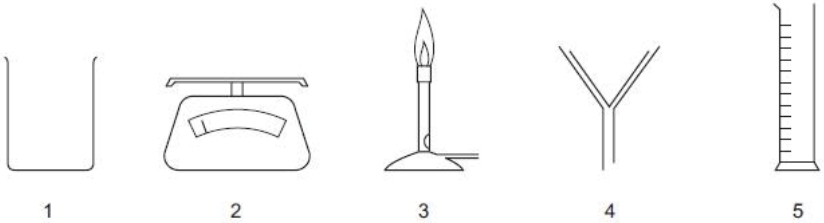
C filtration

D fractional distillation

3 Lead(II) iodide is insoluble in water.

Lead(II) iodide is made by adding aqueous lead(II) nitrate to aqueous potassium iodide.

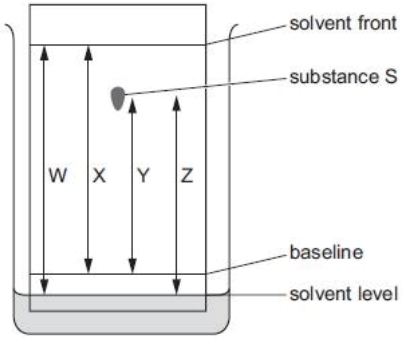
Which pieces of apparatus are needed to obtain solid lead(II) iodide from 20 cm^3 of aqueous lead(II) nitrate?



A 1, 2 and 4 **B** 1, 3 and 5 **C** 1, 4 and 5 **D** 2, 4 and 5

4 The chromatogram of substance S is shown.

Some distances, W, X, Y and Z, are labelled on the diagram.



How is the R_f value of substance S calculated?

A $\frac{X}{Y}$ **B** $\frac{W}{Z}$ **C** $\frac{Y}{X}$ **D** $\frac{Y}{W}$

4.8.1 ESSENTIAL EXAM QUESTIONS Paper 2 T2 11marks Mark Scheme

Q# 1/ iGCSE Chemistry/2018/w/Paper 21/

2	A

Q# 2/ iGCSE Chemistry/2018/s/Paper 23/

2	D
3	A

Q# 3/ iGCSE Chemistry/2018/s/Paper 22/

2	C
3	D

Q# 4/ iGCSE Chemistry/2018/s/Paper 21/

2	D
3	A
4	C

Q# 5/ iGCSE Chemistry/2018/m/Paper 22/

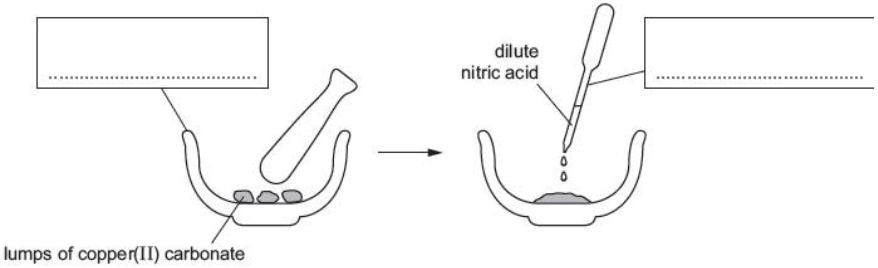
2	D
3	C
4	C

4.9 ESSENTIAL EXAM QUESTIONS Paper 6 Labelling Equipment and Understanding Experiments

iG Chem 2 EQ 18w to 16m Labelling Equipment and Understanding Experiments 66marks

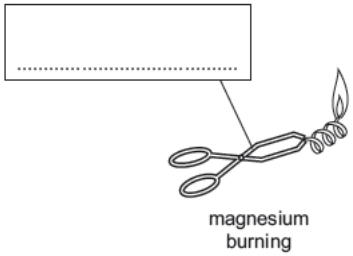
Q# 2/ iGCSE Chemistry/2018/w/Paper 62/Q1

1 A sample of copper was prepared from lumps of copper(II) carbonate. The first step was to make a solution of copper(II) nitrate as shown. Carbon dioxide was produced.



(a) Complete the boxes to name the apparatus. [2]

1 Magnesium ribbon was burned in air.



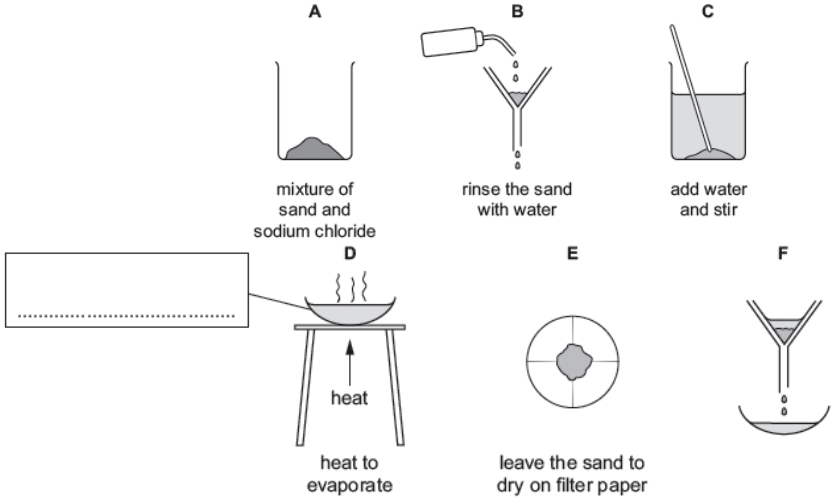
(a) Complete the box to name the apparatus. [1]

(f) State **one** safety precaution that should be taken when magnesium is burned in air.

..... [1]

Q# 3/ iGCSE Chemistry/2018/w/Paper 61/Q1

1 A student obtains pure, dry samples of sand and sodium chloride from a mixture of sand and sodium chloride.
The student uses the apparatus shown. The method consists of six steps, **A**, **B**, **C**, **D**, **E** and **F**, which are shown in the wrong order.



(a) Order the steps in the method.

A → ..... → ..... → ..... → ..... → ..... [2]

(b) Complete the box to name the apparatus in **D**. [1]

(c) Why is the sand rinsed with water in **B**?

.....

..... [1]

(d) Name the process in **F**.

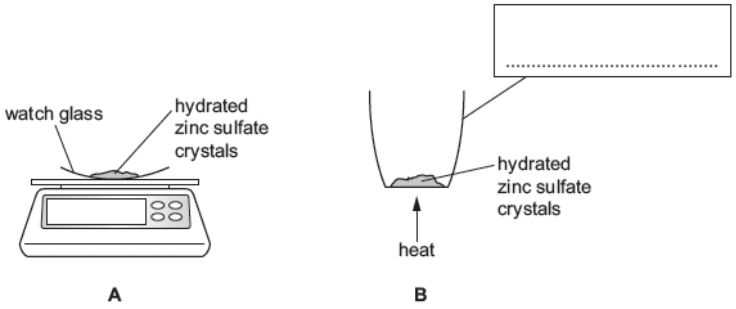
..... [1]

(e) How could the purity of the sodium chloride obtained be checked?

..... [1]

Q# 4/ iGCSE Chemistry/2018/s/Paper 63/Q1

1 Zinc sulfate crystals are hydrated. They contain water of crystallisation. A student did an experiment to find the mass of water in hydrated zinc sulfate crystals.
The hydrated zinc sulfate crystals were weighed and then heated with a Bunsen burner to remove the water as shown.



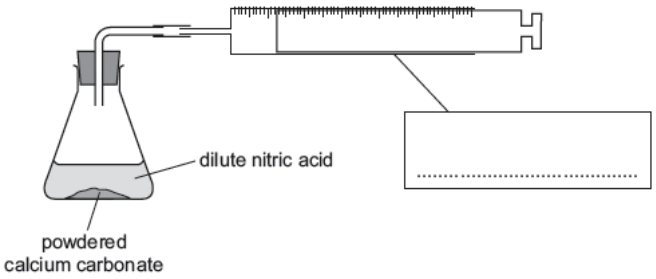
(a) (i) Name the apparatus used to weigh the crystals in **A**.

..... [1]

(ii) Complete the box to name the apparatus. [1]

Q# 5/ iGCSE Chemistry/2018/s/Paper 62/Q1

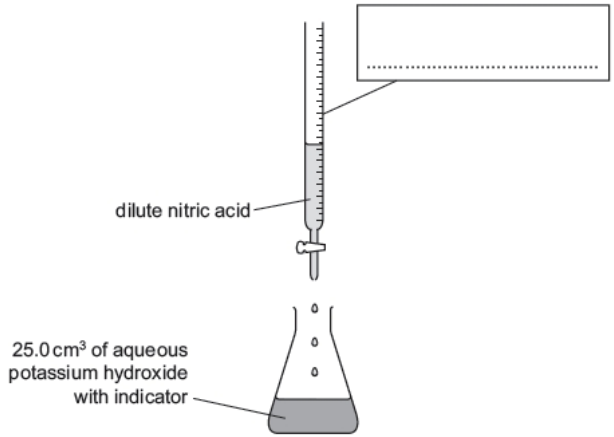
1 The rate of reaction between an excess of dilute nitric acid and powdered calcium carbonate was investigated. The carbon dioxide produced was collected. The apparatus used is shown.



(a) Complete the box to name the apparatus. [1]

Q# 6/ iGCSE Chemistry/2018/s/Paper 61/Q1

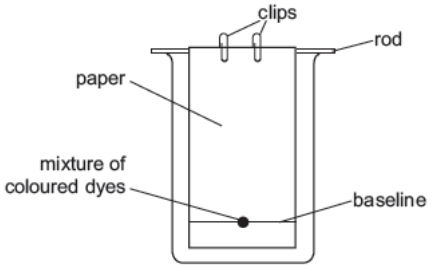
1 The volume of dilute nitric acid that reacts with 25.0 cm^3 of aqueous potassium hydroxide can be found by titration using the apparatus shown.



(a) Complete the box to name the apparatus. [1]

Q# 7/ iGCSE Chemistry/2018/m/Paper 62/Q1

1 A student used paper chromatography to separate a mixture of coloured dyes. The diagram shows the apparatus used.



(a) (i) Draw a line on the diagram to show the level of the solvent. [1]

(ii) Suggest a suitable solvent that could be used.

..... [1]

(b) What could be used to put the mixture of coloured dyes onto the paper?

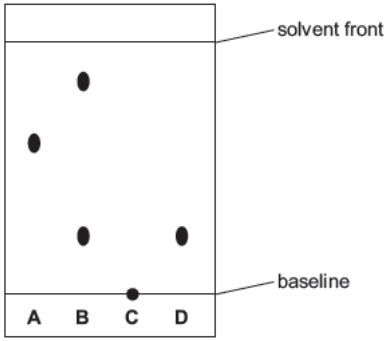
..... [1]

(c) The clips hold the paper in position.

Why is this important for the chromatography experiment?

..... [1]

The diagram shows the chromatogram obtained from four dyes, **A**, **B**, **C** and **D**.



(d) Give **one** conclusion that can be drawn about dye **B**.

..... [1]

(e) Suggest why dye **C** remained on the baseline.

.....

..... [1]

(f) R_f values are used to identify compounds.

$$R_f = \frac{\text{distance travelled by the compound}}{\text{distance travelled by the solvent}}$$

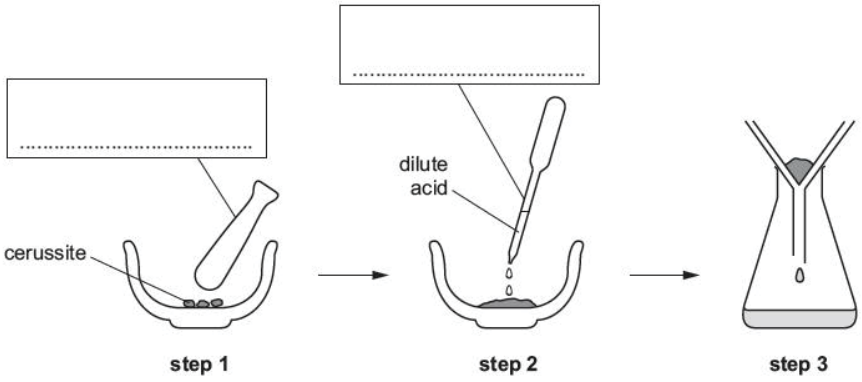
Calculate the R_f value of dye **A**.

R_f = ... [2]

[Total: 8]

Q# 8/ iGCSE Chemistry/2017/w/Paper 63/Q1

1 Cerussite is a lead ore which contains lead(II) carbonate. A student obtained a solution of lead(II) nitrate from cerussite using the apparatus shown.



(a) Complete the boxes to name the apparatus. [2]

(b) Why was the cerussite crushed in **step 1**?

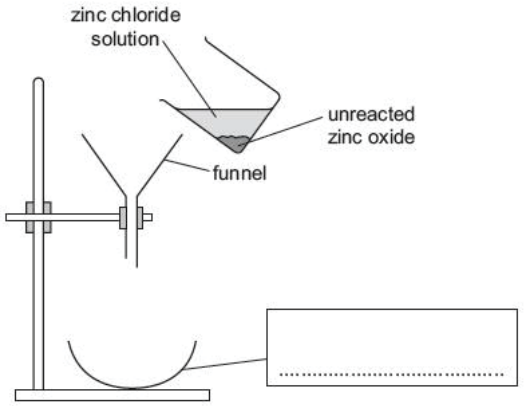
..... [1]

(d) What is the general name given to an insoluble solid left on a filter paper after filtration?

..... [1]

Q# 9/ iGCSE Chemistry/2017/w/Paper 61/Q1

1 A student reacted dilute hydrochloric acid with zinc oxide to prepare zinc chloride solution. The diagram shows part of the procedure.



(a) Complete the box to name the apparatus. [1]

(b) Which of the reactants was in excess?

..... [1]

(c) **(i)** Name the separation process this apparatus is used for.

..... [1]

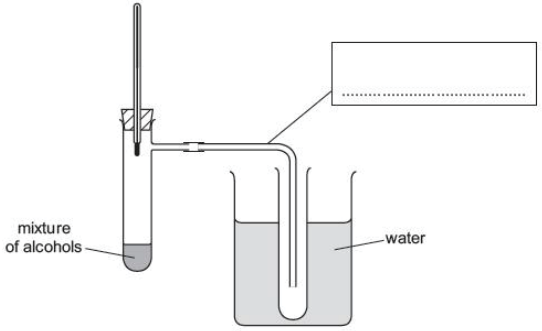
(ii) Suggest why this apparatus would **not** work.

.....

..... [1]

Q# 10/ iGCSE Chemistry/2017/s/Paper 63/Q1

1 A mixture of alcohols can be separated by fractional distillation. The apparatus shown was used to separate ethanol from the mixture.



(a) **(i)** Complete the box to identify the apparatus. [1]

(ii) Indicate with an arrow where heat is applied. [1]

(b) What is the purpose of the water?

.....

..... [2]

(c) Why is the thermometer bulb placed as shown and **not** in the mixture of alcohols?

.....

..... [1]

(d) Use the letter **E** to indicate on the diagram where ethanol would collect. [1]

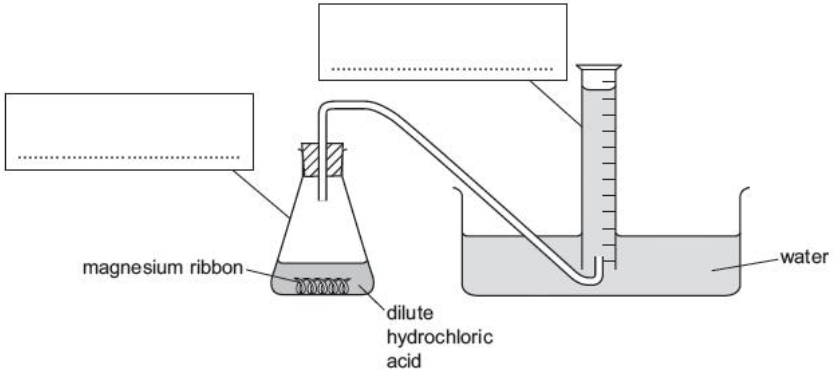
(e)

(ii) Give a physical test to identify pure ethanol.

..... [1]

Q# 11/ iGCSE Chemistry/2017/s/Paper 62/Q1

1 A student investigated the rate of reaction between an excess of dilute hydrochloric acid and magnesium ribbon. The apparatus is shown.



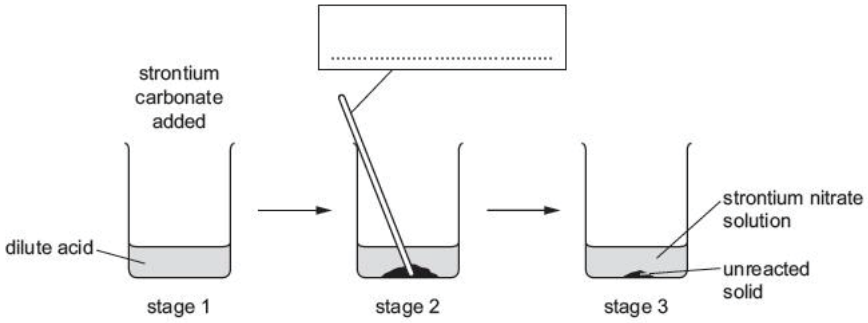
Two experiments were carried out. The temperature was the same in each case.

(a) Complete the boxes to identify the apparatus. [2]

Q# 12/ iGCSE Chemistry/2017/s/Paper 61/Q1

1 A student prepared strontium nitrate crystals.

The diagram shows some of the stages in this preparation.



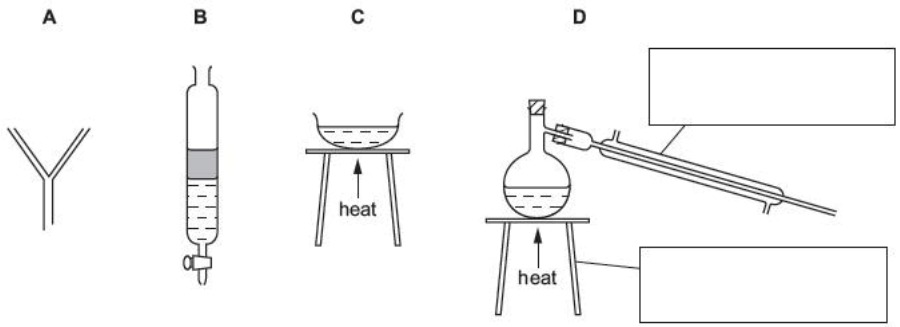
(a) **(i)** Complete the box to identify the apparatus. [1]

(ii) What is used to add the strontium carbonate to the acid in stage 1?

..... [1]

Q# 13/ iGCSE Chemistry/2016/w/Paper 62/Q1

1 This question is about the separation of mixtures.
The diagram shows four sets of apparatus that can be used to separate mixtures.



(a) Complete the boxes to name the apparatus. [2]

(b) The table shows four different mixtures.

Complete the table to show which set of apparatus should be used to obtain the substance listed. The first one has been completed for you. Each set of apparatus can be used once, more than once or not at all.

mixture	to obtain	use apparatus
petroleum and water	petroleum	**B**
sodium chloride dissolved in water	sodium chloride crystals	.....
sodium chloride dissolved in water	water	.....
insoluble silver chloride and water	silver chloride	.....

[3]

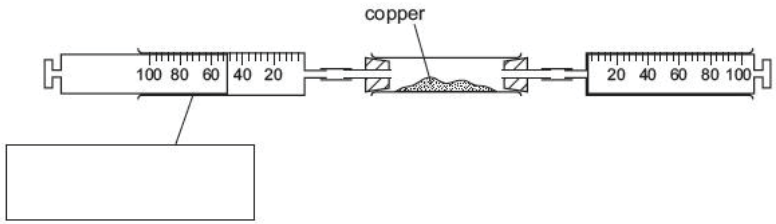
(c) Put a ring around the separation method that should be used to separate a mixture of coloured dyes.

centrifugation chromatography condensation evaporation

[1]

Q# 14/ iGCSE Chemistry/2016/s/Paper 63/Q1

1 Air is a mixture of gases. The diagram shows the apparatus used to find the percentage of oxygen in air.
50 cm^3 of air were passed backwards and forwards over excess heated copper until there was no further change. The apparatus was left to cool and the volume of gas remaining was 40 cm^3.

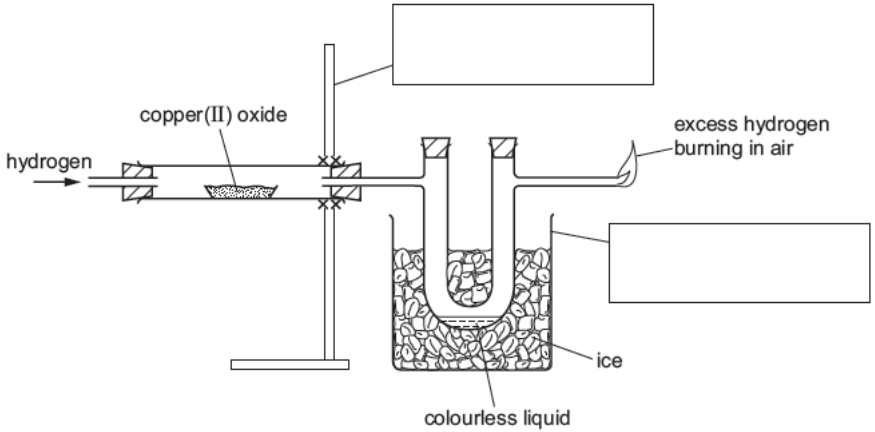


(a) Complete the box to name the apparatus. [1]

(b) Use an arrow to indicate where heat is applied. [1]

Q# 15/ iGCSE Chemistry/2016/s/Paper 62/Q1

1 The diagram shows the apparatus used to reduce copper(II) oxide with hydrogen.



(a) Complete the boxes to name the apparatus. [2]

(d) Suggest a reason why the U-tube is surrounded by ice.

..... [1]

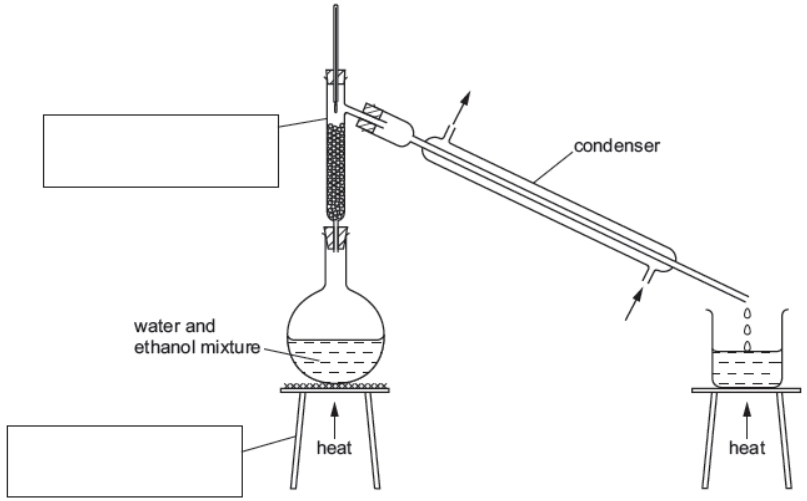
(e) The colourless liquid is water

(iii) How could you show that this liquid is pure?

..... [1]

Q# 16/ iGCSE Chemistry/2016/s/Paper 61/Q1

1 The diagram shows the apparatus used to separate a mixture of water, boiling point 100 °C, and ethanol, boiling point 78 °C.



(a) Complete the boxes to name the apparatus. [2]

(b) Label the arrows on the condenser. [1]

(c) Identify **one** mistake in the apparatus.

..... [1]

(d) Which liquid would collect first? Explain your answer.

.....

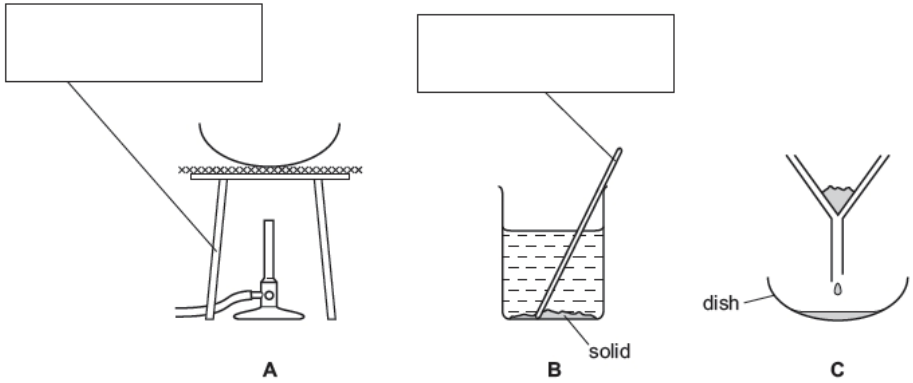
..... [2]

(e) Why would it be better to use an electrical heater instead of a Bunsen burner to heat the water and ethanol mixture?

..... [1]

Q# 17/ iGCSE Chemistry/2016/m/Paper 62/Q1

1 The diagrams show the apparatus used to obtain crystals of calcium chloride from a mixture of solid calcium chloride and solid calcium carbonate.
Calcium chloride is soluble in water and calcium carbonate is insoluble in water.



(a) Complete the boxes to name the apparatus. [2]

(b) (i) Write down the order in which the apparatus should be used in this experiment.

..... [1]

(ii) Name the separation process in **C**.

..... [1]

(c) (i) What has been added to the mixture in **B**?

..... [1]

(ii) What is the general name given to the liquid in the dish in **C**?

..... [1]

(d) How would you know when to stop heating the dish in **A**?

.....

..... [1]

4.9.1 Mark Scheme iG Chem 2 EQ 18w to 16m Labelling Equipment

Q# 1/ iGCSE Chemistry/2018/w/Paper 63/Q1

1(a)	mortar	1
	(Teat / dropping) pipette / dropper	1

Q# 2/ iGCSE Chemistry/2018/w/Paper 62/Q1

1(a)	Tong(s)	1

1(f)	Goggles / blue glass	1

Q# 3/ iGCSE Chemistry/2018/w/Paper 61/Q1

1(a)	**M1** (A),C,F	1
	M2 B,D,E **OR** B,E,D **OR** D,B,E	1
1(b)	Evaporating / crystallising basin / dish	1
1(c)	To wash-out / dissolve / remove sodium chloride / salt	1
1(d)	Filtration	1
1(e)	Melting point	1

Q# 4/ iGCSE Chemistry/2018/s/Paper 63/Q1

1(a)(i)	balance	1
1(a)(ii)	crucible	1
1(b)	open	1
1(c)	weigh the solid	1
	heat to constant mass	1
1(d)	anhydrous copper sulfate / cobalt chloride paper	1
	turns blue / turns pink	1

Q# 5/ iGCSE Chemistry/2018/s/Paper 62/Q1

1(a)	(gas) syringe	1

Q# 6/ iGCSE Chemistry/2018/s/Paper 61/Q1

1(a)	burette	1

Q# 7/ iGCSE Chemistry/2018/m/Paper 62/Q1

1(a)(i)	line drawn on diagram between base line and bottom of paper and below dot	1
1(a)(ii)	water	1
1(b)	dropper / teat pipette	1
1(c)	so mixture is above / not in contact/does not run/dissolve in solvent	1
1(d)	is two substances / contains **D**	1
1(e)	insoluble	1
1(f)	2.8 to 3.2 / 5	1
	0.56–0.64	1

Q# 8/ iGCSE Chemistry/2017/w/Paper 63/

1(a)	pestle	1
	(teat) pipette	1
1(b)	to increase surface area / make it dissolve faster	1
1(c)	nitric (acid)	1
1(d)	residue	1

Q# 9/ iGCSE Chemistry/2017/w/Paper 61/

1(a)	evaporating basin / dish	1
1(b)	zinc oxide	1
1(c)(i)	filtration	1
1(c)(ii)	no filter paper	1

Q# 10/ iGCSE Chemistry/2017/s/Paper 63/

1(a)(i)	(delivery) tube	1
1(a)(iii)	arrow beneath the tube containing the mixture of alcohols	1
1(b)	to cool	1
	the gas into a liquid	1
1(c)	to measure the temperature of the vapour/temperature of liquid would not be constant	1
1(d)	**E** shown on the test-tube in water bath	1
1(a)(i)	(delivery) tube	1
1(a)(iii)	arrow beneath the tube containing the mixture of alcohols	1
1(b)	to cool	1
	the gas into a liquid	1
1(c)	to measure the temperature of the vapour/temperature of liquid would not be constant	1
1(d)	**E** shown on the test-tube in water bath	1
1(e)(i)	lighted splint ignites the liquid / test for water, e.g. add anhydrous copper(II) sulfate gives a negative result	1
1(e)(ii)	melting / boiling point determination	1

Q# 11/ iGCSE Chemistry/2017/s/Paper 62/

1(a)	measuring cylinder	1
	conical flask	1

Q# 12/ iGCSE Chemistry/2017/s/Paper 61/

1(a)(i)	stirrer / glass rod	1
1(a)(ii)	Spatula	1

Q# 13/ iGCSE Chemistry/2016/w/Paper 62/

1(a)	(liebig) condenser tripod	1 1
1(b)	sodium chloride crystals: **C** water: **D** silver chloride: **A**	1 1 1
1(c)	chromatography	1

Q# 14/ iGCSE Chemistry/2016/s/Paper 63/

1(a)	(gas) syringe;	1
1(b)	arrow under copper;	1

Q# 15/ iGCSE Chemistry/2016/s/Paper 62/

1(a)	stand; beaker;	2 1 1
1(d)	to condense (the water vapour);	1
1(e)(iii)	boiling / melting point determination;	1

Q# 16/ iGCSE Chemistry/2016/s/Paper 61/

Question	Answer	Marks
1(a)	fractionating column; tripod;	2 1 1
1(b)	water labelled twice;	1
1(c)	heat under (the collecting) beaker;	1
1(d)	**M1** ethanol; **M2** lowest / lower boiling point;	2 1 1
1(e)	ethanol is flammable;	1

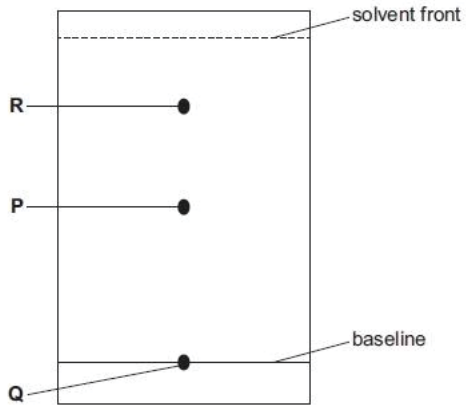
Q# 17/ iGCSE Chemistry/2016/m/Paper 62/

1(a)	tripod; stirring rod/stirrer;	2
1(b)(i)	B C A;	1
1(b)(ii)	filtration;	1
1(c)(i)	water;	1
1(c)(ii)	filtrate;	1
1(d)	solid/crystals appearing on edge/glass rod test;	1

4.10 ESSENTIAL EXAM QUESTIONS Paper 6 Topic 2 Experimental Techniques 79 marks

Q# 1/ iGCSE Chem/2015/w/Paper 62/

2 A mixture of three compounds, **P**, **Q** and **R**, was separated using a piece of paper.



(a) Name this method of separation.

..... [1]

(b) What could have been used to apply the mixture onto the paper?

..... [1]

(c) Suggest a possible solvent that could be used for this separation.

..... [1]

(d) Suggest why compound **Q** remained on the baseline.

.....

..... [1]

(e) R_f values are used to identify compounds.

$$R_f = \frac{\text{distance travelled by compound}}{\text{distance travelled by the solvent}}$$

Use the diagram to work out the R_f value of compound **R**.

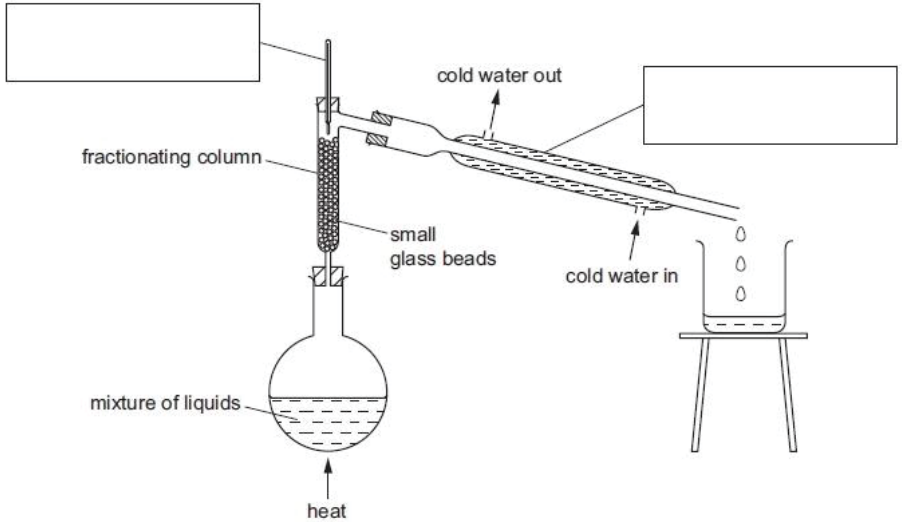
.....

..... [2]

Q# 2/ iGCSE Chem/2015march/Paper 6/

1 A teacher separated a mixture of two liquids using the apparatus shown. The liquids were:

- ethanoic acid, boiling point 118 °C,
- chloroethanoic acid, boiling point 190 °C.



(a) Complete the boxes to label the pieces of apparatus used. [2]

(b) **(i)** Which liquid would be collected first? Explain why.

.....

..... [2]

(ii) How would the teacher know when all of this liquid had been collected?

..... [1]

(c) Suggest why small glass beads are used in the fractionating column instead of large glass beads.

.....

..... [1]

Q# 3/ iGCSE Chem/2015march/Paper 6/

4 A student investigated the solubility of salt **D** in water at various temperatures.

Four experiments were carried out.

(a) *Experiment 1*

4 g of salt **D** was added to a boiling tube. A burette was filled with distilled water and 10.0 cm^3 of water added to the boiling tube. The mixture of salt **D** and water was heated carefully until all of the solid had dissolved. The boiling tube was removed from the heat and the solution allowed to cool. The solution was stirred gently with a thermometer.

The temperature at which crystals first appeared was noted.

The boiling tube and its contents were kept for the remaining three experiments.

(b) *Experiment 2*

From the burette another 2.0 cm^3 of water was added to the boiling tube and contents from Experiment 1.

The mixture was heated to dissolve the crystals and allowed to cool as in Experiment 1. The temperature at which crystals first appeared was noted.
Record, in the table, the total volume of water in the boiling tube.

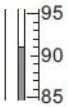
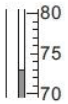
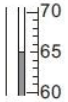
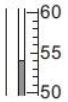
(c) *Experiment 3*

From the burette another 2.0 cm^3 of water was added to the boiling tube and contents from Experiment 2. The experiment was repeated exactly as before.
Record, in the table, the total volume of water in the boiling tube.

(d) *Experiment 4*

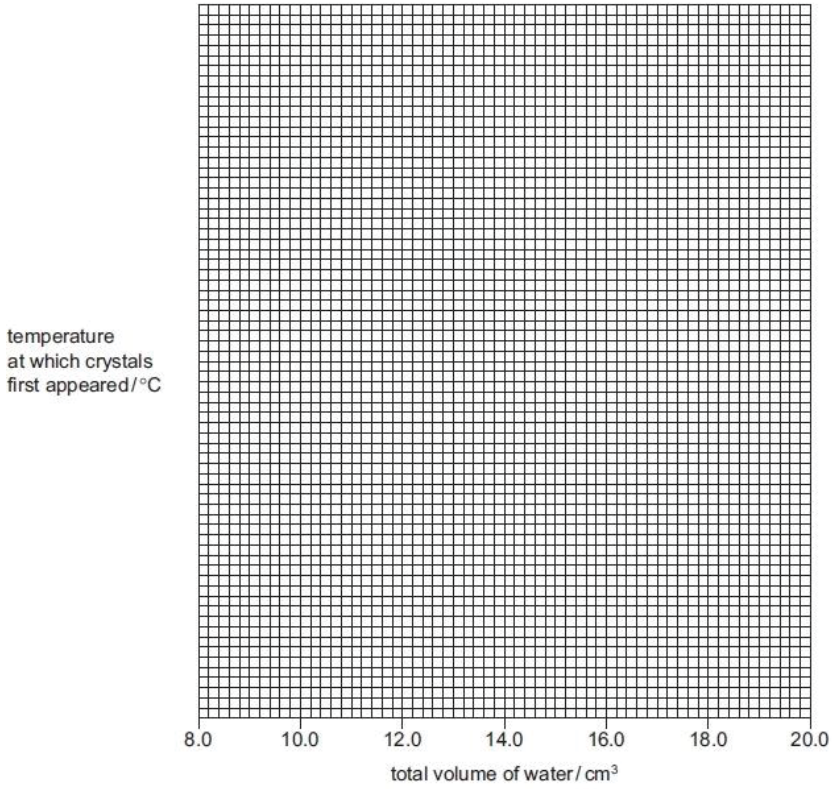
From the burette another 4.0 cm^3 of water was added to the boiling tube and contents from Experiment 3. The experiment was repeated exactly as before.
Record in the table the total volume of water in the boiling tube.

Use the thermometer diagrams in the table to record the temperatures at which crystals first appeared in the four experiments.

Experiment number	total volume of water / cm^3	thermometer diagram	temperature at which crystals first appeared / °C
1	10.0		
2			
3			
4			

[3]

(e) Plot the results on the grid below and draw a smooth line graph.



[5]

(f) **From your graph**, find the temperature at which crystals of **D** would first appear if the total volume of water in the solution was 20.0 cm^3.
Show clearly **on the grid** how you worked out your answer.

..... [3]

(g) How would the student know when salt **D** was completely dissolved in the water?

..... [1]

(h) The solubility of salt **D** at 100 °C is 57 g in 100 cm^3 of water.
Suggest, with a reason, the effect of using 8 g of salt **D** instead of 4 g in these experiments.

.....

..... [2]

(i) Salt **C** is less soluble in water than salt **D**.

Sketch on the grid the graph you would expect for salt **C**. Label this graph. [2]

(j) Describe and explain **one** improvement that could be made to the experimental method to obtain more reliable results in this investigation.

improvement .....

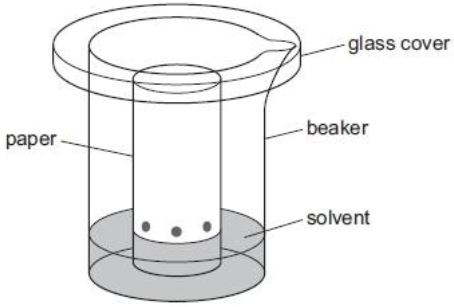
explanation .....

.....

..... [2]

Q# 4/ iGCSE Chem/2014/w/Paper 6/

3 A student investigated the colours present in a fruit drink. The fruit drink was tested to check that no artificial colours had been added. The apparatus below was used.



(a) **(i)** Name the method used.

..... [1]

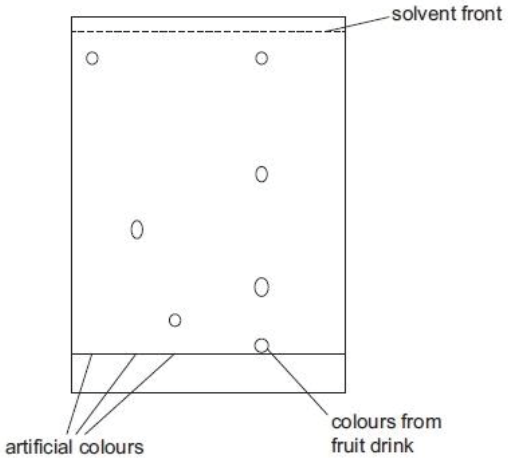
(ii) Why is there a glass cover on the beaker?

..... [1]

(b) When should the paper be removed from the beaker?

..... [1]

(c) The diagram shows the results of the experiment.



(i) How many different coloured compounds were present in the fruit drink?

..... [1]

(ii) Are there any of the artificial colours present in the fruit drink? Explain your answer.

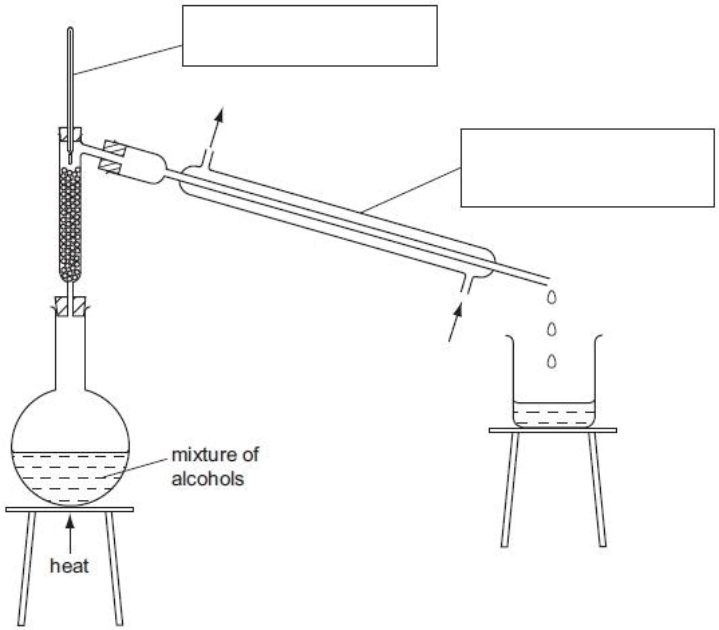
.....

.....

..... [2]

Q# 5/ iGCSE Chem/2014s/Paper 6/

1 A student separated a mixture of two alcohols, ethanol (boiling point 78 °C) and butanol (boiling point 118 °C).
The apparatus used is shown below.



(a) Complete the boxes to identify the pieces of apparatus labelled. [2]

(b) Label the arrows. [1]

(c) State the name of this separation process.

..... [2]

(d) (i) Which liquid is first to collect in the beaker?

..... [1]

(ii) How would the student know when all of this liquid had collected?

.....

..... [1]

(e) Identify and explain a possible hazard in this experiment.

.....

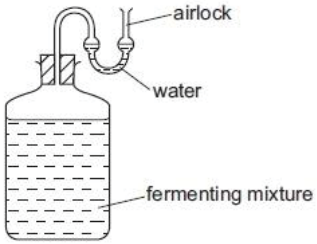
..... [2]

Q# 6/ iGCSE Chem/2013s/Paper 6/

2 A student found a recipe for making elderberry wine by fermentation.

1 kg elderberries
0.5 kg sugar
10 g yeast granules
3 dm^3 water

The student decided to make some elderberry wine using the apparatus below.



The student carried out the following method.

Step 1 The elderberries were crushed.

Step 2 The crushed elderberries and sugar were added to the water and the mixture was boiled for ten minutes. The crushed elderberries were then separated from the mixture.

Step 3 Yeast was added to the liquid when it had cooled to room temperature.

(a) Suggest the purpose of the airlock in the apparatus.

..... [1]

(b) What apparatus could be used in Step 1?

..... [1]

[2]

(d) Why was the yeast in Step 3 not added until the liquid was at room temperature?

..... [1]

(e) **(i)** State **one** observation during the fermentation.

..... [1]

(ii) Suggest how the rate of the fermentation reaction could be measured.

.....

..... [2]

(f) Name the method that could be used to separate ethanol from the fermented mixture.

..... [1]

Q# 7/ iGCSE Chem/2012s/Paper 6/

3 Coffee beans contain caffeine and other compounds. Caffeine is soluble in water and in trichloromethane, an organic solvent.
A student obtained crystals of caffeine by the following method.

Stage 1 Some coffee beans were crushed into small pieces.

Stage 2 Hot water was added to the crushed beans to dissolve the soluble substances.

Stage 3 The crushed beans were separated from the liquid solution.

Stage 4 The liquid was allowed to cool and shaken with trichloromethane to extract the caffeine from the water.

Stage 5 The caffeine was crystallised from the trichloromethane solution.

Stage 6 The caffeine crystals were checked for purity.

(a) What apparatus should be used to crush the beans in Stage 1?

..... [2]

(b) How could the dissolving process in Stage 2 be speeded up?

..... [1]

(c) Draw a diagram of the apparatus used in Stage 3.

[2]

(d) How should Stage 5 be carried out?

.....

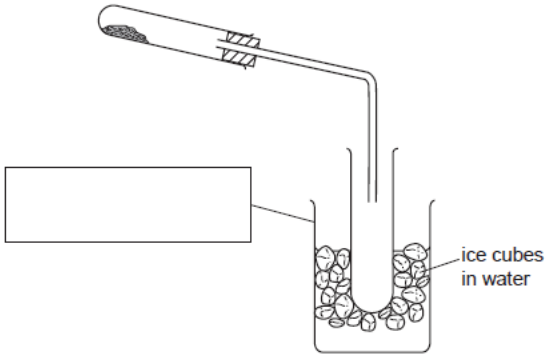
..... [2]

(e) What method could be used to check the purity of the crystals in Stage 6?

..... [1]

Q# 8/ iGCSE Chem/2011s/Paper 6/

1 A student heated hydrated zinc sulfate crystals, $ZnSO_4.7H_2O$, using the apparatus below to obtain a sample of water.



(a) Complete the box to identify the piece of apparatus labelled. [1]

(b) Use labelled arrows to indicate:

(i) where the heat is applied,

(ii) where the sample of water would collect. [2]

(c) State the purpose of the ice cubes.

..... [1]

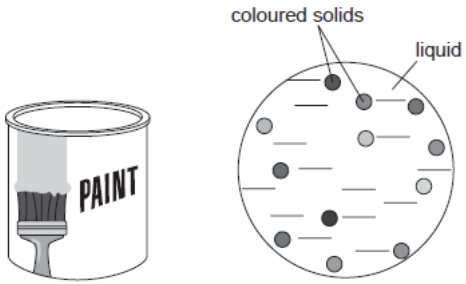
(d) Describe a physical test for pure water.

test .....

result ..... [2]

Q# 9/ iGCSE Chem/2006/w/Paper 6/

6 You are provided with a pot of paint as shown below.



magnified view of paint

The paint is a mixture of a liquid and a solid.
The liquid can be dissolved in water. The solids are insoluble in water but soluble in organic solvents.

(a) How can a sample of the solid be separated from the rest of the paint?

.....

.....

..... [2]

(c) The label on the paint tin states

"Touch-dry in three hours"

(i) How could you check this value?

.....

..... [2]

(ii) Suggest how you could speed up this drying process.

..... [1]

Q# 10/ iGCSE Chem/2003/w/Paper 6/

2 A student extracted and investigated the orange colour in some sweets.
The student followed these instructions:

1 *Collect sweets, a watch glass, a beaker, eye protection and 100 cm^3 of ethanol.*
2 *Crush the sweets.*
3 *Place the crushed sweets in the beaker containing 100 cm^3 of ethanol.*
4 *Boil the mixture with the watch glass covering the beaker.*
5 *Decant the liquid and concentrate it by evaporation until the colour is dark orange.*
6 *Investigate which colours are present in the orange solution.*

(a) Why should the sweets be crushed?

.....

.....[2]

(b) Why should the experiment be carried out in a well-ventilated laboratory?

.....[1]

(c) State **one** safety precaution that the student should have taken, other than carrying out the experiment in a well-ventilated laboratory and using eye protection.

.....[1]

(d) State the purpose of the watch glass.

.....[1]

(e) Explain the term *decant*.

.....[1]

4.10.1 ESSENTIAL EXAM QUESTIONS Paper 6 Topic 2 Experimental Techniques 79 marks Mark Scheme

Q# 1/ iGCSE Chem/2015/w/Paper 62/

Question	Answer	Marks	Guidance
2(a)	chromatography;	1	
2(b)	(teat) pipette/capillary tube;	1	**A:** dropper/glass rod
2(c)	water/organic solvent;	1	
2(d)	compound Q is insoluble;	1	**R:** it reacts with the solvent
2(e)	between (4.7 and 5.1) divided by (6.2 or 6.3); answer: between 0.74 and 0.82;	1 1	correct answer with no working scores 2

Q# 2/ iGCSE Chem/2015march/Paper 6/

1 (a) thermometer (1)

condenser (1) [2]

(b) (i) ethanoic acid (1)

lower boiling point / evaporates first (1) [2]

(ii) temperature reading will rise / gap in liquid coming over / no more collected at 118 °C (1) [1]

(c) larger surface area (1) [1]

Q# 3/ iGCSE Chem/2015march/Paper 6/

4 (d) Table of results

total volume of water boxes completed correctly (1),

10, 12, 14, 18

temperature boxes completed (2)
all 4 correct (2)
3 correct (1)
2 or fewer correct (0)

91, 73, 65, 54 [3]

(e) appropriate scale for y axis (1)
note: must use at least 4 large squares vertically to plot points

all points correctly plotted (3),
all 4 correct (3)
3 correct (2)
2 correct (1)
1 or fewer correct (0)
note: origin should not be included

smooth line graph (1) [5]

(f) value from graph for 20 cm^3 water, 50–53 (1) ± half a small square

shown clearly by extrapolation (1)

unit, °C (1) [3]

(g) clear / colourless liquid forms / no solid / crystals / salt visible (1) [1]

(h) salt would not all dissolve (1)

use of figures (1) [2]
e.g. only 5.7 g would dissolve in 10 cm^3 water at 100 °C

(i) sketch graph always above line (1)

label (1) [2]

(j) any **one** improvement from: (1)

do not remove thermometer from solution
use IT method / second person to note formation of crystals
repeat
do separate experiments
use smaller volumes of water
evaporation

linked explanation (1)

loss of solid on thermometer
observing formation of first crystals may vary
average
more results to plot on graph
method of avoiding evaporation e.g. separate experiments, lid [2]

Q# 4/ iGCSE Chem/2014/w/Paper 6/

3 (a) (i) chromatography (1) [1]

(ii) to prevent loss / evaporation of solvent (1) [1]

(b) when the solvent is near the top of the paper / before the solvent reaches the top of the paper (1) [1]

(c) (i) 4 (1) [1]

(ii) yes, one artificial dye (1)
at same height / matches (1) [2]

Q# 5/ iGCSE Chem/2014s/Paper 6/

1 (a) thermometer (1)

condenser (1)
allow condensing tube, condensating tube, etc. [2]

(b) arrows labelled – water (in) and water (out) (1) [1]

(c) fractional (1)

distillation (1) [2]

(d) (i) ethanol (1) [1]

(ii) temperature would rise (above 78°C) (1) [1]

(e) alcohols are (in)flammable / catch fire / burn (1)
ignore: explode

Bunsen burner / flame / heat (1) [2]

Q# 6/ iGCSE Chem/2013s/Paper 6/

2 (a) to prevent air / oxygen / bacteria entering jar (1) [1]

(b) pestle and / or mortar (1) [1]

(c) diagram of funnel and filter paper (1) labelled (1) [2]

(d) yeast would not work at high temperatures / kills yeast / denatures enzymes / owtte (1) [1]
allow: kills enzyme

(e) (i) bubbles / froth (1) [1]
not: gas / CO_2 given off / turns cloudy

(ii) (collect gas) and measure volume / count bubbles (1)

over certain time interval (1) [2]
allow: one mark for timing until bubbles / reaction stopped

(f) fractional distillation (1) [1]

Q# 7/ iGCSE Chem/2012s/Paper 6/

3 (a) pestle (1) mortar (1) [2]

(b) stir/mix/shake (1) allow: heat/boil [1]

(c) diagram showing funnel (1)
indication of filter paper (1) note: labels not necessary [2]

(d) heat/evaporation (1)
to crystallising point or description (1)
in fume cupboard (1) max 2 [2]

(e) melting point/description of (1) **allow**: chromatography **ignore**: bp [1]

Q# 8/ iGCSE Chem/2011s/Paper 6/

1 (a) beaker (1) [1]

(b) (i) (arrow) labelled heat in correct position under shaded crystals (1)

(ii) arrow labelled water in test-tube at or below the level of the ice (1) [2]

(c) to cool/condense the water or steam/owtte (1) [1]

(d) physical test **ignore** chemical tests
boiling point/freezing point (1)
100/0°C (1) [2]

Q# 9/ iGCSE Chem/2006/w/Paper 6/

6 (a) paint sample + water(1) filter(1) solid residue(1) max 2 **[2]**

(c) (i) apply paint, start timer(1) method of checking dry, note time(1)
no painting = 0 **[2]**

(ii) correct method(1) e.g. hair drier/wind/fan/increase temperature.
NOT catalyst. **[1]**

Q# 10/ iGCSE Chem/2003/w/Paper 6/

2 (a)	Larger surface area (1) Quicker to extract colour/more colour extracted (1) not easier/faster	2
(b)	Reference to ethanol (1)	1
(c)	Reference to flammability of ethanol (1)	1
(d)	To prevent loss cf solvent (1) not splash/evaporation	1
(e)	Pour off liquid (1)	1

4.11 EXTENSION EXAM QUESTIONS Paper 6 Topic 2 Long Answer Questions 53 marks

Q# 1/ iGCSE Chem/2015march/Paper 6/

6 **Rhubarb Leaves**

Ethanedioic acid dihydrate, $H_2C_2O_4.2H_2O$, is a white crystalline solid. This acid is water-soluble and is found in rhubarb leaves.

Plan an investigation to obtain crystals of ethanedioic acid dihydrate from some rhubarb leaves. You are provided with common laboratory apparatus, water and sand.

.....

.....

.....

.....

.....

.....

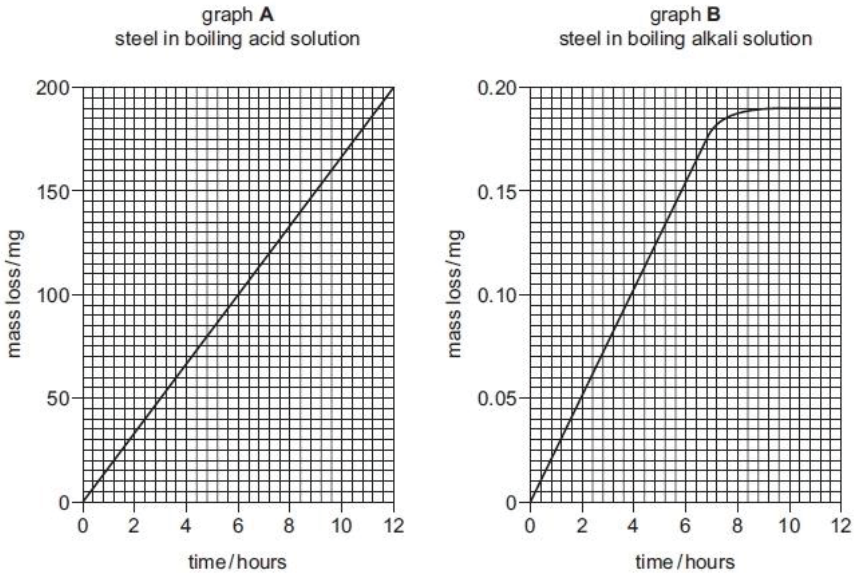
.....

.....

..... [7]

Q# 2/ iGCSE Chem/2013s/Paper 6/

5 Identical pieces of steel were placed in two different boiling liquids for 12 hours. The graphs show how the mass of each piece of steel changed.



(a) Give **one** similarity in the change in mass of the steel in both liquids.

..... [1]

(b) Describe **two** ways in which the mass loss shown in graph **A** is different from that shown in graph **B**.

1. .....

.....

2. .....

..... [3]

(c) State **two** different safety precautions that would need to be taken when carrying out this investigation.

1. .....

2. ..... [2]

Q# 3/ iGCSE Chem/2011/w/Paper 6/

6 Seawater contains sodium chloride and other salts.
Plan an experiment to find the mass of salts in 1 dm^3 of seawater.
You will be provided with a small bottle of seawater.
You should include details of the method and any apparatus used.
(1 dm^3 = 1000 cm^3)

.....

.....

.....

.....

.....

.....

.....

..... [6]

Q# 4/ iGCSE Chem/2010/w/Paper 6/

7 E numbers identify chemicals which are added to foods.

(c) E110 is Sunset yellow.
Outline a method you could use to show the presence of E110 in a food colouring.
A space has been left if you want to draw a diagram to help you answer the question.

.....

.....

.....

.....

..... [4]

Q# 5/ iGCSE Chem/2009/w/Paper 6/

7 Leaves from trees contain a mixture of coloured pigments which are not soluble in water. A student was given these two instructions to investigate the pigments in the leaves.

1. Crush some leaves to extract the coloured pigments.
2. Use the liquid extract to find the number of coloured pigments in the leaves.

(a) What would the student need in order to effectively carry out instruction 1?

.....

.....

.....

..... [3]

(b) Describe an experiment to carry out instruction 2.
A space has been left below if you want to draw a diagram to help answer the question.

.....

.....

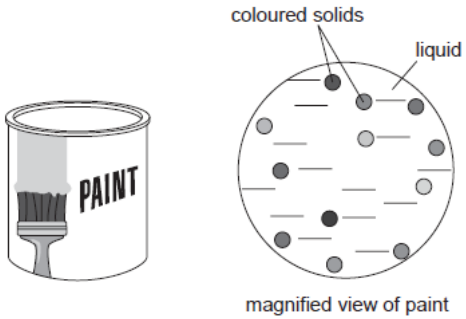
.....

.....

..... [4]

Q# 6/ iGCSE Chem/2006/w/Paper 6/

6 You are provided with a pot of paint as shown below.



The paint is a mixture of a liquid and a solid.
The liquid can be dissolved in water. The solids are insoluble in water but soluble in organic solvents.

(b) How would you determine the number of coloured substances contained in the solid you separated in **(a)**?

.....

.....

.....

..... [4]

Q# 7/ iGCSE Chem/2005/w/Paper 6/

3 The green pigment chlorophyll can be obtained from grass.

Step 1 The grass is crushed with sand.

Step 2 The grass is ground with ethanol until the solution is saturated.

Step 3 The solution is separated from the rest of the mixture.

Step 4 The colours in the solution are separated.

(d) Describe how Step 4 is carried out.

.....

.....

.....

..... [4]

Q# 8/ iGCSE Chem/2004/w/Paper 6/

7 **Forged Banknote**

A fake banknote can be investigated by dissolving the ink off the paper.

You are provided with four different inks from four different criminals. Describe an experiment to show which one of these inks is the same as the ink from the banknote.

You can use a labelled diagram to help you answer the question.

.....

.....

.....

.....

.....

..... [6]

Q# 9/ iGCSE Chem/2003/w/Paper 6/

2 A student extracted and investigated the orange colour in some sweets.
The student followed these instructions:

1 *Collect sweets, a watch glass, a beaker, eye protection and 100 cm^3 of ethanol.*

2 *Crush the sweets.*

3 *Place the crushed sweets in the beaker containing 100 cm^3 of ethanol.*

4 *Boil the mixture with the watch glass covering the beaker.*

5 *Decant the liquid and concentrate it by evaporation until the colour is dark orange.*

6 *Investigate which colours are present in the orange solution.*

(f) Describe how the student could carry out instruction 6. You may draw a diagram in the space below to help you answer the question.

.....

.....

.....

.....

.....[5]

4.11.1 EXTENSION EXAM QUESTIONS Paper 6 Topic 2 Long Answer Questions 53 marks Mark Scheme

Q# 1/ iGCSE Chem/2015march/Paper 6/

6 any **seven** from:

extraction

cut leaves up / small pieces / grind / crush (1)

use of pestle / mortar (1)

add water (1)

sand (1)

boil / heat / stir / mix / shake (1)

separation

decant / filter (1)

obtaining crystals

evaporate / heat solution (1)

to crystallising point / until crystals start to form (1)

leave to cool (1) [7]

Q# 2/ iGCSE Chem/2013s/Paper 6/

5 **(a)** both lose mass (1) [1]
not: change mass

(b) mass loss increases constantly in graph **A** (1)

becomes constant in graph **B** (after about 7–9 hours) (1)

mass loss or change is greater in acid/less in alkali (1) [3]

(c) goggles / lab coat / tongs / fume cupboard / well ventilated area any two [2]
ignore: reference to hair

Q# 3/ iGCSE Chem/2011/w/Paper 6/

6 measured volume of seawater (1)
using measuring cylinder (1)
into evaporating dish/beaker (1)
pre-weighed (1)
evaporate/heat (1)
to dryness/constant mass (1)
re-weigh (1)
indication of calculation method (1) max [6]

would not work = max 0

Q# 4/ iGCSE Chem/2010/w/Paper 6/ Q7

(c) marks can be obtained from diagram
chromatography (1) description of applying E110 to paper (1)
use of solvent (1) results / number of spots (1) [4]

Q# 5/ iGCSE Chem/2009/w/Paper 6/

7 **(a)** pestle/mortar/solvent/sand (any three)
ignore water and/or heat [3]

(b) NB marks can be obtained from a diagram
chromatography or chromatogram (1)
paper (1)
apply spot/extract to paper (1)
description or name of solvent used (1)
and separation e.g. spots on paper (1) (max 4) [4]

If water used as solvent (max 3)
If paper dipped into extract (max 3)
If method would not work (max 2)

Q# 6/ iGCSE Chem/2006/w/Paper 6/ Q6

(b) solid + organic solvent(1) add to paper(1)
chromatography(1) use of solvent(1) description of spots(1)
max 4 NB use of water = max 1 for chromatography **[4]**

Q# 7/ iGCSE Chem/2005/w/Paper 6/

3 **(a)** pestle (1) and mortar (1) **[2]**

(b) chlorophyll more soluble in ethanol or similar **[1]**

(c) filtration **[1]**

(d) chromatography (1), paper (1), add pigments (1), use of solvent (1) **[4]**

Q# 8/ iGCSE Chem/2004/w/Paper 6/

7 chromatography (1) apply inks/spots to paper (1)

organic solvent/water (1) rises up paper (1)

check heights/positions of spots (1) compare to find ink from banknote (1) **(6)**

N.B. all marks can be obtained from a diagram

Q# 9/ iGCSE Chem/2003/w/Paper 6/ Q5

(f) Chromatography (1)
Apply orange concentrate (1) to paper (1)
Use of solvent (1)
Description of elution (1)
Result of experiment (1)

Max 5 – all marks could be obtained from a suitable diagram 5

4.12 FUNDAMENTAL Assessed Activity 1 Keyword Test

Only complete this Assessed Activity if you are struggling in this subject and finding the course and the language really difficult.

English	Meaning
distillation	
downward delivery	
risk assessment	
R_f value	
chromatogram	
locating agent	
soluble	
saturated solution	
solvent front	
solubility	
chromatography	
filtrate	
mixture	
pure substance	
crystallisation	
fractional distillation	

English	Meaning
decanting	
upward delivery	
filtration	
solute	
solvent	
residue	
insoluble	
solution	

4.13 ESSENTIAL Assessed Activity 2 –Which separation technique?

Q#1/

1 The following techniques are used to separate mixtures.

A simple distillation **B** fractional distillation **C** evaporation

D chromatography **E** filtration **F** diffusion

From this list, choose the most suitable technique to separate the following.

(a) methane from a mixture of the gases, methane and ethane ..... [1]

(b) water from aqueous magnesium sulfate ..... [1]

(c) glycine from a mixture of the amino acids, glycine and lysine ..... [1]

(d) iron filings from a mixture of iron filings and water ..... [1]

(e) zinc sulfate crystals from aqueous zinc sulfate ..... [1]

(f) hexane from a mixture of the liquids, hexane and octane ..... [1]

[Total: 6]

EXTENSION activity – How fast can you finish?

Q# 2/

Butane and propane are both gases, silver chloride is a salt that is insoluble in water, glucose and maltose are both sugars.

1 A list of techniques used to separate mixtures is given below.

filtration

diffusion

fractional distillation

simple distillation

crystallisation

chromatography

From this list, choose the most suitable technique to separate the following mixtures.
A technique may be used once, more than once or not at all.

(a) butane from a mixture of propane and butane ..... [1]

(b) oxygen from liquid air ..... [1]

(c) water from aqueous magnesium sulfate ..... [1]

(d) potassium chloride from aqueous potassium chloride ..... [1]

(e) silver chloride from a mixture of silver chloride and water ..... [1]

(f) glucose from a mixture of glucose and maltose ..... [1]

Q# 3/

Helium and argon are gases at room temperature.
Barium sulphate does not dissolve in water.

1 A list of techniques used to separate mixtures is given below.

fractional distillation **simple distillation** **crystallization** **filtration** **diffusion**

From the list choose the most suitable technique to separate the following.

water from aqueous copper(II) sulphate .....

helium from a mixture of helium and argon .....

copper(II) sulphate from aqueous copper(II) sulphate .....

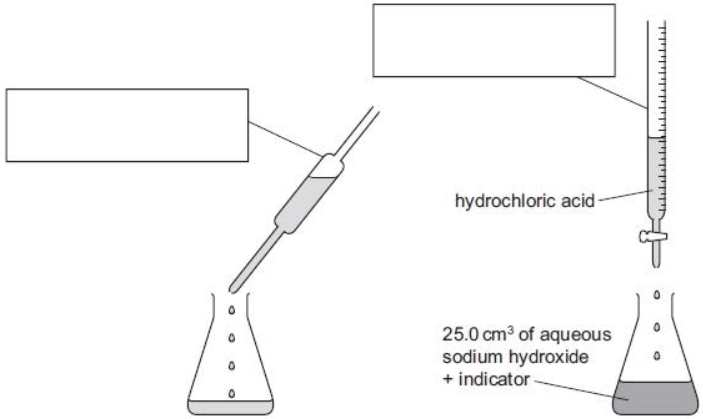
ethanol from aqueous ethanol .....

barium sulphate from a mixture of water and barium sulphate ..... [5]

4.14 ESSENTIAL Assessed Activity 3 Labelling equipment

Q# 2/

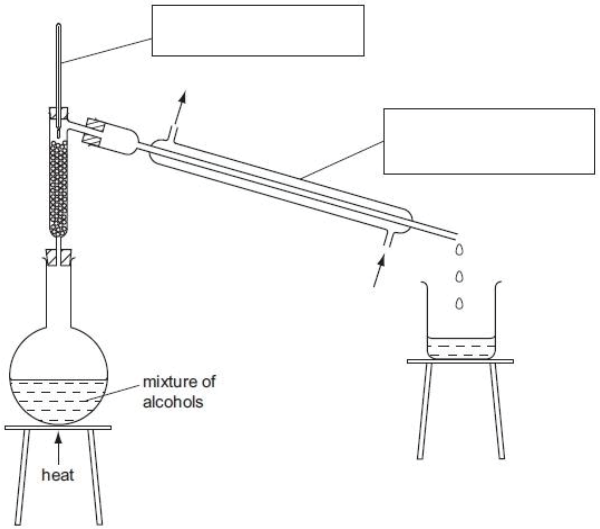
1 The volume of hydrochloric acid that reacts with 25.0 cm^3 of aqueous sodium hydroxide can be found using the apparatus below.



(a) Complete the boxes to identify the pieces of apparatus labelled. [2]

Q# 3/

1 A student separated a mixture of two alcohols, ethanol (boiling point 78 °C) and butanol (boiling point 118 °C).
The apparatus used is shown below.



(a) Complete the boxes to identify the pieces of apparatus labelled. [2]

(b) Label the arrows. [1]

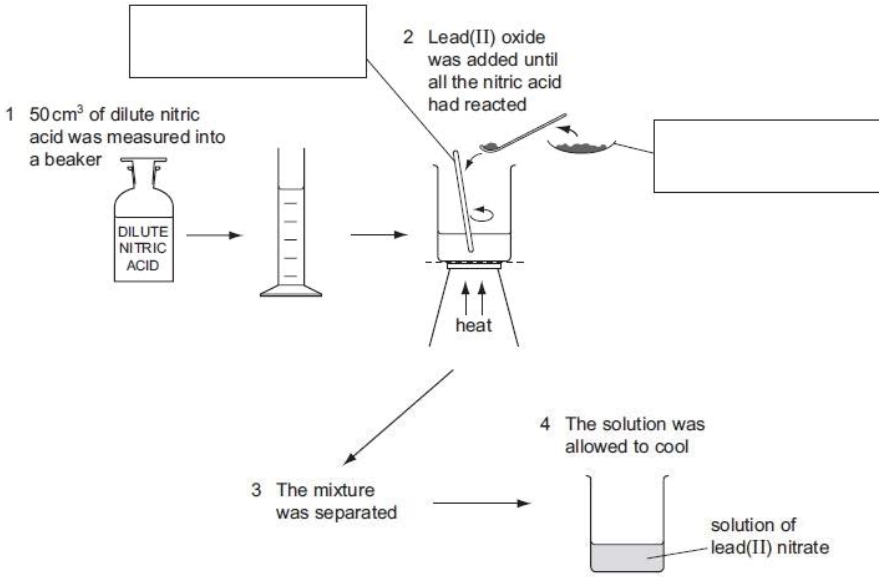
(e) Identify and explain a possible hazard in this experiment.

.....

..... [2]

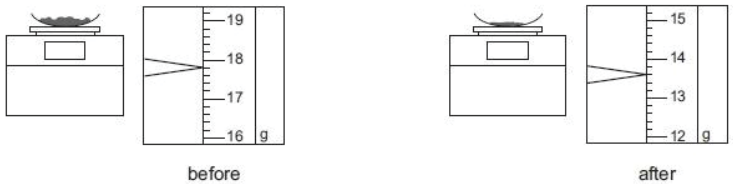
Q# 4/

1 A student reacted dilute nitric acid with lead(II) oxide to prepare lead(II) nitrate. The diagram shows the stages in the method used.



(a) Complete the boxes to identify the pieces of apparatus. [2]

(c) The lead(II) oxide was weighed before and after the additions.



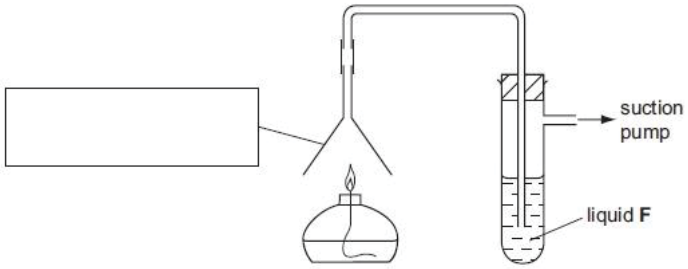
Use the balance diagrams to work out the mass of lead(II) oxide added to the dilute nitric acid.

..... [2]

Extension work Labelling equipment

Q# 6/

1 A student investigated the products formed when ethanol was burned using the apparatus shown.



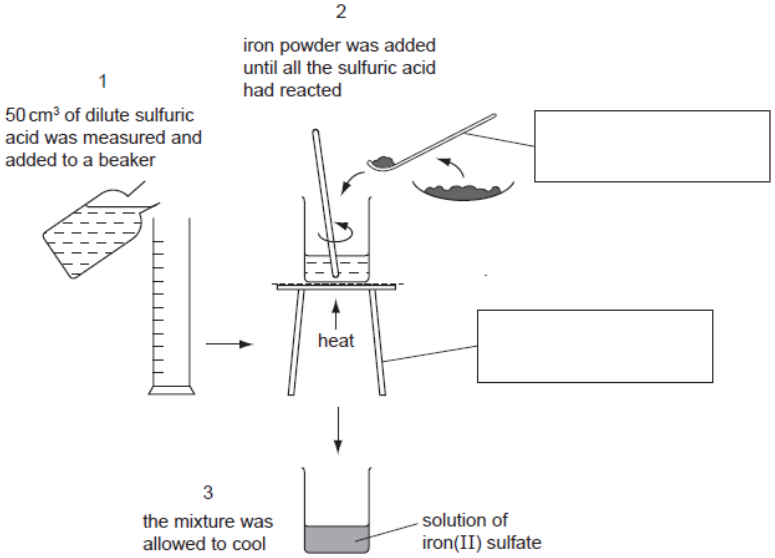
(a) Complete the box to identify the piece of apparatus. [1]

(b) Why is a suction pump used?

..... [1]

Q# 7/

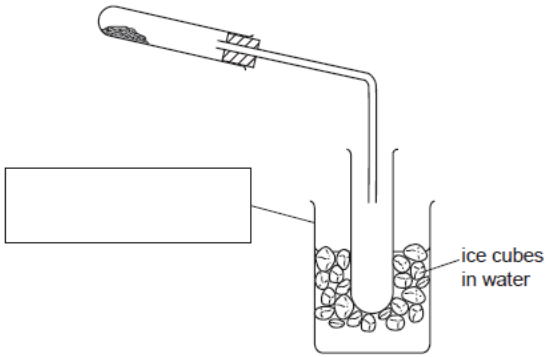
1 A student reacted excess iron powder with sulfuric acid to prepare a solution of iron(II) sulfate.
The diagram shows the procedure followed in three stages.



(a) Complete the boxes to identify the pieces of apparatus labelled. [2]

Q# 8/

1 A student heated hydrated zinc sulfate crystals, $ZnSO_4.7H_2O$, using the apparatus below to obtain a sample of water.



(a) Complete the box to identify the piece of apparatus labelled. [1]

(b) Use labelled arrows to indicate:

(i) where the heat is applied,

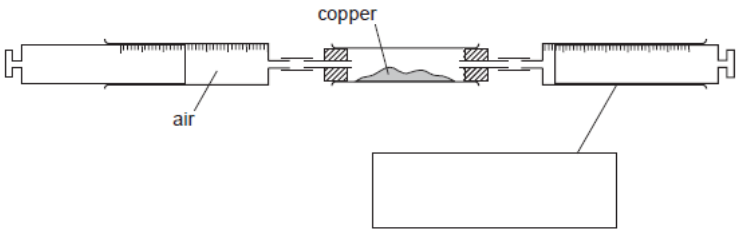
(ii) where the sample of water would collect. [2]

(c) State the purpose of the ice cubes.

..... [1]

Q# 9/

1 A student investigated the reaction of air with copper. 100 cm³ of air was passed continuously over heated copper using the apparatus below. When the volume remained constant, the apparatus was left to cool and the volume of gas was measured.

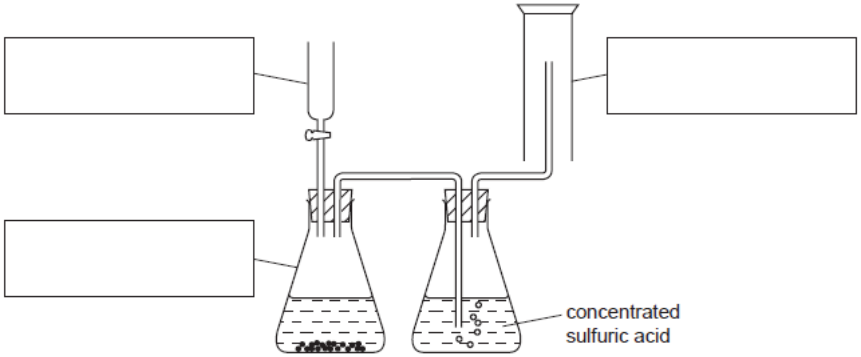


(a) **(i)** Complete the box to show the apparatus labelled. [1]

(ii) Indicate on the diagram, with an arrow, where heat is applied. [1]

Q# 10/ iGCSE Chem/2010s/Paper 6/

1 The diagram shows the apparatus used to prepare a gas. The gas is more dense than air.



(a) Complete the boxes to name the apparatus. [3]

4.15 Extension Mind Map for Topic 2 Experimental Techniques and Seperation

4.16 Essential End of Topic 2 Review and Reflection

Looking at the goals you could have achieved and the goals you actually achieved try to reflect on your progress.

Try to be as honest and as detailed as possible. Sometimes you may think you have thought about an idea well, but when you talk with someone else, or write it out, it helps you better understand and allows you think more completely and more clearly.

Did you achieve more goals this topic than last topic?

Fill in this table

Level	Number of goals achieved at each level	Success rate, %
FUNDAMENTAL	/5	
ESSENTIAL	/10	
EXTENSION	/13	
EXCEPTIONAL	/10	

Do you feel you tired harder? If yes, what helped you to do so? If not, why not?

What could you do differently next time, in addition to what you are already doing to improve, not only your score in the end of topic tests and other assessed activities, but also in how you learn. How could you become a more effective student to get more learning out of the time you are investing in your studies?

What did you enjoy most about this topic?

What did you find most difficult?

What did you find easiest?

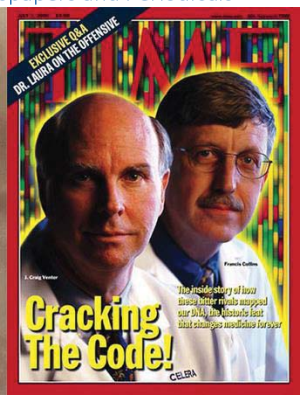
On a scale of 1 being hardest and 5 being most difficult, circle how challenging you found this topic

1 2 3 4 5

What could be done to make this topic easier to understand?

Do you have any questions about this topic?

4.17 Topic 2 EXCEPTIONAL Reading Magazines, Newspapers and Periodicals



Learning about science y reading newspapers, journals, and popular science magazines. Not all of these magazines can be accessed everywhere, but it is important that you understand and read as widely as you can, especially about the subject you are interested in pursuing at A levels and beyond. You may need to buy a subscription, but the school library also has an excellent selection of current magazines and newspapers.

To give you a sample of the kinds of articles and things you could be reading I've downloaded selected articles that relate to this topic, which is about experiments. If you find the language challenging, which is likely, instead of reading for meaning you could instead try reading for vocabulary, print out an article and translate any words you may find. One way to learn another language if you are already very confident in that language is to explain the meaning of new words in English, rather than simply translate them. All are available from here:

https://www.smashingsciencecn.org/igcse-chem-additional-resources

- The Atlantic (an article which helped to introduce the idea that medicine and chemistry might be a new direction in healthcare, back in 1909)
- The Economist, possibly the most read newspaper by CEO's and corporate executives, as well as politicians and academics, published an article which challenged the idea that science is getting better
- The Smithsonian looked at 10 of the most interesting experiments
- The New York Times also looked at 10 important experiments
- Some of the most popular online (and sometimes offline) sources for news aimed at an educated general audience include:
- https://www.wired.com/
- https://www.newscientist.com/
- https://www.scientificamerican.com/
- National Institute of Health: https://kids.niehs.nih.gov/
- Smithsonian website: https://ssec.si.edu/ and https://www.si.edu/kids
- And especially Wikipedia, which also has a Simple English version: https://simple.wikipedia.org/wiki/Main_Page

Academic Journals

This is where new science and discoveries is reported to the scientific community, and then the world. They follow a very specific set of rules, and try to explain exactly what they did in their experiments and what they think their results mean. Normally, even after finishing a degree it is difficult to understand what is going on in these articles (usually you just the read the abstract, which tells you roughly what they found out, and sometimes the conclusions, which tells you in more detail why their study matters) The two most famous journals are : "Nature" and "Science".

You are unlikely to understand anything about these, but two famous experiments are included if you go to the iGCSE Additional Resources webpage.

5 Topic 4.1 Stoichiometry

5.1 End of Topic 4.1 Goals Checklist

For each topic you ought to try to do as many of the following things to get the most out of your time, the resources available to you and to help you grow as a student. Tick each goal off as you complete it. Growth is difficult and uncomfortable, but you should choose to do these things, and the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win!

Aspect	What you should have done	Yes/No	Level
Interacted with your teacher	Ask your teacher 1 question, about anything, once a week		FUNDAMENTAL
	Try to answer one question asked by your teacher at least once a week		ESSENTIAL
	Ask your teacher one question about something you do not understand in science once a week		ESSENTIAL
	Ask your teacher one question about something to do with science every lesson		EXTENSION
Notes and follow up notes	Complete set of class note		FUNDAMENTAL
	Cornell Notetaking Attempted		ESSENTIAL
	Cornell Notetaking Completed		EXTENSION
	Cornell Notetaking Completed to an exemplary standard		EXCEPTIONAL
	Attempted the Mind Map for this topic		ESSENTIAL
	Completed the Mind Map for this topic		EXTENSION
Textbook	Read ahead before the topic has been started		EXTESNION
	Highlighted key ideas and translate new words		FUNDAMENTAL
	Completed the questions at the end of each 2 page spread in your exercise book		EXTENSION
	Added to your class notes ideas and important information from the textbook that you learnt		EXTENSION
Past Exam Questions	Worked on at least 25% of the exam questions in this workbook		FUNDAMENTAL
	Attempted more than 25% of the questions and those questions you have completed you have marked in a different colour pen		ESSENTIAL
	Completed and marked all questions here		EXTENSION
	Completed, marked and additional key ideas where you have located the most difficult marks added to your notebook		EXCEPTIONAL
	Used the resources available online to answer additional questions not found in this workbook on the current topic.		EXCEPTIONAL
	Ask your teacher about an exam question that they cannot answer		EXCEPTIONALLY SMASHING!!!
Assessed Activities	Complete the word list activity using the word list at the front of each topic as little as possible		FUNDAMENTAL
	Complete 2 assessed activities, either in class or as homework		ESSENTIAL
	Complete 2 assessed activities and scored over 70% on average		ESSENTIAL
	Complete 2 assessed activities and scored over 80% on average		EXTENSION
	Complete 2 assessed activities and scored over 90% on average		EXCEPTIONAL
End of Topic Test	Revised sufficiently well to improve upon your score from the previous test (except if you are scoring over 90%, then just write Y for this goal)		ESSENTIAL
	Scored 10% higher than your current average		EXTENSION
	Scored 15% or more than your previous end of topic average		EXCEPTIONAL
	Scored over 90%		EXTESNION
	Scored over 95%		SMASHING!!!

Aspect	What you should have done	Yes/No	Level
Reading	Spend more than 1 hour a week reading a book **you enjoy** (in any language) about anything.		ESSENTIAL
	Spend more than 3 hours a week reading a book **you enjoy** (in any language) about anything.		EXTENSION
	Spend more than 5 hours a week reading a book **you enjoy** (in any language) about anything.		EXCEPTIONAL
	Spend at least one hour a week reading a book **you enjoy** in English about anything.		EXTENSION
	Spend more than 3 hours a week reading a book **you enjoy** in English about anything.		EXCEPTIONAL
Reflection	You completed this goal setting table		FUNDAMENTAL
	You have looked at the goals you have achieved and the ones you have not and added them up and entered them into the table in the Review and Reflection section		ESSENTIAL
	You have given an answer for every question in the Review and Reflection section at the end of this topic		EXTENSION
	You have Given good and thoughtful answers for every question in the Review and Reflection section at the end of this topic		EXCEPTIONAL

5.2 Topic 4.1 Syllabus

4 Stoichiometry

4.1 Stoichiometry

Core

- Use the symbols of the elements and write the formulae of simple compounds
- Deduce the formula of a simple compound from the relative numbers of atoms present
- Deduce the formula of a simple compound from a model or a diagrammatic representation
- Construct word equations and simple balanced chemical equations
- Define *relative atomic mass*, A_r, as the average mass of naturally occurring atoms of an element on a scale where the ^{12}C atom has a mass of exactly 12 units
- Define *relative molecular mass*, M_r, as the sum of the relative atomic masses. (*Relative formula mass* or M_r will be used for ionic compounds.)

  (Calculations involving reacting masses in simple proportions may be set. Calculations will **not** involve the mole concept.)

Supplement

- Determine the formula of an ionic compound from the charges on the ions present
- Construct equations with state symbols, including ionic equations
- Deduce the balanced equation for a chemical reaction, given relevant information

5.3 ESSENTIAL Glossary for Keywords for this topic (4.1 Stoichiometry)

Topic #	English	Chinese
	balanced chemical (symbol) equation a summary of a chemical reaction using chemical formulae – the total number of any of the atoms involved is the same on both the reactant and product sides of the equation	平衡化学（符号）方程式-使用化学式进行化学反应的摘要–涉及的任何原子总数在方程式的反应物和产物侧均相同
	chemical reaction a change in which a new substance is formed	化学反应形成新物质的变化
	formula (chemical) a shorthand method of representing chemical elements and compounds using the symbols of the elements	公式（化学）：使用元素符号表示化学元素和化合物的简写方法
	ionic equation the simplified equation for a reaction involving ionic substances: only those ions which take part in the reaction are shown	离子方程式涉及离子物质的反应的简化方程式：仅显示那些参与反应的离子
	law of conservation of mass matter cannot be lost or gained in a chemical reaction – the total mass of the reactants equals the total mass of the products	物质守恒定律在化学反应中不会丢失或获得–反应物的总质量等于产物的总质量
	molecular formula a formula which shows the actual number of atoms of each element present in a molecule of the compound	分子式，表示化合物分子中存在的每种元素的实际原子数的分子式
	molecular mass another, less precise, name for relative molecular mass	分子量相对不太精确的另一个称呼是相对分子量
	products (in a chemical reaction) the substance(s) produced by a chemical reaction	产品（在化学反应中）由化学反应产生的物质
	reactants (in a chemical reaction) the chemical substances that react together in a chemical reaction	反应物（在化学反应中）在化学反应中一起反应的化学物质
	spectator ions these are present in a chemical reaction but take no part in it. They are not included in ionic equations	这些离子存在于化学反应中，但不参与其中。它们不包含在离子方程式中
	standard atom the atom against which the relative atomic masses of all other atoms are measured using the mass spectrometer; one atom of the carbon-12 isotope is given a mass of exactly 12	标准原子使用质谱仪测量所有其他原子的相对原子质量的原子；碳12同位素的一个原子的质量刚好为12
	state symbols these are used to show the physical state of the reactants and products in a chemical reaction: they are (s) solid, (l) liquid, (g) gas and (aq) dissolved in solution in water	状态符号，用于显示化学反应中反应物和产物的物理状态：它们是（s）固体，（l）液体，（g）气体和（aq）溶解在水中的溶液
	symbol (chemical) a simple letter, or group of letters, that represents an element in a chemical formula	符号（化学）一个简单的字母或一组字母，代表化学式中的元素
	word equation a summary of a chemical reaction using the chemical names of the reactants and products	词方程式，是使用反应物和产物的化学名称进行的化学反应的摘要
	relative formula mass (*Mr*) the sum of all the relative atomic masses of the atoms present in a 'formula unit' of a substance	相对公式质量（Mr）物质"公式单位"中存在的所有原子的相对原子质量的总和
	relative molecular mass (*Mr*) the sum of all the relative atomic masses of the atoms present in a molecule	相对分子质量（Mr）分子中所有原子的所有相对原子质量的总和

5.3.1 Other Keywords that are needed for Topic 4.2 which will be covered later on in your studies:

Topic #	English	Chinese
1	**concentration** a measure of how much solute is dissolved in a solvent. Solutions can be **dilute** (with a high proportion of the solvent), or **concentrated** (with a high proportion of the solute)	浓度衡量溶质溶解在溶剂中的量度。溶液可以是稀溶液（高比例的溶剂），也可以是浓缩液（高比例的溶质）
1	**empirical formula** a formula for a compound which shows the simplest ratio of atoms present	经验公式化合物的公式，显示存在的最简单的原子比
1	**hydrated salts** ionic compounds that contain water of crystallisation between the ions within the solid	在固体中离子之间含有结晶水的水合盐离子化合物
1	**molar concentration** the measure of the concentration of a solution in terms of the number of moles of the solute dissolved per cubic decimetre of solution (mol/dm3)	摩尔浓度溶液浓度的量度，以每立方米溶液中溶解的溶质的摩尔数表示（mol / dm3）
1	**molar mass** the mass, in grams, of one mole of a substance	摩尔质量一摩尔物质的质量，以克为单位
1	**molar volume of a gas** one mole of any gas has the same volume under the same conditions of temperature and pressure (24 dm3 at one atmosphere and room temperature)	气体的摩尔体积一摩尔的任何气体在相同的温度和压力条件下（在一个大气压和室温下为24 dm3）具有相同的体积
1	**mole** the measure of amount of substance in chemistry; one mole of a substance has a mass equal to its relative formula mass in grams – that amount of substance contains 6.02×10^{23} (the **Avogadro constant**) atoms, molecules or formula units depending on the substance considered	摩尔化学中物质含量的量度；一摩尔物质的质量等于其相对分子式的质量（以克为单位）–该物质的数量包含6.02×1023（Avogadro常数）原子，分子或分子式，具体取决于所考虑的物质
1	**percentage purity** a measure of the purity of the product from a reaction carried out experimentally: percentage purity = mass of pure product mass of impure product ×100	纯度百分比衡量通过实验进行的反应的产物纯度的度量：纯度百分比=纯产物的质量不纯产物的质量×100
1	**percentage yield** a measure of the actual yield of a reaction when carried out experimentally compared to the theoretical yield calculated from the equation: percentage yield = actual yield predicted yield ×100	产率百分比相对于根据等式计算出的理论产率，通过实验进行的反应实际产率的量度：产率百分比=实际产率，预测产率×100
1	**standard solution** a solution whose concentration is known precisely – this solution is then used to find the concentration of another solution by titration	标准溶液一种浓度精确已知的溶液–然后将该溶液用于通过滴定找到另一种溶液的浓度
1	**structural formula** the structural formula of an organic molecule shows how the atoms and bonds in a molecule are arranged in space: all the atoms and covalent bonds must be shown	结构分子式：有机分子的结构式表明分子中的原子和键如何在空间中排列：必须显示所有原子和共价键
1	**titration** a method of quantitative analysis using solutions: one solution is slowly added to a known volume of another solution using a burette until an end-point is reached	使用溶液进行滴定的定量分析方法：使用滴定管将一种溶液缓慢添加到已知体积的另一种溶液中，直至达到终点
1	**water of crystallisation** water included in the structure of certain salts as they crystallise; for example, copper(II) sulfate pentahydrate (CuSO4.5H2O) contains five molecules of water of crystallisation per molecule of copper(II) sulfate	结晶水某些盐的结晶过程中所含的水；例如，五水合硫酸铜（II）（CuSO4.5H2O）每分子硫酸铜（II）包含五分子结晶水

5.4 EXTENSION Keywords

You do not need to understand these words to score a good A, or even a low A* but if you are aiming for a good or high A* then understanding words like these here will be helpful.

Avogadro constant another name for a mole	Avogadro常数痣的另一个名字
mass concentration the measure of the concentration of a solution in terms of the mass of the solute, in grams, dissolved per cubic decimetre of solution (g/dm3)	质量浓度，以每立方分米溶液中溶解的溶质质量（克）为单位的溶液浓度的量度（g / dm3）
relative atomic mass (*A*r) the average mass of an atom of an element, taking account of the isotopes of the element, on a scale where a carbon-12 atom has a mass of exactly 12	相对原子质量（Ar）元素的原子平均质量，考虑到元素的同位素，碳12原子的质量恰好为12

5.5 ESSENTIAL Active Learning Activity 1 Balancing chemical equations

Part 1

1. ____ Fe + ____ H_2SO_4 → ____ $Fe_2(SO_4)_3$ + ____ H_2
2. ____ C_2H_6 + ____ O_2 → ____ H_2O + ____ CO_2
3. ____ KOH + ____ H_3PO_4 → ____ K_3PO_4 + ____ H_2O
4. ____ SnO_2 + ____ H_2 → ____ Sn + ____ H_2O
5. ____ NH_3 + ____ O_2 → ____ NO + ____ H_2O
6. ____ KNO_3 + ____ H_2CO_3 → ____ K_2CO_3 + ____ HNO_3
7. ____ B_2Br_6 + ____ HNO_3 → ____ $B(NO_3)_3$ + ____ HBr
8. ____ BF_3 + ____ Li_2SO_3 → ____ $B_2(SO_3)_3$ + ____ LiF
9. ____ $(NH_4)_3PO_4$ + ____ $Pb(NO_3)_4$ → ____ $Pb_3(PO_4)_4$ + ____ NH_4NO_3
10. ____ $SeCl_6$ + ____ O_2 → ____ SeO_2 + ____ Cl_2

Part 2

1. ____ CH_4 + ____ O_2 → ____ CO_2 + ____ H_2O

2. ____ Na^+ + ____ Cl^- → ____ NaCl

3. ____ Al + ____ O_2 → ____ Al_2O_3

4. ____ N_2^+ + ____ H_2 → ____ NH_3

5. ____ CO(g) + ____ $H_2(g)$ → ____ $C_8H_{18}(l)$ + ____ H_2O

6. ____ $FeO_3(s)$ + ____ CO(g) → ____ Fe(l) + ____ $CO_2(g)$

7. ____ H_2SO_4 + ____ $Pb(OH)_4$ → ____ $Pb(SO_4)_2$ + ____ H_2O

8. ____ Al + ____ HCl → ____ $AlCl_3$ + ____ H_2

9. ____ $Ca_3(PO_4)_2$ + ____ H_2SO_4 → ____ $CaSO_4$ + ____ $Ca(H_2PO_4)_2$

10. ____ H_3PO_4 + ____ HCl → ____ PCl_5 + ____ H_2O

Extension activity

Name as many of the chemicals above as you can.

5.5.1 Active Learning Activity Balancing chemical equations Mark Scheme

Part 1

1. 2 Fe + 3 H_2SO_4 → 1 $Fe_2(SO_4)_3$ + 3 H_2
2. 2 C_2H_6 + 7 O_2 → 6 H_2O + 4 CO_2
3. 3 KOH + 1 H_3PO_4 → 1 K_3PO_4 + 3 H_2O
4. 1 SnO_2 + 2 H_2 → 1 Sn + 2 H_2O
5. 4 NH_3 + 5 O_2 → 4 NO + 6 H_2O
6. 2 KNO_3 + 1 H_2CO_3 → 1 K_2CO_3 + 2 HNO_3
7. 1 B_2Br_6 + 6 HNO_3 → 2 $B(NO_3)_3$ + 6 HBr
8. 2 BF_3 + 3 Li_2SO_3 → 1 $B_2(SO_3)_3$ + 6 LiF
9. 4 $(NH_4)_3PO_4$ + 3 $Pb(NO_3)_4$ → 1 $Pb_3(PO_4)_4$ + 12 NH_4NO_3
10. 1 $SiCl_4$ + 1 O_2 → 1 SiO_2 + 3 Cl_2

Part

1. 1 CH_4 + 2 O_2 → 1 CO_2 + 2 H_2O
2. 2 Na^+ + 2 Cl^- → 1 NaCl
3. 4 Al + 3 O_2 → 2 Al_2O_3
4. 1 N_2^+ + 3 H_2 → 2 NH_3
5. 8 CO(g) + 17 $H_2(g)$ → 1 $C_8H_{18}(l)$ + 8 H_2O
6. 1 $FeO_3(s)$ + 3 CO(g) → 1 Fe(l) + 3 $CO_2(g)$
7. 2 H_2SO_4 + 1 $Pb(OH)_4$ → 1 $Pb(SO_4)_2$ + 4 H_2O
8. 2 Al + 6 HCl → 2 $AlCl_3$ + 3 H_2
9. 1 $Ca_3(PO_4)_2$ + 2 H_2SO_4 → 2 $CaSO_4$ + 1 $Ca(H_2PO_4)_2$
10. 1 H_3PO_4 + 5 HCl → 1 PCl_5 + 4 H_2O

5.6 FUNDAMENTAL Active Learning Activity 2 Table of Common, and Not-So Common Ions

Fundamental Activity

Use the information on the next page to find these ions and write out their chemical formula:

Ion	
Carbonate	
Phosphate	
Sulfate	
Nitrate	
Ammonium	
Silver	

Exceptional Reflection:

Transition metals are commonly said, at iGCSE to all have variable oxidation states, but some transition metals listed here are only given one charge. Can you think of why this may be? Is it accurate to call elements like Zn and CD transition metals? If you go onto a website like ChemGuide find out if these metals really are considered transition metals (this is A-level material) either by scanning this code or clicking the link below:

https://www.chemguide.co.uk/inorganic/transition/features.html#top

Table of Ions and Charges

Polyatomic Ions

-1charge

acetate, $C_2H_3O_2^-$, or CH_3COO^-
chlorate, ClO_3^-
chlorite, ClO_2^-
cyanide, CN^-
hydrogen carbonate, HCO_3^-
(also called bicarbonate)
hydroxide, OH^-
hypochlorite, ClO^-
iodate, IO_3^-
nitrate, NO_3^-
nitrite, NO_2^-
permanganate, MnO_4^-
perchlorate, ClO_4^-

-2charge

carbonate, CO_3^{-2}
chromate, CrO_4^{-2}
dichromate, $Cr_2O_7^{-2}$
sulfate, SO_4^{-2}
sulfite, SO_3^{-2}

-3 charge

phosphate, PO_4^{-3}
phosphite, PO_3^{-3}

+1 charge

ammonium, NH_4^+

Transition Metals without varying charges:

Ag^+	silver
Cd^{2+}	cadmium
Zn^{2+}	zinc

Transition Metals with varying charges:

Ion	Systematic Name
Fe^{3+}	iron(III)
Fe^{2+}	iron(II)
Cu^{2+}	copper(II)
Cu^+	copper(I)
Co^{3+}	cobalt(III)
Co^{2+}	cobalt(II)
Sn^{4+}	tin(IV)
Sn^{2+}	tin(II)
Pb^{4+}	lead(IV)
Pb^{2+}	lead(II)

5.7 ESSENTIAL Active Learning Activity Naming Chemical Compounds

Use the table from the last page to name the following compounds

1. The formulas and common names for several substances are given below. Give the systematic names for these substances. (see ion name table on the last page.)

	Common Name	Chemical Formula	Systematic Name
a.	Sugar of lead	$Pb(C_2H_3O_2)_2$	Lead (II) Ethanoate
b.	Blue vitrol	$CuSO_4$	
c.	Epsom salts	$MgSO_4$	
d.	Milk of magnesia	$Mg(OH)_2$	
e.	Gypsum	$CaSO_4$	
f.	Laughing gas	N_2O	

2. Write the formula for each of the following compounds:

a. Sulfur difluoride		g. Ammonium acetate	
b. Sulfur hexafluoride		h. Ammonium hydrogen carbonate	
c. Sodium phosphate		i. Cobalt (III) nitrate	
d. Lithium nitride		j. Copper (II) chloride	
e. Chromium (III) carbonate		k. Potassium sulfite	
f. Tin (II) fluoride		l. Sodium hydroxide	

3. EXTENSION Name each of the following compounds

a. CuF		i. $NaNO_3$	
b. CdI_2		j. $Ca(NO_2)_2$	
c. HI		k. $Mg_3(PO_4)_2$	
d. NO		l. H_3P	
e. NF_3		m. Na_2SO_4	
f. N_2Cl_2		n. $Ca(HCO_3)_2$	
g. CF_4			
h. KCl			

5.7.1 Naming Chemical Compounds Mark Scheme

1.
a. lead (II) acetate
b. copper (II) sulfate
c. magnesium sulfate
d. magnesium hydroxide
e. calcium sulfate
f. dinitrogen monoxide

2.
a. SF_2
b. SF_6
c. Na_3PO_4
d. Li_3N
e. $Cr_2(CO_3)_3$
f. SnF_2
g. $NH_4C_2H_3O_2$ or NH_4CH_3COO
h. NH_4HCO_3
i. $Co(NO_3)_3$
j. $CuCl_2$
k. K_2SO_3
l. NaOH

3
a. copper (I) fluoride
b. cadmium iodide
c. hydrogen moniodide
d. nitrogen monoxide
e. nitrogen trifluoride
f. dinitrogen dichloride
g. carbon tetrafluoride
h. potassium chloride
i. sodium nitrate
j. calcium nitrite
k. magnesium phosphate
l. trihydrogen monophosphide
m. sodium sulfate
n. calcium hydrogen carbonate or calcium bicarbonate

5.8 EXCEPTIONAL INFORMATION Naming compounds (Nomenclature) – The Complete Set of Rules

These rules go into even more detail than is needed at A level, but knowing that these rules exist is important for the very ablest students and hopefully will allow you to make sense of the names you will throughout your career in chemistry.

From: https://chemed.chem.purdue.edu/genchem/topicreview/bp/ch2/names.html

Long before chemists knew the formulas for chemical compounds, they developed a system of **nomenclature** that gave each compound a unique name. Today we often use chemical formulas, such as NaCl, $C_{12}H_{22}O_{11}$, and $Co(NH_3)_6(ClO_4)_3$, to describe chemical compounds. But we still need unique names that unambiguously identify each compound.

Common Names

Some compounds have been known for so long that a systematic nomenclature cannot compete with well-established common names. Examples of compounds for which common names are used include water (H_2O), ammonia (NH_3), and methane (CH_4).

Naming Ionic Compounds

(Metals with Non-metals)

The names of ionic compounds are written by listing the name of the positive ion followed by the name of the negative ion.

NaCl	sodium chloride
$(NH_4)_2SO_4$	ammonium sulfate
$NaHCO_3$	sodium bicarbonate

We therefore need a series of rules that allow us to unambiguously name positive and negative ions before we can name the salts these ions form.

Naming Positive Ions

Monatomic positive ions have the name of the element from which they are formed.

Na^+	sodium	Zn^{2+}	zinc
Ca^{2+}	calcium	H^+	hydrogen
K^+	potassium	Sr^{2+}	strontium

Some metals form positive ions in more than one oxidation state. One of the earliest methods of distinguishing between these ions used the suffixes *-ous* and *-ic* added to the Latin name of the element to represent the lower and higher oxidation states, respectively.

Fe^{2+}	ferrous	Fe^{3+}	ferric
Sn^{2+}	stannous	Sn^{4+}	stannic
Cu^+	cuprous	Cu^{2+}	cupric

Chemists now use a simpler method, in which the charge on the ion is indicated by a Roman numeral in parentheses immediately after the name of the element.

Fe^{2+}	iron(II)	Fe^{3+}	iron (III)
Sn^{2+}	tin(II)	Sn^{4+}	tin(IV)
Cu^+	copper(I)	Cu^{2+}	copper(II)

Polyatomic positive ions often have common names ending with the suffix *-onium*.

H_3O^+	hydronium
NH_4^+	ammonium

Naming Negative Ions

Negative ions that consist of a single atom are named by adding the suffix *-ide* to the stem of the name of the element.

F^-	fluoride	O^{2-}	oxide
Cl^-	chloride	S^{2-}	sulfide
Br^-	bromide	N^{3-}	nitride
I^-	iodide	P^{3-}	phosphide
H^-	hydride	C^{4-}	carbide

Common Polyatomic Negative Ions

	-1 ions		
HCO_3^-	bicarbonate	HSO_4^-	hydrogen sulfate (bisulfate)
$CH_3CO_2^-$	acetate	ClO_4^-	perchlorate
NO_3^-	nitrate	ClO_3^-	chlorate
NO_2^-	nitrite	ClO_2^-	chlorite
MnO_4^-	permanganate	ClO^-	hypochlorite
CN^-	cyanide	OH^-	hydroxide
	-2 ions		
CO_3^{2-}	carbonate	O_2^{2-}	peroxide
SO_4^{2-}	sulfate	CrO_4^{2-}	chromate
SO_3^{2-}	sulfite	$Cr_2O_7^{2-}$	dichromate
$S_2O_3^{2-}$	thiosulfate	HPO_4^{2-}	hydrogen phosphate
	-3 ions		
PO_4^{3-}	phosphate	AsO_4^{3-}	arsenate
BO_3^{3-}	borate		

Naming Polyatomic Ions

At first glance, the nomenclature of the polyatomic negative ions in the table above seems hopeless. There are several general rules, however, that can bring some order out of this apparent chaos.

The name of the ion usually ends in either *-ite* or *-ate*. The *-ite* ending indicates a low oxidation state. Thus,the NO_2^- ion is the nitrite ion.

The *-ate* ending indicates a high oxidation state. The NO_3^- ion, for example, is the nitrate ion.

The prefix *hypo-* is used to indicate the very lowest oxidation state. The ClO- ion, for example, is the hypochlorite ion.

The prefix *per-* (as in hyper-) is used to indicate the very highest oxidation state. The ClO_4^- ion is therefore the perchlorate ion.

There are only a handful of exceptions to these generalizations. The names of the hydroxide (OH^-), cyanide (CN^-), and peroxide (O_2^{2-}) ions, for example, have the *-ide* ending because they were once thought to be monatomic ions.

Naming Simple Covalent Compounds

(Non-metals with non-metals)

Oxidation states also play an important role in naming simple covalent compounds. The name of the atom in the positive oxidation state is listed first. The suffix *-ide* is then added to the stem of the name of the atom in the negative oxidation state.

HCl	hydrogen chloride
NO	nitrogen oxide
BrCl	bromine chloride

As a rule, chemists write formulas in which the element in the positive oxidation state is written first, followed by the element(s) with negative oxidation numbers.

The number of atoms of an element in simple covalent compounds is indicated by adding one of the following Greek prefixes to the name of the element.

1 mono-	6 hexa-
2 di-	7 hepta-
3 tri-	8 octa-
4 tetra-	9 nona-
5 penta-	10 deca-

The prefix *mono-* is seldom used because it is redundant. The principal exception to this rule is carbon monoxide (CO).

Naming Acids

Simple covalent compounds that contain hydrogen, such as HCl, HBr, and HCN, often dissolve in water to produce acids. These solutions are named by adding the prefix *hydro-* to the name of the compound and then replacing the suffix *-ide* with *-ic*. For example, hydrogen chloride (HCl) dissolves in water to form hydrochloric acid; hydrogen bromide (HBr) forms hydrobromic acid; and hydrogen cyanide (HCN) forms hydrocyanic acid.

Many of the oxygen-rich polyatomic negative ions in Table 2.1 form acids that are named by replacing the suffix *-ate* with *-ic* and the suffix *-ite* with *-ous*.

	Acids containing ions ending with ***ide*** often become		***hydro -ic acid***
Cl^-	chloride	HCl	hydrochloric acid
F^-	fluoride	HF	hydrofluoric acid
S^{2-}	sulfide	H_2S	hydrosulfuric acid

	Acids containing ions ending with ***ate*** usually become	***-ic acid***

CH_3CO2^-	acetate	CH_3CO_2H	acetic acid
CO_3^{2-}	carbonate	H_2CO_3	carbonic acid
BO_3^{3-}	borate	H_3BO_3	boric acid
NO_3^-	nitrate	HNO_3	nitric acid
SO_4^{2-}	sulfate	H_2SO_4	sulfuric acid
ClO_4^-	perchlorate	$HClO_4$	perchloric acid
PO_4^{3-}	phosphate	H_3PO_4	phosphoric acid
MnO_4^-	permanganate	$HMnO_4$	permanganic acid
CrO_4^{2-}	chromate	H_2CrO_4	chromic acid
ClO_3^-	chlorate	$HClO_3$	chloric acid
	Acids containing ions ending with ***ite*** usually become		***-ous acid***
ClO_2^-	chlorite	$HClO_2$	chlorous acid
NO_2^-	nitrite	HNO_2	nitrous acid
SO_3^{2-}	sulfite	H_2SO_3	sulfurous acid
ClO^-	hypochlorite	$HClO$	hypochlorous acid

Complex acids can be named by indicating the presence of an acidic hydrogen as follows.

$NaHCO_3$	sodium hydrogen carbonate (also known as sodium bicarbonate)
$NaHSO_3$	sodium hydrogen sulfite (also known as sodium bisulfite)
KH_2PO_4	potassium dihydrogen phosphate

5.9 Active Learning Activity 4 Word and Symbol Equations

Task 1: Complete the following word equations

1- Calcium carbonate + hydrochloric acid → calcium chloride + water + _____ _____

2 _____+ sulfuric acid → magnesium sulfate + hydrogen

3. Magnesium + nitric acid → _____+ hydrogen

4. Zinc hydroxide + _____ → zinc chloride + water

5. _____+ hydrochloric acid → magnesium chloride + water + carbon Dioxide

6. Aluminium + hydrochloric acid → _____ + hydrogen

7. Sodium hydroxide + hydrochloric acid →_____+ _____

8. Sodium carbonate + _____ → sodium sulfate +water + _____ _____

9._____+ nitric acid → calcium nitrate + water + carbon dioxide

10. _____+ sulfuric acid → iron(II) sulfate + hydrogen

Task 2: Complete the following word equations

1- Hydrochloric acid + sodium hydroxide → ..... + ...

2- Sodium + water → ..... + ...

3- Magnesium + oxygen → .....

4- Sulfuric acid + magnesium carbonate → ..... + ... + ...

5- Zinc + copper sulfate → ..... + ...

6- Sulfuric acid + sodium hydroxide → ..... + ...

7- Hydrogen + oxygen → .....

8- Carbon + oxygen → .....

9- Aluminium + nitric acid → ..... + ...

10- Sodium + sulfur → ……

Task 3: Complete and balance the symbol equations

(you are allowed to write in the spaces only)

1. _____ + $2HCl_{(aq)}$ → $MgCl_{2(aq)}$ + $H_2O_{(l)}$ + _____
2. $Mg(OH)_{2(s)}$ + $H_2SO_{4(aq)}$ → _____ + _____
3. $CuO_{(s)}$ + _____ → $Cu(NO_3)_{2(aq)}$ + $H_2O_{(l)}$
4. _____ + $H_2SO_{4(aq)}$ → $MgSO_{4(aq)}$ + $H_2O_{(l)}$
5. _____ + $H_2SO_{4(aq)}$ → $MgSO_{4(aq)}$ + $H_2O_{(l)}$ + $CO_{2(g)}$
6. $Zn(OH)_{2(s)}$ + $2HCl_{(aq)}$ → $ZnCl_{2(aq)}$ + _____
7. $Mg_{(s)}$ + $H_2SO_{4(aq)}$ → _____ + _____

Task 4: Complete the following word equations and write balanced symbol equations

1- Calcium carbonate + hydrochloric acid → ……

Symbol equation:

……

2- Iron (III) oxide + sulfuric acid → ……

Symbol equation:

……

3- Sodium carbonate + sulfuric acid → ……

Symbol equation:

……

4- Zinc + hydrochloric acid → ……

Symbol equation:

……

5- Aluminium + nitric acid → ……

Symbol equation:

……

Extension Word and Symbol Equations

Task 5: Read the following paragraphs about some chemical processes. Write word and balanced chemical symbol equations for reactions 1 to 8

(reactants and products are underlined):

Reaction 1:

In car engines, where the temperature is very high, nitrogen gas reacts with oxygen to form different oxides, one of these oxides is nitrogen dioxide which contributes to acid rain .

……

…….. (3)

Reaction 2

Carbon monoxide, a poisonous gas, is also formed by the reaction of oxygen and carbon (present in fuels).

Car manufactures use catalytic convertors to change these gases into the less harmful products nitrogen, oxygen and carbon dioxide.

……

…….. (3)

Reaction 3

During the process of photosynthesis, plant combine carbon dioxide gas from the atmosphere and water from the soil to produce glucose ($C_6H_{12}O_6$) and oxygen gas

……

…….. (3)

Reaction 4

In respiring, some living organisms burn glucose to produce carbon dioxide gas and water vapor. (Reaction4).

……

…….. (3)

Reaction 5

In an industrial process, limestone (calcium carbonate) is strongly heated to produce quicklime (calcium oxide) and carbon dioxide gas (reaction 5).

……

…….. (3)

Reaction 6

In the presence of water, iron (and steel) articles react with oxygen in the air to form iron (III) oxide (Reaction 6).

……

…….. (3)

Reaction 7
In industry, zinc metal is extracted from zinc blend (zinc sulfide) by heating the blend in air. The products are sulfur dioxide and zinc oxide (reaction7)

……

…….. (3)

Reaction 8
The metal oxide from the previous equations is then heated with carbon to produce the pure metal and a colourless gas (reaction 8)

……

…….. (3)

5.9.1 Word and symbol equations mark scheme

Task 1

1. Carbon dioxide
2. Magnesium
3. Magnesium nitrate
4. Hydrochloric acid
5. Magnesium carbonate
6. Aluminium chloride
7. Sodium chloride + water
8. Sulfuric acid→carbon dioxide
9. Calcium carbonate
10. Iron

Task 2

1. Sodium hydroxide + water
2. Sodium hydroxide + hydrogen
3. Magnesium oxide
4. Magnesium sulfate + carbon dioxide + water
5. Zinc sulfate + copper
6. Sodium sulfate + water
7. Water
8. Carbon dioxide
9. Aluminium nitrate + hydrogen
10. Sodium sulfide

Task 3

1. $MgCO_3(aq) \rightarrow CO_2(g)$
2. $MgSO_{4=}(aq) + H_2O(l)$
3. $2HNO_2(aq)$
4. $Mg(OH)_2(s)$
5. $MgCO_3(s)$
6. $H_2O(l)$
7. $MgSO_4(s) + H_2(g)$

Task 4

1. Calcium chloride + water + carbon dioxide
   $CaCO_3(s) + 2\ HCl\ (aq) \rightarrow CaCl_2\ (aq)\ \ H_2O(l) + CO_2(g)$

2. Iron (III) Sulfate + water
   $Fe_2O_3\ (s) + 3H_2SO_4(aq) \rightarrow Fe_2(SO_4)_3 + 3H_2O(l)$

3. Sodium Carbonate + Sulfuric acid → Sodium sulfate + carbon dioxide + water
   $Na_2CO_3(s) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + CO_2(g) + H_2O(l)$

4. Zinc + hydrochloric acid → Zinc chloride + hydrogen
   $Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$

5. Aluminium + Nitric acid → Alumium nitrate + hydrogen
   $2Al(s) + 6HNO_3(aq) \rightarrow 2Al(NO_3)_3\ (aq) + 3H_2(g)$

Task 6

1. $2N_2(g) + O_2(g) \rightarrow 2NO_2(g)$
2. $2C(s) + O_2(g) \rightarrow 2CO(g)$
3. $6CO_2\ (aq) + 6H_2O(l) \rightarrow C_6H_{12}O_6(aq) + 6O_2(g)$
4. $C_6H_{12}O_6(aq) + 6O_2(g) \rightarrow 6CO_2\ (aq) + 6H_2O(l)$
5. $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$
6. $4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s)$
7. $2ZnS\ (s) \rightarrow 2ZnO(s) + SO_2(g)$
8. $C\ (s) + 2ZnO(s) \rightarrow 2Zn(s) + 2ZnCl(aq)\ CO_2(g))$

5.10 FUNDAMENTAL EXAM QUESTIONS T4.1 Paper 1 12marks

All of these questions in this section come from Paper 1, which only assesses Core syllabus material and they are designed to all be answerable by students who can only achieve a C grade.

Q# 16/ iGCSE Chemistry/2004/w/Paper 1/

9 When propane is burned, carbon dioxide and water are formed, as shown.

$$C_3H_8 + 5O_2 \rightarrow rCO_2 + sH_2O$$

Which values of *r* and *s* balance the equation?

	r	*s*
A	1	3
B	1	5
C	3	4
D	3	8

10 Which formula represents a compound containing three atoms?

A HNO_3 **B** H_2O **C** LiF **D** $ZnSO_4$

Q# 17/ iGCSE Chemistry/2004/s/Paper 1/

9 The oxide Pb_3O_4 reacts with dilute nitric acid to form lead(II) nitrate, lead(IV) oxide and another product.

What is the equation for this reaction?

A $Pb_3O_4 + 4HNO_3 \rightarrow 2Pb(NO_3)_2 + PbO_2 + 2H_2O$

B $Pb_3O_4 + 2HNO_3 \rightarrow 2PbNO_3 + PbO_4 + H_2$

C $Pb_3O_4 + 4HNO_3 \rightarrow Pb(NO_3)_4 + 2PbO + 2H_2O$

D $2Pb_3O_4 + 2HNO_3 \rightarrow 2Pb_2NO_3 + 2PbO_2 + H_2$

Q# 18/ iGCSE Chemistry/2004/s/Paper 1/

10 The compound ethyl mercaptan, C_2H_5SH, has a very unpleasant smell.

What is its relative molecular mass?

A 34 **B** 50 **C** 61 **D** 62

Q# 19/ iGCSE Chemistry/2003/w/Paper 1/

10 Two gases react as shown.

$$\underset{\text{reactants}}{X_2 + Y_2} \rightarrow \underset{\text{product}}{2XY}$$

When measured at the same temperature and pressure, what is the value of

$$\frac{\text{volume of product}}{\text{volume of reactants}}\ ?$$

A $\frac{1}{2}$

B 1

C 2

D 4

11 Carbon and chlorine form a chloride.

What is the formula of this chloride?

A CCl_2

B CCl_4

C $CaCl_2$

D $CaCl_4$

Q# 20/ iGCSE Chemistry/2003/s/Paper 1/

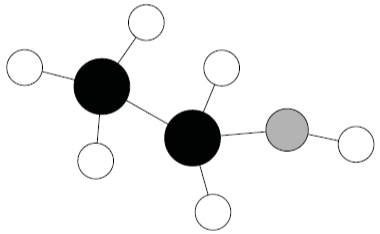
9 The relative atomic mass of oxygen is 16 and that of hydrogen is 1.

This means that …(i)… of oxygen has the same mass as …(ii)… of hydrogen.

Which words correctly complete the gaps?

	gap (i)	gap (ii)
A	an atom	thirty-two molecules
B	an atom	eight molecules
C	a molecule	sixteen atoms
D	a molecule	eight atoms

10 The diagram shows a model of a molecule containing carbon, hydrogen and oxygen.



How many atoms of each element are in the molecule?

	carbon	hydrogen	oxygen
A	1	6	2
B	2	5	1
C	2	6	1
D	6	2	1

Q# 21/ iGCSE Chemistry/2002/w/Paper 1/

9 One method of producing carbon dioxide is to react calcium carbonate with dilute hydrochloric acid.

What is the balanced chemical equation for the reaction?

A $CaCO_3 + HCl \longrightarrow CaO + CO_2 + HCl$

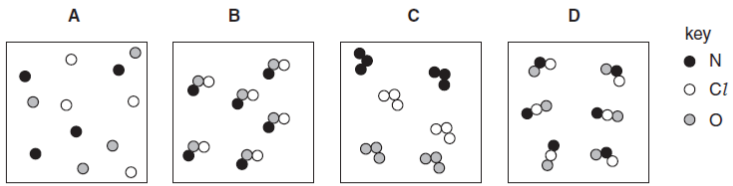
B $CaCO_3 + 2HCl \longrightarrow CaCl_2 + CO_2 + H_2O$

C $CaCO_3 + 4HCl \longrightarrow CaCl_4 + CO_2 + H_2 + H_2O$

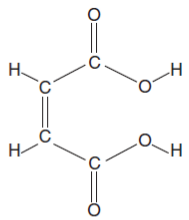
D $Ca(HCO_3)_2 + HCl \longrightarrow CaCl + 2CO_2 + H_2O$

10 A gas has the molecular formula NOC*l*.

Which diagram could show molecules of the pure gas NOC*l*?



11 Butenedioic acid has the structure shown.



What is the molecular formula of butenedioic acid?

A CHO **B** $C_4H_4O_4$ **C** $C_6H_4O_2$ **D** $C_6H_4O_6$

Q# 22/ iGCSE Chemistry/2002/s/Paper 1/

10 What is the formula of copper(II) oxide and of sulphur hexafluoride?

	copper(II) oxide	sulphur hexafluoride
A	CuO	S_6F
B	CuO	SF_6
C	Cu_2O	S_6F
D	Cu_2O	SF_6

5.10.1 FUNDAMENTAL EXAM QUESTIONS

T4.1 Paper 1 12marks Mark Scheme

Q# 1/ iGCSE Chemistry/2012/w/Paper 11/

4 B

Q# 2/ iGCSE Chemistry/2012/s/Paper 11/

9 C

Q# 3/ iGCSE Chemistry/2011/w/Paper 11/

8 B

Q# 4/ iGCSE Chemistry/2011/s/Paper 11/

8 D

Q# 5/ iGCSE Chemistry/2010/w/Paper 11/

10 B

Q# 6/ iGCSE Chemistry/2010/s/Paper 11/

10 C

Q# 7/ iGCSE Chemistry/2009/w/Paper 11/

10 C
11 B

Q# 8/ iGCSE Chemistry/2009/s/Paper 1/

10 C

11 D

Q# 9/ iGCSE Chemistry/2008/w/Paper 1/

10 B
11 B

Q# 10/ iGCSE Chemistry/2008/s/Paper 1/

11 D

Q# 11/ iGCSE Chemistry/2007/w/Paper 1/

10 D
11 B

Q# 12/ iGCSE Chemistry/2007/s/Paper 1/

10 D

Q# 13/ iGCSE Chemistry/2007/s/Paper 1/

11 B

Q# 14/ iGCSE Chemistry/2006/w/Paper 1/

9 D
10 C

Q# 15/ iGCSE Chemistry/2005/s/Paper 1/

10 D

Q# 16/ iGCSE Chemistry/2004/w/Paper 1/

9 C
10 B

Q# 17/ iGCSE Chemistry/2004/s/Paper 1/

9 A

Q# 18/ iGCSE Chemistry/2004/s/Paper 1/

10 D

Q# 19/ iGCSE Chemistry/2003/w/Paper 1/

10 B
11 B

Q# 20/ iGCSE Chemistry/2003/s/Paper 1/

9 B
10 C

Q# 21/ iGCSE Chemistry/2002/w/Paper 1/

9 B
10 B
11 B

Q# 22/ iGCSE Chemistry/2002/s/Paper 1/

10 B

5.11 FUNDAMENTAL EXAM QUESTIONS Paper 2 9marks

Q# 1/ iGCSE Chemistry/2018/w/Paper 23/

9 Iron(III) chromate is a yellow solid. It contains the ions Fe^{3+} and CrO_4^{2-}.

What is the formula of iron(III) chromate?

A $FeCrO_4$ **B** $Fe_3(CrO_4)_2$ **C** Fe_2CrO_4 **D** $Fe_2(CrO_4)_3$

Q# 2/ iGCSE Chemistry/2018/w/Paper 22/

9 The formulae of some ions are shown.

positive ion	negative ion
Ti^{4+}	PO_4^{3-}
Al^{3+}	SO_4^{2-}
Mg^{2+}	NO_3^-
K^+	Cl^-

Which formula is **not** correct?

A $Al_3(SO_4)_2$ **B** K_3PO_4 **C** $Mg(NO_3)_2$ **D** $TiCl_4$

Q# 3/ iGCSE Chemistry/2018/w/Paper 21/

9 Iron can react with sulfur to form two ionic compounds.

The iron is present as Fe^{2+} in one compound and as Fe^{3+} in the other compound.

The sulfur ion is present as S^{2-} in both compounds.

What are the formulae of the two compounds?

A FeS and Fe_2S_3

B FeS and Fe_3S_2

C FeS_2 and Fe_3S_2

D FeS_2 and Fe_2S_3

Q# 4/ iGCSE Chemistry/2017/w/Paper 23/

8 A compound contains 34.5% calcium, 24.1% silicon and 41.4% oxygen by mass.

What is its empirical formula?

A Ca_2SiO_3 **B** $CaSiO_3$ **C** $CaSi_2O_3$ **D** $CaSiO_6$

Q# 5/ iGCSE Chemistry/2017/w/Paper 22/

7 The equation for the reaction between phosphorus and oxygen is shown.

$$xP_4 + yO_2 \rightarrow zP_2O_5$$

Which values of *x*, *y* and *z* balance the equation?

	x	*y*	*z*
A	1	5	2
B	1	10	2
C	2	5	2
D	2	10	1

Q# 6/ iGCSE Chemistry/2017/s/Paper 23/

7 Aqueous iron(III) sulfate and aqueous sodium hydroxide react to give a precipitate of iron(III) hydroxide and a solution of sodium sulfate.

What is the balanced equation for this reaction?

A $Fe_2(SO_4)_3(aq) + 2NaOH(aq) \rightarrow Fe(OH)_3(s) + Na_2SO_4(aq)$

B $Fe_2(SO_4)_3(aq) + 3NaOH(aq) \rightarrow Fe(OH)_3(s) + 3Na_2SO_4(aq)$

C $Fe_2(SO_4)_3(aq) + 6NaOH(aq) \rightarrow 2Fe(OH)_3(s) + 3Na_2SO_4(aq)$

D $2Fe_2(SO_4)_3(aq) + 6NaOH(aq) \rightarrow 4Fe(OH)_3(s) + 6Na_2SO_4(aq)$

Q# 7/ iGCSE Chemistry/2017/s/Paper 22/

7 Which equations are balanced?

1 $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

2 $ZnCO_3 + 2HCl \rightarrow ZnCl_2 + CO_2 + 2H_2O$

3 $Mg(NO_3)_2 + NaOH \rightarrow Mg(OH)_2 + 2NaNO_3$

4 $CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + H_2O + CO_2$

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

Q# 8/ iGCSE Chemistry/2017/s/Paper 21/

7 Aluminium reacts with fluorine.

$$xAl(s) + yF_2(g) \rightarrow zAlF_3(s)$$

Which values of *x*, *y* and *z* balance the equation?

	x	*y*	*z*
A	1	2	1
B	2	3	2
C	3	2	3
D	4	3	4

Q# 9/ iGCSE Chemistry/2016/m/Paper 22/

9 Magnesium nitride is formed when magnesium burns in air. Magnesium nitride is an ionic compound.

What is the formula of magnesium nitride?

A MgN_2 **B** Mg_2N_2 **C** Mg_2N_3 **D** Mg_3N_2

5.11.1 FUNDAMENTAL EXAM QUESTIONS Paper 2 9marks mark Scheme

Q# 1/ iGCSE Chemistry/2018/w/Paper 23/

9	D

Q# 2/ iGCSE Chemistry/2018/w/Paper 22/

9	A

Q# 3/ iGCSE Chemistry/2018/w/Paper 21/

9	A

Q# 4/ iGCSE Chemistry/2017/w/Paper 23/

8	B

Q# 5/ iGCSE Chemistry/2017/w/Paper 22/

7	A

Q# 6/ iGCSE Chemistry/2017/s/Paper 23/

7	C

Q# 7/ iGCSE Chemistry/2017/s/Paper 22/

8	A

Q# 8/ iGCSE Chemistry/2017/s/Paper 21/

7	B

Q# 9/ iGCSE Chemistry/2016/m/Paper 22/

9 **D**

5.12 ESSENTIAL EXAM QUESTIONS T4.1 Paper 4 9marks

Q# 1/ iGCSE Chemistry/2014/w/Paper 31/

7 Nitrogen can form ionic compounds with reactive metals and covalent compounds with non-metals.

(a) Nitrogen reacts with lithium to form the ionic compound lithium nitride, Li_3N.

(i) Write the equation for the reaction between lithium and nitrogen.

..... [2]

Q# 2/ iGCSE Chemistry/2013/s/Paper 31/ Q6

Ammonia is a compound with the molecular formula NH_3

(c) Another compound which contains only nitrogen and hydrogen is hydrazine, N_2H_4.

Complete the equation for the preparation of hydrazine from ammonia.

$$.....NH_3 + NaClO \rightarrow N_2H_4 + ... + H_2O$$ [2]

Q# 3/ iGCSE Chemistry/2013/s/Paper 31/

3 A small piece of marble, $CaCO_3$, was added to 5.0 cm^3 of hydrochloric acid, concentration 1.0 mol/dm^3, at 25 °C. The time taken for the reaction to stop was measured. The experiment was repeated using 5.0 cm^3 of different solutions of acids. The acid was in excess in all of the experiments.

Typical results are given in the table.

experiment	temperature / °C	acid solution	time / min
1	25	hydrochloric acid 1.0 mol/dm^3	3

(b) The equation for the reaction in experiment 1 is:

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

Complete the following ionic equation.

$$CaCO_3(s) + 2H^+(aq) \rightarrow ..... + ... + ...$$ [1]

Q# 4/ iGCSE Chemistry/2004/s/Paper 3/

3 An organic compound decomposes to form nitrogen.

$$C_6H_5N_2Cl(aq) \rightarrow C_6H_5Cl(l) + N_2(g)$$

(a) Explain the state symbols.

aq .....

l .....

g ..... [2]

Q# 5/ iGCSE Chemistry/2002/w/Paper 3/ Q3

(b) The following compounds contain two elements. Predict their formulae.

aluminium sulphide .....

silicon phosphide ..... [2]

5.12.1 EXAM QUESTIONS T4.1 Paper 4 9marks

Q# 1/ iGCSE Chemistry/2014/w/Paper 31/

7 **(a)** **(i)** $6Li + N_2 = 2Li_3N$
species (1) balancing (1)

Q# 2/ iGCSE Chemistry/2013/s/Paper 31/ Q6

(c) $2NH_3 + NaClO \rightarrow N_2H_4 + NaCl + H_2O$ [2]
not balanced only 1

Q# 3/ iGCSE Chemistry/2013/s/Paper 31/ Q3

(b) experiment 1 $Ca^{2+} + CO_2 + H_2O$ [1]

Q# 4/ iGCSE Chemistry/2004/s/Paper 3/

3. (a) dissolved **or** solution in water [1]
NOT aqueous **NOT** soluble in water
l liquid and g gas [1]

Q# 5/ iGCSE Chemistry/2002/w/Paper 3/ Q3

(b) Al_2S_3 [1]
Si_3P_4 [1]

5.13 FUNDAMENTAL Assessed Activity 1 Keyword Test

English	Chinese
law of conservation of mass	
molecular formula	
relative molecular mass (*M*r)	
relative formula mass (*M*r)	
balanced chemical (symbol) equation	
standard atom	
chemical reaction	
molecular mass	
state symbols	
symbol (chemical)	
formula (chemical)	

English	Chinese
reactants	
ionic equation	
products	
word equation	
spectator ions	

5.14 ESSENTIAL Assessed Activity 2 T4.1 Paper 1 (Core only material) 15marks

Q# 1/

8 A compound has the formula CH_3CO_2H.

How should the relative molecular mass, M_r, of this compound be calculated?

A 12 + 1 + 16

B 3(12 + 1) + 2(12 + 16) + 1

C (4 × 12) + (2 × 1) + 16

D (2 × 12) + (4 × 1) + (2 × 16)

Q# 2/

9 The equation for the reaction between magnesium and dilute sulfuric acid is shown.

$$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$$

M_r of $MgSO_4$ is 120

Which mass of magnesium sulfate will be formed if 12 g of magnesium are reacted with sulfuric acid?

A 5 g **B** 10 g **C** 60 g **D** 120 g

Q# 3/

8 The relative formula mass, M_r, of copper(II) sulfate, $CuSO_4$, is 160.

Which mass of sulfur is present in 160 g of copper(II) sulfate?

A 16 g **B** 32 g **C** 64 g **D** 128 g

Q# 4/

8 What is the relative molecular mass (M_r) of HNO_3?

A 5 **B** 31 **C** 32 **D** 63

Q# 5/

10 The chemical compositions of two substances, W and X, are given.

W $Na(AlSi_3)O_8$

X $Ca(Al_2Si_2)O_8$

Which statements are correct?

1 W and X contain the same amount of oxygen.

2 W contains three times as much silicon as X.

3 X contains twice as much aluminium as W.

A 1 and 2 **B** 1 and 3 **C** 2 and 3 **D** 1, 2 and 3

Q# 6/

10 Hydrogen and chlorine react as shown.

1 molecule of hydrogen + 1 molecule of chlorine → 2 molecules of hydrogen chloride

What is the equation for this reaction?

A $2H + 2Cl \rightarrow 2HCl$

B $2H + 2Cl \rightarrow H_2Cl_2$

C $H_2 + Cl_2 \rightarrow 2HCl$

D $H_2 + Cl_2 \rightarrow H_2Cl_2$

Q# 7/

10 For each atom of carbon present in a molecule, there is an equal number of atoms of oxygen but twice as many atoms of hydrogen.

What is the formula of the molecule?

A $C_2H_2O_2$ **B** $C_2H_2O_4$ **C** $C_2H_4O_2$ **D** C_2H_6O

11 Water is formed when 48 g of oxygen combine with 6 g of hydrogen.

What mass of oxygen combines with 2 g of hydrogen?

A 12 g **B** 16 g **C** 96 g **D** 144 g

Q# 8/

10 Nitrogen and hydrogen react together to form ammonia.

$$N_2 + 3H_2 \rightarrow 2NH_3$$

When completely converted, 7 tonnes of nitrogen gives 8.5 tonnes of ammonia.

How much nitrogen will be needed to produce 34 tonnes of ammonia?

A 7 tonnes **B** 8.5 tonnes **C** 28 tonnes **D** 34 tonnes

11 Which relative molecular mass, M_r, is **not** correct for the molecule given?

	molecule	M_r
A	ammonia, NH_3	17
B	carbon dioxide, CO_2	44
C	methane, CH_4	16
D	oxygen, O_2	16

Q# 9/

10 Lead(II) nitrate can be decomposed as shown.

$$xPb(NO_3)_2 \rightarrow yPbO + zNO_2 + O_2$$

Which numbers x, y and z balance the equation?

	x	y	z
A	2	2	2
B	2	2	4
C	2	4	4
D	4	4	2

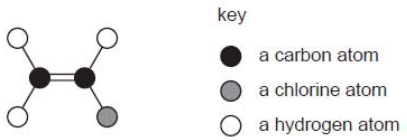
11 Carbon and chlorine form a chloride.

What is the formula of this chloride?

A CCl_2 **B** CCl_4 **C** $CaCl_2$ **D** $CaCl_4$

Q# 10/

11 The diagram shows a molecule of vinyl chloride (used to make pvc).

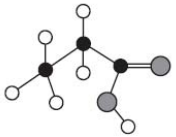


What is the formula of vinyl chloride?

A CH_2Cl_3 **B** CH_3Cl_2 **C** C_2HCl_3 **D** C_2H_3Cl

Q# 11/

10 The diagram shows a model of a molecule of an organic acid.



What is the relative molecular mass of this acid?

A 11 **B** 40 **C** 58 **D** 74

11 For complete combustion, one molecule of an organic compound needs 8 molecules of oxygen.

What could the formula of this compound be?

A $C_5H_{11}OH$

B C_6H_9OH

C $C_6H_{11}OH$

D C_6H_{12}

Q# 12/

10 Boron, B, forms an oxide.

Which equation is correctly balanced?

A $2B + 3O_2 \rightarrow B_2O_3$

B $2B + 3O_2 \rightarrow 2B_2O_3$

C $4B + 2O_2 \rightarrow 2B_2O_3$

D $4B + 3O_2 \rightarrow 2B_2O_3$

Q# 13/

11 Students are asked to state

- the number of atoms in one molecule of ethanoic acid,
- the relative molecular mass, M_r, of this acid.

Which line is correct?

	number of atoms	M_r
A	8	32
B	8	60
C	9	26
D	9	46

Q# 14/

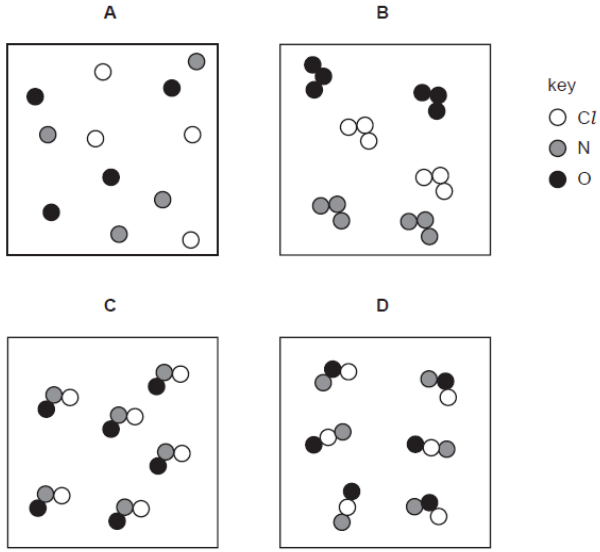
9 Magnesium and sulphur each form a chloride.

What could be the formulae of these chlorides?

	magnesium	sulphur
A	Mg_2Cl	S_2Cl
B	Mg_2Cl	SCl_2
C	$MgCl_2$	S_2Cl
D	$MgCl_2$	SCl_2

10 A gas has the molecular formula $NOCl$.

Which diagram could show molecules of the pure gas $NOCl$?



Q# 15/

10 For which compound is the formula correct?

	compound	formula
A	ammonia	NH_4
B	carbon monoxide	CO_2
C	iron(III) oxide	Fe_3O_2
D	zinc hydroxide	$Zn(OH)_2$

5.15 Extension Assessed Activity 3 T4.1 Stoichiometry 11marks

Q# 1/

(c) Deduce the formula of iron(III) sulfate.

..... [1]

Q# 2/

2 Choose from the following list of gases. A gas may be chosen once, more than once or not at all.

sulfur dioxide **hydrogen** **methane** **carbon monoxide**

argon **ethene** **butane**

(b) When burned in oxygen, the only product is water. ..... [1]

(e) When reacted with oxygen, the only product is carbon dioxide. ..... [1]

Q# 3/

1 Use your copy of the Periodic Table to help you answer some of these questions.

(c) Use the following ions to determine the formulae of the compounds.

ions OH^- Cr^{3+} Ba^{2+} SO_4^{2-}

compounds

(i) chromium(III) sulfate .....

(ii) barium hydroxide .....

[2]

Q# 4/

5 The law of constant composition states that all pure samples of a compound contain the same elements in the same proportion by weight.

A typical experiment to test this law is to prepare the same compound by different methods and then show that the samples have the same composition.

Methods of making copper(II) oxide include:

- heating copper carbonate,
- heating copper hydroxide,
- heating copper nitrate,
- heating copper foil in air.

(c) The table below shows the results obtained by reducing the copper(II) oxide produced by different methods to copper.

(i) Complete the table.

source of copper(II) oxide	mass of copper(II) oxide / g	mass of copper / g	percentage copper / %
$CuCO_3$	2.37	1.89	79.7
$Cu(OH)_2$	2.51	1.99	
$Cu(NO_3)_2$	2.11	1.68	
Cu and O_2	2.29	1.94	

[2]

(ii) One of the samples of copper(II) oxide is impure.

Identify this sample and suggest an explanation why the percentage of copper in this sample is bigger than in the other three samples.

.....

..... [2]

Q# 5/

(b) In the lattice of calcium nitride, the ratio of calcium ions to nitride ions is 3 : 2.

(ii) In terms of ionic charges, explain why the ratio of ions is 3 : 2.

.....

..... [2]

5.16 Extension Mind Map for Topic 4.1 Chemical equations

5.17 Essential End of Topic 4.1 Review and Reflection

Looking at the goals you could have achieved and the goals you actually achieved try to reflect on your progress.

Try to be as honest and as detailed as possible. Sometimes you may think you have thought about an idea well, but when you talk with someone else, or write it out, it helps you better understand and allows you think more completely and more clearly.

Did you achieve more goals this topic than last topic?

Fill in this table

Level	Number of goals achieved at each level	Success rate, %
FUNDAMENTAL	/5	
ESSENTIAL	/10	
EXTENSION	/13	
EXCEPTIONAL	/10	

Do you feel you tired harder? If yes, what helped you to do so? If not, why not?

What could you do differently next time, in addition to what you are already doing to improve, not only your score in the end of topic tests and other assessed activities, but also in how you learn. How could you become a more effective student to get more learning out of the time you are investing in your studies?

What did you enjoy most about this topic?

What did you find most difficult?

What did you find easiest?

On a scale of 1 being hardest and 5 being most difficult, circle how challenging you found this topic

1 2 3 4 5

What could be done to make this topic easier to understand?

Do you have any questions about this topic?

5.18 Exceptional Stretch and Challenge Activities and Additional Reading The SI System

The Mole is the unit for amount of substance. When you are writing out chemical equations you are in fact dealing with molar amounts.

Name	Symbol	Measure	Current (2005) formal definition[11]	Historical origin / justification	Dimension symbol
metre	m	length	"The metre is the length of the path travelled by light in vacuum during a time interval of 1/299792458 of a second." *17th CGPM (1983, Resolution 1, CR, 97)*	1/10,000,000 of the distance from the Earth's equator to the North Pole measured on the circumference through Paris.	L
kilogram	kg	mass	"The kilogram is the unit of mass; it is equal to the mass of the international prototype of the kilogram." *3rd CGPM (1901, CR, 70)*	The mass of one litre of water at the temperature of melting ice. A litre is one thousandth of a cubic metre.	M
second	s	time	"The second is the duration of 9192631770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium 133 atom." *13th CGPM (1967/68, Resolution 1; CR, 103)* "This definition refers to a caesium atom at rest at a temperature of 0 K." *(Added by CIPM in 1997)*	The day is divided in 24 hours, each hour divided in 60 minutes, each minute divided in 60 seconds. A second is 1/(24 × 60 × 60) of the day.	T
ampere	A	electric current	"The ampere is that constant current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross-section, and placed 1 metre apart in vacuum, would produce between these conductors a force equal to 2 × 10^{-7} newton per metre of length." *9th CGPM (1948)*	The original "International Ampere" was defined electrochemically as the current required to deposit 1.118 milligrams of silver per second from a solution of silver nitrate. Compared to the SI ampere, the difference is 0.015%.	I
kelvin	K	thermodynamic temperature	"The kelvin, unit of thermodynamic temperature, is the fraction 1/273.16 of the thermodynamic temperature of the triple point of water." *13th CGPM (1967/68, Resolution 4; CR, 104)* "This definition refers to water having the isotopic composition defined exactly by the following amount of substance ratios: 0.000 155 76 mole of ^{2}H per mole of ^{1}H, 0.000 379 9 mole of ^{17}O per mole of ^{16}O, and 0.002 005 2 mole of ^{18}O per mole of ^{16}O." *(Added by CIPM in 2005)*	The Celsius scale: the Kelvin scale uses the degree Celsius for its unit increment, but is a thermodynamic scale (0 K is absolute zero).	Θ

Name	Symbol	Measure	Current (2005) formal definition[11]	Historical origin / justification	Dimension symbol
mole	mol	amount of substance	"1. The mole is the amount of substance of a system which contains as many elementary entities as there are atoms in 0.012 kilogram of carbon 12; its symbol is 'mol'. 2. When the mole is used, the elementary entities must be specified and may be atoms, molecules, ions, electrons, other particles, or specified groups of such particles." *14th CGPM (1971, Resolution 3; CR, 78)* "In this definition, it is understood that unbound atoms of carbon 12, at rest and in their ground state, are referred to." *(Added by CIPM in 1980)*	Atomic weight or molecular weight divided by the molar mass constant, 1 g/mol.	N
candela	cd	luminous intensity	"The candela is the luminous intensity, in a given direction, of a source that emits monochromatic radiation of frequency 540×10^{12} hertz and that has a radiant intensity in that direction of 1/683 watt per steradian." *16th CGPM (1979, Resolution 3; CR, 100)*	The candlepower, which is based on the light emitted from a burning candle of standard properties.	J

To find out more about the SI system click on this link: https://www.nist.gov/pml/weights-and-measures/metric-si/si-units Or scan this QR code:

Exceptional Reflection

Why do you think the SI units exist? Do any countries not use this system? Who gets to decide on these standards? One of these, until 2019 is not based on a universal law, the kilogram. To find out more about this exceptional unit and how and why it changed in 2019 read these articles:

- https://www.theverge.com/2018/11/13/18087002/kilogram-new-definition-kg-metric-unit-ijk-measurement
- https://www.nist.gov/pml/weights-and-measures/si-units-mass
- https://www.sciencealert.com/it-s-official-the-definition-of-a-kilogram-has-changed

For an alternate version of the kilogram, which was not adopted can be found by finding out about the world's roundest object:

- https://www.heason.com/news-media/technical-blog-archive/world-s-roundest-object#:~:text=World's%20Roundest%20Object,in%20measurement%3B%20defining%20the%20kilogram.
- https://www.newscientist.com/article/dn14229-roundest-objects-in-the-world-created/

Exceptional Activity – Create a short 2-3 minute presentation about any part of an SI unit you find most interesting. You should try to explain as much as possible, rather than just describing facts to show analysis, which is a higher order thinking skill that becomes increasingly important as you progress through your education.

6 Topic 7.4 Redox

6.1 End of Topic 7.4 Goals Checklist

For each topic you ought to try to do as many of the following things to get the most out of your time, the resources available to you and to help you grow as a student. Tick each goal off as you complete it. Growth is difficult and uncomfortable, but you should choose to do these things, and the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win!

Aspect	What you should have done	Yes/No	Level
Interacted with your teacher	Ask your teacher 1 question, about anything, once a week		FUNDAMENTAL
	Try to answer one question asked by your teacher at least once a week		ESSENTIAL
	Ask your teacher one question about something you do not understand in science once a week		ESSENTIAL
	Ask your teacher one question about something to do with science every lesson		EXTENSION
Notes and follow up notes	Complete set of class note		FUNDAMENTAL
	Cornell Notetaking Attempted		ESSENTIAL
	Cornell Notetaking Completed		EXTENSION
	Cornell Notetaking Completed to an exemplary standard		EXCEPTIONAL
	Attempted the Mind Map for this topic		ESSENTIAL
	Completed the Mind Map for this topic		EXTENSION
Textbook	Read ahead before the topic has been started		EXTENSION
	Highlighted key ideas and translate new words		FUNDAMENTAL
	Completed the questions at the end of each 2 page spread in your exercise book		EXTENSION
	Added to your class notes ideas and important information from the textbook that you learnt		EXTENSION
Past Exam Questions	Worked on at least 25% of the exam questions in this workbook		FUNDAMENTAL
	Attempted more than 25% of the questions and those questions you have completed you have marked in a different colour pen		ESSENTIAL
	Completed and marked all questions here		EXTENSION
	Completed, marked and additional key ideas where you have located the most difficult marks added to your notebook		EXCEPTIONAL
	Used the resources available online to answer additional questions not found in this workbook on the current topic.		EXCEPTIONAL
	Ask your teacher about an exam question that they cannot answer		EXCEPTIONALLY SMASHING!!!
Assessed Activities	Complete the word list activity using the word list at the front of each topic as little as possible		FUNDAMENTAL
	Complete 2 assessed activities, either in class or as homework		ESSENTIAL
	Complete 2 assessed activities and scored over 70% on average		ESSENTIAL
	Complete 2 assessed activities and scored over 80% on average		EXTENSION
	Complete 2 assessed activities and scored over 90% on average		EXCEPTIONAL
End of Topic Test	Revised sufficiently well to improve upon your score from the previous test (except if you are scoring over 90%, then just write Y for this goal)		ESSENTIAL
	Scored 10% higher than your current average		EXTENSION
	Scored 15% or more than your previous end of topic average		EXCEPTIONAL
	Scored over 90%		EXTENSION
	Scored over 95%		SMASHING!!!

Aspect	What you should have done	Yes/No	Level
Reading	Spend more than 1 hour a week reading a book **you enjoy** (in any language) about anything.		ESSENTIAL
	Spend more than 3 hours a week reading a book **you enjoy** (in any language) about anything.		EXTENSION
	Spend more than 5 hours a week reading a book **you enjoy** (in any language) about anything.		EXCEPTIONAL
	Spend at least one hour a week reading a book **you enjoy** in English about anything.		EXTENSION
	Spend more than 3 hours a week reading a book **you enjoy** in English about anything.		EXCEPTIONAL
Reflection	You completed this goal setting table		FUNDAMENTAL
	You have looked at the goals you have achieved and the ones you have not and added them up and entered them into the table in the Review and Reflection section		ESSENTIAL
	You have given an answer for every question in the Review and Reflection section at the end of this topic		EXTENSION
	You have Given good and thoughtful answers for every question in the Review and Reflection section at the end of this topic		EXCEPTIONAL

6.2 Topic 7.4 Syllabus

7.4 Redox

Core

- Define *oxidation* and *reduction* in terms of oxygen loss/gain. (Oxidation state limited to its use to name ions, e.g. iron(II), iron(III), copper(II), manganate(VII).)

Supplement

- Define *redox* in terms of electron transfer
- Identify redox reactions by changes in oxidation state and by the colour changes involved when using acidified potassium manganate(VII), and potassium iodide. (Recall of equations involving $KMnO_4$ is **not** required.)
- Define *oxidising agent* as a substance which oxidises another substance during a redox reaction. Define *reducing agent* as a substance which reduces another substance during a redox reaction.
- Identify oxidising agents and reducing agents from simple equations

6.3 ESSENTIAL Glossary for Keywords for this topic

Topic #	English	Chinese
7	**oxidation state** a number given to show whether an element has been oxidised or reduced; the oxidation state of an ion is simply the charge on the ion	**氧化**态表示元素是否被氧化或还原的数字；离子的氧化态只是离子上的电**荷**
7	**oxidation** there are three definitions of oxidation: (i) a reaction in which oxygen is added to an element or compound; (ii) a reaction involving the loss of electrons from an atom, molecule or ion; (iii) a reaction in which the oxidation state of an element is increased	**氧化氧化具有三个定**义：（i）**将氧添加到元素或化合物中的反**应；（ii）**涉及原子，分子或离子失去**电子的反应；（iii）**增加元素的氧化**态的反应
7	**oxidising agent** a substance which will oxidise another in a redox reaction	**氧化**剂一种在氧化还原反应中会氧化另一种物质的物质
7	**redox reaction** a reaction involving both **reduction** and **oxidation reducing agent** a substance which will reduce another in a redox reaction	**氧化**还原反应一种同时涉及还原剂和氧化还原剂的反应，一种物质将在氧化还原反应中还原另一种物质
7	**reduction** there are three definitions of reduction: (i) a reaction in which oxygen is removed from a compound; (ii) a reaction involving the gain of electrons by an atom, molecule or ion; (iii) a reaction in which the oxidation state of an element is decreased	还原有三种还原的定义：（i）**从化合物中除去氧的反**应；（ii）**涉及通**过原子，分子或离子获得电子的反应；（iii）**使元素的氧化**态降低的反应

6.4 ESSENTIAL Classroom Active Learning Task 1 Assigning Oxidation States

Oxidation number rules:

Elements have an oxidation number of **0**
Group I and **II** – In addition to the elemental oxidation state of 0, Group I has an oxidation state of **+1** and Group II has an oxidation state of **+2**.
Hydrogen –usually **+1**, except when bonded to Group I or Group II, when it forms hydrides, **-1**.
Oxygen – usually **-2**, except when it forms a O-O single bond, a peroxide, when it is **-1**.
Fluorine is always **-1**. Other halogens are usually -1, except when bonded to O.

1. Give the oxidation numbers of all the elements in the following molecules and ions:

   a. SO, SO_2, SO_3, SO_3^{2-}, SO_4^{2-}

   b. ClO_2, ClO^-, ClO_2^-, ClO_3^-, ClO_4^-

   c. N_2O, NO, NO_2, N_2O_4, N_2O_5, NO_2^-, NO_3^-

2. Determine the oxidation number of the sulfur atom:

   a. H_2S b. S c. H_2SO_4 d. S^{2-} e. HS^- f. SO_2 g. SO_3

3. Indicate the oxidation number of phosphorus in each of the following compounds:

   a. HPO_3 _____ d. H_3PO_4 _____

   b. H_3PO_2 _____ e. $H_4P_2O_7$ _____

   c. H_3PO_3 _____ f. $H_5P_3O_{10}$ _____

4. Give oxidation numbers for the underlined atoms in these molecules and ions:

a. $\underline{Cs_2}O$	f. $\underline{Cl}F_3$	k. $\underline{Mo}O_4^{2-}$
b. $\underline{Pt}Cl_6^{2-}$	g. $H_3\underline{As}O_3$	l. $\underline{Mn}O_4^-$
c. $\underline{Ca}I_2$	h. $\underline{Sb}F_6^-$	m. $\underline{Pt}Cl_4^{2-}$
d. $\underline{Sn}F_2$	i. $\underline{Ti}O_2$	n. $\underline{O_2}$
e. $\underline{Al_2}O_3$	j. $\underline{P_4}$	o. $\underline{O_3}$

6.4.1 ESSENTIAL Classroom Active Learning Task 1 Assigning Oxidation States Mark Scheme

NOTE: The both terms Oxidation State and Oxidation Number effectively mean the same thing at iGCSE and A Level, although Oxidation Number in fact refers to the Roman numerals in the names of transition metal containing compounds, like Iron (III) oxide

1. Give the oxidation numbers of all the elements in the following molecules and ions:

   a. $\overset{+2\,-2}{SO}$, $\overset{+4\,-2}{SO_2}$, $\overset{+6\,-2}{SO_3}$, $\overset{+4\,-2}{SO_3^{2-}}$, $\overset{+6\,-2}{SO_4^{2-}}$

   b. $\overset{+4\,-2}{ClO_2}$, $\overset{+1\,-2}{ClO^-}$, $\overset{+3\,-2}{ClO_2^-}$, $\overset{+5\,-2}{ClO_3^-}$, $\overset{+7\,-2}{ClO_4^-}$

   c. $\overset{+1\,-2}{N_2O}$, $\overset{+2\,-2}{NO}$, $\overset{+4\,+2}{NO_2}$, $\overset{+4\,-2}{N_2O_4}$, $\overset{+5\,-2}{N_2O_5}$, $\overset{+3\,-2}{NO_2^-}$, $\overset{+5\,-2}{NO_3^-}$

2. Determine the oxidation number of the sulfur atom:

   a. $\overset{+\,-2}{H_2S}$ b. $\overset{0}{S}$ c. $\overset{+1\,+6\,-2}{H_2SO_4}$ d. $\overset{-2}{S^{2-}}$ e. $\overset{+1\,-2}{HS^-}$ f. $\overset{+4\,-2}{SO_2}$ g. $\overset{+6\,-2}{SO_3}$

3. Indicate the oxidation number of phosphorus in each of the following compounds:

   a. $\overset{+1\,+5\,-2}{HPO_3}$ +5 d. $\overset{+1\,+5\,-2}{H_3PO_4}$ +5

   b. $\overset{+1\,+1\,-2}{H_3PO_2}$ +1 e. $\overset{+1\,+5\,-2}{H_4P_2O_7}$ +5

   c. $\overset{+1\,+3\,-2}{H_3PO_3}$ +3 f. $\overset{+1\,+5\,-2}{H_5P_3O_{10}}$ +5

4. Give oxidation numbers for the underlined atoms in these molecules and ions:

a. $\overset{+1\,-2}{\underline{Cs_2}O}$	f. $\overset{+3\,-1}{\underline{Cl}F_3}$	k. $\overset{+6\,-2}{\underline{Mo}O_4^{2-}}$
b. $\overset{+4\,-1}{\underline{Pt}Cl_6^{2-}}$	g. $\overset{+1\,+3\,-2}{H_3\underline{As}O_3}$	l. $\overset{+7\,-2}{\underline{Mn}O_4^-}$
c. $\overset{+2\,-1}{\underline{Ca}I_2}$	h. $\overset{+5\,-1}{\underline{Sb}F_6^-}$	m. $\overset{+2\,-1}{\underline{Pt}Cl_4^{2-}}$
d. $\overset{+2\,-1}{\underline{Sn}F_2}$	i. $\overset{+4\,-2}{\underline{Ti}O_2}$	n. $\overset{0}{\underline{O_2}}$
e. $\overset{+3\,-2}{\underline{Al_2}O_3}$	j. $\overset{0}{\underline{P_4}}$	o. $\overset{0}{\underline{O_3}}$

6.5 ESSENTIAL Classroom Active Learning Task 2 Assigning Oxidation States

1. Assign **oxidation numbers** to each of the atoms in the following compounds:

Na_2CrO_4	Na =	O =	Cr =
$K_2Cr_2O_7$	K =	O =	Cr =
CO_2	O =	C =	
CH_4	H =	C =	
$HClO_4$	O =	H =	Cl =
MnO_2	O =	Mn =	
SO_3^{2-}	O =	S =	
SF_4	F =	S =	

a. What is the range of oxidation states for **carbon**?

b. Which compound has C in a +4 state?

c. Which compound has C in a -4 state?

2. Nitrogen has 5 valence electrons (Group V). It can gain up to 3 electrons (-3), or lose up to 5 (+5) electrons. Fill in the missing names or formulas and assign an oxidation state to each of the following nitrogen containing compounds:

name	formula	oxidation state of N
	NH_3	
nitrogen		
nitrite		
	NO_3^-	
dinitrogen monoxide		
	NO_2	
hydroxylamine	NH_2OH	
nitrogen monoxide		
hydrazine	N_2H_4	

6.6 ESSENTIAL Classroom Active Learning Task 3 Oxidising and Reducing Agents

3. During chemical reactions, the **oxidation state** of atoms can change. This occurs when compounds gain or lose electrons, or when the **bonds** to an atom change. This is illustrated by the reaction between nitrogen and hydrogen to make ammonia:

$$N_2(g) + 3\ H_2(g) \rightarrow 2\ NH_3(g)$$

a. Assign **oxidation numbers** to each of the atoms in this reaction.

N (in N_2) = N (in NH_3) =

H (in H_2) = H (in NH_3) =

When an oxidation number **increases**, that species has been **oxidized**.

b. Which reactant undergoes an increase in its oxidation number?

When an oxidation number **decreases**, that species has been **reduced**.

c. Which reactant undergoes a decrease in its oxidation number?

The species that is oxidized is called the **reducing agent** because it gives up an electron, so that another species can gain an electron (be reduced).

d. What is the **reducing agent** in this reaction?

The species that is reduced is called the **oxidizing agent** because it takes an electron away from another group, raising that group's oxidation number.

e. What is the **oxidizing agent** in this reaction?

4. In each of the following reactions, assign **oxidation numbers** to all of the elements and identify the **oxidizing** and **reducing agents** and the **change in oxidation number**.

a. $4\ Fe + 3\ O_2 \rightarrow 2\ Fe_2O_3$

change in oxidation number

oxidizing agent

reducing agent

c. $NH_4NO_2 \rightarrow N_2 + 2\ H_2O$

change in oxidation number

oxidizing agent

reducing agent

d. $P_4 + 10\ Cl_2 \rightarrow 4\ PCl_5$

change in oxidation number

oxidizing agent

reducing agent

e. $2\ Cr^{3+} + H_2O + 6\ ClO_3^- \rightarrow Cr_2O_7^{2-} + 6ClO_2 + 2\ H^+$

change in oxidation number

oxidizing agent

reducing agent

6.7 EXCEPTIONAL Active Learning Activity 4 Balancing Redox Reactions

The material here does beyond the iGCSE syllabus, but if you are really interested in this topic this is what you would go on to cover at A Level.

Balancing Redox Reactions

Oxidation/Reduction (Redox) reactions can be balanced using the oxidation state changes, as seen in the previous example. However, there is an easier method, which involves breaking a redox reaction into two **half- reactions**. This is best shown by working an example.

Hydrobromic acid will react with permanganate to form elemental bromine and the manganese(II) ion. The unbalanced, net reaction is shown below,

$$\mathbf{Br^- + MnO_4^- \rightarrow Br_2 + Mn^{2+}}$$

5. Break this into two **half-reactions**, one involving bromine and the other involving manganese.

Bromine half-reaction	**Manganese half-reaction**
$Br^- \rightarrow Br_2$	$MnO_4^- \rightarrow Mn^{2+}$

6. First balance the bromine half-reaction first.

   a. Balance the **bromine** atoms of the reaction

   ___ $Br^- \rightarrow$ ___ Br_2

   b. Now balance **charge** by adding **electrons** (**e**$^-$)

   ___ $Br^- \rightarrow$ ___ Br_2

   This half-reaction is **producing/consuming electrons**. This is an **oxidation/reduction** half-reaction. Confirm this by assigning oxidation numbers to the bromine species.

7. Next, balance the manganese half-reaction.

   a. Balance the **manganese** atoms of the half-reaction

   ___ $MnO_4^- \rightarrow$ ___ Mn^{2+}

   b. Next, balance **oxygen** by adding water molecules (**H_2O**)

   ___ $MnO_4^- \rightarrow$ ___ Mn^{2+}

   c. Next, balance **hydrogen** by adding protons (**H^+**)

   ___ $MnO_4^- \rightarrow$ ___ Mn^{2+}

   d. Finally, balance **charge** by adding electrons (**e**$^-$).

   ___ $MnO_4^- \rightarrow$ ___ Mn^{2+}

   This half-reaction is **producing/consuming electrons**. This is a **oxidation/reduction** half-reaction. Confirm this by assigning oxidation numbers to the manganese atoms.

   Notice that the number of electrons equals the change in oxidation number.

8. Now put the two **half-reactions** together. **The number of electrons produced must equal the number of electrons consumed**.

$2\ Br^- \rightarrow Br_2 + \mathbf{2e^-}$	$\mathbf{5e^-} + 8H^+ + MnO_4^- \rightarrow Mn^{2+} + 4H_2O$
multiply this half-reaction by ____	multiply this half-reaction by ___
___$Br^- \rightarrow$ ___Br_2 + ___e^-	___e^- + ___H^+ + ___$MnO_4^- \rightarrow$ ___Mn^{2+} + ___H_2O

Add the two half-reactions, canceling out species that appear on both sides (including electrons)

___Br^- + ___H^+ + ___$MnO_4^- \rightarrow$ ___Br_2 + ___Mn^{2+} + ___H_2O

Which compound is the **oxidizing agent** ?

Which compound is the **reducing agent** ?

6.7.1 ESSENTIAL Classroom Active Learning Task 2,3 &4 Mark Scheme

Worksheet 25 - Oxidation/Reduction Reactions

Oxidation number rules:

Elements have an oxidation number of 0
Group I and II – In addition to the elemental oxidation state of 0, Group I has an oxidation state of +1 and Group II has an oxidation state of +2.
Hydrogen –usually +1, except when bonded to Group I or Group II, when it forms hydrides, -1.
Oxygen – usually -2, except when it forms a O-O single bond, a peroxide, when it is -1.
Fluorine is always -1. Other halogens are usually -1, except when bonded to O.

1. Assign **oxidation numbers** to each of the atoms in the following compounds:

Na_2CrO_4	Na = +1	O = -2	Cr = +6
$H_2Cr_2O_7$	H = +1	O = -2	Cr = +6
CO_2	O = -2	C = +4	
CH_4	H = +1	C = -4	
$HClO_4$	O = -2	H = +1	Cl = +7
MnO_2	O = -2	Mn = +4	
SO_3^{2-}	O = -2	S = +4	
SF_4	F = -1	S = +4	

a. What is the range of oxidation states for **carbon**? -4 to +4

b. Which compound has C in a +4 state? CH_4

c. Which compound has C in a -4 state? CO_2.

The species that is oxidized is called the **reducing agent** because it gives up an electron, so that another species can gain an electron (be reduced).

d. What is the **reducing agent** in this reaction? N_2

The species that is reduced is called the **oxidizing agent** because it takes an electron away from another group, raising that group's oxidation number.

e. What is the **oxidizing agent** in this reaction? H_2.

4. In each of the following reactions, assign **oxidation numbers** to all of the elements and identify the **oxidizing** and **reducing agents** and the **change in oxidation number**.

a. $4\ Fe + 3\ O_2 \rightarrow 2\ Fe_2O_3$

		change in oxidation number
oxidizing agent	O_2.	0 → -2.
reducing agent	Fe	0 → +3

b. $2K + 2H_2O \rightarrow 2KOH + H_2$

oxidizing agent	H	+1 → 0
reducing agent	K	0 → +1

c. $NH_4NO_2 \rightarrow N_2 + 2\ H_2O$

		change in oxidation number
oxidizing agent	NH_4^+	-3 → 0
reducing agent	NO_2^-	+3 → 0

d. $P_4 + 10\ Cl_2 \rightarrow 4\ PCl_5$

		change in oxidation number
oxidizing agent	Cl_2.	0 → -1
reducing agent	P_4	0 → +5

e. $2\ Cr^{3+} + H_2O + 6\ ClO_3^- \rightarrow Cr_2O_7^{2-} + 6ClO_2 + 2\ H^+$

		change in oxidation number
oxidizing agent	Cr^{3+}	+3 → +8
reducing agent	ClO_3^-	+7 → +4

2. Nitrogen has 5 valence electrons (Group V). It can gain up to 3 electrons (-3), or lose up to 5 (+5) electrons. Fill in the missing names or formulas and assign an oxidation state to each of the following nitrogen containing compounds:

name	formula	oxidation state of N
AMMONIA	NH_3	-3
nitrogen	N_2	0
nitrite	NO_2^-	+3
NITRATE	NO_3^-	+5
dinitrogen monoxide	N_2O	+1
NITROGEN DIOXIDE	NO_2	+4
hydroxylamine	NH_2OH	-1
nitrogen monoxide	NO	+2
hydrazine	N_2H_4	-2

3. During chemical reactions, the **oxidation state** of atoms can change. This occurs when compounds gain or lose electrons, or when the **bonds** to an atom change. This is illustrated by the reaction between nitrogen and hydrogen to make ammonia:

$$N_2(g) + 3\ H_2(g) \rightarrow 2\ NH_3(g)$$

a. Assign **oxidation numbers** to each of the atoms in this reaction.

N (in N_2) = 0 N (in NH_3) = -3

H (in H_2) = 0 H (in NH_3) = +1

When an oxidation number **increases**, that species has been **oxidized**.

b. Which reactant undergoes an increase in its oxidation number? H_2.

When an oxidation number **decreases**, that species has been **reduced**.

c. Which reactant undergoes a decrease in its oxidation number? N_2.

BEYOND iGCSE **Balancing Redox Reactions** EXCEPTIONAL

Oxidation/Reduction (Redox) reactions can be balanced using the oxidation state changes, as seen in the previous example. However, there is an easier method, which involves breaking a redox reaction into two **half- reactions**. This is best shown by working an example.

Hydrobromic acid will react with permanganate to form elemental bromine and the manganese(II) ion. The unbalanced, net reaction is shown below.

$$Br^- + MnO_4^- \rightarrow Br_2 + Mn^{2+}$$

5. Break this into two **half-reactions**, one involving bromine and the other involving manganese.

Bromine half-reaction	**Manganese half-reaction**
$Br^- \rightarrow Br_2$	$MnO_4^- \rightarrow Mn^{2+}$

6. First balance the bromine half-reaction first.

a. Balance the **bromine** atoms of the reaction

$2\ Br^- \rightarrow 1\ Br_2$

b. Now balance **charge** by adding **electrons** (e^-)

$2\ Br^- \rightarrow 1\ Br_2 + 2e^-$

This half-reaction is **producing/consuming electrons**. This is an **oxidation/reduction** half-reaction. Confirm this by assigning oxidation numbers to the bromine species.

7. Next, balance the manganese half-reaction.

a. Balance the **manganese** atoms of the half-reaction

$1\ MnO_4^- \rightarrow 1\ Mn^{2+}$

b. Next, balance **oxygen** by adding water molecules (H_2O)

$1\ MnO_4^- \rightarrow 1\ Mn^{2+} + 4H_2O$

c. Next, balance **hydrogen** by adding protons (H^+)

$8H^+ + 1\ MnO_4^- \rightarrow 1\ Mn^{2+} + 4H_2O$

d. Finally, balance **charge** by adding electrons (e^-).

$5e^- + 8H^+ + 1\ MnO_4^- \rightarrow 1\ Mn^{2+} + 4H_2O$

This half-reaction is **producing/consuming electrons**. This is a **oxidation/reduction** half-reaction. Confirm this by assigning oxidation numbers to the **manganese atoms**.

Notice that the number of electrons equals the change in oxidation number.

8. Now put the two **half-reactions** together. **The number of electrons produced must equal the number of electrons consumed.**

$2\ Br^- \rightarrow Br_2 + 2e^-$ $5e^- + 8H^+ + MnO_4^- \rightarrow Mn^{2+} + 4H_2O$

multiply this half-reaction by 5 multiply this half-reaction by 2.

$10\ Br^- + 5\ Br_2 + 10e^-$ $10e^- + 16\ H^+ + 2\ MnO_4^- \rightarrow 2\ Mn^{2+} + 8\ H_2O$

Add the two half-reactions, canceling out species that appear on both sides (including electrons)

$10\ Br^- + 16\ H^+ + 2\ MnO_4^- \rightarrow 5\ Br_2 + 2\ Mn^{2+} + 8\ H_2O$

Which compound is the **oxidizing agent** ? MnO_4^-

Which compound is the **reducing agent** ? Br^-

6.8 ESSENTIAL EXAM QUESTIONS Paper 3/4 48marks

Q# 1/ iGCSE Chemistry/2015/s/Paper 31/

3 **(a)** The reactions between metals and acids are redox reactions.

$$Zn + 2H^+ \rightarrow Zn^{2+} + H_2$$

(i) Which change in the above reaction is oxidation, Zn to Zn^{2+} or $2H^+$ to H_2? Give a reason for your choice.

.....

..... [2]

(ii) Which reactant in the above reaction is the oxidising agent? Give a reason for your choice.

.....

..... [2]

Q# 2/ iGCSE Chemistry/2012/s/Paper 31/

4 Vanadium is a transition element. It has more than one oxidation state. The element and its compounds are often used as catalysts.

(d) The oxidation states of vanadium in its compounds are V(+5), V(+4), V(+3) and V(+2). The vanadium(III) ion can behave as a reductant or an oxidant.

(i) Indicate on the following equation which reactant is the oxidant.

$$2V^{3+} + Zn \rightarrow 2V^{2+} + Zn^{2+}$$

[1]

(ii) Which change in the following equation is oxidation? Explain your choice.

$$V^{3+} + Fe^{3+} \rightarrow V^{4+} + Fe^{2+}$$

.....

..... [2]

Q# 3/ iGCSE Chemistry/2011/w/Paper 31/ Q5

(b) Iron has two oxidation states +2 and +3. There are two possible equations for the redox reaction between iron and bromine.

$$Fe + Br_2 \rightarrow Fe^{2+} + 2Br^-$$

$$2Fe + 3Br_2 \rightarrow 2Fe^{3+} + 6Br^-$$

(i) Indicate, on the first equation, the change which is oxidation. Give a reason for your choice.

.....

..... [2]

(ii) Which substance in the first equation is the reductant (reducing agent)?

..... [1]

Q# 4/ iGCSE Chemistry/2010/w/Paper 31/Q3

This equation is needed for the question that follows:

(iii) $Br_2 + 2e \rightarrow 2Br^-$

(iv) Is the change in **(iii)** oxidation or reduction? Give a reason for your choice.

.....

..... [1]

(v) Complete the following description of the reaction in the right hand beaker.

Fe^{2+} changes into ..... . [1]

Q# 5/ iGCSE Chemistry/2010/w/Paper 31/

6 The table below shows the elements in the second period of the Periodic Table and some of their oxidation states in their most common compounds.

element	Li	Be	B	C	N	O	F	Ne
number of outer electrons	1	2	3	4	5	6	7	8
oxidation state	+1	+2	+3	+4	–3	–2	–1	0

(a) (i) What does it mean when the only oxidation state of an element is zero?

.....

..... [1]

(ii) Explain why some elements have positive oxidation states but others have negative ones.

.....

..... [2]

Q# 6/ iGCSE Chemistry/2009/w/Paper 3/ Q4

(b) Ozone is an oxidant. It can oxidise an iodide to iodine.

$$2I^- + O_3 + 2H^+ \rightarrow I_2 + O_2 + H_2O$$

(ii) Explain in terms of electron transfer why the change from iodide ions to iodine molecules is oxidation.

.....

..... [1]

(iii) Explain, using your answer to **b(ii)**, why ozone is the oxidant in this reaction.

.....

..... [1]

Q# 7/ iGCSE Chemistry/2007/w/Paper 3/ Q2 (b)

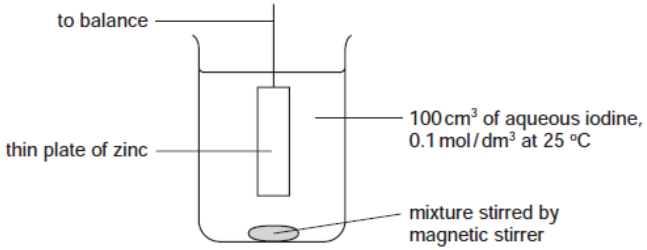
(iii) The reaction between magnesium and bromine is redox. Complete the sentences.

Magnesium is the ..... agent because it has ..... electrons.

Bromine has been ..... because it has ..... electrons. [4]

Q# 8/ iGCSE Chemistry/2005/s/Paper 3/ Q2

2 The following apparatus was used to measure the rate of the reaction between zinc and iodine.



The mass of the zinc plate was measured every minute until the reaction was complete.

(a) Write an ionic equation for the redox reaction that occurred between zinc atoms and iodine molecules.

..... [2]

Q# 9/ iGCSE Chemistry/2004/s/Paper 31/

(c) Silicon is made by the carbon reduction of the macromolecular compound, silicon(IV) oxide.

(i) Balance the equation for the reduction of silicon(IV) oxide.

SiO_2 + ... C → Si + ... CO [1]

(ii) Explain why the silicon(IV) oxide is said to be reduced.

..... [1]

Q# 10/ iGCSE Chemistry/2003/w/Paper 3/ Q2

(c) A solution of an impure zinc ore contained zinc, lead and silver(I) ions. The addition of zinc dust will displace both lead and silver.

(i) The ionic equation for the displacement of lead is as follows.

change 1

$Zn(s) + Pb^{2+}(aq) \rightarrow Zn^{2+}(aq) + Pb(s)$

change 2

Which change is reduction? Explain your answer.

.....

.....[2]

(ii) Write an ionic equation for the reaction between zinc atoms and silver(I) ions.

.....[2]

Q# 11/ iGCSE Chemistry/2002/w/Paper 3/

3 The elements in Period 3 and some of their common oxidation states are shown below.

Element	Na	Mg	Al	Si	P	S	Cl	Ar
Oxidation State	+1	+2	+3	+4	–3	–2	–1	0

(a) **(i)** Why do the oxidation states increase from sodium to silicon?

.....[1]

(ii) After Group(IV) the oxidation states are negative and decrease across the period. Explain why.

.....

.....[2]

Q# 12/ iGCSE Chemistry/2002/s/Paper 3/ Q4

(b) Bromine is obtained from the bromide ions in sea water. Sea water is concentrated by evaporation. Chlorine gas is bubbled through the solution. Chlorine oxidises the bromide ion to bromine.

(i) Complete the following equation.

Cl_2 + ...Br^- ⟶ ..... + ... [2]

(ii) Explain using the idea of electron transfer why the bromide ion is oxidised by chlorine.

The bromide ion is oxidised because .....

.....

Chlorine is the oxidising agent because .....

.....[2]

(iii) Name a reagent that can be oxidised by bromine molecules.

.....[1]

Q# 13/ iGCSE Chemistry/2001/w/Paper 3/ QiGCSE Chemistry/201 (a)

(iii) The following reaction is used to detect carbon monoxide.

$CO + Pd^{2+} + H_2O \longrightarrow CO_2 + Pd + 2H^+$

orange black

What type of chemical reaction is the change Pd^{2+} to Pd? Give a reason for your answer.

.....[2]

6.8.1 Mark Scheme iG Chem 7.4 EQ Paper 3/4

Q# 1/ iGCSE Chemistry/2015/s/Paper 31/

3(a)(i)	Zn to Zn^{2+} ; because electron loss;	2	**A** because oxidation number has increased for M2
3(a)(ii)	(2)H^+ or 'hydrogen ion(s)'; it accepts electrons or takes electrons (from zinc atoms);	2	**R** H_2 or 'hydrogen' **A** because it is reduced or because it decreases in oxidation number **A** it causes zinc to lose electrons

Q# 2/ iGCSE Chemistry/2012/s/Paper 31/Q4

(d) (i) V^{3+} is oxidant; [1]

(ii) V^{3+} to V^{4+}; [1]
increase in oxidation number / electron loss; [1]

Q# 3/ iGCSE Chemistry/2011/w/Paper 31/ Q5

(b) (i) Fe to Fe^{2+} [1]
because oxidation is electron loss / increase in oxidation number [1]

(ii) Fe [1]

Q# 4/ iGCSE Chemistry/2010/w/Paper 31/

(iv) reduction because electron gain [1]
/ because oxidation number decreases
need both points

(v) Fe^{3+} [1]

Q# 5/ iGCSE Chemistry/2010/w/Paper 31/

6 (a) (i) does not form compounds / does not accept and does not lose electrons / has full outer shell/has 8e in outer shell / it is a Noble Gas / it is in Group 0/8 [1]

(ii) small number of outer electrons / lose electrons then positive [1]
large number of outer electrons / gain electrons then negative [1]

Q# 6/ iGCSE Chemistry/2009/w/Paper 3/ Q4

(ii) I^- loses electrons (to form iodine molecules) [1]
must be in terms of electron transfer **NOT** oxidation number

(iii) they (electrons) are accepted by ozone
or it is an electron acceptor [1]

Q# 7/ iGCSE Chemistry/2007/w/Paper 3/ Q3 (b)

(iii) reducing **or** reduction **or** reductant [1]
lost electrons **or** given **or** donated electrons **or** transferred (to bromine) [1]
reduced [1]
gained **or** accepted electrons [1]

Q# 8/ iGCSE Chemistry/2005/s/Paper 3/

2 (a) $Zn + I_2 = Zn^{2+} + 2I^-$ **[2]**
For having either reactants **or** products correct ONLY [1]

Q# 9/ iGCSE Chemistry/2004/s/Paper 3/

(c) (i) correctly balanced **[1]**

(ii) lost oxygen **[1]**
or decrease in oxidation number
NOT accepts electrons unless valid explanation

Q# 10/ iGCSE Chemistry/2003/w/Paper 3/ Q3

(c) (i) one involving lead – change 2 [1]
cond because electrons are gained [1]
or oxidation number less

(ii) correct equation [2]
$Zn + 2Ag^+ = 2Ag + Zn^{2+}$
not balanced **ONLY** [1]

Q# 11/ iGCSE Chemistry/2002/w/Paper 3/

3 (a) (i) number of outer electrons increases [1]
or number of electrons more than complete energy level
or number of electrons to be lost
or accept clear examples
NOT just different groups or valencies

(ii) gain electrons [1]
number of electrons to be gained is less across period [1]

or number of outer electrons increases

Q# 12/ iGCSE Chemistry/2002/s/Paper 3/

4 (a) (i) fluorine **[1]**

(ii) iodine and astatine **[1]**

(b) (i) $Cl_2 + 2Br^- \Longrightarrow 2Cl^- + Br_2$ **[2]**
not balanced **ONLY [1]**

(ii) because it has lost electron(s)(Must be electron transfer) **[1]**

Not conseq because it took electrons from the bromide **[1]**
or chlorine gained electrons
or because chlorine was reduced

(iii) Iodide **or** metals **or** iron(II) etc **[1]**
not iodine accept iodine ions **or** alkene

Q# 13/ iGCSE Chemistry/2001/w/Paper 3/ QiGCSE Chemistry/201 (a)

(iii) reduction [1]
COND electron gain or decrease in oxidation number [1]

6.9 ESSENTIAL EXAM QUESTIONS Paper 2 18marks

Q# 1/ iGCSE Chemistry/2018/w/Paper 23/

16 The equation for the reaction between zinc and copper(II) oxide is shown.

$$Zn + CuO \rightarrow ZnO + Cu$$

Which row shows the oxidising agent and the reducing agent?

	oxidising agent	reducing agent
A	CuO	Cu
B	CuO	Zn
C	Zn	CuO
D	Zn	ZnO

Q# 2/ iGCSE Chemistry/2018/w/Paper 22/

16 The thermite reaction can be used to produce iron from iron(III) oxide.

The equation for the reaction is shown.

$$2Al + Fe_2O_3 \rightarrow 2Fe + Al_2O_3$$

Which statements about this reaction are correct?

1 Aluminium is the oxidising agent.

2 Aluminium is less reactive than iron.

3 Electrons are transferred from aluminium to iron.

4 The iron in the iron(III) oxide is reduced.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

Q# 3/ iGCSE Chemistry/2018/w/Paper 21/

16 An excess of iron(II) chloride is added to acidified potassium manganate(VII).

Which statements are correct?

1 The purple colour disappears.

2 Iron(II) is reduced to iron(III).

3 Manganate(VII) ions are oxidised to manganese(II) ions.

4 Potassium manganate(VII) is an oxidising agent.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

Q# 4/ iGCSE Chemistry/2018/s/Paper 23/

16 The equation for a redox reaction is shown.

$$2Fe^{3+} + Zn \rightarrow 2Fe^{2+} + Zn^{2+}$$

Which statements are correct?

1 Fe^{3+} is reduced to form Fe^{2+}.

2 Zn oxidises the Fe^{3+} ions.

3 Fe^{3+} is an oxidising agent.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

Q# 5/ iGCSE Chemistry/2018/s/Paper 22/

16 Iron(II) chloride solution reacts with chlorine gas.

The equation is shown.

$$2FeCl_2(aq) + Cl_2(g) \rightarrow 2FeCl_3(aq)$$

Which statements about this reaction are correct?

1 Fe^{2+} ions are reduced to Fe^{3+} ions.

2 Chlorine acts as a reducing agent.

3 Fe^{2+} ions each lose an electron.

4 Cl_2 molecules are reduced to Cl^- ions.

A 1 and 2 **B** 2 and 3 **C** 2 and 4 **D** 3 and 4

Q# 6/ iGCSE Chemistry/2018/s/Paper 21/

16 Chlorine displaces iodide ions from potassium iodide.

$$Cl_2 + 2I^- \rightarrow I_2 + 2Cl^-$$

What is the oxidising agent?

A chloride ions

B chlorine

C iodide ions

D iodine

Q# 7/ iGCSE Chemistry/2018/m/Paper 22/

18 The reaction between magnesium and carbon dioxide is shown in the equation.

$$2Mg + CO_2 \rightarrow 2MgO + C$$

Which statement describes what happens in this reaction?

A Carbon is oxidised.

B Magnesium is reduced.

C Neither oxidation nor reduction happens.

D The carbon in carbon dioxide is reduced.

19 Which changes involve reduction?

1 $2I^- \rightarrow I_2 + 2e^-$

2 $CuO + H_2 \rightarrow Cu + H_2O$

3 $Al^{3+} + 3e^- \rightarrow Al$

4 $Pb^{2+} + SO_4^{2-} \rightarrow PbSO_4$

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

Q# 8/ iGCSE Chemistry/2017/w/Paper 23/

14 Silver chloride reacts when it is exposed to light.

Which row shows what happens to the silver in this process?

	half-equation	type of reaction
A	$Ag \rightarrow Ag^+ + e^-$	oxidation
B	$Ag \rightarrow Ag^+ + e^-$	reduction
C	$Ag^+ + e^- \rightarrow Ag$	oxidation
D	$Ag^+ + e^- \rightarrow Ag$	reduction

Q# 9/ iGCSE Chemistry/2017/w/Paper 22/

14 Copper metal donates electrons to silver ions.

Zinc metal donates electrons to copper ions.

What is the strongest reducing agent?

A copper ions

B copper metal

C silver ions

D zinc metal

Q# 10/ iGCSE Chemistry/2017/w/Paper 21/

14 Copper(II) oxide reacts with hydrogen.

$$CuO + H_2 \rightarrow Cu + H_2O$$

Which row is correct?

	oxidising agent	reducing agent
A	H_2	CuO
B	CuO	H_2
C	H_2O	Cu
D	Cu	H_2O

Q# 11/ iGCSE Chemistry/2017/s/Paper 21/

17 An example of a redox reaction is shown.

$$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$$

Which statement about the reaction is correct?

A Zn is the oxidising agent and it oxidises Cu^{2+}.

B Zn is the oxidising agent and it reduces Cu^{2+}.

C Zn is the reducing agent and it oxidises Cu^{2+}.

D Zn is the reducing agent and it reduces Cu^{2+}.

Q# 12/ iGCSE Chemistry/2017/m/Paper 22/

17 Chlorine displaces bromine from a solution of potassium bromide.

$$Cl_2 + 2KBr \rightarrow 2KCl + Br_2$$

What is the oxidising agent in this reaction?

A bromide ions

B bromine

C chloride ions

D chlorine

Q# 13/ iGCSE Chemistry/2016/w/Paper 23/

17 Which change represents an oxidation reaction?

A chlorine changes to chlorate(I) ions

B chlorine changes to chloride ions

C copper(II) ions change to copper

D potassium manganate(VII) ions change to potassium manganate(VI) ions

Q# 14/ iGCSE Chemistry/2016/w/Paper 22/

17 Chromium forms the compound chromium(III) sulfate.

What does the (III) represent?

A the charge on a sulfate ion

B the number of chromium ions combined with one sulfate ion

C the number of sulfate ions combined with one chromium ion

D the oxidation state of chromium

Q# 15/ iGCSE Chemistry/2016/w/Paper 21/

17 Four ionic half-equations are shown.

1 $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

2 $2I^-(aq) \rightarrow I_2(aq) + 2e^-$

3 $Fe^{2+}(aq) \rightarrow Fe^{3+}(aq) + e^-$

4 $Cl_2(g) + 2e^- \rightarrow 2Cl^-(aq)$

Which statement is correct?

A In equation 1, copper(II) ions are oxidised to copper.

B In equation 2, iodide ions are reduced to iodine.

C In equation 3, iron(II) ions are oxidised to iron(III) ions.

D In equation 4, chlorine is oxidised to chloride ions.

Q# 16/ iGCSE Chemistry/2016/s/Paper 21/

17 Which equation represents a reduction reaction?

A $Fe^{2+} + e^- \rightarrow Fe^{3+}$

B $Fe^{2+} \rightarrow Fe^{3+} + e^-$

C $Fe^{3+} + e^- \rightarrow Fe^{2+}$

D $Fe^{3+} \rightarrow Fe^{2+} + e^-$

Q# 17/ iGCSE Chemistry/2016/m/Paper 22/

16 Zinc is extracted from zinc blende by roasting it in air to form zinc oxide.

The zinc oxide is then heated with carbon to form zinc.

The equations for the reactions are shown.

1 $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$

2 $ZnO + C \rightarrow Zn + CO$

Which statement about reactions 1 and 2 is **not** correct?

A In reaction 1 the oxidation state of sulfur increases and it is oxidised.

B In reaction 1 the oxidation state of zinc increases and it is oxidised.

C In reaction 2 the carbon acts as a reducing agent and it is oxidised.

D In reaction 2 the oxidation state of zinc decreases and it is reduced.

6.9.1 ESSENTIAL EXAM QUESTIONS T7.4 Paper 2 Mark Scheme

Q# 1/ iGCSE Chemistry/2018/w/Paper 23/

16	B

Q# 2/ iGCSE Chemistry/2018/w/Paper 22/

16	D

Q# 3/ iGCSE Chemistry/2018/w/Paper 21/

16	B

Q# 4/ iGCSE Chemistry/2018/s/Paper 23/

16	C

Q# 5/ iGCSE Chemistry/2018/s/Paper 22/

16	D

Q# 6/ iGCSE Chemistry/2018/s/Paper 21/

16	B

Q# 7/ iGCSE Chemistry/2018/m/Paper 22/

18	D
19	C

Q# 8/ iGCSE Chemistry/2017/w/Paper 23/

14	D

Q# 9/ iGCSE Chemistry/2017/w/Paper 22/

14	D

Q# 10/ iGCSE Chemistry/2017/w/Paper 21/

14	B

Q# 11/ iGCSE Chemistry/2017/s/Paper 21/

17	D

Q# 12/ iGCSE Chemistry/2017/m/Paper 22/

17	D

Q# 13/ iGCSE Chemistry/2016/w/Paper 23/

17 **A**

Q# 14/ iGCSE Chemistry/2016/w/Paper 22/

17 **D**

Q# 15/ iGCSE Chemistry/2016/w/Paper 21/

17 **C**

Q# 16/ iGCSE Chemistry/2016/s/Paper 21/

17 **C**

Q# 17/ iGCSE Chemistry/2016/m/Paper 22/

16 **B**

6.10 FUNDAMENTAL Assessed Activity 1 Keyword Test

English	Meaning
oxidation state	
oxidation	
oxidising agent	
redox reaction	
reduction	

6.11 FUNDAMENTAL Assessed Activity 2 Paper 1 17marks

Q# 1/

14 Which change is an oxidation?

A FeO to Fe_2O_3

B Fe_2O_3 to FeO

C H_2O_2 to H_2O

D H_2O to H_2

Q# 2/

14 The element vanadium, V, forms several oxides.

In which change is oxidation taking place?

A $VO_2 \rightarrow V_2O_3$

B $V_2O_5 \rightarrow VO_2$

C $V_2O_3 \rightarrow VO$

D $V_2O_3 \rightarrow V_2O_5$

Q# 3/

18 The red colour in some pottery glazes may be formed as a result of the reactions shown.

$$CuCO_3 \xrightarrow{heat} CuO + CO_2$$

$$CuO + SnO \longrightarrow Cu + SnO_2$$

These equations show that ……1…… is oxidised and ……2…… is reduced.

Which substances correctly complete gaps 1 and 2 in the above sentence?

	1	2
A	CO_2	SnO_2
B	$CuCO_3$	CuO
C	CuO	SnO
D	SnO	CuO

Q# 4/

18 Iron is extracted from iron oxide using carbon monoxide as shown in the equation.

iron oxide + carbon monoxide → iron + carbon dioxide

What does the equation show?

A Carbon monoxide is oxidised to carbon dioxide.

B Carbon monoxide is reduced to carbon dioxide.

C Iron is oxidised to iron oxide.

D Iron oxide is oxidised to iron.

Q# 5/

18 The equations represent redox reactions.

In which equation is the underlined substance acting as a reducing agent?

A $\underline{CaO} + H_2O \rightarrow Ca(OH)_2$

B $\underline{CO_2} + C \rightarrow 2CO$

C $\underline{CuO} + H_2 \rightarrow Cu + H_2O$

D $3\underline{CO} + Fe_2O_3 \rightarrow 2Fe + 3CO_2$

Q# 6/

18 The reactions shown may occur in the air during a thunder storm.

$N_2 + O_2 \rightarrow 2NO$

$2NO + O_2 \rightarrow 2NO_2$

$NO + O_3 \rightarrow NO_2 + O_2$

Which line shows what happens to the reactant molecules in each of these reactions?

	N_2	NO	O_3
A	oxidised	oxidised	oxidised
B	oxidised	oxidised	reduced
C	reduced	reduced	oxidised
D	reduced	reduced	reduced

Q# 7/

17 In which of the following reactions is the substance printed in **bold** oxidised?

A burning the **wax** in a candle

B dissolving **hydrogen chloride** in water

C making glucose from **carbon dioxide** and water by photosynthesis

D reacting **sodium hydroxide** with sulphuric acid

Q# 8/

18 When written as formulae, which compound has the greatest number of oxygen atoms?

A calcium oxide

B copper(II) oxide

C iron(III) oxide

D potassium oxide

Q# 9/

19 The equation explains the colour change that occurs when aqueous potassium hydroxide is added to aqueous potassium dichromate(VI).

$K_2Cr_2O_7$	+	2KOH	→	$2K_2CrO_4$	+	H_2O
potassium dichromate(VI)				potassium chromate(VI)		
orange				yellow		

As a result of adding an excess of aqueous potassium hydroxide to aqeous potassium dichromate(VI), what happens to the oxidation state of the chromium and the pH of the reaction mixture?

	oxidation state of the chromium	pH of the mixture
A	decreases	decreases
B	decreases	increases
C	stays the same	decreases
D	stays the same	increases

Q# 10/

16 Which equation shows an oxidation reaction?

A $C + O_2 \rightarrow CO_2$

B $CaCO_3 \rightarrow CaO + CO_2$

C $2H_2O_2 \rightarrow 2H_2O + O_2$

D $N_2O_4 \rightarrow 2NO_2$

Q# 11/

15 Which process does **not** involve either oxidation or reduction?

A burning methane in the air

B extracting iron from hematite

C heating copper(II) oxide with carbon

D reacting sodium carbonate with dilute hydrochloric acid

Q# 12/

29 What is used to test for the presence of water?

A anhydrous copper(II) sulphate

B aqueous barium chloride

C aqueous sodium hydroxide

D Universal indicator paper

Q# 13/

17 In which reaction does reduction of the underlined substance take place?

A $\underline{Cu_2O} + C \rightarrow 2Cu + CO$

B $\underline{2Cu_2O} + O_2 \rightarrow 4CuO$

C $\underline{2Cu} + O_2 \rightarrow 2CuO$

D $CuO + \underline{CO} \rightarrow Cu + CO_2$

Q# 14/

16 In an experiment, copper(II) oxide is changed to copper by a gas **X**.

What happens to the copper(II) oxide and what is **X**?

	copper(II) oxide	gas **X**
A	oxidised	carbon dioxide
B	oxidised	carbon monoxide
C	reduced	carbon dioxide
D	reduced	carbon monoxide

Q# 15/

17 The equation shows what happens when hydrated copper(II) sulphate is heated.

$$CuSO_4.5H_2O(s) \rightleftharpoons CuSO_4(s) + 5H_2O(g)$$

What can be deduced from the equation?

A The hydrated copper(II) sulphate is oxidised.

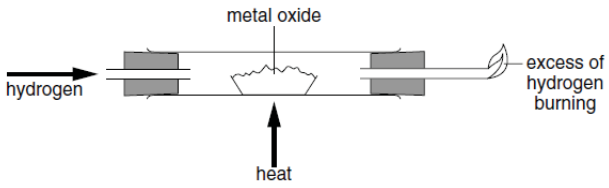
B The hydrated copper(II) sulphate is reduced.

C The reaction is reversible.

D There is no colour change.

Q# 16/

15 When hydrogen is passed over a heated metal oxide, the metal and steam are formed.



What happens to the hydrogen and to the metal oxide?

	hydrogen	metal oxide
A	oxidised	oxidised
B	oxidised	reduced
C	reduced	oxidised
D	reduced	reduced

Q# 17/

18 Zinc reacts with steam to form zinc oxide and hydrogen.

$$Zn + H_2O \longrightarrow ZnO + H_2$$

During the reaction, which substance is oxidised?

A hydrogen

B water

C zinc

D zinc oxide

6.12 Extension Assessed Activity 3 T7.4 P4 13marks

Q# 1/

(i) The chemical process taking place on the surface of the object is

$$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$$

Explain whether this process is oxidation or reduction.

.....

..... [1]

Q# 2/

(d) When a sample of steel is added to dilute hydrochloric acid, an aqueous solution of iron(II) chloride, $FeCl_2$, is formed.

When a sample of rust is added to dilute hydrochloric acid, an aqueous solution of iron(III) chloride, $FeCl_3$, is formed.

Solutions of iron(II) chloride and iron(III) chloride were added to solutions of potassium iodide and acidified potassium manganate(VII). The results are shown in the table.

	iron(II) chloride solution	iron(III) chloride solution
potassium iodide solution	no change	solution turns from colourless to brown
acidified potassium manganate(VII) solution	solution turns from purple to colourless	no change

(ii) What **types** of substance cause potassium iodide solution to turn from colourless to brown?

..... [1]

(iii) What **types** of substance cause acidified potassium manganate(VII) solution to turn from purple to colourless?

..... [1]

Q# 3/

(c) When chlorine gas is bubbled through an aqueous solution of potassium iodide, a redox reaction takes place.

$$2I^- + Cl_2 \rightarrow I_2 + 2Cl^-$$

(ii) Identify the reducing agent in this reaction. Explain your answer.

.....

.....

..... [2]

Q# 4/

(c) The electrolysis was repeated using copper electrodes in place of carbon electrodes. The ionic half-equations for the reactions at the two electrodes are shown.

anode $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$

cathode $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

(i) Which species is reduced during the electrolysis? Explain your answer.

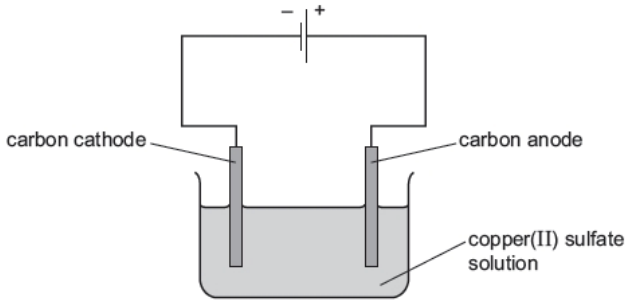
.....

.....

..... [2]

Q# 5/

4 Copper(II) sulfate solution was electrolysed using the apparatus shown.



(b) Oxygen was formed at the anode and copper was formed at the cathode.

(i) The ionic half-equation for the formation of oxygen is shown.

$$4OH^- \rightarrow O_2 + 2H_2O + 4e^-$$

Explain why this reaction is oxidation.

..... [1]

(ii) Write the ionic half-equation for the formation of copper at the cathode.

..... [2]

Q# 6/

3 **(a)** When magnesium is added to aqueous copper(II) sulfate a reaction occurs. The ionic equation for the reaction is shown.

$$Mg + Cu^{2+} \rightarrow Mg^{2+} + Cu$$

(i) Give **one** change you would observe during this reaction.

..... [1]

(ii) Explain why this is a redox reaction.

.....

..... [1]

(iii) Identify the oxidising agent in this reaction. Give a reason for your answer.

.....

..... [2]

6.13 Extension Mind Map for Topic 7.4 Redox

6.14 Essential End of Topic 7.4 Review and Reflection

Looking at the goals you could have achieved and the goals you actually achieved try to reflect on your progress.

Try to be as honest and as detailed as possible. Sometimes you may think you have thought about an idea well, but when you talk with someone else, or write it out, it helps you better understand and allows you think more completely and more clearly.

Did you achieve more goals this topic than last topic?

Fill in this table

Level	Number of goals achieved at each level	Success rate, %
FUNDAMENTAL	/5	
ESSENTIAL	/10	
EXTENSION	/13	
EXCEPTIONAL	/10	

Do you feel you tired harder? If yes, what helped you to do so? If not, why not?

What could you do differently next time, in addition to what you are already doing to improve, not only your score in the end of topic tests and other assessed activities, but also in how you learn. How could you become a more effective student to get more learning out of the time you are investing in your studies?

What did you enjoy most about this topic?

What did you find most difficult?

What did you find easiest?

On a scale of 1 being hardest and 5 being most difficult, circle how challenging you found this topic

1 2 3 4 5

What could be done to make this topic easier to understand?

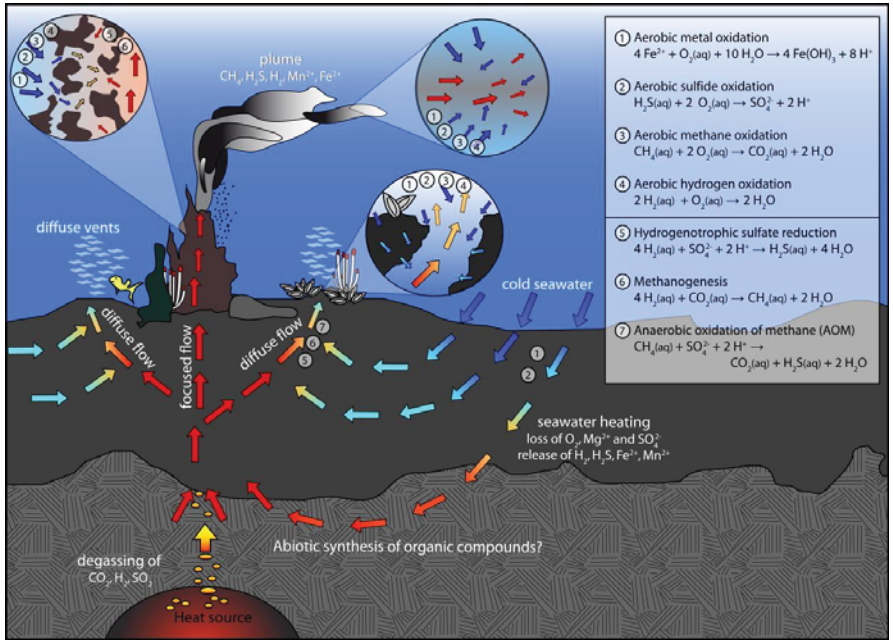
Do you have any questions about this topic?

6.15 Exceptional Additional Activities, Further Reading and Exploring Beyond the Syllabus

6.16 Topic 7.4 Exceptional Redox Reactions and the Origins of Life

Redox processes are essential for all life that we have ever discovered and can ever imagine, the redox processes provide the necessary energy to allow the life processes to persist. There are a variety of articles about life discovered underground (it the soil and rocks of the Earth's crust may in fact be where the majority, by dry mass, of life on Earth exists, not on the land, in the air or in the sea). Increasingly biologists understand life on earth started deep under water, and did not rely on energy from the sun, but instead energy from redox processes where the energy source is volcanic vents. It is even believed that this kind of life may in fact exist on other planets and moons, not only in our solar systems, or even in any solar system: perhaps half of all planets that are made in early solar systems are ejected out of the gravity field of their star or stars, and wander the astronomically empty spaces between solar systems, but if they are young enough, so just a few billion years old, they may have enough inner heat to support this kind of life beneath their icy surface.

All of these articles are available here: https://www.smashingsciencecn.org/igcse-chem-additional-resources



From: https://geochemicaltransactions.biomedcentral.com/articles/10.1186/1467-4866-13-2

7 Topic 5 Electrochemistry

7.1 End of Topic 6 Goals Checklist

For each topic you ought to try to do as many of the following things to get the most out of your time, the resources available to you and to help you grow as a student. Tick each goal off as you complete it. Growth is difficult and uncomfortable, but you should choose to do these things, and the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win!

Aspect	What you should have done	Yes/No	Level
Interacted with your teacher	Ask your teacher 1 question, about anything, once a week		FUNDAMENTAL
	Try to answer one question asked by your teacher at least once a week		ESSENTIAL
	Ask your teacher one question about something you do not understand in science once a week		ESSENTIAL
	Ask your teacher one question about something to do with science every lesson		EXTENSION
Notes and follow up notes	Complete set of class note		FUNDAMENTAL
	Cornell Notetaking Attempted		ESSENTIAL
	Cornell Notetaking Completed		EXTENSION
	Cornell Notetaking Completed to an exemplary standard		EXCEPTIONAL
	Attempted the Mind Map for this topic		ESSENTIAL
	Completed the Mind Map for this topic		EXTENSION
Textbook	Read ahead before the topic has been started		EXTESNION
	Highlighted key ideas and translate new words		FUNDAMENTAL
	Completed the questions at the end of each 2 page spread in your exercise book		EXTENSION
	Added to your class notes ideas and important information from the textbook that you learnt		EXTENSION
Past Exam Questions	Worked on at least 25% of the exam questions in this workbook		FUNDAMENTAL
	Attempted more than 25% of the questions and those questions you have completed you have marked in a different colour pen		ESSENTIAL
	Completed and marked all questions here		EXTENSION
	Completed, marked and additional key ideas where you have located the most difficult marks added to your notebook		EXCEPTIONAL
	Used the resources available online to answer additional questions not found in this workbook on the current topic.		EXCEPTIONAL
	Ask your teacher about an exam question that they cannot answer		EXCEPTIONALLY SMASHING!!!
Assessed Activities	Complete the word list activity using the word list at the front of each topic as little as possible		FUNDAMENTAL
	Complete 2 assessed activities, either in class or as homework		ESSENTIAL
	Complete 2 assessed activities and scored over 70% on average		ESSENTIAL
	Complete 2 assessed activities and scored over 80% on average		EXTENSION
	Complete 2 assessed activities and scored over 90% on average		EXCEPTIONAL
End of Topic Test	Revised sufficiently well to improve upon your score from the previous test (except if you are scoring over 90%, then just write Y for this goal)		ESSENTIAL
	Scored 10% higher than your current average		EXTENSION
	Scored 15% or more than your previous end of topic average		EXCEPTIONAL
	Scored over 90%		EXTESNION
	Scored over 95%		SMASHING!!!
Reading	Spend more than 1 hour a week reading a book **you enjoy** (in any language) about anything.		ESSENTIAL

Aspect	What you should have done	Yes/No	Level
	Spend more than 3 hours a week reading a book **you enjoy** (in any language) about anything.		EXTENSION
	Spend more than 5 hours a week reading a book **you enjoy** (in any language) about anything.		EXCEPTIONAL
	Spend at least one hour a week reading a book **you enjoy** in English about anything.		EXTENSION
	Spend more than 3 hours a week reading a book **you enjoy** in English about anything.		EXCEPTIONAL
Reflection	You completed this goal setting table		FUNDAMENTAL
	You have looked at the goals you have achieved and the ones you have not and added them up and entered them into the table in the Review and Reflection section		ESSENTIAL
	You have given an answer for every question in the Review and Reflection section at the end of this topic		EXTENSION
	You have Given good and thoughtful answers for every question in the Review and Reflection section at the end of this topic		EXCEPTIONAL

7.2 Topic 5 Syllabus

5 Electricity and chemistry

5.1 Electricity and chemistry

Core

- Define electrolysis as the breakdown of an ionic compound, molten or in aqueous solution, by the passage of electricity
- Describe the electrode products and the observations made during the electrolysis of:
  - molten lead(II) bromide
  - concentrated hydrochloric acid
  - concentrated aqueous sodium chloride
  - dilute sulfuric acid

  between inert electrodes (platinum or carbon)
- State the general principle that metals or hydrogen are formed at the negative electrode (cathode), and that non-metals (other than hydrogen) are formed at the positive electrode (anode)
- Predict the products of the electrolysis of a specified binary compound in the molten state
- Describe the electroplating of metals
- Outline the uses of electroplating

Supplement

- Relate the products of electrolysis to the electrolyte and electrodes used, exemplified by the specific examples in the Core together with aqueous copper(II) sulfate using carbon electrodes and using copper electrodes (as used in the refining of copper)
- Describe electrolysis in terms of the ions present and reactions at the electrodes in the examples given
- Predict the products of electrolysis of a specified halide in dilute or concentrated aqueous solution
- Construct ionic half-equations for reactions at the cathode

continued

5.1 Electricity and chemistry continued

Core

- Describe the reasons for the use of copper and (steel-cored) aluminium in cables, and why plastics and ceramics are used as insulators

Supplement

- Describe the transfer of charge during electrolysis to include:
  - the movement of electrons in the metallic conductor
  - the removal or addition of electrons from the external circuit at the electrodes
  - the movement of ions in the electrolyte
- Describe the production of electrical energy from simple cells, i.e. two electrodes in an electrolyte. (This should be linked with the reactivity series in section 10.2 and redox in section 7.4.)
- Describe, in outline, the manufacture of:
  - aluminium from pure aluminium oxide in molten cryolite (refer to section 10.3)
  - chlorine, hydrogen and sodium hydroxide from concentrated aqueous sodium chloride

  (Starting materials and essential conditions should be given but not technical details or diagrams.)

7.3 ESSENTIAL Glossary for Keywords for this topic

English	Chinese
anion a negative ion which would be attracted to the anode in electrolysis	**阴离子**负离子，在电解中会被吸引到阳**极**
anode the electrode in any type of cell at which oxidation (the loss of electrons) takes place – in **electrolysis** it is the positive electrode.	**在**发生氧化（电子损失）的任何类型的电池中，使电极阳极化-**在**电解中，它为正电极。
brine a concentrated solution of sodium chloride in water	盐水在水中的氯化钠浓缩溶**液**
cathode the electrode in any type of cell at which reduction (the gain of electrons) takes place; in **electrolysis** it is the negative electrode	**使任何**类型的发生还原（电子增益）的电池中的电极阴极；在电解中它是负**极**
cation a positive ion which would be attracted to the cathode in electrolysis. Remember smiling cats: cats are positive!	**阳离子在**电解中会被吸引到阴极的阳离子。记住微笑的猫：猫是积极的！
electrochemical cell a system for converting chemical energy to electrical energy, made by connecting two metals of different reactivity via an electrolyte;	电化学电池一种将化学能转化为电能的系统，通过将两种反应性不同的金属通过电解质连接制成。
electrode the point where the electric current enters or leaves a battery or **electrolytic cell**	电极电流进入或离开电池或电解池的位置
electrolysis a process in which a chemical reaction is caused by the passage of an electric current	电解一种通过电流通过引起化学反应的过**程**
electrolyte an ionic compound which will conduct electricity when it is molten or dissolved in water; electrolytes will not conduct electricity when solid	电解质是一种离子化合物，当熔融或溶于水时会导电。固体时电解质不会导电
electrolytic cell a cell consisting of an electrolyte and two electrodes (anode and cathode) connected to an external DC power source where positive and negative ions in the electrolyte are separated and discharged	电解池一种由电解质和两个与外部直流电源相连的电极（阳极和阴极）组成的电池，电解质中的正负离子被分离并放电
electroplating a process of electrolysis in which a metal object is coated (plated) with a layer of another metal	电镀一种电解过程，其中金属物体被另一种金属层覆盖（电镀）

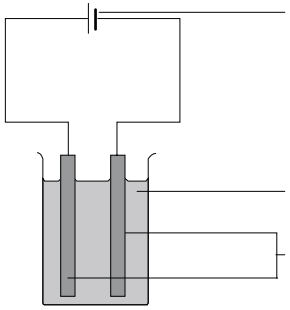
7.4 ESSENTIAL Active Learning Tasks Electrolysis 1

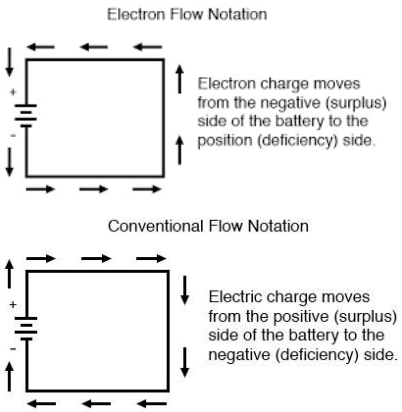
Match the following words with their meanings

Word		Meaning	
Electrode	1	Breaking up a substance by passing electricity through it	A
Electrolyte	2	Adding oxygen to, or removing electrons from, a substance	B
Reduction	3	Positive electrode	C
Oxidation	4	When one element is pushed out of its compound by a more reactive element	D
Cathode	5	Substance that is broken up when electricity is passed through it – usually a liquid	E
Anode	6	The percentage of the reactants that end up in the desired products of a reaction	F
Electrolysis	7	Removing oxygen from, or adding electrons to, a substance	G
Displacement	8	Negative electrode	H
Atom economy	9	A conductor made of a metal or graphite used in electrolysis	I

Word	Meaning
1	
2	
3	
4	
5	
6	
7	
8	D
9	

Essential Now label this diagram showing electrolysis





Extension activity

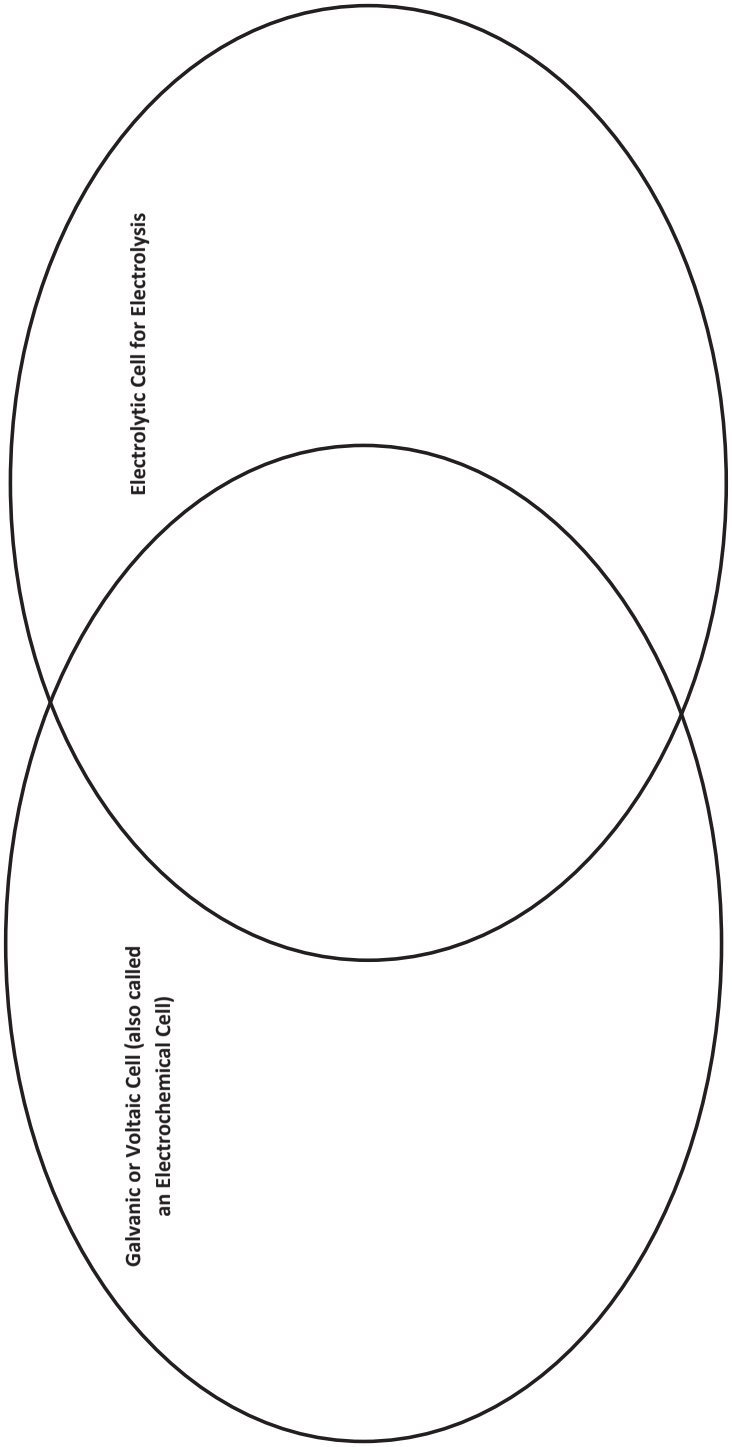
Assume that the substance being electrolysed is Lead (II) Bromide use the information above about Electron Flow Notation to label the electrodes with the ionic half equation that is happening at each side.

Exceptional activity

Why is the electron flow notation different from the conventional flow notation?

7.5 Extension Classroom Active Learning Task 2 Voltaic & Electrolytic Cells Venn Diagram

Compare and contrast what these two processes have in common and how are they different to each other



7.6 Extension Classroom Active Learning Task 3

1. What is the oxidation number of chlorine in $HClO_4$?
   1. −1 2. +1 3. +7 4. +8

2. What is the oxidation number of carbon in C_2H_6?
   1. −6 2. −3 3. +3 4. +6

4. Given the reaction: $Mg + CuSO_4 \rightarrow MgSO_4 + Cu$ Which equation represents the oxidation that takes place?
   1. $Mg^{+2} + 2e^- \rightarrow Mg$ 2. $Mg \rightarrow Mg^{+2} + 2e^-$
   3. $Cu^{+2} + 2e^- \rightarrow Cu$ 4. $Cu \rightarrow Cu^{+2} + 2e^-$

5. In the following reaction: $Fe + Zn^{+2} \rightarrow Fe^{+2} + Zn$
   A. Fe is reduced and Zn^{+2} is the oxidizing agent
   B. Fe is reduced and Zn^{+2} is the reducing agent
   C. Fe is oxidized and Zn^{+2} is the oxidizing agent
   D. Fe is oxidized and Zn^{+2} is the reducing agent

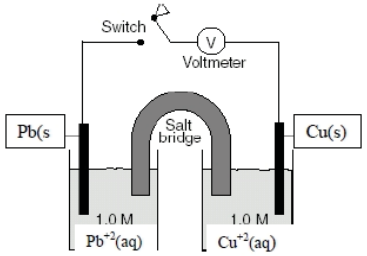
6. In which species does oxygen have an oxidation number of −1?
   A. H_2O 2. Na_2O_2 3. Al_2O_3 4. O_2

9. What is the purpose of a salt bridge in an electrochemical cell?
   1. To act as a reducing agent 2. To act as an oxidizing agent
   3. To provide electrons that flow between the two half cells and complete the electrical circuit
   4. To provide ions that flow between the two half cells and complete the electrical circuit

11. Given the equations A, B, C, and D; which <u>two</u> equations represent redox reactions?
   A. $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$
   B. $Cl_2 + H_2O \rightarrow HClO + HCl$
   C. $CuO + CO \rightarrow CO_2 + Cu$
   D. $NaOH + HCl \rightarrow NaCl + H_2O$
   1. A and B 2. B and C 3. C and A 4. D and B

12. Given the unbalanced equation: ___ NO_3^- + $4H^+$ + ___ Ag → ____Ag^+ + ____NO + $2H_2O$
   What is the coefficient in front of Ag when the equation is correctly balanced? (Where coefficients are given, these are correct and should not be changed)
   1. 1 2. 2 3. 3 4. 4

Use the diagram of the electrochemical cell below to answer the next four questions



$Pb(s) + Cu^{+2}(aq) \rightarrow Pb^{+2}(aq) + Cu(s)$

13. When the switch is closed which electrode will become heavier?
   A. Pb
   B. Cu
   C. Both Pb and Cu will increase in mass
   D. Neither Pb nor Cu will increase in mass

14. Which direction will electrons flow?
   A. From Pb through the voltmeter to Cu
   B. From Cu through the voltmeter to Pb
   C. From Pb through the salt bridge to Cu
   D. From Cu through the salt bridge to Pb

15. Which metal ion will increase in concentration as the cell runs
   1. Cu^{+2} only 2. Pb^{+2} only
   3. Both Cu^{+2} and Pb^{+2} 4. Neither Cu^{+2} nor Pb^{+2}

18. In the following reaction, how many **total** electrons are transferred between chlorine and oxygen?
   $2\ ClO_2 \rightarrow Cl_2 + 2O_2$
   1. 1 2. 2 3. 8 4. 4

19. In the following reaction what is the reducing agent?
   $Mg + 2HNO_3 \rightarrow Mg(NO_3)_2 + H_2$
   1. Mg 2. H^+ 3. O^{-2} 4. N^{+5}

Answer the next four questions from the reaction below:

Given the unbalanced reaction:
_____$Au^{3+}(aq)$ + ____$I^-(aq)$ → ____$Au(s)$ + ____$I_2(s)$

21. Write the reduction half reaction

_____

22. Write the oxidation half reaction

_____

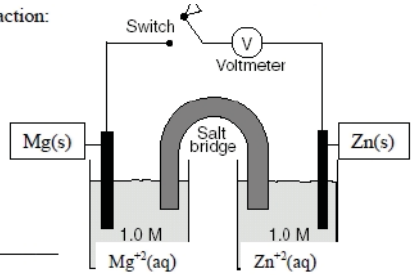
23. Write the balanced reaction

_____

23. How many <u>total</u> electrons are <u>transferred</u> when the reaction is balanced _____

The diagram below represents an electrochemical cell for the reaction:

$Mg(s) + Zn(NO_3)_2(aq) \rightarrow Mg(NO_3)_2 + Zn(s)$



24. Label the cathode
25. Label the anode
26. Write the half reaction which occurs at the cathode

_____

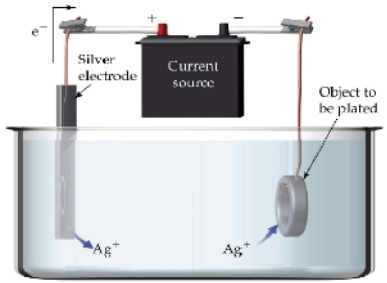
27. Write the half reaction which occurs at the anode

_____

28. Show the direction of movement of Mg^{+2} ions on the diagram above
29. Show the direction of Zn^{+2} ions ion the diagram above
30. Label and show the direction of movement of electrons

31. The diagram at right shows a cell for silver plating jewelry, adding a thin coat of silver on top of a cheaper metal such as steel.

A. There are two electrodes in the diagram, the silver electrode and the copper wire that holds the object to be plated. Label correctly in the diagram with anode or cathode.
B. Write the half reaction next to each electrode.
C. In what two ways does this differ from the other type of cell you have studied?



Answers to Electrochemistry: Practice Questions

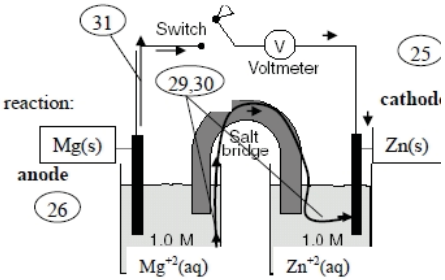
1. 3	2. 2		4. 2	5. 3	6. 2
		9. 4		11. 2	12. 3
13. 2	14. 1	15. 2		18. 3	
19. 1					

Given the unbalanced reaction: ____$Au^{3+}(aq)$ + ____$I^-(aq) \rightarrow$ ____$Au(s)$ + ___$I_2(s)$

21. Write the reduction half reaction $Au^{+3} + 3e^- \rightarrow Au(s)$ => $2Au^{+3} + 6e^- \rightarrow 2Au(s)$
22. Write the oxidation half reaction: $2I^- \rightarrow I_2(s) + 2e^-$ => $6I^- \rightarrow 3I_2(s) + 6e^-$
23. Write the balanced reaction $2Au^{+3} + 6I^- \rightarrow 3I_2(s) + 2Au(s)$
24. How many total electrons are transferred when the reaction is balanced ? 6 electrons
(Not 12 electrons! The 6 electrons lost by $6I^-$ are the same ones gained by $2Au^{+3}$– don't double count them)

The diagram below represents an electrochemical cell for the reaction:

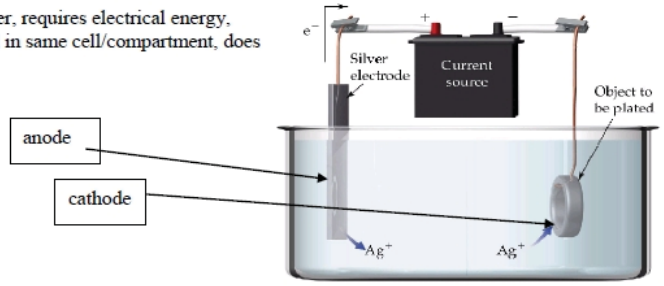
$Mg(s) + Zn(NO_3)_2(aq) \rightarrow Mg(NO_3)_2 + Zn(s)$



$Mg(s) \rightarrow Mg^{+2} + 2e^{-1}$ (28)

$Zn^{+2}(aq) + 2e^{-1} \rightarrow Zn(s)$ (27)

32.
D. requires power, requires electrical energy, the cathode and anode are all in same cell/compartment, does have a salt bridge



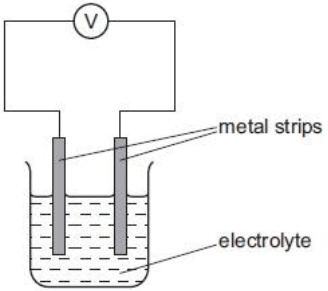
$Ag(s) \rightarrow Ag^+(aq) + e^{-1}$

$Ag^+(aq) + e^{-1} \rightarrow Ag(s)$

7.7 ESSENTIAL EXAM QUESTIONS Paper 2 11marks

Q# 1/ iGCSE Chemistry/2016/w/Paper 23/

11 The diagram shows two different metal strips dipped into an electrolyte.



Which pair of metals produces the highest voltage?

A copper and iron

B copper and magnesium

C copper and zinc

D magnesium and iron

Q# 2/ iGCSE Chemistry/2016/w/Paper 22/

11 A student sets up a number of simple cells by putting strips of two different metals into dilute sulfuric acid.

Which cell produces the highest voltage?

A copper and magnesium

B copper and zinc

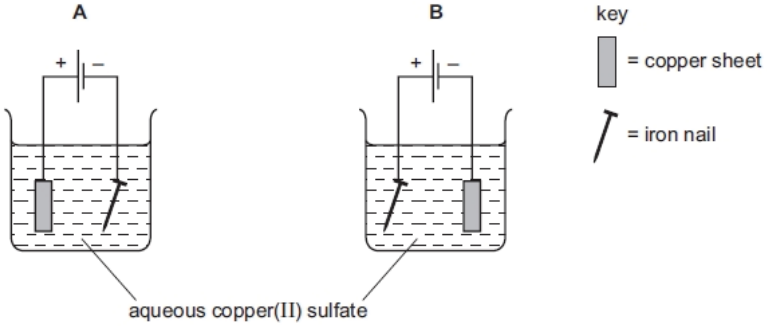
C iron and copper

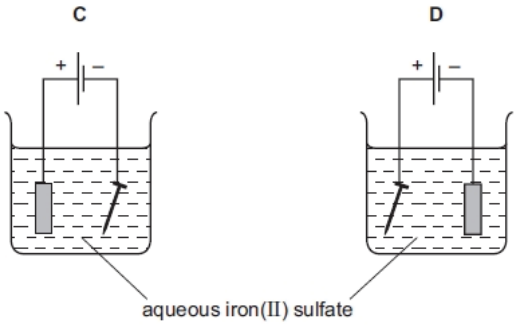
D magnesium and zinc

Q# 3/ iGCSE Chemistry/2016/w/Paper 21/

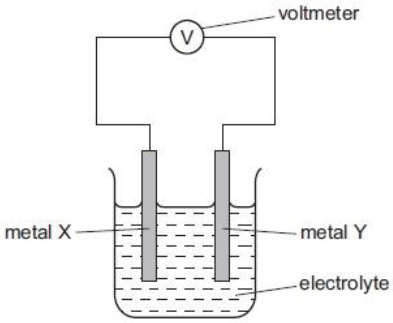
C

10 Which apparatus could be used to electroplate an iron nail with copper?





11 The diagram shows a simple cell.

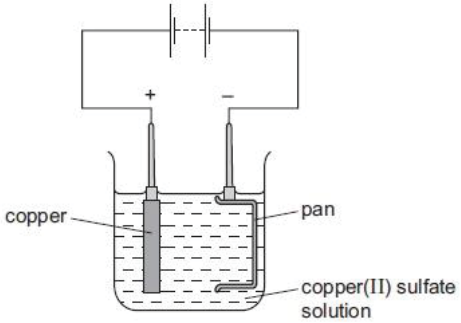


Which two metals produce the highest reading on the voltmeter?

	X	Y
A	magnesium	copper
B	magnesium	iron
C	zinc	copper
D	zinc	iron

Q# 4/ iGCSE Chemistry/2016/s/Paper 23/

10 The diagram shows a method used to copper-plate a pan



Which equation represents the reaction at the cathode?

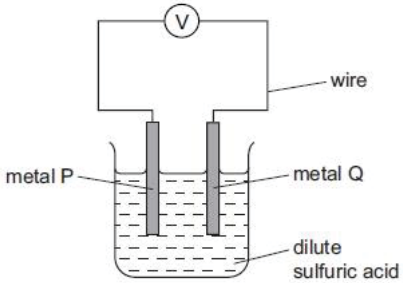
A $Cu^{2+} + 2e^- \rightarrow Cu$

B $2H^+ + 2e^- \rightarrow H_2$

C $4OH^- \rightarrow O_2 + 2H_2O + 4e^-$

D $2O^{2-} \rightarrow O_2 + 4e^-$

12 The diagram shows a simple cell.

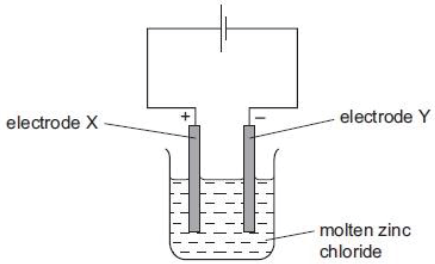


Which pair of metals produces the largest voltage?

	metal P	metal Q
A	iron	copper
B	magnesium	copper
C	magnesium	zinc
D	zinc	copper

Q# 5/ iGCSE Chemistry/2016/s/Paper 22/

10 The diagram shows the electrolysis of molten zinc chloride, $ZnCl_2$.



Which statement is correct?

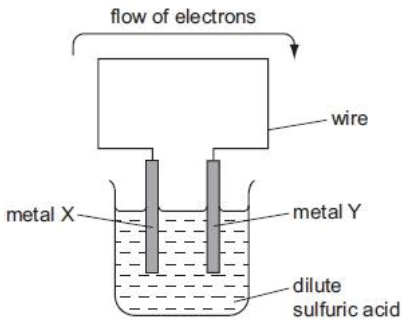
A Oxidation occurs at electrode X and the equation is: $2Cl^- \rightarrow Cl_2 + 2e^-$.

B Oxidation occurs at electrode Y and the equation is: $Zn^{2+} + 2e^- \rightarrow Zn$.

C Reduction occurs at electrode X and the equation is: $Zn^{2+} + 2e^- \rightarrow Zn$.

D Reduction occurs at electrode Y and the equation is: $2Cl^- \rightarrow Cl_2 + 2e^-$.

12 The diagram shows a simple cell.



For which pair of metals would electrons flow from metal X to metal Y?

	X	Y
A	copper	iron
B	copper	zinc
C	iron	zinc
D	zinc	iron

Q# 6/ iGCSE Chemistry/2016/s/Paper 21/

10 Which reactions could take place at the anode during electrolysis?

1 $4OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e^-$

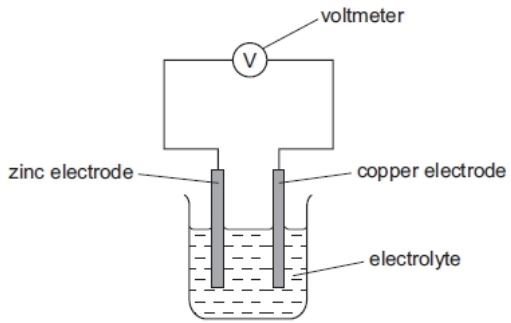
2 $2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$

3 $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

4 $2H^+(aq) + 2e^- \rightarrow H_2(g)$

A 1 and 2 **B** 1 and 4 **C** 2 and 4 **D** 3 and 4

12 The diagram shows a simple cell.



Which statement about the process occurring when the cell is in operation is correct?

A Cu^{2+} ions are formed in solution.

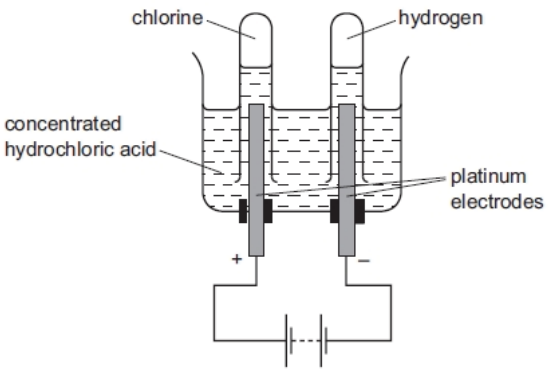
B Electrons travel through the solution.

C The reaction $Zn \rightarrow Zn^{2+} + 2e^-$ occurs.

D The zinc electrode increases in mass.

Q# 7/ iGCSE Chemistry/2016/m/Paper 22/

10 The electrolysis of concentrated hydrochloric acid is shown.



Which statement describes what happens to the electrons during the electrolysis?

A They are added to chloride ions.

B They are added to hydrogen ions.

C They move through the circuit from positive to negative.

D They move through the solution from negative to positive.

7.7.1 ESSENTIAL EXAM QUESTIONS Paper 2 T5 11marks MARK SCHEME

Q# 1/ iGCSE Chemistry/2016/w/Paper 23/
11 **B**

Q# 2/ iGCSE Chemistry/2016/w/Paper 22/
10 **A**

11 **A**

Q# 3/ iGCSE Chemistry/2016/w/Paper 21/
10 **A**

11 **A**

Q# 4/ iGCSE Chemistry/2016/s/Paper 23/
10 **A**
12 **B**

Q# 5/ iGCSE Chemistry/2016/s/Paper 22/
10 **A**
12 **D**

Q# 6/ iGCSE Chemistry/2016/s/Paper 21/
10 **A** 12 **C**

Q# 7/ iGCSE Chemistry/2016/m/Paper 22/
10 **B**

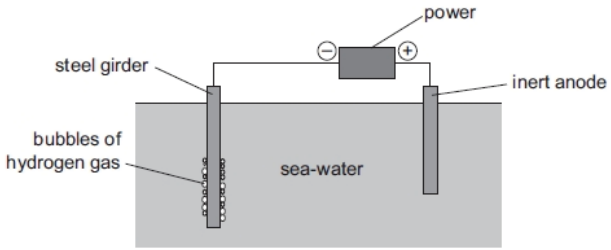
7.8 ESSENTIAL EXAM QUESTIONS T5 Paper 3/4 100 marks

Q# 1/ iGCSE Chemistry/2014/w/Paper 31/ Q4

(d) There are two electrochemical methods of rust prevention.

(i) The first method is sacrificial protection.

The second method is to make the steel article the cathode in a circuit for electrolysis.



(ii) Mark on the diagram the direction of the electron flow. [1]

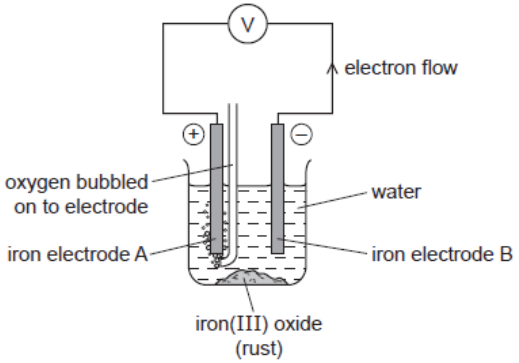
(iii) The steel girder does not rust because it is the cathode. Reduction takes place at the cathode. Give the equation for the reduction of hydrogen ions.

..... [2]

Q# 2/ iGCSE Chemistry/2012/s/Paper 31/

8 Iron and steel rust when exposed to water and oxygen. Rust is hydrated iron(III) oxide.

(a) The following cell can be used to investigate rusting.



(i) What is a cell?

.....

..... [2]

(ii) Which electrode will be oxidised and become smaller? Explain your choice.

.....

.....

..... [3]

(iii) What measurements would you need make to find the rate of rusting of the electrode you have chosen in **(ii)**?

.....

..... [2]

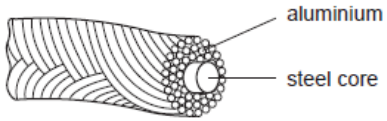
(iv) Suggest an explanation why the addition of salt to the water increases the rate of rusting.

..... [1]

Q# 3/ iGCSE Chemistry/2011/w/Paper 31/ Q3

(c) The uses of a metal are determined by its properties.

(ii) Explain why overhead electrical power cables are made from aluminium with a steel core.



.....

.....

..... [3]

Q# 4/ iGCSE Chemistry/2011/s/Paper 31/ Q2 (a)

(ii) Name a device which can change chemical energy into electrical energy.

..... [2]

Q# 5/ iGCSE Chemistry/2010/w/Paper 31/Q3

This equation is needed for the question that follows:

(iii) $Br_2 + 2e \rightarrow 2Br^-$

(vi) When a solution of bromine is replaced by a solution of chlorine, the voltage increases. When a solution of bromine is replaced by a solution of iodine, the voltage decreases.
Suggest an explanation for this difference.

.....

..... [1]

Q# 6/ iGCSE Chemistry/2010/w/Paper 31/ Q5 (b)

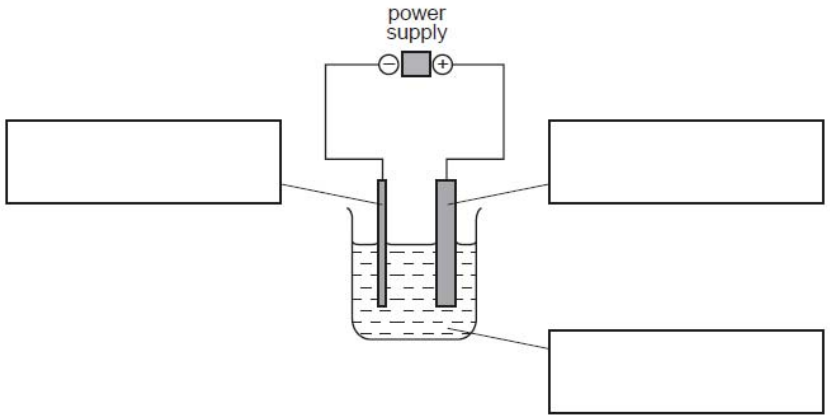
(iii) Describe an industrial method of making chlorine.

.....

..... [2]

Q# 7/ iGCSE Chemistry/2010/w/Paper 31/ Q2c

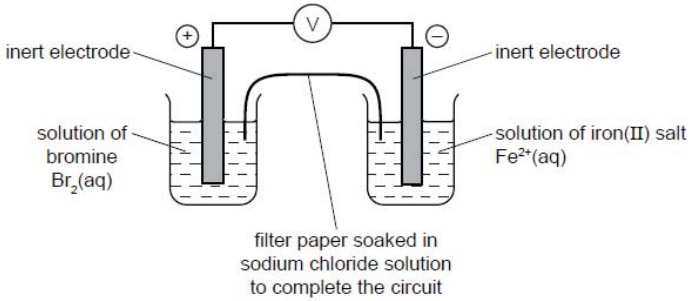
(iii) Copper oxide is reduced to copper which is then refined by electrolysis.
Label the diagram of the apparatus which could be used to refine copper.



[3]

Q# 8/ iGCSE Chemistry/2010/w/Paper 31/

3 The diagram shows a cell. This is a device which produces electrical energy. The reaction in a cell is a redox reaction and involves electron transfer.



(i) Complete the sentence.

A cell will change ..... energy into electrical energy. [1]

(ii) Draw an arrow on the diagram to show the direction of the electron flow. [1]

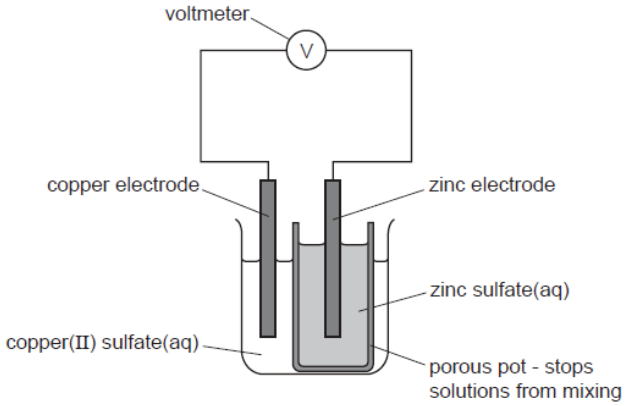
(iii) In the left hand beaker, the colour changes from brown to colourless. Complete the equation for the reaction.

Br_2 + ... → .....

[2]

Q# 9/ iGCSE Chemistry/2009/w/Paper 3/ Q3

(c) Zinc electrodes have been used in cells for many years, one of the first was the Daniel cell in 1831.



(i) Give an explanation for the following in terms of atoms and ions.

observation at zinc electrode – *the electrode becomes smaller*

explanation .....

..... [1]

observation at copper electrode – *the electrode becomes bigger*

explanation .....

..... [1]

(ii) When a current flows, charged particles move around the circuit.

What type of particle moves through the electrolytes?

..... [1]

Which particle moves through the wires and the voltmeter?

..... [1]

Q# 10/ iGCSE Chemistry/2009/s/Paper 31/

2 The results of experiments on electrolysis using inert electrodes are given in the table.

Complete the table; the first line has been completed as an example.

electrolyte	change at negative electrode	change at positive electrode	change to electrolyte
molten lead(II) bromide	lead formed	bromine formed	used up
....	potassium formed	iodine formed	used up
dilute aqueous sodium chloride	.....	.....	....
aqueous copper(II) sulfate	.....	.....	....
....	hydrogen formed	bromine formed	potassium hydroxide formed

[Total: 8]

Q# 11/ iGCSE Chemistry/2008/w/Paper 31/

5 The electrolysis of concentrated aqueous sodium chloride produces three commercially important chemicals hydrogen, chlorine and sodium hydroxide.

(a) The ions present are $Na^+(aq)$, $H^+(aq)$,$Cl^-(aq)$ and $OH^-(aq)$.

(i) Complete the ionic equation for the reaction at the negative electrode (cathode).

..... + ... → H_2 [1]

(ii) Complete the ionic equation for the reaction at the positive electrode (anode).

..... − ..... → Cl_2 [1]

(iii) Explain why the solution changes from sodium chloride to sodium hydroxide.

..... [1]

Q# 12/ iGCSE Chemistry/2008/s/Paper 31/

3 Copper is purified by electrolysis.

(a) Complete the following.

The positive electrode (anode) is made from .....

The negative electrode (cathode) is made from .....

The electrolyte is aqueous ..... [3]

(b) Write an ionic equation for the reaction at the positive electrode (anode).

..... [2]

Q# 13/ iGCSE Chemistry/2007/w/Paper 3/ Q4

(c) The remaining zinc oxide reacts with sulphuric acid to give aqueous zinc sulphate. This is electrolysed with inert electrodes (the electrolysis is the same as that of copper(II) sulphate with inert electrodes).
ions present: $Zn^{2+}(aq)$ $SO_4^{2-}(aq)$ $H^+(aq)$ $OH^-(aq)$

(i) Zinc forms at the negative electrode (cathode). Write the equation for this reaction.

..... [1]

(ii) Write the equation for the reaction at the positive electrode (anode).

..... [2]

(iii) The electrolyte changes from aqueous zinc sulphate to

..... [1]

Q# 14/ iGCSE Chemistry/2007/w/Paper 3/

6 The alcohols form a homologous series. The first four members are methanol, ethanol, propan-1-ol and butan-1-ol.

(a) One characteristic of a homologous series is that the physical properties vary in a predictable way. The table below gives the heats of combustion of the first three alcohols.

alcohol	formula	heat of combustion in kJ/mol
methanol	CH_3OH	-730
ethanol	CH_3-CH_2-OH	-1370
propan-1-ol	CH_3-CH_2-CH_2-OH	-2020
butan-1-ol	CH_3-CH_2-CH_2-CH_2-OH	

(i) The minus sign indicates that there is less chemical energy in the products than in the reactants. What form of energy is given out by the reaction?

..... [1]

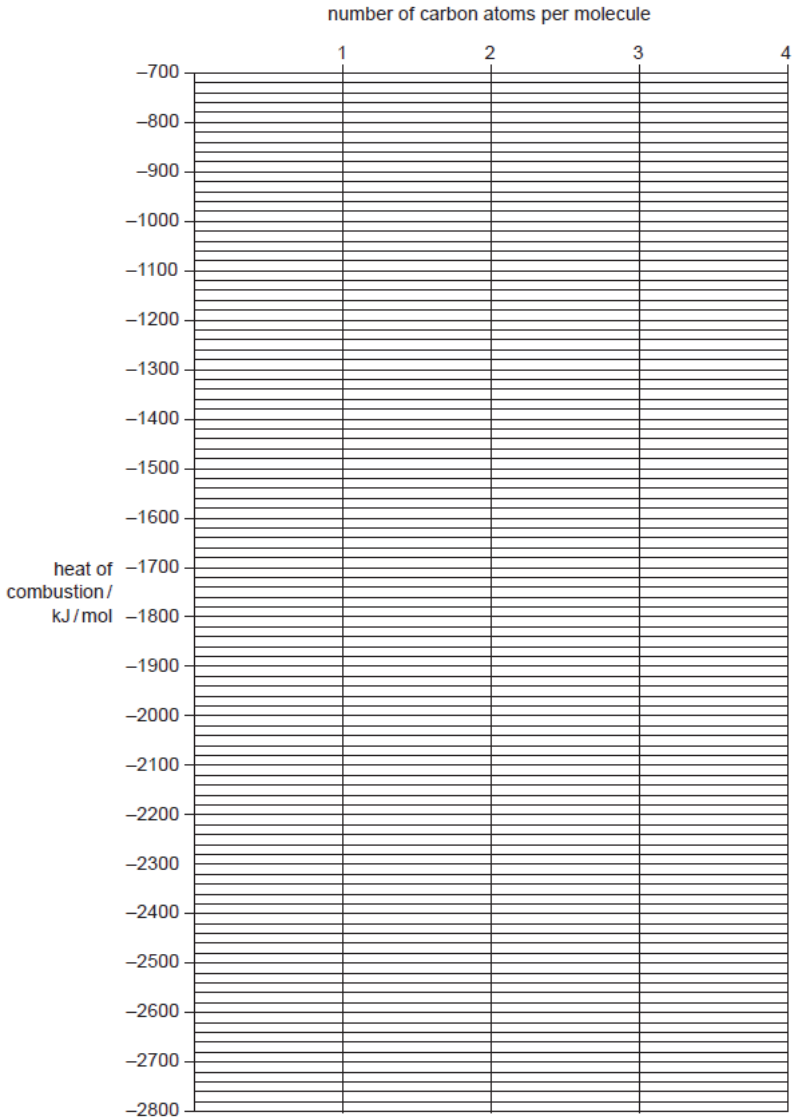
(ii) Is the reaction exothermic or endothermic?

..... [1]

(iii) Complete the equation for the complete combustion of ethanol.

C_2H_5OH + ...O_2 → ..... + ... [2]

(iv) Determine the heat of combustion of butan-1-ol by plotting the heats of combustion of the first three alcohols against the number of carbon atoms per molecule.



The heat of combustion of butan-1-ol = ... kJ / mol [3]

Q# 15/ iGCSE Chemistry/2006/w/Paper 3/ Q6

(b) Impure copper is extracted from the ore. This copper is refined by electrolysis.

(i) Name;
the material used for the positive electrode (anode),

.....

the material used for the negative electrode (cathode),

.....

a suitable electrolyte.

..... [3]

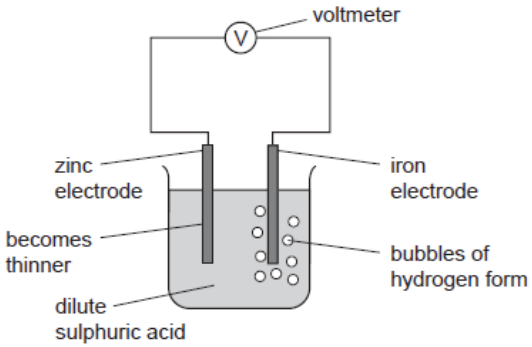
(ii) Write an ionic equation for the reaction at the negative electrode.

..... [1]

Q# 16/ iGCSE Chemistry/2006/s/Paper 3/ Q6

(c) Cell reactions are both exothermic and redox. They produce electrical energy as well as heat energy.

(i) The diagram shows a simple cell.



Which substance in this cell is the reductant and which ion is the oxidant?

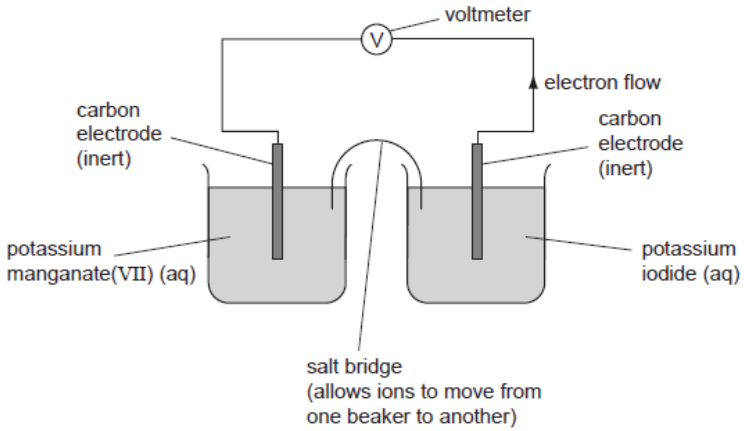
reductant .....

oxidant ..... [2]

(ii) How could the voltage of this cell be increased?

..... [1]

(d) Cells can be set up with inert electrodes and the electrolytes as oxidant and reductant.



The potassium manganate(VII) is the oxidant and the potassium iodide is the reductant.

(i) Describe the colour change that would be observed in the left hand beaker.

..... [2]

(ii) Write an ionic equation for the reaction in the right hand beaker.

..... [2]

Q# 17/ iGCSE Chemistry/2005/w/Paper 3/ Q5

(c) The major ore of strontium is its carbonate, $SrCO_3$. Strontium is extracted by the electrolysis of its molten chloride.

(ii) The electrolysis of molten strontium chloride produces strontium metal and chlorine. Write ionic equations for the reactions at the electrodes.

negative electrode (cathode) .....

positive electrode (anode) ..... [2]

(iii) One of the products of the electrolysis of concentrated aqueous strontium chloride is chlorine. Name the other two.

..... [2]

Q# 18/ iGCSE Chemistry/2004/s/Paper 3/ Q5

(b) Aqueous copper(II) sulphate solution can be electrolysed using carbon electrodes. The ions present in the solution are as follows.

$Cu^{2+}(aq)$, $SO_4^{2-}(aq)$, $H^+(aq)$, $OH^-(aq)$

(i) Write an ionic equation for the reaction at the negative electrode (cathode).

..... [1]

(ii) A colourless gas was given off at the positive electrode (anode) and the solution changes from blue to colourless.

Explain these observations.

.....

..... [2]

(c) Aqueous copper(II) sulphate can be electrolysed using copper electrodes. The reaction at the negative electrode is the same but the positive electrode becomes smaller and the solution remains blue.

(i) Write a word equation for the reaction at the positive electrode.

..... [1]

(ii) Explain why the colour of the solution does not change.

.....

..... [2]

(iii) What is the large scale use of this electrolysis?

..... [1]

Q# 19/ iGCSE Chemistry/2003/s/Paper 3/

5 The first three elements in Period 6 of the Periodic Table of the Elements are caesium, barium and lanthanum.

(b) All three metals can be obtained by the electrolysis of a molten halide. The electrolysis of the aqueous halides does not produce the metal.

(i) Complete the equation for the reduction of lanthanum ions at the negative electrode (cathode).

La^{3+} + ... → .....

(ii) Name the **three** products formed by the electrolysis of aqueous caesium bromide.

.....

.....[4]

Q# 20/ iGCSE Chemistry/2003/s/Paper 3/

1 No one knows where iron was first isolated. It appeared in China, the Middle East and in Africa. It was obtained by reducing iron ore with charcoal.

(e) One of the methods used to prevent iron or steel from rusting is to electroplate it with another metal, such as tin. Complete the following.

The anode is made of ..... .

The cathode is made of ..... .

The electrolyte is a solution of ..... .

[3]

Q# 21/ iGCSE Chemistry/2002/w/Paper 3/ Q4

(b) Copper is refined by the electrolysis of aqueous copper(II) sulphate using copper electrodes. Describe the change that occurs at the electrodes.

(i) cathode (pure copper) .....

.....[1]

(ii) anode (impure copper) .....

.....[1]

(iii) Write an ionic equation for the reaction at the cathode.

.....[1]

(iv) If carbon electrodes are used, a colourless gas is given off at the anode and the electrolyte changes from a blue to a colourless solution.

The colourless gas is ..... .

The solution changes into ..... . [2]

(c) Electrolysis and cells both involve chemical reactions and electricity.

What is the essential difference between them?

.....

.....[2]

Q# 22/ iGCSE Chemistry/2002/s/Paper 3/

3 A major food retailer in the UK is going to distribute sandwiches using hydrogen-powered vehicles.

(c) Outline how hydrogen is manufactured from water.

.....

.....[2]

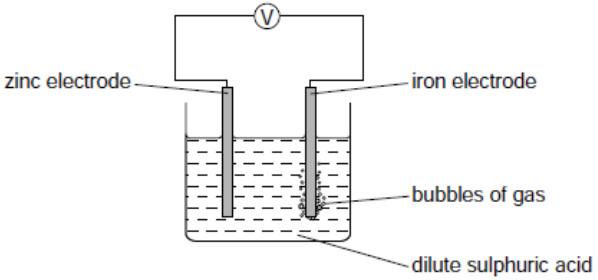
Q# 23/ iGCSE Chemistry/2001/w/Paper 3/Q1 (b)

(ii) The main impurity in the nickel is copper. What technique is used to purify copper after it has been separated from the nickel?

.....[1]

Q# 24/ iGCSE Chemistry/2001/w/Paper 3/ Q4

(e) The diagram below represents a simple cell.



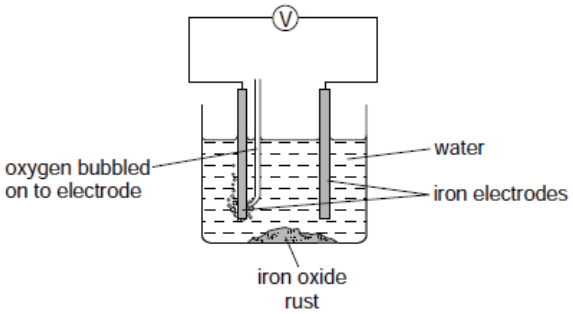
(i) Write an ionic equation for the reaction that occurs at the zinc electrode.

.....[1]

(ii) How could the voltage of the cell be increased?

.....[1]

(f) A different type of cell is drawn below.



(i) The pH of the solution increases. Give the name of the ion formed.

.....[1]

(ii) Complete the equation that represents the formation of this ion.

O_2 + ... H_2O + ... → ..... [2]

7.9 ESSENTIAL EXAM QUESTIONS T5 Paper 3/4 Mark Scheme

Q# 1/ iGCSE Chemistry/2014/w/Paper 31/ Q4 (d)

(ii) R to L in wire [1]

(iii) $2H^+ + 2e^- \rightarrow H_2$
species (1) balancing (1) [2]

Q# 2/ iGCSE Chemistry/2012/s/Paper 31/

8 (a) (i) device which changes chemical energy; [1]
into electrical energy; [1]
OR
produces a voltage / potential difference / electricity; [1]
due to difference in reactivity of two metals; [1]
OR
produces a voltage / potential difference / electricity; [1]
by redox reactions; [1]

(ii) negative / electrode B / right electrode; [1]
accept: anode because it is the electrode which supplies electrons to external circuit
loses ions / iron ions / Fe^{2+} or Fe^{3+}; [1]
electrons move from this electrode; [1]

(iii) change of mass of electrode / mass of rust formed; [1]
time / mention of stop watch / regular intervals; [1]

(iv) to make it a better conductor; [1]

Q# 3/ iGCSE Chemistry/2011/w/Paper 31/ Q3

(ii) aluminium low density / light [1]
aluminium is a good conductor [1]
strength / prevent sagging / allows greater separation of pylons / core made of steel because it is strong [1]

Q# 4/ iGCSE Chemistry/2011/s/Paper 31/ Q2 (a)

(ii) cell [1]
accept battery
not generator

Q# 5/ iGCSE Chemistry/2010/w/Paper 31/

(vi) any correct discussion of the reactivity of the halogens [1]
e.g. the more reactive the halogen the higher the voltage
not better conductor

Q# 6/ iGCSE Chemistry/2010/w/Paper 31/ Q5 (b)

(iii) electrolysis [1]
aqueous sodium chloride [1]

Q# 7/ iGCSE Chemistry/2010/w/Paper 31/ Q2

(c) (i) tin(IV) oxide + carbon → tin + carbon dioxide [1]
not carbon monoxide as a reductant
accept carbon monoxide as a product
not tin(IV)
accept correct symbol equation

(ii) water [1]
carbon dioxide [1]

(iii) correct labels for
(pure) copper cathode [1]
impure copper anode [1]
electrolyte copper(II) sulfate / any soluble copper(II) salt / Cu^{2+} [1]
if labels on electrodes reversed [0]

(iv) wires / pipes / jewellery / nails / roofing / ammunition / coins / cookware / catalyst / sculpture [1]

Q# 8/ iGCSE Chemistry/2010/w/Paper 31/

3 (i) chemical [1]

(ii) from right to left [1]
not through salt bridge

(iii) $Br_2 + 2e \rightarrow 2Br^-$ [2]
for Br- as product [1]

Q# 9/ iGCSE Chemistry/2009/w/Paper 3/ Q3

(c) (i) zinc atoms change into ions, (the zinc dissolves) [1]
copper(II) ions change into atoms, (becomes plated with copper) [1]

(ii) ions [1]
electrons [1]

Q# 10/ iGCSE Chemistry/2009/s/Paper 31/

2 molten potassium iodide **NOT** aqueous [1]

hydrogen [1]
oxygen [1]
water used up **or** solution becomes more concentrated **or** sodium chloride remains
NOT no change [1]
If products are given as hydrogen, chlorine and sodium hydroxide then 2/3

copper [1]
oxygen (and water) [1]
sulfuric acid accept hydrogen sulfate [1]

aqueous **or** dilute **or** concentrated potassium bromide [1]
accept correct formulae

[Total: 8]

Q# 11/ iGCSE Chemistry/2008/w/Paper 31/

5 (a) (i) $2H^+ + 2e \rightarrow H_2$ [1]

(ii) $2Cl^- - 2e \rightarrow Cl_2$ **or** $2Cl^- \rightarrow Cl_2 + 2e$ [1]

(iii) Na^+ and OH^- are left [1]
OR Cl^- removed OH^- left
NB ions by name **or** formula essential
NOT any reaction of Na **or** Na^+
NOT Na^+ and OH^- combine

Q# 12/ iGCSE Chemistry/2008/s/Paper 31/

3 (a) impure copper [1]
(pure) copper [1]
ACCEPT any (soluble) copper salt **or** Cu^{2+} [1]
if both name and formulae given, both have to be correct

(b) $Cu - 2e \rightarrow Cu^{2+}$ **or** $Cu \rightarrow Cu^{2+} + 2e$ [2]
for having $Cu \rightarrow Cu^{2+}$ [1] **ONLY**

Q# 13/ iGCSE Chemistry/2007/w/Paper 3/ Q4

(c) (i) $Zn^{2+} + 2e = Zn$ [1]

(ii) $4OH^- - 4e = O_2 + 2H_2O$ [2]
or $4OH^- = O_2 + 2H_2O + 4e$
or $2H_2O = 4H^+ + O_2 + 4e$
or $2H_2O - 4e = 4H^+ + O_2$
oxygen as product [1]

(iii) sulphuric acid [1]
NOTE there are no alternative answers to the above

Q# 14/ iGCSE Chemistry/2007/w/Paper 3/

6 (a) (i) heat (energy) [1]

(ii) exothermic [1]

(iii) $C_2H_5OH + 3O_2 = 2CO_2 + 3H_2O$ [2]
For $CO_2 + H_2O$ **ONLY** [1]

(iv) plotting points correctly [1]
straight line [1]
between –2640 and –2700kJ/mol [1]
NOTE minus sign needed

Q# 15/ iGCSE Chemistry/2006/w/Paper 3/ Q6

(b) (i) impure copper/blister copper/boulder copper etc [1]
(pure) copper [1]
copper sulphate **or** nitrate **or** chloride **or** contains $Cu^{2+}aq$ [1]

(ii) $Cu^{2+} + 2e^- = Cu$ [1]

Q# 16/ iGCSE Chemistry/2006/s/Paper 3/ Q6

(c) (i) reductant zinc [1]
oxidant hydrogen (ions) [1]

(ii) magnesium instead of zinc **or** increase concentration of acid
or copper instead of iron [1]

(iii) sacrificial protection **or** stop iron/steel rusting [1]
or galvanising

(d) (i) pink **or** purple [1]
to colourless **or** decolourised [1]
NOT red **NOT** clear

(ii) $2I^- - 2e = I_2$ [2]
unbalanced **ONLY** [1]

Q# 17/ iGCSE Chemistry/2005/w/Paper 3/ Q5(c)

(ii) $Sr^{2+} + 2e = Sr$ [1]
$2Cl^- - 2e = Cl_2$ [1]
or $2Cl^- = Cl_2 + 2e$

(iii) hydrogen **[1]** and strontium hydroxide **[1]** [2]

Q# 18/ iGCSE Chemistry/2004/s/Paper 3/ Q5

(b) (i) $Cu^{2+} + 2e = Cu$ [1]

(ii) gas is oxygen [1]

(copper(II) sulphate) changes to sulphuric acid [1]
or copper ions removed from solution

(c) (i) copper atoms - electrons = copper ions [1]
accept correct symbol equation

(ii) concentration of copper ions does not change **or** [1]
amount **or** number of copper ions does not change

copper ions are removed and then replaced [1]
or copper is transferred from anode to cathode

(iii) refining copper **or** plating (core) [1]
or extraction of boulder copper

Q# 19/ iGCSE Chemistry/2003/s/Paper 3/ Q5

(b) (i) $La^{3+} + 3e- = La$ [1]
(ii) hydrogen [1]
bromine NOT Bromide [1]
caesium hydroxide [1]
ignore any comments about electrodes

Q# 20/ iGCSE Chemistry/2003/s/Paper 3/ QiGCSE Chemistry/201

(e) anode tin NOT impure time [1]
cathode iron or steel [1]
tin salt **or** tin ions as electrolyte [1]
NOT oxide or hydroxide or carbonate

Q# 21/ iGCSE Chemistry/2002/w/Paper 3/ Q4

(b) (i) copper deposited **or** mass increases [1]

(ii) copper goes into solution **or** mass decreases [1]

(iii) $Cu^{2+} + 2e^- \Longrightarrow Cu$ [1]

(iv) oxygen [1]
sulphuric acid accept hydrogen sulphate [1]

(c) (ii) cells produce electricity **or** exothermic **or** change
chemical energy into electrical energy [1]

electrolysis uses it **or** endothermic **or** change
electrical energy into chemical energy [1]

Q# 22/ iGCSE Chemistry/2002/s/Paper 3/ Q3

(c) (steam) and alkane [1]
heat or catalyst or details of chemistry – forms carbon monoxide/dioxide and (hydrogen) [1]

OR electrolysis [1]
brine or acidified water
or hydrogen forms at cathode [1]

OR carbon/coke [1]
heat or details of chemistry – forms carbon monoxide/dioxide and (hydrogen) [1]

Q# 23/ iGCSE Chemistry/2001/w/Paper 3/Q1 (b)

(ii) electrolysis [1]

Q# 24/ iGCSE Chemistry/2001/w/Paper 3/ Q4

(e) (i) $Zn - 2e \Rightarrow Zn^{2+}$ [1]

(ii) Higher reactivity metal instead of Zn
or lower instead of iron or bigger difference in reactivity or increase concentration of acid [1]

(f) (i) hydroxide [1]

(ii) $O_2 + 2H_2O + 4e \Rightarrow 4OH^-$ [2]
unbalanced only [1]
$O_2 + 2H_2O + 2Fe \rightarrow 2Fe(OH)_2$ [2]

7.10 FUNDAMENTAL Assessed Activity 1 Keyword Test

English	Meaning
anion	
anode	
brine	
cathode	
cation	
electrochemical cell	
electrode	
electrolysis	
electrolyte	
electrolytic cell	
electroplating	

7.11 ESSENTIAL Assessed Activity 2 Multiple Choice T5 16marks

Q# 1

10 Electrolysis of copper(II) sulfate can be done using either carbon electrodes or copper electrodes.

Which statement describes what happens at the positive electrode?

A Copper is deposited if the electrode is made from carbon.

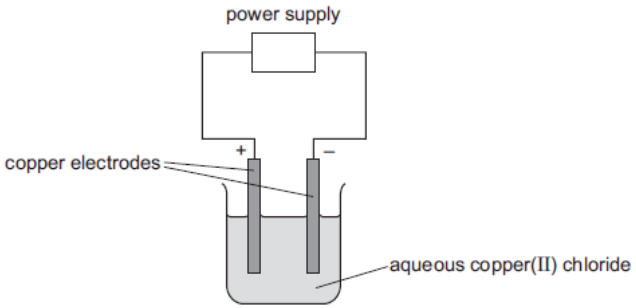
B Copper is deposited if the electrode is made from copper.

C Oxygen gas is produced if the electrode is made from carbon.

D Oxygen gas is produced if the electrode is made from copper.

Q# 2/

10 Concentrated aqueous copper(II) chloride is electrolysed using copper electrodes as shown.



What happens to the mass of each electrode during this process?

	positive electrode	negative electrode
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

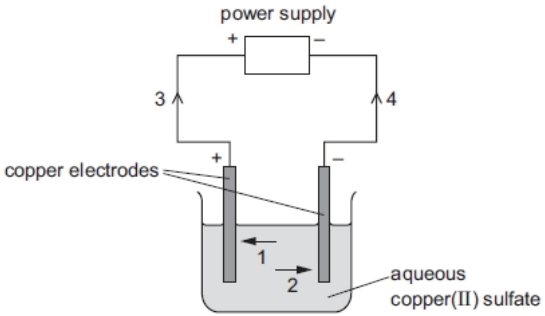
Q# 3/

10 Aqueous copper(II) sulfate is electrolysed using carbon electrodes.

What is the product at each electrode?

	product at the positive electrode	product at the negative electrode
A	copper	oxygen
B	hydrogen	oxygen
C	oxygen	copper
D	oxygen	hydrogen

11 The diagram shows a circuit used to electrolyse aqueous copper(II) sulfate.



Which arrows indicate the movement of the copper ions in the electrolyte and of the electrons in the external circuit?

	copper ions	electrons
A	1	3
B	1	4
C	2	3
D	2	4

Q# 4/

10 Aqueous copper(II) sulfate is electrolysed using copper electrodes.

Which statement is correct?

A Oxygen gas is produced at the positive electrode.

B The blue colour of the solution gradually fades.

C The concentration of copper ions in the solution stays the same.

D The mass of the negative electrode decreases.

Q# 5/

10 Aqueous copper(II) sulfate is electrolysed using copper electrodes.

Which statement about the electrolysis is **not** correct?

A An oxidation reaction occurs at the positive electrode.

B The current is carried through the electrolyte by ions.

C The negative electrode gains mass.

D The number of copper(II) ions in the electrolyte decreases.

Q# 6/

10 Aqueous copper(II) sulfate is electrolysed using copper electrodes.

Which statement is correct?

A A reduction reaction occurs at the positive electrode.

B The blue colour of the solution becomes darker.

C The concentration of copper ions in the solution decreases.

D The mass of the negative electrode increases.

11 Dilute sulfuric acid is electrolysed using inert electrodes.

What are the ionic half-equations for the reactions that take place at each electrode?

	positive electrode	negative electrode
A	$2H^+ + 2e^- \rightarrow H_2$	$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$
B	$2H^+ + 2e^- \rightarrow H_2$	$4OH^- + 4H^+ \rightarrow 4H_2O$
C	$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$	$2H^+ + 2e^- \rightarrow H_2$
D	$4OH^- + 4H^+ \rightarrow 4H_2O$	$2H^+ + 2e^- \rightarrow H_2$

Q# 7/

10 Which substance is **not** produced during the electrolysis of concentrated aqueous sodium chloride?

A chlorine

B hydrogen

C sodium

D sodium hydroxide

11 Aqueous copper(II) sulfate is electrolysed using copper electrodes.

What are the ionic half-equations for the reactions that occur at each electrode?

	anode	cathode
A	$Cu \rightarrow Cu^{2+} + 2e^-$	$Cu^{2+} + 2e^- \rightarrow Cu$
B	$Cu^{2+} + 2e^- \rightarrow Cu$	$Cu \rightarrow Cu^{2+} + 2e^-$
C	$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$	$Cu^{2+} + 2e^- \rightarrow Cu$
D	$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$	$2H^+ + 2e^- \rightarrow H_2$

Q# 8/

9 Which statements about the electrolysis of concentrated copper(II) chloride are correct?

1 Electrons are transferred from the cathode to the copper(II) ions.

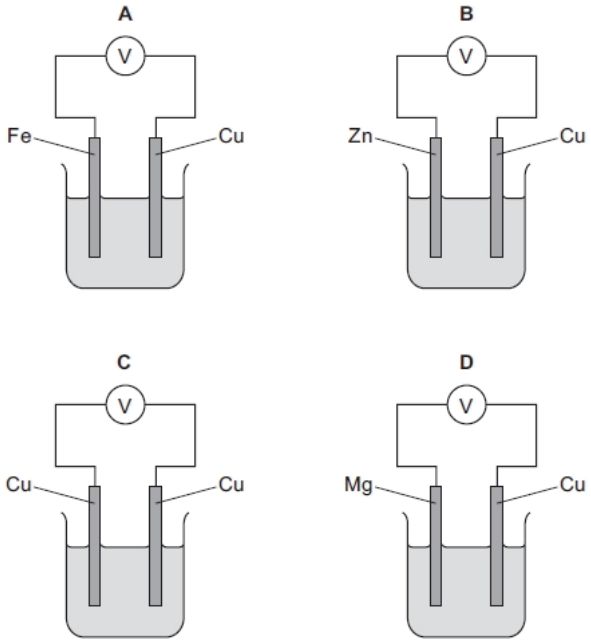
2 Electrons move round the external circuit from the cathode to the anode.

3 Chloride ions are attracted to the anode.

4 Hydroxide ions transfer electrons to the cathode.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

10 Which metal combination produces the highest voltage reading in the cells shown?



Q# 9/

9 Which statement about electrolysis is correct?

A Electrons move through the electrolyte from the cathode to the anode.

B Electrons move towards the cathode in the external circuit.

C Negative ions move towards the anode in the external circuit.

D Positive ions move through the electrolyte towards the anode during electrolysis.

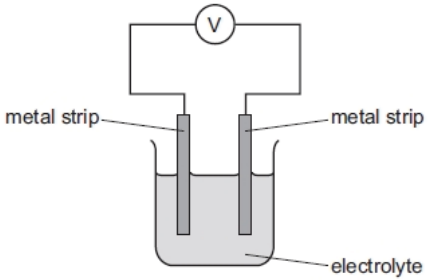
Q# 10/

10 The reactivity series for a number of different metals is shown.

most reactive → least reactive

magnesium	zinc	iron	copper	silver	platinum

The diagram shows different metal strips dipped into an electrolyte.



Which pair of metals produces the highest voltage?

A copper and magnesium

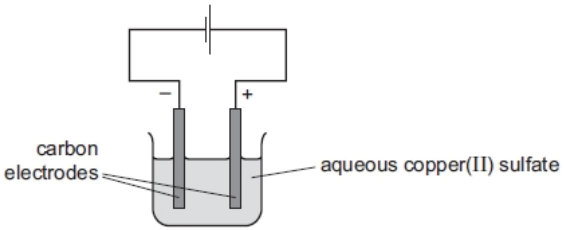
B magnesium and platinum

C magnesium and zinc

D silver and platinum

Q# 11/

10 The diagram shows the electrolysis of aqueous copper(II) sulfate.



Which statement is correct?

A Copper metal is deposited at the positive electrode.

B In the external circuit the electrons move from positive to negative.

C In the solution the electrons move from negative to positive.

D Oxygen gas is produced at the positive electrode.

11 Four solutions are separately electrolysed.

experiment	solution	electrodes
1	dilute aqueous sodium chloride	carbon
2	aqueous copper(II) sulfate	copper
3	concentrated hydrochloric acid	carbon
4	dilute sulfuric acid	carbon

In which two experiments is a colourless gas evolved at the anode?

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

7.12 EXTENTION Assessed Activity 3 T5 Longer answer questions 21marks

Q# 1/

(b) The ions present in aqueous sodium chloride are $Na^+(aq)$, $Cl^-(aq)$, $H^+(aq)$ and $OH^-(aq)$.

The electrolysis of concentrated aqueous sodium chloride forms three products. They are hydrogen, chlorine and sodium hydroxide.

(i) Explain how these **three** products are formed. Give ionic equations for the reactions at the electrodes.

.....

.....

.....

.....

..... [4]

(ii) If the solution of the electrolyte is stirred, chlorine reacts with sodium hydroxide to form sodium chlorate(I), sodium chloride and water.
Write an equation for this reaction.

Cl_2 + ...NaOH → ..... + ... + ...

[2]

Q# 2/

7 Aluminium is obtained from purified alumina, Al_2O_3, by electrolysis.

(b) Describe the extraction of aluminium from alumina. Include the electrolyte, the electrodes and the reactions at the electrodes.

.....

.....

.....

.....

.....

.....

..... [6]

(c) Aluminium is resistant to corrosion. It is protected by an oxide layer on its surface.
The thickness of this oxide layer can be increased by anodising.

(ii) Anodising is an electrolytic process. Dilute sulfuric acid is electrolysed with an aluminium object as the anode. The thickness of the oxide layer is increased. Complete the equations for the reactions at the aluminium anode.

.....OH^- → O_2 + $2H_2O$ + ...e^-

....Al + ... → .....Al_2O_3 [4]

Q# 3/

(b) Chlorine is made by the electrolysis of concentrated aqueous sodium chloride.
Describe this electrolysis. Write ionic equations for the reactions at the electrodes and name the sodium compound formed.

.....

.....

.....

.....

.....

..... [5]

Extension Mind Map for Topic 5 Electrochemistry

7.13 Essential End of Topic 5 Review and Reflection

Looking at the goals you could have achieved and the goals you actually achieved try to reflect on your progress.

Try to be as honest and as detailed as possible. Sometimes you may think you have thought about an idea well, but when you talk with someone else, or write it out, it helps you better understand and allows you think more completely and more clearly.

Did you achieve more goals this topic than last topic?

Fill in this table

Level	Number of goals achieved at each level	Success rate, %
FUNDAMENTAL	/5	
ESSENTIAL	/10	
EXTENSION	/13	
EXCEPTIONAL	/10	

Do you feel you tired harder? If yes, what helped you to do so? If not, why not?

What could you do differently next time, in addition to what you are already doing to improve, not only your score in the end of topic tests and other assessed activities, but also in how you learn. How could you become a more effective student to get more learning out of the time you are investing in your studies?

What did you enjoy most about this topic?

What did you find most difficult?

What did you find easiest?

On a scale of 1 being hardest and 5 being most difficult, circle how challenging you found this topic

1 2 3 4 5

What could be done to make this topic easier to understand?

Do you have any questions about this topic?

7.14 Exceptional Additional Activities, Further Reading and Exploring Beyond the Syllabus

Michael Faraday, for a long while he was on the back of the UK 20 pound note (who was recently replaced by the artist J. M. W. Turner, click here to find out more about the artist). Einstein famously said that Faraday was the greatest experimental scientist in history and kept a picture of him in his study (*Gleeson-White, Jane (10 November 2003). "Einstein's Heroes (book review)". The Sydney Morning Herald. Retrieved 24 October 2017.)*. It's been suggested that it was Faraday's work on invisible magnetic fields allowed Einstein to create his ideas on how gravity is able ot curve space-time which he explores in his theories on special and general relativity.

Who was Michael Faraday and what did he discover?

To find out more about electricity you can go here:
https://www.chemguide.co.uk/inorganic/electrolysismenu.html#top

And read this Wikipedia article which can be found here:

https://www.smashingsciencecn.org/igcse-chem-additional-resources

8 Topic 6 Chemical Energetics

8.1 End of Topic 6 Goals Checklist

For each topic you ought to try to do as many of the following things to get the most out of your time, the resources available to you and to help you grow as a student. Tick each goal off as you complete it. Growth is difficult and uncomfortable, but you should choose to do these things, and the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win!

Aspect	What you should have done	Yes/No	Level
Interacted with your teacher	Ask your teacher 1 question, about anything, once a week		FUNDAMENTAL
	Try to answer one question asked by your teacher at least once a week		ESSENTIAL
	Ask your teacher one question about something you do not understand in science once a week		ESSENTIAL
	Ask your teacher one question about something to do with science every lesson		EXTENSION
Notes and follow up notes	Complete set of class note		FUNDAMENTAL
	Cornell Notetaking Attempted		ESSENTIAL
	Cornell Notetaking Completed		EXTENSION
	Cornell Notetaking Completed to an exemplary standard		EXCEPTIONAL
	Attempted the Mind Map for this topic		ESSENTIAL
	Completed the Mind Map for this topic		EXTENSION
Textbook	Read ahead before the topic has been started		EXTESNION
	Highlighted key ideas and translate new words		FUNDAMENTAL
	Completed the questions at the end of each 2 page spread in your exercise book		EXTENSION
	Added to your class notes ideas and important information from the textbook that you learnt		EXTENSION
Past Exam Questions	Worked on at least 25% of the exam questions in this workbook		FUNDAMENTAL
	Attempted more than 25% of the questions and those questions you have completed you have marked in a different colour pen		ESSENTIAL
	Completed and marked all questions here		EXTENSION
	Completed, marked and additional key ideas where you have located the most difficult marks added to your notebook		EXCEPTIONAL
	Used the resources available online to answer additional questions not found in this workbook on the current topic.		EXCEPTIONAL
	Ask your teacher about an exam question that they cannot answer		EXCEPTIONALLY SMASHING!!!
Assessed Activities	Complete the word list activity using the word list at the front of each topic as little as possible		FUNDAMENTAL
	Complete 2 assessed activities, either in class or as homework		ESSENTIAL
	Complete 2 assessed activities and scored over 70% on average		ESSENTIAL
	Complete 2 assessed activities and scored over 80% on average		EXTENSION
	Complete 2 assessed activities and scored over 90% on average		EXCEPTIONAL
End of Topic Test	Revised sufficiently well to improve upon your score from the previous test (except if you are scoring over 90%, then just write Y for this goal)		ESSENTIAL
	Scored 10% higher than your current average		EXTENSION
	Scored 15% or more than your previous end of topic average		EXCEPTIONAL
	Scored over 90%		EXTESNION
	Scored over 95%		SMASHING!!!

Aspect	What you should have done	Yes/No	Level
Reading	Spend more than 1 hour a week reading a book **you enjoy** (in any language) about anything.		ESSENTIAL
	Spend more than 3 hours a week reading a book **you enjoy** (in any language) about anything.		EXTENSION
	Spend more than 5 hours a week reading a book **you enjoy** (in any language) about anything.		EXCEPTIONAL
	Spend at least one hour a week reading a book **you enjoy** in English about anything.		EXTENSION
	Spend more than 3 hours a week reading a book **you enjoy** in English about anything.		EXCEPTIONAL
Reflection	You completed this goal setting table		FUNDAMENTAL
	You have looked at the goals you have achieved and the ones you have not and added them up and entered them into the table in the Review and Reflection section		ESSENTIAL
	You have given an answer for every question in the Review and Reflection section at the end of this topic		EXTENSION
	You have Given good and thoughtful answers for every question in the Review and Reflection section at the end of this topic		EXCEPTIONAL

8.2 Topic 6 Syllabus

6 Chemical energetics

6.1 Energetics of a reaction

Core

- Describe the meaning of *exothermic* and *endothermic* reactions
- Interpret energy level diagrams showing exothermic and endothermic reactions

Supplement

- Describe bond breaking as an endothermic process and bond forming as an exothermic process
- Draw and label energy level diagrams for exothermic and endothermic reactions using data provided
- Calculate the energy of a reaction using bond energies

6.2 Energy transfer

Core

- Describe the release of heat energy by burning fuels
- State the use of hydrogen as a fuel
- Describe radioactive isotopes, such as ^{235}U, as a source of energy

Supplement

- Describe the use of hydrogen as a fuel reacting with oxygen to generate electricity in a fuel cell. (Details of the construction and operation of a fuel cell are **not** required.)

8.3 ESSENTIAL Glossary for Keywords for Topic 6

Topic #	English	Chinese
6	**activation energy** (*EA*) the energy required to start a chemical reaction – for a reaction to take place the colliding particles must possess at least this amount of energy	**活化能**（EA）， **用于启**动化学反应所需的能量-为了发生反应，碰撞的粒子必须至少具有此能量
6	**bond energy** the energy required to break a particular type of covalent bond	键能打破特定类型的共价键所需的能量
6	**burning** is a combustion reaction which produces a flame	燃烧是产生火焰的燃烧反应
6	**catalyst** a substance which increases the rate of a chemical reaction but itself remains unchanged at the end of the reaction	**催化**剂一种增加化学反应速率但在反应结束时本身保持不变的物质
6	**collision theory** a theory which states that a chemical reaction takes place when particles for the reactants collide with sufficient energy to initiate the reaction	**碰撞理**论一种理论，该理论指出，当反应物的颗粒与足够的能量碰撞以引发反应时，就会发生化学反应
6	**combustion** a chemical reaction in which a substance reacts with oxygen – the reaction is exothermic;	燃烧一种化学反应，其中一种物质与氧气**反**应–该反应是放热的；
6	**endothermic change** a process or chemical reaction which takes in heat from the surroundings; Δ*H* has a positive value	**吸**热改变从周围吸收热量的过程或化学反应；ΔH为正值
6	**exothermic change** a process or chemical reaction in which heat energy is produced and released to the surroundings; Δ*H* has a negative value	**放**热的变化过程或化学反应，在其中产生热能并释放到周围； ΔH为负值
6	**fuel** a substance that can be used as a source of energy, usually by burning (combustion)	**燃料通常可以通**过燃烧（燃烧）用作能源的物质
6	**fuel cell** a device for continuously converting chemical energy into electrical energy using a combustion reaction; a hydrogen fuel cell uses the reaction between hydrogen and oxygen	**燃料**电池：一种通过燃烧反应将化学能连续转换为电能的装置。氢燃料电池利用氢和氧之间的反应
6	**fuel cells** are electrolytic cells capable of providing a continuous supply of electricity without recharging	**燃料**电池是能够连续供电而无需充电的电解电**池**
6	**heat of combustion** the heat change which takes place when one mole of a substance is completely burnt in oxygen	燃烧热当一摩尔物质在氧气中完全燃烧时发生的热变**化**
6	**heat of reaction** the heat change during the course of a reaction; can be either **exothermic** or **endothermic**	**反**应热反应过程中的热变化；可以是放热的或吸热**的**
6	**kinetic (particle) theory** a theory which accounts for the bulk properties of the different states of matter in terms of the movement of particles (atoms or molecules) – the theory explains what happens during changes in physical state	动力学（粒子）理论，根据粒子（**原子或分子**）**的运**动解释物质不同状态的整体性质的理论–该理论解释了物理状态变化时发生的情**况**

8.4 ESSENTIAL Classroom Active Learning Tasks 1 Drawing AND Interpreting Graphs for Paper 6

Q# 4/ iGCSE Chemistry/2017/w/Paper 63/Q2

2 A student investigated what happened to the temperature when two different solids, **W** and **X**, dissolved in water.

Two experiments were carried out.

Experiment 1

- Using a measuring cylinder, 30 cm^3 of distilled water were poured into a polystyrene cup. The initial temperature of the water was measured at time = 0 seconds.
- Solid **W** was added to the water, a timer was started and the solution was stirred with a thermometer.
- The temperature of the solution was measured every 10 seconds for 90 seconds.

(a) Use the thermometer diagrams to record the temperatures in the table.

time / s	0	10	20	30	40	50	60	70	80	90
thermometer diagram	30 25 20	20 15 10	20 15 10	20 15 10	20 15 10	15 10 5	15 10 5	15 10 5	15 10 5	15 10 5
temperature of the solution / °C										

[2]

Experiment 2

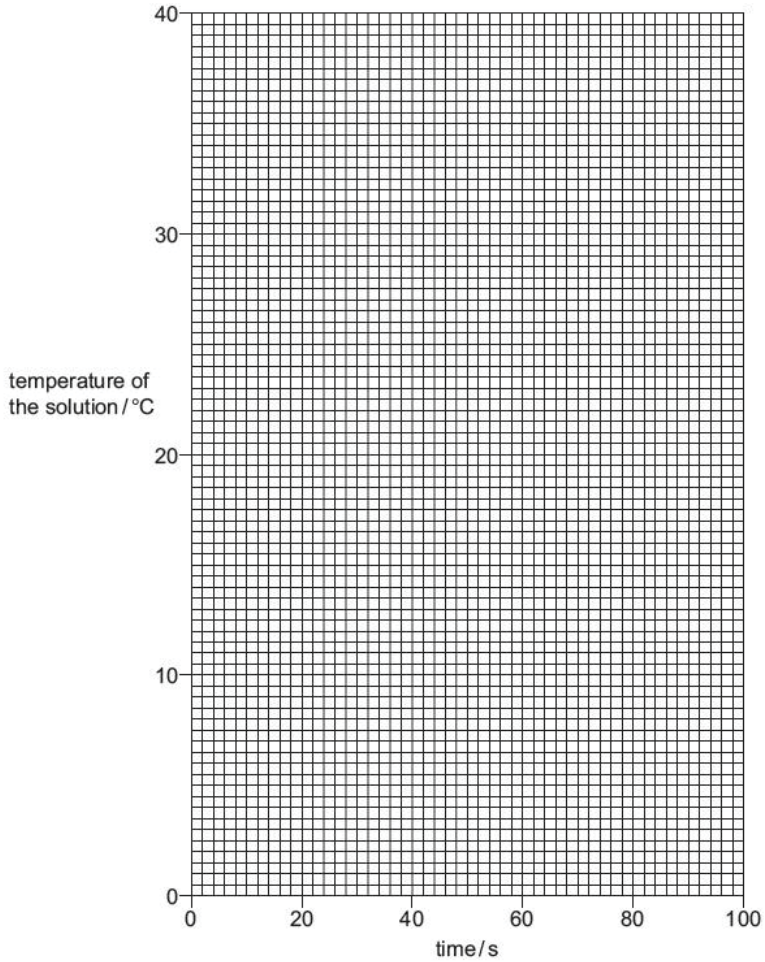
- The polystyrene cup was emptied and rinsed with water.
- Experiment 1 was repeated using solid **X**.
- The temperature of the solution was measured every 10 seconds for 90 seconds.

(b) Use the thermometer diagrams to record the temperatures in the table.

time / s	0	10	20	30	40	50	60	70	80	90
thermometer diagram	30 25 20	30 25 20	30 25 20	35 30 25	35 30 25	35 30 25	40 35 30	40 35 30	40 35 30	40 35 30
temperature of the solution / °C										

[2]

(c) Plot the results for Experiments 1 and 2 on the grid. Draw **two** smooth line graphs. Clearly label your lines.



[4]

(d) (i) **From your graph**, deduce the temperature of the solution in Experiment 1 after 15 seconds. Show clearly **on the grid** how you worked out your answer.

..... °C [2]

(ii) **From your graph**, deduce the time taken for the temperature of the solution in Experiment 2 to change by 6 °C from the initial temperature. Show clearly **on the grid** how you worked out your answer.

..... s [2]

(e) Use the results to identify the type of energy change that occurs when solid **X** dissolves in water.

..... [1]

(f) Predict the temperature of the solution in Experiment 2 after 1 hour. Explain your answer.

.....

..... [1]

(g) State **two** sources of error in these experiments. Give **one** improvement to reduce each of these sources of error.

source of error 1 .....

improvement 1 .....

source of error 2 .....

improvement 2 .....

[4]

(h) When carrying out the experiments, what would be a disadvantage of taking the temperature readings only every 30 seconds?

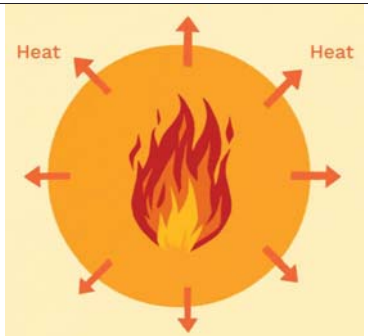
.....

..... [1]

8.5 ESSNETIAL Classroom Active Learning Tasks 2 Endothermic or Exothermic?

Circe or highlight if these processes are either exothermic or endothermic. The first has already been done for you

Q# 1/



Exothermic or Endothermic?

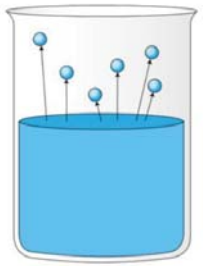
Q# 2/

Boiling water

Exothermic or Endothermic?

Q# 3/

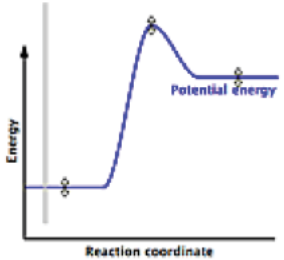
Evaporation



Vapor Pressure < Atmospheric Pressure

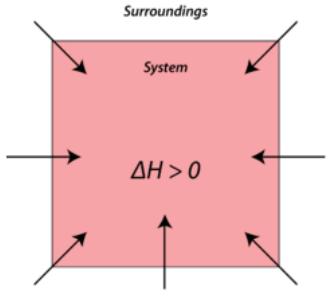
Bubbles cannot form

Q# 4/



Exothermic or Endothermic?

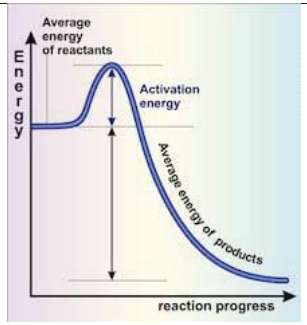
Q# 5/



A Surroundings get cooler

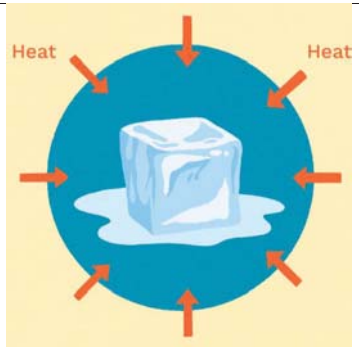
Exothermic or Endothermic?

Q# 6/



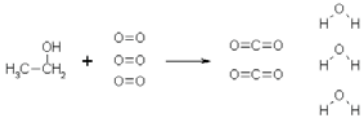
Exothermic or Endothermic?

Q# 7/

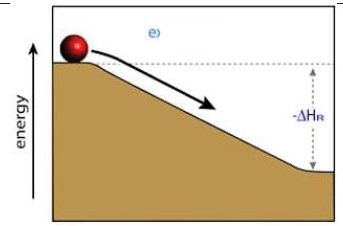
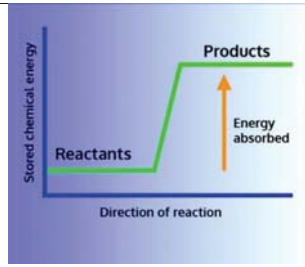
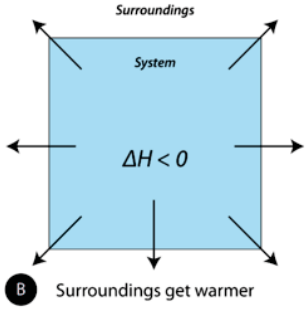
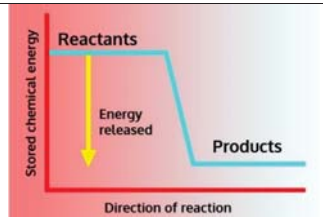


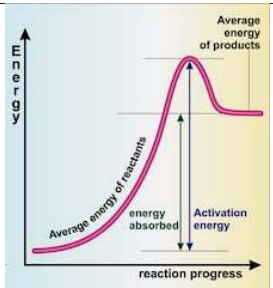
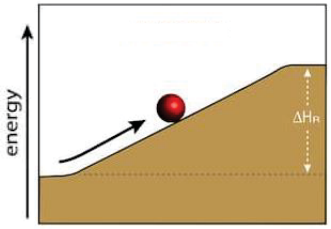
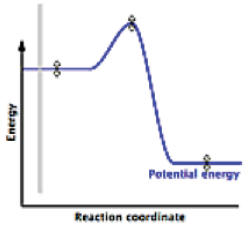
Exothermic or Endothermic?

Q# 8/



Exothermic or Endothermic?

Q# 9/	 Exothermic or Endothermic
Q# 10/	 Exothermic or Endothermic?
Q# 11/	 Exothermic or Endothermic?
Q# 12/	 Exothermic or Endothermic?
Q# 13/	 Exothermic or Endothermic?

Q# 14/	 Exothermic or Endothermic?
Q# 15/	 Exothermic or Endothermic?
Q# 16/	 Exothermic or Endothermic?
Q# 17/	$CaCO_3(s) \xrightarrow{Heat} CaO(s) + CO_2(g)$ Calcium carbonate (Limestone) → Calciumoxide (Lime) + Carbondioxide Exothermic or Endothermic?
Q# 18/	Acid +Alkali → Salt + Water Exothermic or Endothermic?
Q# 19/	$Br_2(l) \rightarrow Br_2(s)$ Exothermic or Endothermic?
Q# 20/	Sulfuric acid → Sodium sulfate + Sodium hydroxide + Water Exothermic or Endothermic?
Q# 21/	$N_2(g) \rightarrow 2N(g)$ Exothermic or Endothermic?
Q# 22/	$Hg(l) \rightarrow Hg(g)$ Exothermic or Endothermic?
Q# 23/	$I_2(s) \rightarrow I_2(g)$ Exothermic or Endothermic?
Q# 24/	Photosynthesis Exothermic or Endothermic?

Extension Activity: Name the reaction that is being shown, if it could be more than one reaction, name a reaction it could be and try to include the chemical formula

Q#	Q# 1/	Q# 2/	Q# 3/	Q# 4/	Q# 5/	Q# 6/	Q# 7/	Q# 8/	Q# 9/	Q# 10/	Q# 11/	Q# 12/	Q# 13/	Q# 14/	Q# 15/	Q# 16/	Q# 17/	Q# 18/	Q# 19/	Q# 20/	Q# 21/	Q# 22/	Q# 23/	Q# 24/	Q# 25/
Endo/Exo?	Exo	Endo	Endo	Endo	Endo	Exo	Endo	Exo	Exo	Exo	Endo	Exo	Exo	Endo	Endo	Exo	Endo	Exo	Exo	Exo	Endo	Endo	Endo	Endo	Exo

8.6 ESSENTIAL EXAM QUESTIONS Topic 6 Paper 2 31marks Mark Scheme

Q# 1/ iGCSE Chemistry/2018/m/Paper 22/

12 10 g of ammonium nitrate is added to water at 25 °C and the mixture stirred.

The ammonium nitrate dissolves and, after one minute, the temperature of the solution is 10 °C.

Which word describes this change?

A endothermic

B exothermic

C neutralisation

D reduction

13 Hydrogen reacts with chlorine according to the following equation.

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$$

The reaction is exothermic.

Which statement about this reaction is correct?

A Energy absorbed for bond breaking is greater than the energy released in bond making.

B Energy absorbed for bond breaking is less than the energy released in bond making.

C Energy released in bond breaking is greater than the energy absorbed in bond making.

D Energy released in bond breaking is less than the energy absorbed in bond making.

14 Hydrogen-oxygen fuel cells can be used to power cars. Platinum is used as a catalyst.

The amount of energy produced per gram is shown for three fuels.

fuel	energy produced per g of fuel / kJ
hydrogen	143
methane	55
petrol	44

Which statement is correct and is an advantage of a hydrogen-oxygen fuel cell?

A Hydrogen is difficult to store.

B Hydrogen produces less energy per gram than methane or petrol.

C Platinum is rare and expensive.

D The only product is water.

Q# 2/ iGCSE Chemistry/2017/w/Paper 23/

11 Some bond energies are shown in the table.

bond	bond energy in kJ/mol
H–H	+436
O=O	+496
H–O	+460

Hydrogen reacts with oxygen. The reaction is exothermic.

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

What is the energy change for the reaction?

A –3208 kJ/mol

B –908 kJ/mol

C –472 kJ/mol

D –448 kJ/mol

Q# 3/ iGCSE Chemistry/2017/w/Paper 22/

11 The equation for the combustion of methane is shown.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

The energy change for the combustion of methane is –890 kJ/mol.

The bond energies are shown in the table.

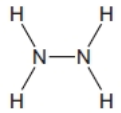
bond	bond energy in kJ/mol
C–H	+410
O=O	+496
H–O	+460

What is the bond energy of the C=O bond?

A +49 kJ/mol **B** +841 kJ/mol **C** +1301 kJ/mol **D** +1335 kJ/mol

Q# 4/ iGCSE Chemistry/2017/w/Paper 21/

11 The compound hydrazine is used as a rocket fuel. It has the structural formula shown.



One of the reactions of hydrazine is shown. This reaction is exothermic.

$$N_2H_4 \rightarrow N_2 + 2H_2$$

The bond energies are shown in the table.

	bond energy in kJ/mol
H–H	+436
N–H	+390
N–N	+160
N≡N	+945

What is the energy change for this reaction?

A –339 kJ/mol **B** –97 kJ/mol **C** +97 kJ/mol **D** +339 kJ/mol

12 Which statement describes an exothermic reaction?

A The energy absorbed for bond breaking is greater than the energy released by bond formation.

B The energy absorbed for bond breaking is less than the energy released by bond formation.

C The energy released by bond breaking is greater than the energy absorbed for bond formation.

D The energy released by bond breaking is less than the energy absorbed for bond formation.

Q# 5/ iGCSE Chemistry/2017/s/Paper 23/

11 Heat energy is produced when hydrocarbons burn in air.

Which equations represent this statement?

1 $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$

2 $C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$

3 $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

13 Hydrogen and chlorine react to form hydrogen chloride.

The reaction is exothermic.

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$$

The overall energy change for this reaction is –184 kJ / mol.

The table gives some of the bond energies involved.

bond	bond energy in kJ / mol
H–Cl	+430
H–H	+436

What is the energy of the Cl–Cl bond?

A –240 kJ / mol

B –190 kJ / mol

C +190 kJ / mol

D +240 kJ / mol

Q# 6/ iGCSE Chemistry/2017/s/Paper 22/

11 Which statement about fuels is correct?

A Heat energy can only be produced by burning fuels.

B Hydrogen is used as a fuel although it is difficult to store.

C Methane is a good fuel because it produces only water when burned.

D Uranium is burned in air to produce energy.

13 The equation for the reaction between hydrogen and chlorine is shown.

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$$

The reaction is exothermic.

The bond energies are shown in the table.

bond	bond energy in kJ / mol
Cl–Cl	+240
H–Cl	+430
H–H	+436

What is the energy change for the reaction?

A –1536 kJ / mol

B –184 kJ / mol

C +184 kJ / mol

D +246 kJ / mol

Q# 7/ iGCSE Chemistry/2017/s/Paper 21/

11 Some properties of four fuels are shown in the table.

Which fuel is a gas at room temperature and makes two products when it burns in a plentiful supply of air?

	fuel	formula	melting point / °C	boiling point / °C
A	hydrogen	H_2	–259	–253
B	methane	CH_4	–182	–164
C	octane	C_8H_{18}	–57	126
D	wax	$C_{31}H_{64}$	60	400

12 Which statements about exothermic and endothermic reactions are correct?

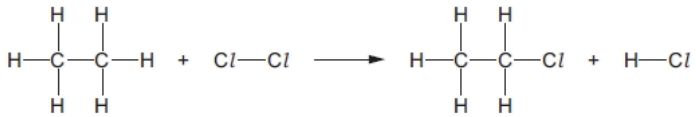
1 During an exothermic reaction, heat is given out.

2 The temperature of an endothermic reaction goes up because heat is taken in.

3 Burning methane in the air is an exothermic reaction.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

13 Chlorine reacts with ethane to produce chloroethane and hydrogen chloride.



The reaction is exothermic.

The bond energies are shown in the table.

bond	bond energy in kJ / mol
C–Cl	+340
C–C	+350
C–H	+410
Cl–Cl	+240
H–Cl	+430

What is the energy change for the reaction?

A –1420 kJ/mol

B –120 kJ/mol

C +120 kJ/mol

D +1420 kJ/mol

Q# 8/ iGCSE Chemistry/2017/m/Paper 22/

12 Ammonia is made by reacting nitrogen with hydrogen in the presence of an iron catalyst.

The reaction is exothermic.

The equation for the reaction is shown.

$$N_2 + 3H_2 \rightarrow 2NH_3$$

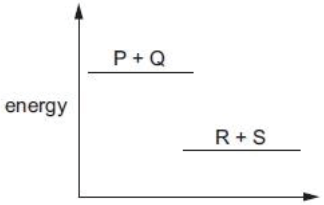
The bond energies are shown in the table.

bond	bond energy in kJ/mol
H–H	436
N–H	390
N≡N	945

What is the energy given out during this reaction?

A –4593 kJ/mol **B** –1083 kJ/mol **C** –959 kJ/mol **D** –87 kJ/mol

13 The energy level diagram for the reaction between P and Q to form R and S is shown.



Which row describes the energy changes involved and the type of reaction?

	energy changes involved	type of reaction
A	more energy is given out when the bonds in the products are formed than is needed to break the bonds in the reactants	endothermic
B	more energy is given out when the bonds in the products are formed than is needed to break the bonds in the reactants	exothermic
C	more energy is needed to break the bonds in the reactants than is given out when the bonds in the products are formed	endothermic
D	more energy is needed to break the bonds in the reactants than is given out when the bonds in the products are formed	exothermic

Q# 9/ iGCSE Chemistry/2016/w/Paper 23/

12 10 g of ammonium nitrate are added to water at 25 °C and the mixture stirred. The ammonium nitrate dissolves and, after one minute, the temperature of the solution is 10 °C.

Which word describes this change?

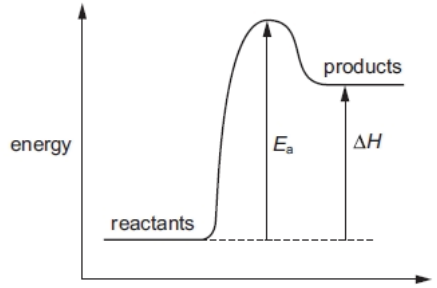
A endothermic

B exothermic

C neutralisation

D reduction

13 The energy level diagram for a reaction is shown.



Which row is correct?

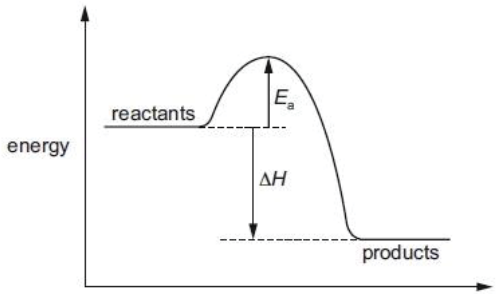
	sign of ΔH	overall energy change	sign of E_a
A	–	exothermic	–
B	+	endothermic	+
C	+	endothermic	–
D	+	exothermic	+

Q# 10/ iGCSE Chemistry/2016/w/Paper 22/

12 Which experiment is the most exothermic?

	initial temperature / °C	final temperature / °C
A	20	5
B	20	32
C	25	12
D	25	34

13 The energy level diagram for a reaction is shown.

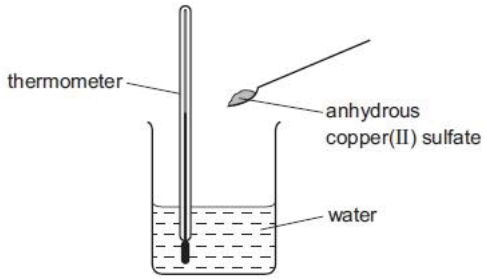


Which row is correct?

	sign of ΔH	overall energy change	sign of E_a
A	–	exothermic	–
B	+	endothermic	+
C	+	endothermic	–
D	–	exothermic	+

Q# 11/ iGCSE Chemistry/2016/w/Paper 21/

12 When anhydrous copper(II) sulfate is added to water a solution is formed and heat is given out.

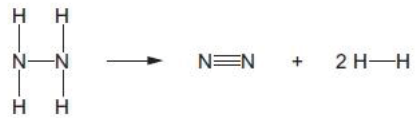


Which row shows the temperature change and the type of reaction taking place?

	temperature change	type of reaction
A	decrease	endothermic
B	decrease	exothermic
C	increase	endothermic
D	increase	exothermic

Q# 12/ iGCSE Chemistry/2016/s/Paper 23/

13 Hydrazine, N_2H_4, decomposes as shown.



The energy change for this reaction is –95 kJ / mol.

The table shows some bond energies involved.

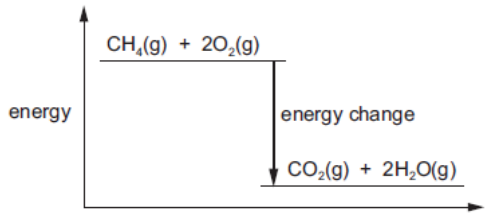
bond	bond energy in kJ / mol
N≡N	945
N–H	391
H–H	436

What is the bond energy of the N–N bond?

A 158 kJ / mol **B** 315 kJ / mol **C** 348 kJ / mol **D** 895 kJ / mol

Q# 13/ iGCSE Chemistry/2016/s/Paper 22/

13 The energy level diagram for the combustion of methane is shown.



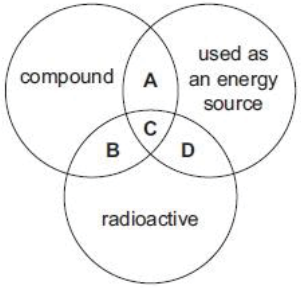
Which row gives the equation and energy change for this reaction?

	equation	energy change in kJ / mol
A	$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$	+891
B	$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$	–891
C	$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$	+891
D	$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$	–891

Q# 14/ iGCSE Chemistry/2016/s/Paper 21/

11 The diagram shows some properties that substances may have.

To which labelled part of the diagram does ^{235}U belong?



13 Hydrogen burns exothermically in oxygen.

The equation for the reaction is:

$$2H_2 + O_2 \rightarrow 2H_2O$$

The table shows the bond energies involved.

bond	bond energy in kJ/mol
H–H	436
O=O	498
O–H	464

What is the energy given out during the reaction?

A –3226 kJ/mol

B –884 kJ/mol

C –486 kJ/mol

D –442 kJ/mol

Q# 15/ iGCSE Chemistry/2016/m/Paper 22/

12 Which substance could **not** be used as a fuel to heat water in a boiler?

A ethanol

B hydrogen

C methane

D oxygen

13 Which row describes an endothermic reaction?

	energy needed to break bonds/kJ	energy released by forming bonds/kJ	temperature
A	400	200	decreases
B	400	800	decreases
C	600	200	increases
D	600	800	increases

8.6.1 ESSENTIAL EXAM QUESTIONS Topic 6 Paper 2 31marks Mark Scheme

Q# 1/ iGCSE Chemistry/2018/m/Paper 22/

12	A
13	B
14	D

Q# 2/ iGCSE Chemistry/2017/w/Paper 23/

11	C
12	B

Q# 3/ iGCSE Chemistry/2017/w/Paper 22/

11	B
12	B

Q# 4/ iGCSE Chemistry/2017/w/Paper 21/

11	B
12	B

Q# 5/ iGCSE Chemistry/2017/s/Paper 23/

11	D
13	D

Q# 6/ iGCSE Chemistry/2017/s/Paper 22/

11	B
12	C
13	B

Q# 7/ iGCSE Chemistry/2017/s/Paper 21/

11	B
12	C
13	B

Q# 8/ iGCSE Chemistry/2017/m/Paper 22/

12	D
13	B

Q# 9/ iGCSE Chemistry/2016/w/Paper 23/

12 **A**

13 **B**

Q# 10/ iGCSE Chemistry/2016/w/Paper 22/

12 **B**

13 **D**

Q# 11/ iGCSE Chemistry/2016/w/Paper 21/

12 **D**

Q# 12/ iGCSE Chemistry/2016/s/Paper 23/

13 **A**

Q# 13/ iGCSE Chemistry/2016/s/Paper 22/

13 **B**

Q# 14/ iGCSE Chemistry/2016/s/Paper 21/

11 **D**

13 **C**

Q# 15/ iGCSE Chemistry/2016/m/Paper 22/

12 **D**

13 **A**

8.7 ESSENTIAL EXAM QUESTIONS T6 Paper 3/4 29marks

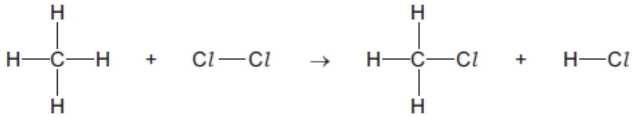
Q# 1/ iGCSE Chemistry/2013/w/Paper 31/ Q7

(b) Bond forming is exothermic, bond breaking is endothermic. Explain the difference between an exothermic reaction and an endothermic reaction.

.....

..... [2]

(c) Use the bond energies to show that the following reaction is exothermic.
Bond energy is the amount of energy (kJ / mol) which must be supplied to break one mole of the bond.



Bond energies in kJ / mol

Cl–Cl	+242
C–Cl	+338
C–H	+412
H–Cl	+431

bonds broken energy in kJ / mol

....

....

total energy = ...

bonds formed energy in kJ / mol

....

....

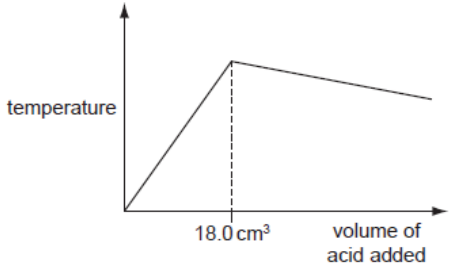
total energy = ...

.....

..... [4]

Q# 2/ iGCSE Chemistry/2011/s/Paper 31/ Q5

(d) 20.0 cm^3 of aqueous sodium hydroxide, 2.00 mol / dm^3, was placed in a beaker. The temperature of the alkali was measured and 1.0 cm^3 portions of hydriodic acid were added. After each addition, the temperature of the mixture was measured. Typical results are shown on the graph.



$$NaOH(aq) + HI(aq) \rightarrow NaI(aq) + H_2O(l)$$

(i) Explain why the temperature increases rapidly at first then stops increasing.

.....

..... [2]

(ii) Suggest why the temperature drops after the addition of 18.0 cm^3 of acid.

..... [1]

Q# 3/ iGCSE Chemistry/2009/s/Paper 31/

7 Hydrogen reacts with the halogens to form hydrogen halides.

(a) Bond energy is the amount of energy, in kJ, that must be supplied (endothermic) to break one mole of a bond.

bond	bond energy in kJ / mol
H–H	+436
Cl–Cl	+242
H–Cl	+431

Use the above data to show that the following reaction is exothermic.

H–H + Cl–Cl → 2H–Cl

.....

.....

.....

.....

..... [3]

Q# 4/ iGCSE Chemistry/2006/s/Paper 3/

6 **(a)** Exothermic reactions produce heat energy.

An important fuel is methane, natural gas. The equation for its combustion is as follows.

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

(i) In chemical reactions bonds are broken and new bonds are formed.
Using this reaction give an example of

a bond that is broken, ...

a bond that is formed. ..... [2]

(ii) Explain, using the idea of bonds forming and breaking, why this reaction is exothermic, that is it produces heat energy.

.....

..... [2]

(b) Some radioactive isotopes are used as nuclear fuels.

(i) Give the symbol and the nucleon number of an isotope that is used as a nuclear fuel.

..... [2]

Q# 5/ iGCSE Chemistry/2005/w/Paper 3/ Q7

7 In 1909, Haber discovered that nitrogen and hydrogen would react to form ammonia. The yield of ammonia was 8%.

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ the forward reaction is exothermic

catalyst platinum
temperature 600 °C
pressure 200 atm

(c) **(i)** Complete the following table that describes the bond breaking and forming in the reaction between nitrogen and hydrogen to form ammonia.

bonds	energy change /kJ	exothermic or endothermic
1 mole of N ≡ N broken	+945	.....
3 moles of ..... broken	+1308	.....
6 moles of N – H formed	-2328	.....

[3]

(ii) Explain, using the above data, why the forward reaction is exothermic.

.....

..... [2]

Q# 6/ iGCSE Chemistry/2004/s/Paper 3/

1 It was reported from America that a turbine engine, the size of a button, might replace batteries. The engine would be built from silicon which has suitable properties for this purpose.

(a) **(i)** Why are batteries a convenient source of energy?

..... [1]

(ii) The engine will run on a small pack of jet fuel. What other chemical is needed to burn this fuel?

..... [1]

Q# 7/ iGCSE Chemistry/2003/s/Paper 3/Q5

(f) The reactions of these metals with oxygen are exothermic.

$$2Ba(s) + O_2(g) \rightarrow 2BaO(s)$$

(i) Give an example of bond forming in this reaction.

.....

(ii) Explain using the idea of bond breaking and forming why this reaction is exothermic.

.....

.....[3]

8.7.1 ESSENTIAL EXAM QUESTIONS Paper 2 29marks Mark Scheme

Q# 1/ iGCSE Chemistry/2013/w/Paper 31/ Q7

(b) exothermic reaction gives out energy [1]
endothermic reaction absorbs
takes in energy [1]

(c)

bonds broken	energy	
C-H	+412	
Cl-Cl	+242	
total energy	+654	[1]
bonds formed	energy	
C-Cl	–338	
H-Cl	–431	
total energy	–769	[1]
energy change	–115	[1]

negative sign indicates exothermic [1]

Q# 2/ iGCSE Chemistry/2011/s/Paper 31/ Q5

(d) (i) the reaction is exothermic / reaction produces heat/energy [1]
all the sodium hydroxide used up/neutralised / reaction has stopped [1]

(ii) adding colder acid / no more heat produced [1]
if not given in **(d)(i)** any comments such as "reaction has stopped" can gain mark

Q# 3/ iGCSE Chemistry/2009/s/Paper 31/

7 (a) (total endothermic change = 436 + 242 = +)678 kJ [1]
(total exothermic change = 2 × 431 = –)862 kJ [1]
accept correct sign/supplied/absorbed for endo etc.
accept correct sign/evolved/produced for exo etc.
change for reaction = –184 kJ [1]

not necessary to calculate –184, just show that exo change > than endo
ecf allowed provided negative
–184 kJ scores all 3 marks

Q# 4/ iGCSE Chemistry/2006/s/Paper 3/

6 (a) (i) Any bond that is broken C-H **or** O=O **[1]**

Bond that is formed C=O **or** O-H **[1]**
Do not insist on double bonds

(ii) More energy is released forming bonds **[1]**
than is used breaking bonds **[1]**
For just - more energy released than used [1]
For - energy is released forming bonds and it is used
breaking bonds [1]

(b) (i) U **[1]**
235 **[1]**

Q# 5/ iGCSE Chemistry/2005/w/Paper 3/ Q7

(c)(i) H—H **[1]**
endothermic **[1]**
endothermic **[1]**
exothermic

(ii) More heat given out than taken in **[1]**
–2328 + 945 + 1308 = –75(kJ) **[1]**

OR More heat given out bond forming than taken in bond breaking **[2]**
Must mention bond breaking and forming **[2]**

Q# 6/ iGCSE Chemistry/2004/s/Paper 3/

1. (a) (i) portable [1]

(ii) oxygen **or** air [1]

Q# 7/ iGCSE Chemistry/2003/s/Paper 3/Q5

(f) (i) barium - oxygen or ionic [1]
(ii) bond forming energy released/exothermic [1]
bond breaking energy taken in/endothermic [1]
more energy released [1]

8.8 ESSENTIAL EXAM QUESTIONS Topic 6 Paper 6 75marks

Most of the exam questions on this topic will be found in Paper 6 and relate to drawing graphs using them to get data from the trend line and explaining what they are showing.

Q# 2/ iGCSE Chemistry/2018/s/Paper 63/Q2

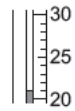
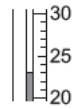
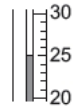
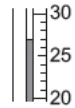
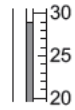
2 A student investigated how the temperature changed when aqueous sodium hydroxide reacted with solutions of two different acids, acid **R** and acid **S**.

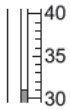
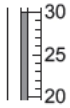
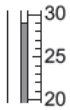
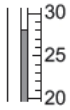
Two experiments were done.

Experiment 1

- A measuring cylinder was used to pour 50 cm³ of aqueous sodium hydroxide into a polystyrene cup. The temperature of the solution was measured.
- A burette was filled up to the 0.0 cm³ mark with acid **R**.
- 5.0 cm³ of acid **R** was added to the aqueous sodium hydroxide in the polystyrene cup and the solution stirred.
- The highest temperature of the solution was measured.
- A further 5.0 cm³ of acid **R** was added to the polystyrene cup and the solution was stirred.
- The highest temperature of the solution was measured.
- Further 5.0 cm³ portions of acid **R** were added to the polystyrene cup until a total volume of 40.0 cm³ of acid **R** had been added. The highest temperature of the solution was measured after each addition.

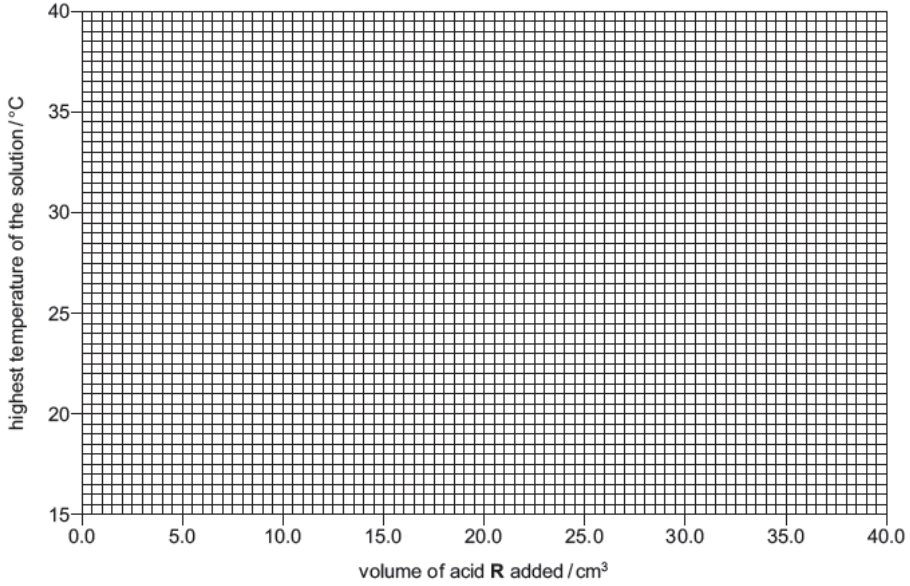
(a) Use the thermometer diagrams to record the results in the table.

volume of acid **R** added / cm³	thermometer diagram	highest temperature of the solution / °C
0.0		
5.0		
10.0		
15.0		
20.0		

25.0		
30.0		
35.0		
40.0		

[2]

(b) Plot the results for Experiment 1 on the grid and draw **two** intersecting straight line graphs.

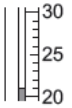
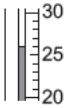
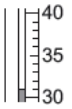
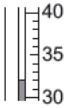
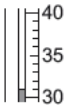
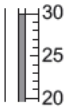
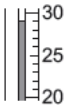
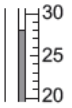
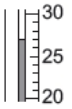


[2]

Experiment 2

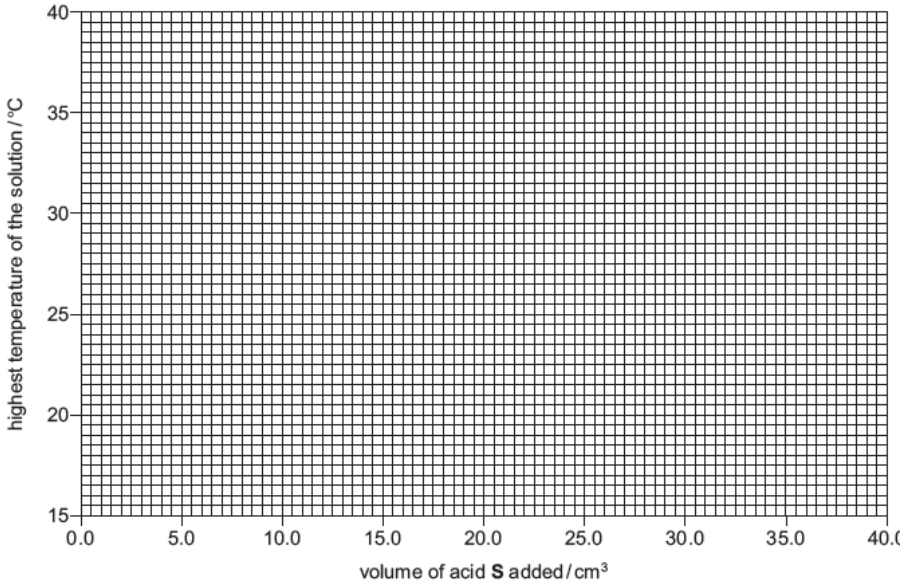
- The burette was rinsed with distilled water and then with acid **S**.
- Experiment 1 was repeated but using acid **S** instead of acid **R**.

(c) Use the thermometer diagrams to record the results in the table.

volume of acid **S** added / cm³	thermometer diagram	highest temperature of the solution / °C
0.0		
5.0		
10.0		
15.0		
20.0		
25.0		
30.0		
35.0		
40.0		

[2]

(d) Plot the results for Experiment 2 on the grid and draw **two** intersecting straight line graphs.



[2]

(e) **(i)** **Use your graph** to estimate the volume of acid **S** which must be added to neutralise 50 cm³ of aqueous sodium hydroxide.

Show clearly **on the grid** how you worked out your answer.

..... cm³ [2]

(ii) Suggest how the volume in **(e)(i)** would differ if the experiment were repeated using 25 cm³ instead of 50 cm³ of aqueous sodium hydroxide.
Explain your answer.

.....

..... [2]

(f) What type of energy change occurs when acid **S** reacts with aqueous sodium hydroxide?

..... [1]

(g) **(i)** In Experiment 2, why was the burette rinsed with distilled water?

..... [1]

(ii) Why was the burette then rinsed with acid **S**?

..... [1]

(h) Describe **one** source of error in Experiment 2. Suggest an improvement to reduce this source of error.

source of error .....

improvement .....

[2]

[Total: 17]

Q# 3/ iGCSE Chemistry/2018/s/Paper 62/Q2

2 A student investigated the temperature changes when two different solids, solid **C** and solid **D**, dissolved in water.

Two experiments were done.

Experiment 1

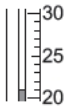
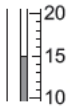
- Using a measuring cylinder, 40 cm³ of distilled water was poured into a polystyrene cup. The initial temperature of the distilled water was measured.
- 3 g of solid **C** was added to the polystyrene cup and the mixture was stirred with a thermometer. The temperature of the solution was measured after 1 minute.

- The procedure was repeated using 4 g of solid **C**.
- The procedure was repeated using 6 g of solid **C**.

(a) Use the thermometer diagrams to record the results in the table.

Calculate and record the temperature change in each case, including whether the temperature increased (+) or decreased (–).

mass of solid **C** / g	thermometer diagram	initial temperature of the distilled water / °C	thermometer diagram	temperature of the solution after 1 min / °C	temperature change / °C
3	30 25 20		20 15 10		
4	30 25 20		20 15 10		

6					

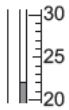
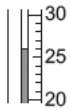
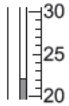
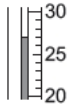
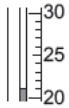
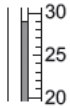
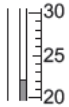
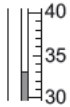
[2]

Experiment 2

- Experiment 1 was repeated but using 3 g, 4 g, 6 g and 8 g of solid **D** .

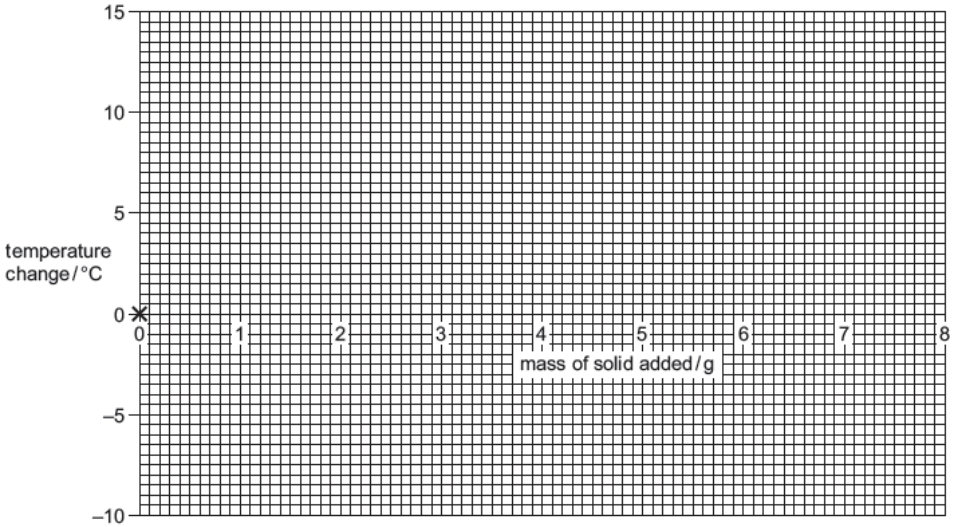
(b) Use the thermometer diagrams to record the results in the table.

Calculate and record the temperature change in each case, including whether the temperature increased (+) or decreased (–).

mass of solid **D** / g	thermometer diagram	initial temperature of the distilled water / °C	thermometer diagram	temperature of the solution after 1 min / °C	temperature change / °C
3					
4					
6					
8					

[2]

(c) Plot the results for Experiments 1 and 2 on the grid. The (0,0) point has been plotted for you.
Draw **two** straight lines of best fit.
Clearly label your graphs.



[4]

(d) **Use your graph** to estimate the temperature change after 1 minute if 8 g of solid **C** were added to 40 cm³ of distilled water.

Show clearly **on the grid** how you worked out your answer.

..... °C [2]

(e) What type of energy change occurs when solid **D** dissolves in water?

..... [1]

(f) Suggest the temperature of the solution containing 8 g of solid **D**, if the solution were left for 2 hours.
Explain your answer.

.....

..... [2]

(g) How would the temperature changes measured after 1 minute differ if the experiments were repeated using 80 cm^3 instead of 40 cm^3 of distilled water in each case?

.....

..... [2]

(h) Suggest **one** change you could make to the experiments to obtain more accurate results. Explain how this change would make the results more accurate.

change .....

explanation .....

.....

[2]

(i) Suggest how the reliability of the results could be checked.

.....

..... [2]

[Total: 19]

8.8.1 ESSENTIAL EXAM QUESTIONS Topic 6 Paper 6 75marks Mark Scheme

Q# 2/ iGCSE Chemistry/2018/s/Paper 63/Q2

2(a)	all temperature boxes completed correctly: 21, 23, 25, 27, 29, 31, 30, 29, 28	2
2(b)	all points plotted correctly (□ half a small square)	1
	best-fit intersecting straight-line graphs	1
2(c)	temperature boxes completed correctly: 21, 26, 31, 32, 31, 30, 29, 28, 27	2
2(d)	all points plotted correctly	1
	best-fit intersecting straight-line graphs	1
2(e)(i)	value from graph where lines cross: 12 cm^3	1
	shown clearly at intersection	1
2(e)(ii)	half volume of acid	1
	less / half as many moles of sodium hydroxide present	1
2(f)	exothermic / heat given out	1
2(g)(i)	to remove traces of acid / clean / remove impurities	1
2(g)(ii)	to remove traces of water	1
2(h)	sources of error using a measuring cylinder or heat losses	1
	improvement use a pipette / use a burette / lag / insulation / lid	1

Q# 3/ iGCSE Chemistry/2018/s/Paper 62/Q2

2(a)	initial temperatures all 21 **AND** final temperatures 18, 17, 15	1
	temperature changes –3, –4, –6	1
2(b)	initial temperatures 22, 22, 21, 22 **AND** final temperatures 26, 27, 29, 33	1
	temperature changes +4, +5, +8, +11	1
2(c)	all points plotted correctly (□ half a small square)	2
	best-fit straight-line graphs	1
	labels **D** (upper) **and C** (lower) or (expt.) 2 and 1	1
2(d)	value from graph, –8 °C	1
	extrapolation	1
2(e)	exothermic	1
2(f)	room temperature / 21 °C / 22 °C	1
	heat lost to surroundings	1
2(g)	half as much	2
2(h)	change in apparatus or method e.g. use a pipette / burette or use insulation / lid	1
	explanation e.g. as more accurate / precise, than a measuring cylinder / reduce heat losses	1
2(i)	repeat experiments	1
	compare / average	1

Q# 4/ iGCSE Chemistry/2017/w/Paper 63/

2(a)	temperature boxes completed: 23, 16, 14, 13, 12, 11, 11, 11, 11, 11 all readings correct = [2] 8 or 9 readings correct = [1]	2
2(b)	temperature boxes completed correctly: 22, 26, 29, 31, 32, 33, 34, 35, 35, 35 all readings correct = [2] 8 or 9 readings correct = [1]	2
2(c)	all points plotted	1
	two smooth line graphs (one line graph correct = [1])	2
	both graphs appropriately labelled	1
2(d)(i)	value from graph	1
	shown clearly	1
2(d)(ii)	value from graph	1
	shown clearly	1
2(e)	exothermic	1
2(f)	room temperature / 22 °C **AND** reaction has finished / all the solid has dissolved	1
2(g)	(see table below)	4
2(h)	fewer data / less detail / fewer readings / graph not as good / not enough readings whilst the solid is reacting	1

source of error	improvement
heat losses	use a lid / lag the apparatus
use of a measuring cylinder	use a pipette/burette
wet cup in the second experiment	use new/another cup **OR** dry the cup
the solid absorbs water from the air	store in a sealed container / airtight container / desiccator
only done once	repeat **and** average
different masses of solids used / masses of solids not measured	use same mass of solid / weigh the solids

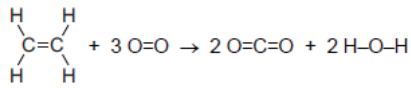
8.9 FUNDAMENTAL Assessed Activity 1 Keyword Test

Topic #	English	Meaning
9985	**exothermic change**	
8429	**activation energy** (*EA*)	
7763	**burning**	
7008	**combustion**	
6649	**fuel cells**	
6421	**kinetic (particle) theory**	
6213	**fuel cell**	
5928	**collision theory**	
5307	**endothermic change**	
4347	**fuel**	
3071	**bond energy**	
1836	**catalyst**	
724	**heat of combustion**	
133	**heat of reaction**	

8.10 ESSENTIAL Assessed Activity 2 Topic 6 Paper 2 14marks

Q# 1/

12 Ethene burns in oxygen to form carbon dioxide and water vapour.



The bond energies are shown in the table.

bond	bond energy in kJ/mol
C=C	+610
C–H	+410
O=O	+497
C=O	+805
O–H	+460

What is the energy change for the reaction?

A –2959 kJ/mol

B –2313 kJ/mol

C –1319 kJ/mol

D –399 kJ/mol

Q# 2/

12 Hydrogen peroxide, H–O–O–H, decomposes to form water and oxygen.

$$2H_2O_2(g) \rightarrow 2H_2O(g) + O_2(g)$$

The bond energies are shown in the table. The reaction is exothermic.

bond	bond energy in kJ/mol
O–H	+460
O–O	+150
O=O	+496

What is the energy change for the reaction?

A –346 kJ/mol **B** –196 kJ/mol **C** +196 kJ/mol **D** +346 kJ/mol

Q# 3/

12 Methane burns in an excess of oxygen. The equation is shown.

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$

The bond energies are shown in the table.

bond	bond energy in kJ/mol
C–H	+410
C=O	+805
O–H	+460
O=O	+496

What is the energy change for the reaction?

A +818 kJ/mol

B +102 kJ/mol

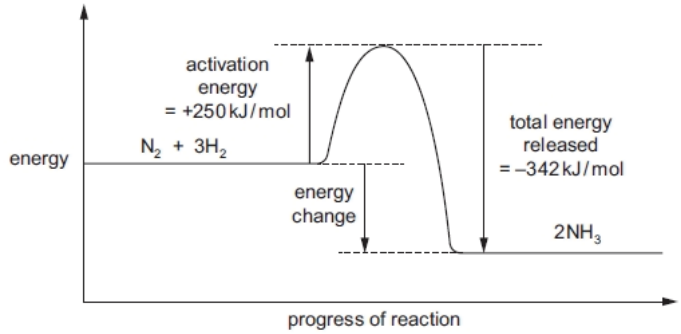
C –359 kJ/mol

D –818 kJ/mol

13 The equation for the formation of ammonia is shown.

$$N_2 + 3H_2 \rightarrow 2NH_3$$

The energy level diagram for the reaction is shown.



What is the energy change for the reaction?

A –592 kJ/mol

B –92 kJ/mol

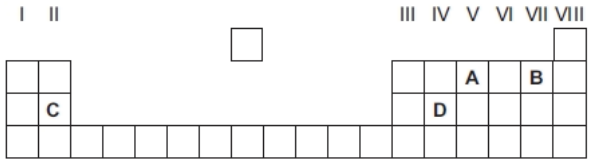
C +92 kJ/mol

D +592 kJ/mol

Q# 4/

17 Part of the Periodic Table is shown.

Which element forms an oxide that reacts with dilute acid to form a salt and water?



18 Aqueous sodium hydroxide is added to solid Q in a test-tube.

A gas is produced which turns damp red litmus blue.

What is Q?

A aluminium

B ammonia

C ammonium chloride

D sodium nitrate

19 Potassium hydroxide is a base.

Which statement describes a reaction of potassium hydroxide?

A Chlorine is formed when it is heated with ammonium chloride.

B It turns Universal Indicator green.

C It reacts with an acid to produce a salt and water.

D It turns methyl orange red.

20 Some general rules for the solubility of salts in water are listed.

- Carbonates are insoluble (except ammonium carbonate, potassium carbonate and sodium carbonate).
- Chlorides are soluble (except lead(II) chloride and silver chloride).
- Nitrates are soluble.
- Sulfates are soluble (except barium sulfate, calcium sulfate and lead(II) sulfate).

Which substances produce an insoluble salt when aqueous solutions of them are mixed?

A barium chloride and magnesium nitrate

B calcium chloride and ammonium nitrate

C silver nitrate and zinc chloride

D sodium carbonate and potassium sulfate

Q# 5/

12 Information about two reactions is given.

- The neutralisation reaction between citric acid and sodium hydrogencarbonate is endothermic.
- The displacement reaction between magnesium and carbon dioxide is exothermic.

Which statements about the two reactions are correct?

1 The energy of the products formed in the neutralisation reaction is greater than the energy of the reactants.

2 The energy of magnesium and carbon dioxide is greater than the energy of magnesium oxide and carbon.

3 In an exothermic reaction, the energy required to break the bonds is greater than the energy released when the new bonds are formed.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

13 Ethene reacts with hydrogen. The equation is shown.

$$CH_2{=}CH_2 + H_2 \rightarrow C_2H_6$$

The bond energies are shown in the table. The reaction is exothermic.

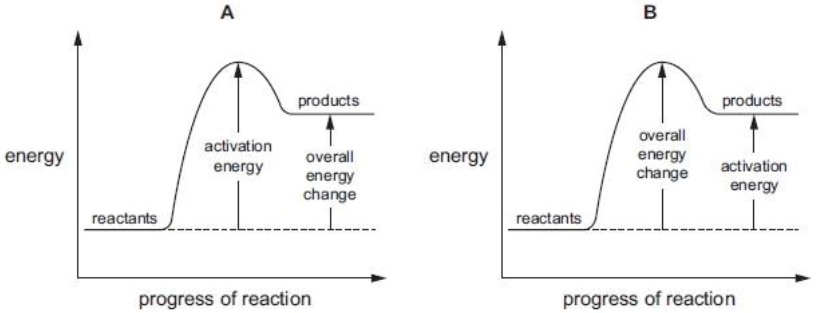
bond	bond energy in kJ/mol
C–C	+350
C=C	+610
C–H	+410
H–H	+436

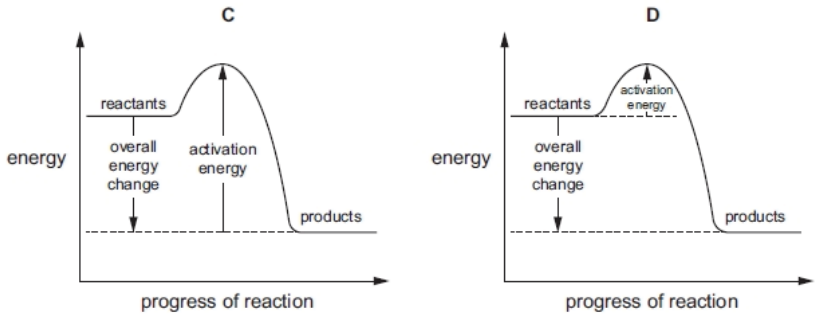
What is the energy change for the reaction?

A –560 kJ/mol **B** –124 kJ/mol **C** +486 kJ/mol **D** +5496 kJ/mol

Q# 6/

12 Which diagram is a correctly labelled energy level diagram for an endothermic reaction?





13 The equation for the complete combustion of methane is shown.

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$

The bond energies are shown in the table.

bond	bond energy in kJ/mol
C–H	+410
C=O	+805
O–H	+460
O=O	+496

What is the energy change for the reaction?

A –818 kJ/mol **B** –359 kJ/mol **C** –323 kJ/mol **D** +102 kJ/mol

Q# 7/

12 Plant cells use energy from sunlight for photosynthesis.

Which row describes and explains the energy change that occurs?

	type of energy change	explanation
A	endothermic	less energy is released making bonds than is absorbed to break bonds
B	endothermic	more energy is released making bonds than is absorbed to break bonds
C	exothermic	less energy is released making bonds than is absorbed to break bonds
D	exothermic	more energy is released making bonds than is absorbed to break bonds

13 Hydrogen bromide decomposes to form hydrogen and bromine. The equation is shown.

$$2HBr(g) \rightarrow H_2(g) + Br_2(g)$$

The bond energies are shown in the table. The reaction is endothermic.

bond	bond energy in kJ/mol
Br–Br	+193
H–Br	+366
H–H	+436

What is the energy change for the reaction?

A +263 kJ/mol **B** +103 kJ/mol **C** –103 kJ/mol **D** –263 kJ/mol

8.11 Essential Assessed Activity 3 Topic 6 Paper 6 19marks

Q# 1/

2 A student investigated the temperature changes when two different metals, zinc and magnesium, reacted with aqueous copper(II) sulfate.

Three experiments were done.

Experiment 1

- A measuring cylinder was used to pour 25 cm^3 aqueous copper(II) sulfate into a polystyrene cup.
- The initial temperature of the solution was measured and the timer was started.
- The temperature of the solution was measured at 30 seconds and at 60 seconds.
- At 60 seconds, 5 g of zinc powder was added to the aqueous copper(II) sulfate. The mixture was stirred with a thermometer.
- The temperature of the mixture was measured every 30 seconds for 210 seconds. The mixture was stirred continuously.

(a) Use the thermometer diagrams to record the temperatures in the table.

time / s	0	30	60	90	120	150	180	210
thermometer diagram								
temperature of mixture / °C								

[2]

Experiment 2

- Experiment 1 was repeated using 5 g of magnesium powder instead of zinc powder.

(b) Use the thermometer diagrams to record the temperatures in the table.

time / s	0	30	60	90	120	150	180	210
thermometer diagram								
temperature of mixture / °C								

[1]

Experiment 3

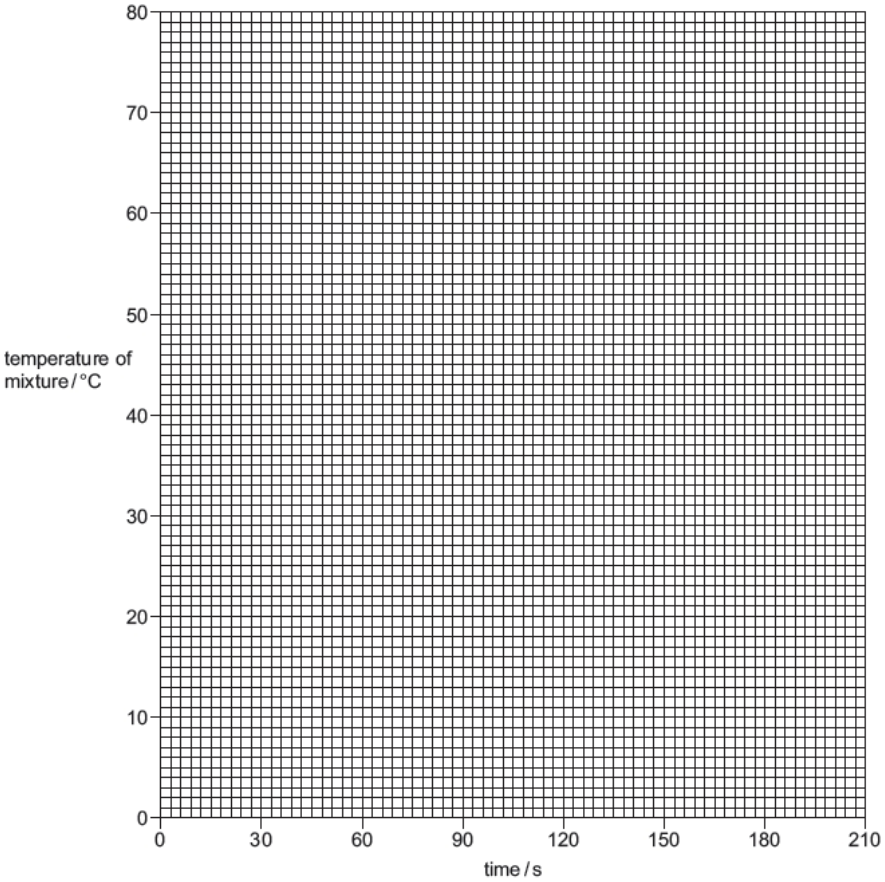
- Experiment 1 was repeated using 5 g of zinc granules instead of zinc powder.

(c) Use the thermometer diagrams to record the temperatures in the table.

time / s	0	30	60	90	120	150	180	210
thermometer diagram								
temperature of mixture / °C								

[1]

(d) Plot the results for Experiments 1–3 on the grid and draw **three** smooth line graphs. Clearly label your lines.



[3]

(e) **From your graph**, deduce the temperature of the mixture in Experiment 2 after 75 seconds.

Show clearly **on the grid** how you worked out your answer.

..... °C [2]

(f) **(i)** From the results, which Experiment was the most exothermic? Explain your answer.

.....

..... [2]

(ii) Compare the rates of reaction in Experiments 1 and 3. Explain why the rates of reaction are different.

.....

.....

..... [2]

(g) Predict the temperature of the mixture in Experiment 2 after 2 hours. Explain your answer.

.....

..... [2]

(h) When doing the experiments, what would be the advantage of taking the temperature readings every 15 seconds?

.....

..... [2]

(i) Explain why a copper can should **not** be used in place of the polystyrene cup in these experiments.

.....

.....

..... [2]

[Total: 19]

8.12 EXCEPTIONAL Assessed Activity 4 T6 13marks

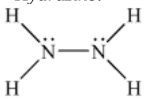
10. Bond enthalpies and average bond enthalpies at 298 K

Bond	ΔH / kJ mol^{-1}	Bond	ΔH / kJ mol^{-1}
H–H	436	C–H	413
C–C	347	Si–H	318
C=C	612	N–H	391
C≡C	838	P–H	321
C=C (benzene)	505	O–H	464
Si–Si	226	S–H	364
N–N	158	F–H	568
N=N	410	Cl–H	432
N≡N	945	Br–H	366
P–P	198	I–H	298
O–O	144		
O=O	498	C–O	358
S–S	266	C=O	746
F–F	158	C–N	286

11. One important property of a rocket fuel mixture is the large volume of gaseous products formed which provide thrust. Hydrazine, N_2H_4, is often used as a rocket fuel. The combustion of hydrazine is represented by the equation below.

$$N_2H_4(g) + O_2(g) \rightarrow N_2(g) + 2H_2O(g) \qquad \Delta H_c^{\ominus} = -585 \text{ kJ mol}^{-1}$$

Hydrazine:



;

(a) Hydrazine reacts with fluorine to produce nitrogen and hydrogen fluoride only, all in the gaseous state. State an equation for the reaction.

.....

(2)

(c) Use the average bond enthalpies given in Table 10 of the Data Booklet to determine the enthalpy change for the reaction in part (a) above.

.....

.....

.....

(3)

(d) Based on your answers to parts (a) and (c), suggest whether a mixture of hydrazine and fluorine is a better rocket fuel than a mixture of hydrazine and oxygen.

.....

.....

(2)

13. Which equation best represents the bond enthalpy of HCl?

A. $HCl(g) \rightarrow H^+(g) + Cl^-(g)$
B. $HCl(g) \rightarrow H(g) + Cl(g)$
C. $HCl(g) \rightarrow \frac{1}{2} H_2(g) + \frac{1}{2} Cl_2(g)$
D. $2HCl(g) \rightarrow H_2(g) + Cl_2(g)$

(Total 1 mark)

14. Which process represents the C–Cl bond enthalpy in tetrachloromethane?

A. $CCl_4(g) \rightarrow C(g) + 4Cl(g)$
B. $CCl_4(g) \rightarrow CCl_3(g) + Cl(g)$
C. $CCl_4(l) \rightarrow C(g) + 4Cl(g)$
D. $CCl_4(l) \rightarrow C(s) + 2Cl_2(g)$

(Total 1 mark)

15. Hydrazine is a valuable rocket fuel.
The equation for the reaction between hydrazine and oxygen is given below.

$$N_2H_4(g) + O_2(g) \rightarrow N_2(g) + 2H_2O(g)$$

Use the bond enthalpy values from Table 10 to determine the enthalpy change for this reaction.

.....

.....

.....

(Total 3 marks)

16. When some solid barium hydroxide and solid ammonium thiosulfate were reacted together, the temperature of the surroundings was observed to decrease from 15 ºC to – 4 ºC. What can be deduced from this observation?

A. The reaction is exothermic and ΔH is negative.
B. The reaction is exothermic and ΔH is positive.
C. The reaction is endothermic and ΔH is negative.
D. The reaction is endothermic and ΔH is positive.

8.13 ESSENTIAL End of Topic 6 Review and Reflection

Looking at the goals you could have achieved and the goals you actually achieved try to reflect on your progress.

Try to be as honest and as detailed as possible. Sometimes you may think you have thought about an idea well, but when you talk with someone else, or write it out, it helps you better understand and allows you think more completely and more clearly.

Did you achieve more goals this topic than last topic?

Fill in this table

Level	Number of goals achieved at each level	Success rate, %
FUNDAMENTAL	/5	
ESSENTIAL	/10	
EXTENSION	/13	
EXCEPTIONAL	/10	

Do you feel you tired harder? If yes, what helped you to do so? If not, why not?

What could you do differently next time, in addition to what you are already doing to improve, not only your score in the end of topic tests and other assessed activities, but also in how you learn. How could you become a more effective student to get more learning out of the time you are investing in your studies?

What did you enjoy most about this topic?

What did you find most difficult?

What did you find easiest?

On a scale of 1 being hardest and 5 being most difficult, circle how challenging you found this topic

1 2 3 4 5

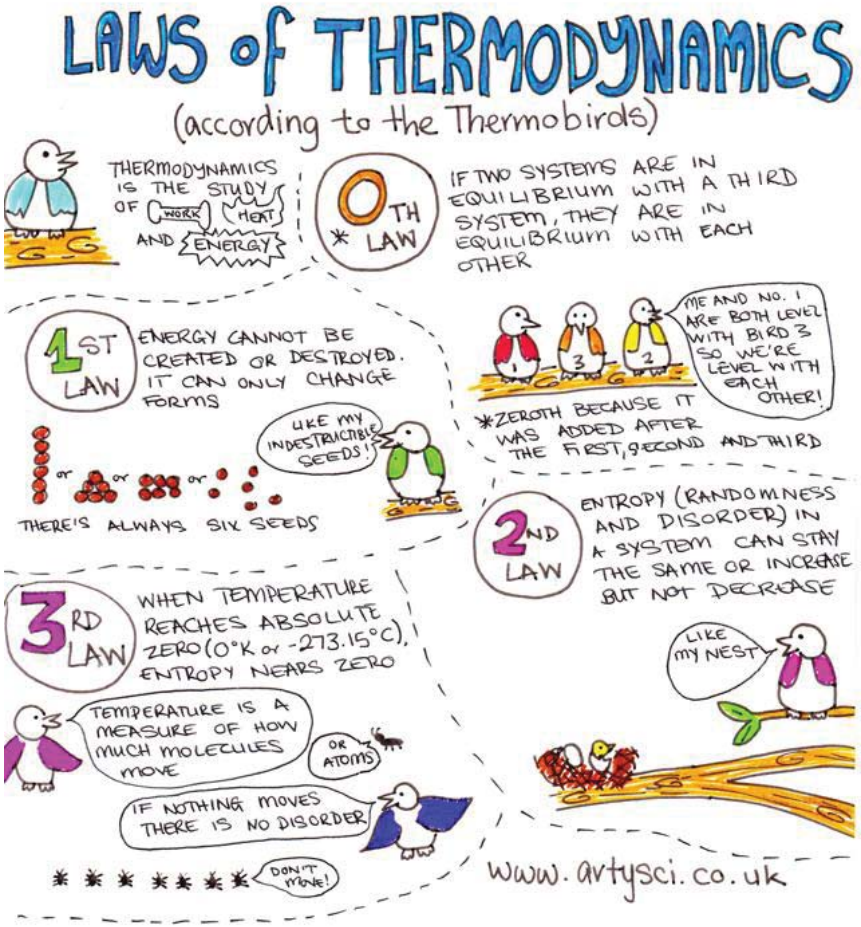
What could be done to make this topic easier to understand?

Do you have any questions about this topic?

8.14 Exceptional Additional Activities, Further Reading and Exploring Beyond the Syllabus

8.15 EXCEPTIONAL Additional Activities, Further Reading and Exploring Beyond the Syllabus

Most reactions that happen on Earth give out heat energy, but not all of them. The first law of thermodynamics suggests that energy can neither be created nor destroyed. But it is not the only law, nor is it the most important law. Pick one law and create a short presentation about it



You could investigate Entropy. What is it, and what isn't it?

EXCEPTIONALLY SMASHING Ideas: Why has Entropy created problems for the existence of Black Holes? Have these problems been solved? If so how?

8.16 EXCEPTIONAL EXAM QUESTIONS T6 From IB SL 31marks

These questions are taken from an AS Level style syllabus called IB Standard Level. In theory a top level an iGCSE student has covered everything needed answer these questions, but most A* level students probably wouldn't be able to answer them all.

10. Bond enthalpies and average bond enthalpies at 298 K

Bond	ΔH / kJ mol^{-1}	Bond	ΔH / kJ mol^{-1}
H–H	436	C–H	413
C–C	347	Si–H	318
C=C	612	N–H	391
C≡C	838	P–H	321
C=C (benzene)	505	O–H	464
Si–Si	226	S–H	364
N–N	158	F–H	568
N=N	410	Cl–H	432
N≡N	945	Br–H	366
P–P	198	I–H	298
O–O	144		
O=O	498	C–O	358
S–S	266	C=O	746
F–F	158	C–N	286
Cl–Cl	243	C=N	615
Br–Br	193	C≡N	887
I–I	151	C–F	467
		C–Cl	346
		C–Br	290
		C–I	228
		Si–O	466

1. Which statement about bonding is correct?
A. Bond breaking is endothermic and requires energy.
B. Bond breaking is endothermic and releases energy.
C. Bond making is exothermic and requires energy.
D. Bond making is endothermic and releases energy.

(Total 1 mark)

2. Propane can be formed by the hydrogenation of propene.

$$CH_3CH{=}CH_2(g) + H_2(g) \rightarrow CH_3CH_2CH_3(g)$$

(ii) Enthalpy changes can be determined using average bond enthalpies. Define the term *average bond enthalpy.*

.....

.....

(2)

(iii) Determine a value for the hydrogenation of propene using information from Table 10 above.

.....

.....

(2)

(iv) Explain why the enthalpy of hydrogenation of propene is an exothermic process.

.....

(1)

3. Which types of reaction are always exothermic?
I. Neutralization
II. Decomposition
III. Combustion
A. I and II only
B. I and III only
C. II and III only
D. I, II and III

(Total 1 mark)

4. Which equation represents the bond enthalpy for the H–Br bond in hydrogen bromide?
A. $HBr(g) \rightarrow H(g) + Br(g)$
B. $HBr(g) \rightarrow H(g) + Br(l)$
C. $HBr(g) \rightarrow H(g) + \frac{1}{2}Br_2(l)$
D. $HBr(g) \rightarrow H(g) + \frac{1}{2}Br_2(g)$

(Total 1 mark)

5. Which is correct about energy changes during bond breaking and bond formation?

	Bond breaking	Bond formation
A.	exothermic and ΔH positive	endothermic and ΔH negative
B.	exothermic and ΔH negative	endothermic and ΔH positive
C.	endothermic and ΔH positive	exothermic and ΔH negative
D.	endothermic and ΔH negative	exothermic and ΔH positive

(Total 1 mark)

6. Which processes are exothermic?
I. Ice melting
II. Neutralization
III. Combustion
A. I and II only
B. I and III only
C. II and III only
D. I, II and III

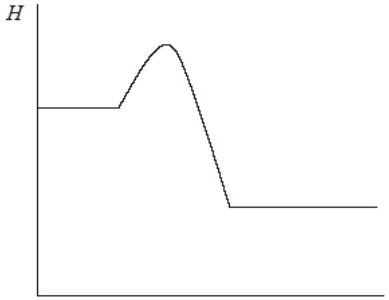
(Total 1 mark)

7. Which is true for a chemical reaction in which the products have a higher enthalpy than the reactants?

	Reaction	ΔH
A.	endothermic	positive
B.	endothermic	negative
C.	exothermic	positive
D.	exothermic	negative

(Total 1 mark)

8. Which statement is correct given the enthalpy level diagram below?



A. The reaction is endothermic and the products are more thermodynamically stable than the reactants.

B. The reaction is exothermic and the products are more thermodynamically stable than the reactants.
C. The reaction is endothermic and the reactants are more thermodynamically stable than the products.
D. The reaction is exothermic and the reactants are more thermodynamically stable than the products.

(Total 1 mark)

9. (b) Use the information from Table 10 above to calculate the enthalpy change for the complete combustion of but-1-ene, according to the following equation.

$$C_4H_8(g) + 6O_2(g) \rightarrow 4CO_2(g) + 4H_2O(g)$$

.....

.....

.....

(3)

10. Two students were asked to use information from the Data Booklet to calculate a value for the enthalpy of hydrogenation of ethene to form ethane.

$$C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$$

John used the average bond enthalpies from Table 10. Marit used the values of enthalpies of combustion from Table 12.

(a) Calculate the value for the enthalpy of hydrogenation of ethene obtained using the average bond enthalpies given in Table 10.

.....

.....

(2)

(d) John then decided to determine the enthalpy of hydrogenation of cyclohexene to produce cyclohexane.

$$C_6H_{10}(l) + H_2(g) \rightarrow C_6H_{12}(l)$$

(i) Use the average bond enthalpies to deduce a value for the enthalpy of hydrogenation of cyclohexene.

.....

(1)

(Total 1 mark)

8.16.1 EXCEPTIONAL EXAM QUESTIONS T6 From IB SL 31marks Mark Scheme

1. A

[1]

2. (ii) the enthalpy change when (one mole of) the gaseous bond is broken (or formed) / X–Y(g) → X(g) + Y(g) / X(g) + Y(g) → X–Y(g); averaged for the same bond in a number of similar compounds / *OWTTE*; 2

(iii) energy in: C=C + H–H **and** energy out: C–C + 2C–H;
Accept energy in C–C + 6C–H + C=C + H–H and energy out 2C–C + 8C–H.
ΔH = (612 + 436) – (347 + 826) = 1048 – 1173 / –125 (kJ mol^{-1}); 2
*Award **[2]** for correct final answer.*
*Award **[1]** for +125.*
If old Data Booklet values then allow: ΔH = 1048 – 1172 = –124 (kJ mol^{-1})

(iv) due to the relative strength of the C–C and 2C–H bonds compared to the C=C and H–H bonds / bonds in products stronger than bonds in reactants; 1

[7]

3. B

[1]

4. A

[1]

5. C

[1]

6. C

[1]

7. A

[1]

8. B

[1]

9. (b) Bonds broken
(612) + (2×348) + (8×412) + (6×496)/7580 (kJ mol^{-1});
Bonds made
(8×743) + (8×463) / 9648 (kJ mol^{-1});
ΔH = –2068 (kJ mol^{-1}); 3
*Award **[3]** for the correct answer.*
Allow full ECF.
Allow kJ but no other incorrect units.
*Even if the first two marks are lost, the candidate can score **[1]** for a clear correct subtraction for ΔH.*

[5]

10. (a) energy required = C=C + H–H/612 + 436 and
energy released = C–C + 2(C–H)/347 + 2(413) /
energy required = C=C + H–H + 4(C–H)/612 + 436 + 4(413) and
energy released = C–C + 6(C–H)/347 + 6(413);
ΔH = (1048 – 1173)/(2700 – 2825) = –125 kJ mol^{-1} 2

(d) (i) –125 kJ mol^{-1}; 1

[1]

9 Topic 7.1 &7.2 Chemical and Physical Reactions and Rate of Reactions

9.1 End of Topic 7.1 &7.2 Goals Checklist

For each topic you ought to try to do as many of the following things to get the most out of your time, the resources available to you and to help you grow as a student. Tick each goal off as you complete it. Growth is difficult and uncomfortable, but you should choose to do these things, and the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win!

Aspect	What you should have done	Yes/No	Level
Interacted with your teacher	Ask your teacher 1 question, about anything, once a week		FUNDAMENTAL
	Try to answer one question asked by your teacher at least once a week		ESSENTIAL
	Ask your teacher one question about something you do not understand in science once a week		ESSENTIAL
	Ask your teacher one question about something to do with science every lesson		EXTENSION
Notes and follow up notes	Complete set of class note		FUNDAMENTAL
	Cornell Notetaking Attempted		ESSENTIAL
	Cornell Notetaking Completed		EXTENSION
	Cornell Notetaking Completed to an exemplary standard		EXCEPTIONAL
	Attempted the Mind Map for this topic		ESSENTIAL
	Completed the Mind Map for this topic		EXTENSION
Textbook	Read ahead before the topic has been started		EXTESNION
	Highlighted key ideas and translate new words		FUNDAMENTAL
	Completed the questions at the end of each 2 page spread in your exercise book		EXTENSION
	Added to your class notes ideas and important information from the textbook that you learnt		EXTENSION
Past Exam Questions	Worked on at least 25% of the exam questions in this workbook		FUNDAMENTAL
	Attempted more than 25% of the questions and those questions you have completed you have marked in a different colour pen		ESSENTIAL
	Completed and marked all questions here		EXTENSION
	Completed, marked and additional key ideas where you have located the most difficult marks added to your notebook		EXCEPTIONAL
	Used the resources available online to answer additional questions not found in this workbook on the current topic.		EXCEPTIONAL
	Ask your teacher about an exam question that they cannot answer		EXCEPTIONALLY SMASHING!!!
Assessed Activities	Complete the word list activity using the word list at the front of each topic as little as possible		FUNDAMENTAL
	Complete 2 assessed activities, either in class or as homework		ESSENTIAL
	Complete 2 assessed activities and scored over 70% on average		ESSENTIAL
	Complete 2 assessed activities and scored over 80% on average		EXTENSION
	Complete 2 assessed activities and scored over 90% on average		EXCEPTIONAL
End of Topic Test	Revised sufficiently well to improve upon your score from the previous test (except if you are scoring over 90%, then just write Y for this goal)		ESSENTIAL
	Scored 10% higher than your current average		EXTENSION
	Scored 15% or more than your previous end of topic average		EXCEPTIONAL
	Scored over 90%		EXTESNION
	Scored over 95%		SMASHING!!!

Aspect	What you should have done	Yes/No	Level
Reading	Spend more than 1 hour a week reading a book **you enjoy** (in any language) about anything.		ESSENTIAL
	Spend more than 3 hours a week reading a book **you enjoy** (in any language) about anything.		EXTENSION
	Spend more than 5 hours a week reading a book **you enjoy** (in any language) about anything.		EXCEPTIONAL
	Spend at least one hour a week reading a book **you enjoy** in English about anything.		EXTENSION
	Spend more than 3 hours a week reading a book **you enjoy** in English about anything.		EXCEPTIONAL
Reflection	You completed this goal setting table		FUNDAMENTAL
	You have looked at the goals you have achieved and the ones you have not and added them up and entered them into the table in the Review and Reflection section		ESSENTIAL
	You have given an answer for every question in the Review and Reflection section at the end of this topic		EXTENSION
	You have Given good and thoughtful answers for every question in the Review and Reflection section at the end of this topic		EXCEPTIONAL

9.2 Topic 7.1 and 7.2 Syllabus

7 Chemical reactions

7.1 Physical and chemical changes

Core

- Identify physical and chemical changes, and understand the differences between them

7.2 Rate (speed) of reaction

Core

- Describe and explain the effect of concentration, particle size, catalysts (including enzymes) and temperature on the rate of reactions
- Describe the application of the above factors to the danger of explosive combustion with fine powders (e.g. flour mills) and gases (e.g. methane in mines)
- Demonstrate knowledge and understanding of a practical method for investigating the rate of a reaction involving gas evolution
- Interpret data obtained from experiments concerned with rate of reaction

Note: Candidates should be encouraged to use the term *rate* rather than *speed*.

Supplement

- Devise and evaluate a suitable method for investigating the effect of a given variable on the rate of a reaction
- Describe and explain the effects of temperature and concentration in terms of collisions between reacting particles. (An increase in temperature causes an increase in collision rate **and** more of the colliding molecules have sufficient energy (activation energy) to react whereas an increase in concentration only causes an increase in collision rate.)
- Describe and explain the role of light in photochemical reactions and the effect of light on the rate of these reactions. (This should be linked to section 14.4.)
- Describe the use of silver salts in photography as a process of reduction of silver ions to silver; and photosynthesis as the reaction between carbon dioxide and water in the presence of chlorophyll and sunlight (energy) to produce glucose and oxygen

9.3 ESSENTIAL Glossary for Keywords for Topic 7.1 & 7.2

Topic #	English	Chinese
7	**enzymes** protein molecules that act as biological catalysts	酶充当生物催化剂的蛋白质分子
7	**photochemical reaction** a chemical reaction that occurs when light, usually of a particular wavelength, falls on the reactants	光化学反应当通常是特定波长的光照射到反应物上时发生的化学反应
7	**photosynthesis** the chemical process by which plants synthesise glucose from atmospheric carbon dioxide and water: the energy required for the process is captured from sunlight by chlorophyll molecules in the green leaves of the plants	光合作用是植物从大气中的二氧化碳和水合成葡萄糖的化学过程：该过程所需的能量是由植物的绿叶中的叶绿素分子从阳光中捕获的
	Denature If an enzyme is placed in an extreme environment, e.g. too acidic or alkali, too hot or is physically damaged by motion I (like shaking) will no longer be able to function. Usually this change is permanent.	变性如果将酶置于极端环境中，例如 太酸或太碱，太热或被运动I物理损坏（如摇晃）将不再起作用。通常，此更改是永久性的。
7	**reaction rate** a measure of how fast a reaction takes place	反应速率衡量反应发生的速度
7	**speed of reaction** a less accurate name for reaction rate	反应速度反应速度的名称不太准确

9.4 EXTENSION Keywords

You do not need to understand these words to score a good A, or even a low A* but if you are aiming for a good or high A* then understanding words like these here will be helpful.

9.5 ESSENTIAL Classroom Active Learning Tasks Drawing Graphs Based on the Rate of a Reaction from Paper 6 36marks

Q# 1/ iGCSE Chemistry/2018/w/Paper 63/Q2

2 A student investigated the rate of reaction between solution **S** and solution **T** at different temperatures. When these chemicals react they form iodine. Sodium thiosulfate solution and starch solution were used to show how fast the reaction proceeded.

Four experiments were done.

Experiment 1

- A measuring cylinder was used to add 10 cm^3 of solution **S** and 10 cm^3 of sodium thiosulfate solution to a conical flask.
- A teat pipette was then used to add 1 cm^3 of starch solution to the mixture.
- The temperature of the mixture was measured and recorded in the table.
- The reaction was started by using a measuring cylinder to add 10 cm^3 of solution **T** to the conical flask. A timer was started immediately and the mixture was swirled.
- The time taken for the mixture to turn blue-black was measured.
- The final temperature of the mixture was measured and recorded.
- The conical flask was emptied and rinsed with distilled water.

Experiment 2

- A measuring cylinder was used to add 10 cm^3 of solution **S** and 10 cm^3 of sodium thiosulfate solution to the conical flask.
- A teat pipette was then used to add 1 cm^3 of starch solution to the mixture.
- The mixture was then heated to about 30 °C.
- The temperature of the mixture was measured and recorded in the table.
- The reaction was started by using a measuring cylinder to add 10 cm^3 of solution **T** to the conical flask. The timer was started immediately and the mixture was swirled.
- The time taken for the mixture to turn blue-black was measured.
- The final temperature of the mixture was measured and recorded.
- The conical flask was emptied and rinsed with distilled water.

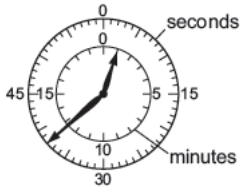
Experiment 3

- Experiment 2 was repeated but the mixture of solution **S**, sodium thiosulfate solution and starch solution in the conical flask was heated to about 40 °C before adding solution **T**.

Experiment 4

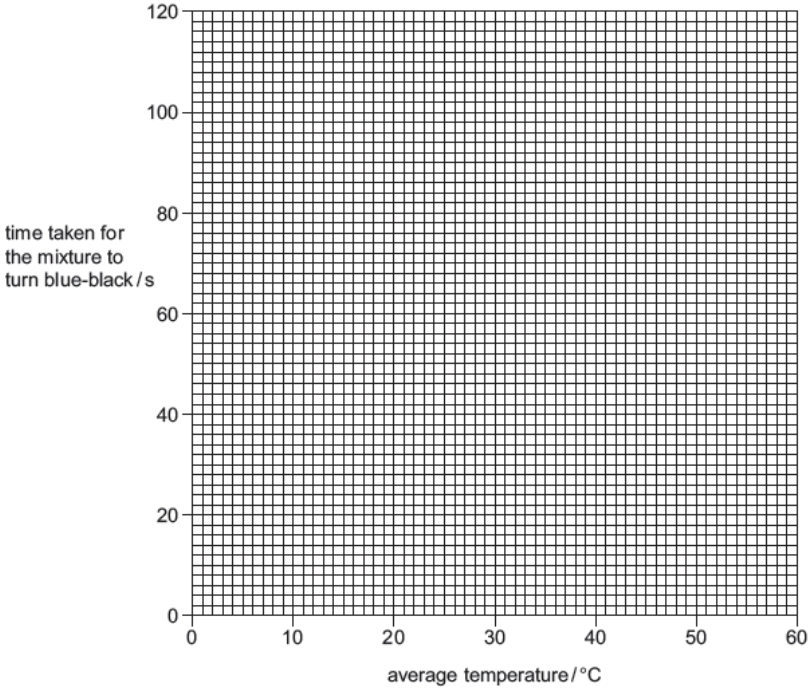
- Experiment 2 was repeated but the mixture of solution **S**, sodium thiosulfate solution and starch solution in the conical flask was heated to about 50 °C before adding solution **T**.

(a) Calculate the average temperatures in the table.
Use the stop-clock diagrams to record the time taken for each experiment in the table.

experiment number	initial temperature / °C	final temperature / °C	average temperature / °C	stop-clock diagram	time taken for the mixture to turn blue-black / s
1	22	22			
2	31	29			
3	41	37			
4	51	45			

[4]

(b) Plot the results for Experiments 1–4 on the grid. Draw a smooth line graph.



[4]

(c) **From your graph**, deduce the average temperature needed for the mixture to turn blue-black in 60 s.

Show clearly **on the grid** how you worked out your answer.

..... [3]

(d) **(i)** In which experiment, 1, 2, 3 or 4, was the rate of reaction greatest?

..... [1]

(ii) Explain, in terms of particles, why the rate of reaction was greatest in this experiment.

.....

.....

..... [2]

(e) Pipettes or burettes could be used to measure the volumes of solution **S** and the sodium thiosulfate solution more accurately.

State and explain **one other** way to improve the accuracy of the results of these experiments.

way to improve the accuracy .....

explanation .....

.....

[2]

(f) A student predicted that using a burette to add solution **T** would improve the accuracy of the results of these experiments.

Suggest why the student's prediction would **not** improve the accuracy of the results of these experiments.

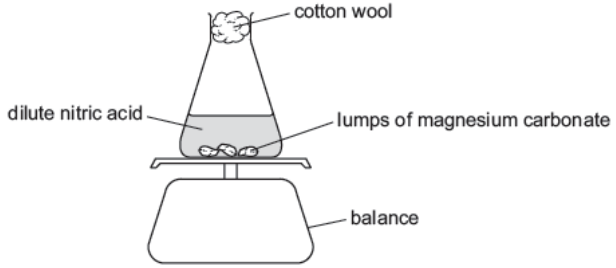
.....

..... [2]

[Total: 18]

Q#2/ iGCSE Chemistry/2018/w/Paper 61/Q2

2 A student investigated the rate of reaction between dilute nitric acid and lumps of magnesium carbonate. The apparatus shown was used.

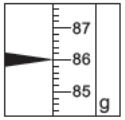
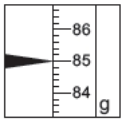
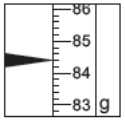
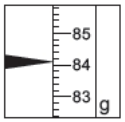
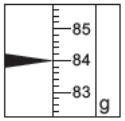
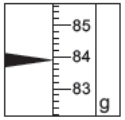
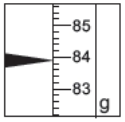
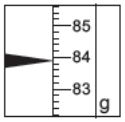


Lumps of magnesium carbonate were added to a conical flask. 40 cm^3 of dilute nitric acid was then poured into the conical flask using a measuring cylinder. The magnesium carbonate was in **excess**.

The conical flask was placed on a balance. Cotton wool was placed in the top of the conical flask.

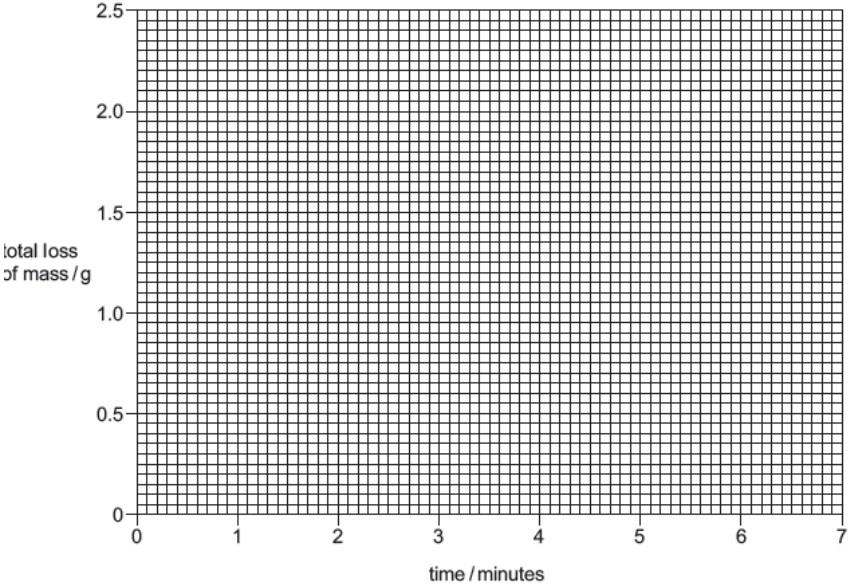
The mass of the conical flask and its contents was measured and a timer was started. The mass of the conical flask and its contents was measured every minute for 7 minutes.

(a) Use the balance diagrams to record the mass of the conical flask and its contents in the table. Complete the table to work out the total loss of mass of the conical flask and its contents since the start of the experiment.

time / minutes	balance diagram	mass of conical flask and its contents / g	total loss of mass / g
0			
1			
2			
3			
4			
5			
6			
7			

[3]

(b) Plot the results on the grid. Draw a smooth line graph.



[3]

(c) The average rate of reaction can be calculated using the equation shown.

$$\text{average rate of reaction} = \frac{\text{total loss of mass / g}}{\text{time taken / s}}$$

Calculate the average rate of reaction for the first 30 **seconds** of the reaction.
Deduce the unit.

rate = ...

unit = ...

[3]

(d) The experiment is repeated using an excess of powdered magnesium carbonate. All other conditions are kept the same.

Sketch on the grid the graph you would expect. [2]

(e) (i) Why does the mass of the conical flask and its contents decrease?

.....

..... [1]

(ii) Suggest the purpose of the cotton wool.

.....

.....

..... [2]

(iii) Why does the graph level off? Explain your answer.

.....

..... [2]

(f) Give **one** advantage and **one** disadvantage of using a burette instead of a measuring cylinder to add the dilute nitric acid to the conical flask.

advantage .....

disadvantage .....

[2]

[Total: 18]

Makr Scheme For Drawing Graphs Active Learning Excercise

Q# 1/ iGCSE Chemistry/2018/w/Paper 63/Q2

2(a)	Table of results for experiments 1–4 average temperature boxes completed correctly 22, 30, 39, 48	1
	Time boxes completed correctly 98, 42, 26, 22	2
	Times completed in seconds	1
2(b)	All points plotted correctly	3
	Smooth line graph (curve)	1
2(c)	indication on graph	1
	Value from graph	1
	°C	1
2(d)(i)	Experiment 4	1
2(d)(ii)	**M1** particles (of solution L) have more / most (kinetic) energy / move faster	1
	M2 more frequent collisions / particles collide more often	1
2(e)	**M1** Insulation / use a lid	1
	M2 To reduce heat losses	1
2(f)	**M1** Too slow / slower addition of solution	1
	M2 Measuring time-taken / results less accurate	1

Q#2/ iGCSE Chemistry/2018/w/Paper 61/Q2

2(a)	mass boxes correctly completed to 1 dp 86.0, 85.0, 84.4, 84.1,84.0, 83.9, 83.9, 83.9	2
	Loss in mass boxes correctly completed 0.0, 1.0, 1.6, 1.9, 2.0, 2.1, 2.1, 2.1	1
2(b)	points correctly plotted:	2
	smooth line graph;	1
2(c)	**M1** mass loss from graph at 30 seconds (0.5)	1
	M2 mass in M1 / 30 calculated (= 0.017)	1
	M3 g / s;	1
2(d)	Sketch steeper than original graph	1
	To same level	1
2(e)(i)	gas / carbon dioxide given off	1
2(e)(ii)	Allow gas to escape	1
	Prevent loss of acid;	1
2(e)(iii)	Reaction finished	1
	All nitric acid has reacted	1
2(f)	Advantage: more accurate;	1
	Disadvantage: slow	1

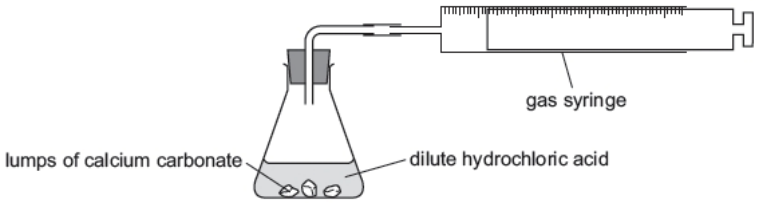
9.6 Extension Classroom Active Learning Tasks Dealing with Multi-mark Questions Based on Rate of reaction 43 Marks

Q# 1/ IGCSE Chemistry/2018/w/Paper 43/Q5

5 A student investigates the rate of reaction between lumps of calcium carbonate and dilute hydrochloric acid using the apparatus shown.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

The calcium carbonate was in excess.



(a) Which measurements should the student make during the reaction to determine the rate of reaction?

.....

..... [2]

(b) What happens to the rate of reaction as the reaction proceeds? Explain your answer.

.....

.....

.....

..... [3]

(c) The student repeated the experiment at a higher temperature. All other conditions were kept the same. The student found that the rate of reaction increased.

Explain, in terms of collisions, why the rate of reaction increased.

.....

.....

.....

.....

..... [4]

Q# 2/ IGCSE Chemistry/2018/w/Paper 42/Q4

(c) The original experiment was repeated at a higher temperature. All other conditions were kept the same.

Describe and explain, in terms of collisions between particles, the effect of using a higher temperature on the time taken for the reaction to finish.

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

Q# 3/ IGCSE Chemistry/2018/s/Paper 43/Q3

(d) Cobalt reacts with dilute hydrochloric acid to make the salt cobalt(II) chloride. Bubbles of hydrogen gas are produced.

(iii) Use collision theory to explain how heating the dilute hydrochloric acid makes the rate of reaction faster.

.....

.....

.....

.....

..... [3]

Q# 4/ IGCSE Chemistry/2017/w/Paper 41/

7 Copper(II) oxide reacts with dilute hydrochloric acid.

$$CuO(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l)$$

6.00 g of copper(II) oxide were added to 50.0 cm^3 of 1.00 mol / dm^3 hydrochloric acid. This was an excess of copper(II) oxide.

(a) The rate of the reaction can be increased by increasing the concentration of the hydrochloric acid or by heating it.

(i) In terms of collisions, explain why increasing the concentration of the hydrochloric acid increases the rate of the reaction.

.....

.....

.....

..... [2]

(ii) In terms of collisions, explain why heating the hydrochloric acid increases the rate of the reaction.

.....

.....

.....

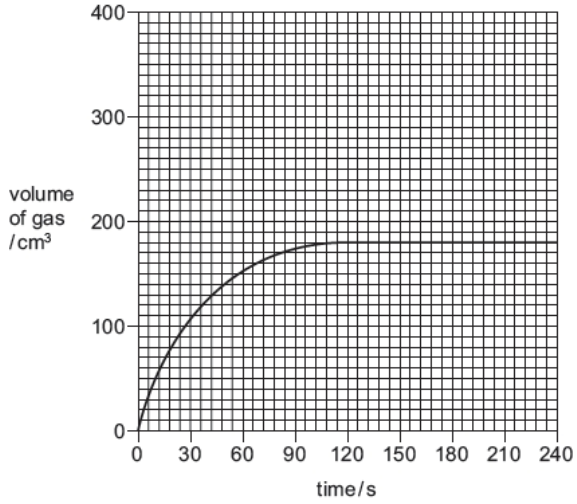
..... [2]

Q# 5/ IGCSE Chemistry/2017/s/Paper 41/

(e) The original graph has been drawn again.

On the grid, draw the graph expected if the concentration of dilute hydrochloric acid is changed from 0.1 mol / dm^3 to 0.2 mol / dm^3. All other conditions are the same as in the original experiment.

Explain, in terms of particles, why your graph is different from the original graph.



.....

.....

.....

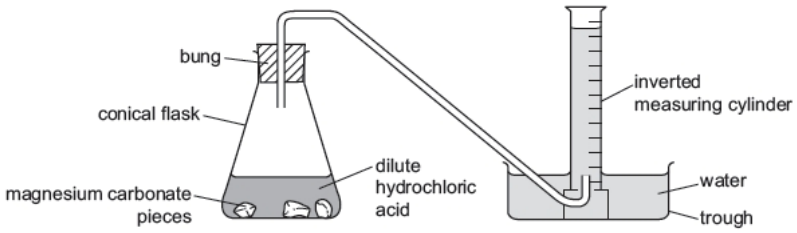
..... [4]

Q# 6/ IGCSE Chemistry/2016/w/Paper 41/

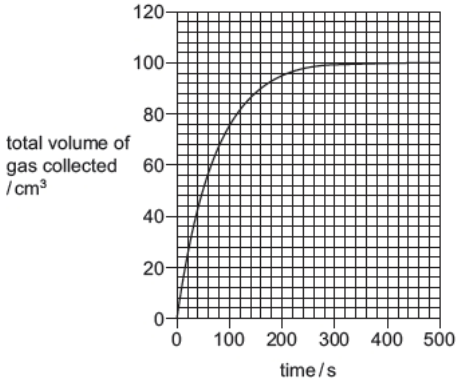
8 Magnesium carbonate reacts with dilute hydrochloric acid.

$$MgCO_3(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l) + CO_2(g)$$

An excess of magnesium carbonate pieces was added to dilute hydrochloric acid. The apparatus in the diagram was used to measure the volume of gas produced. The total volume of gas collected was recorded every 20 seconds.



(a) The results obtained are shown on the graph.



(i) Describe how the rate of this reaction changed during the reaction. Explain why the rate changed in this way.

.....

.....

.....

.....

..... [4]

(ii) The experiment was repeated using the same mass of **powdered** magnesium carbonate with the same volume and concentration of dilute hydrochloric acid.

Explain how the initial rate of reaction and total volume of gas collected would compare to the first experiment.

initial rate of reaction .....

.....

.....

total volume of gas .....

.....

.....

[4]

(b) A piece of magnesium ribbon was cleaned. The experiment was repeated using this clean magnesium ribbon instead of magnesium carbonate.

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

This reaction is exothermic.
The rate of the reaction gradually increased over the first 2 minutes.

Explain why the rate of the reaction increased.

.....

.....

.....

.....

.....

.....

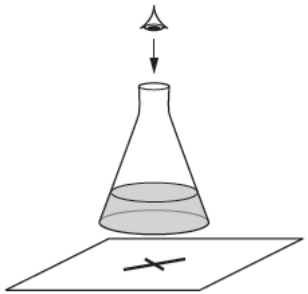
..... [5]

Q# 7/ IGCSE Chemistry/2016/s/Paper 41/

3 When aqueous sodium thiosulfate and dilute hydrochloric acid are mixed, a precipitate of insoluble sulfur is produced. This makes the mixture difficult to see through.

$$Na_2S_2O_3(aq) + 2HCl(aq) \rightarrow S(s) + 2NaCl(aq) + H_2O(l) + SO_2(g)$$

The time taken for the cross to disappear from view is measured.



A student adds the following volumes of aqueous sodium thiosulfate, dilute hydrochloric acid and distilled water to the conical flask.

The time taken for the formation of the precipitate of sulfur to make the cross disappear from view is recorded.

experiment number	volume of sodium thiosulfate / cm^3	volume of hydrochloric acid / cm^3	volume of distilled water / cm^3	time taken for cross to disappear from view / s
1	10	10	40	56
2	20	10	30	28
3				

(ii) Use collision theory to explain why increasing the concentration of sodium thiosulfate would change the rate of reaction.

.....

.....

.....

..... [2]

(c) The student repeated experiment 1 at a higher temperature.

Use collision theory to explain why the rate of reaction would increase.

.....

.....

.....

..... [3]

Mark Scheme Extension Classroom Active Learning Tasks Dealing With Multi-mark Questions Based on Rate of reaction 43 Marks

Q# 1/ IGCSE Chemistry/2018/w/Paper 43/

5(a)	**M1** volume of gas **M2** time	2
5(b)	**M1** rate decreases / reaction gets slower **M2** concentration of acid decreases **M3** fewer collisions per unit time	3

5(c)	**M1** particles have **more** kinetic energy **M2** particles move faster **M3 more** collisions **per unit time** **M4 more** of the particles have energy greater than or equal to activation energy / **more** of the collisions have energy greater than or equal to activation energy **OR** **more** of the particles have sufficient energy to react / **more** of the collisions have sufficient energy to react **OR** A greater percentage or greater proportion or greater fraction of collisions are successful	4

Q# 2/ IGCSE Chemistry/2018/w/Paper 42/

4(c)	M1 **Time** taken is less M2 (particles) have more energy M3 (particles) move faster M4 More collisions (of particles) occur per second / per unit time M5 More (of the) particles / collisions have energy greater than activation energy **or** More (of the) particles / collisions have sufficient energy to react **or** A greater percentage / proportion / fraction of collisions (of particles) are successful	5

Q# 3/ IGCSE Chemistry/2018/s/Paper 43/

3(d)(iii)	(particles) have more energy / (particles) move faster	1
	more collisions per second / greater collision rate	1
	more of the colliding molecules have sufficient energy (activation energy) to react	1

Q# 4/ IGCSE Chemistry/2017/w/Paper 41/

7(a)(i)	more particles (of acid) in a given volume / dm^3 / cm^3	1
	more collisions per second / unit time OR greater collision rate	1
7(a)(ii)	particles have more energy / particles move faster / more collisions per second / more collisions per unit time / greater collision rate	1
	more (of the) particles / collisions have energy greater than the activation energy / more particles have sufficient energy to react / more collisions have sufficient energy to react / a greater percentage of collisions are successful	1

Q# 5/ IGCSE Chemistry/2017/s/Paper 41/

5(d)	curve starts from (0,0) and has a lower gradient than the original curve	1
	because lumps have a lower surface area	1

5(d)	curve starts from (0,0) and has a lower gradient than the original curve	1
	because lumps have a lower surface area	1

Q# 6/ IGCSE Chemistry/2016/w/Paper 41/

8(a)(i)	any 4 from: slowed down acid became less concentrated OR fewer particles per unit volume fewer collisions per second OR lower collision rate (then the reaction) stopped all the hydrochloric acid reacted	4
8(a)(ii)	any 4 from: faster (reaction) (powder has) larger surface area more collisions per second OR higher collision rate same volume of gas amount/moles hydrochloric acid is not changed	4
8(b)	any 5 from: temperature increased particles have more energy (particles) move faster more collisions per second OR higher collision rate more particles have sufficient energy to react/activation energy more of the collisions are successful	5

Q# 7/ IGCSE Chemistry/2016/s/Paper 41/

3(b)(ii)	**M1** more particles per unit volume/particles are closer together; **M2** increases the rate of collisions/there are more collisions per unit time;	2 1 1
3(c)	**M1** particles gain more energy **and** move faster; **M2** increasing rate of collisions/more collisions per unit time; **M3** higher proportion of particles have sufficient energy to react/collisions have sufficient energy to react/are above the activation energy;	3 1 1 1

9.7 ESSENTIAL EXAM QUESTIONS Paper 2 Topic 7.1 & 7.2 12marks

Q# 1/ iGCSE Chemistry/2018/w/Paper 23/

14 Dilute hydrochloric acid reacts with 1 g of limestone.

Which conditions produce the fastest rate of reaction?

A 2 mol/dm^3 hydrochloric acid and a single lump of limestone

B 4 mol/dm^3 hydrochloric acid and a single lump of limestone

C 4 mol/dm^3 hydrochloric acid and small pieces of limestone

D 4 mol/dm^3 hydrochloric acid and powdered limestone

Q# 2/ iGCSE Chemistry/2018/w/Paper 22/

14 The rate of reaction between magnesium ribbon and 2 mol/dm^3 hydrochloric acid at 25 °C to produce hydrogen gas is measured.

In another experiment, either the concentration of the hydrochloric acid or the temperature is changed. All other conditions are kept the same.

Which conditions increase the rate of reaction?

A 1 mol/dm^3 hydrochloric acid at 25 °C

B 2 mol/dm^3 hydrochloric acid at 10 °C

C 2 mol/dm^3 hydrochloric acid at 20 °C

D 3 mol/dm^3 hydrochloric acid at 25 °C

Q# 3/ iGCSE Chemistry/2018/w/Paper 21/

14 The effects of a change in conditions on a chemical reaction are listed.

1 The total number of collisions per minute increased.

2 The number of effective collisions per minute increased.

3 The average energy of the particles increased.

Which change in conditions caused all of these effects?

A addition of a catalyst

B increasing the concentration of a solution of a reactant

C increasing the surface area of a solid reactant

D increasing the temperature

Q# 4/ iGCSE Chemistry/2018/s/Paper 21/

14 Which row describes the effects of increasing both concentration and temperature on the collisions between reacting particles?

	increasing concentration	increasing temperature
A	more collisions per second only	more collisions per second only
B	more collisions per second and more collisions with sufficient energy to react	more collisions per second only
C	more collisions per second only	more collisions per second and more collisions with sufficient energy to react
D	more collisions per second and more collisions with sufficient energy to react	more collisions per second and more collisions with sufficient energy to react

Q# 5/ iGCSE Chemistry/2018/m/Paper 22/

15 A student adds dilute hydrochloric acid at two different temperatures to two different lumps of limestone. The lumps of limestone have the same mass.

The carbon dioxide gas produced is collected in a gas syringe.

The volume of carbon dioxide collected in 1 minute at each temperature is shown.

temperature / °C	volume of carbon dioxide produced in 1 minute / cm^3
25	10
50	40

Which row describes and explains the results obtained at 50 °C compared with 25 °C?

	reaction rate	energy of collisions
A	higher	lower
B	higher	higher
C	lower	lower
D	lower	higher

Q# 6/ iGCSE Chemistry/2017/w/Paper 23/

15 Which statement about the effect of concentration and temperature on the rate of a reaction is **not** correct?

A If the concentration of a reactant is increased, the rate of reaction increases because more particles have sufficient energy to react.

B If the concentration of a reactant is increased, the rate of reaction increases because there are more collisions between particles per second.

C If the temperature is increased, the rate of reaction increases because there are more collisions between particles per second.

D If the temperature is increased, the rate of reaction increases because more particles have sufficient energy to react.

Q# 7/ iGCSE Chemistry/2017/w/Paper 22/

15 Four statements about the effect of increasing temperature on a reaction are shown.

1 The activation energy becomes lower.

2 The particles move faster.

3 There are more collisions between reacting particles.

4 There are more collisions which have energy greater than the activation energy.

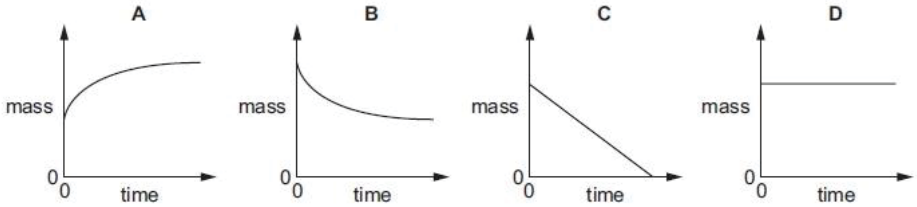
Which statements are correct?

A 1, 2 and 3 **B** 1, 3 and 4 **C** 2, 3 and 4 **D** 2 and 3 only

Q# 8/ iGCSE Chemistry/2017/w/Paper 21/

13 The mass of a beaker and its contents is plotted against time.

Which graph represents what happens when sodium carbonate reacts with an excess of dilute hydrochloric acid in an open beaker?



Q# 9/ iGCSE Chemistry/2017/s/Paper 23/

14 Which changes are physical changes?

1 melting ice to form water

2 burning hydrogen to form water

3 adding sodium to water

4 boiling water to form steam

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

Q# 10/ iGCSE Chemistry/2017/s/Paper 22/

14 A gas is produced when calcium carbonate is heated.

Which type of change is this?

A chemical

B exothermic

C physical

D separation

Q# 11/ iGCSE Chemistry/2017/s/Paper 21/

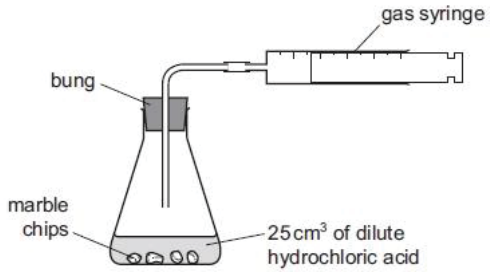
14 When sulfur is heated it undergoes a .....1..... change as it melts.

Further heating causes the sulfur to undergo a .....2..... change and form sulfur dioxide.

Which words complete gaps 1 and 2?

	1	2
A	chemical	chemical
B	chemical	physical
C	physical	chemical
D	physical	physical

15 A student was investigating the reaction between marble chips and dilute hydrochloric acid.



Which changes slow down the rate of reaction?

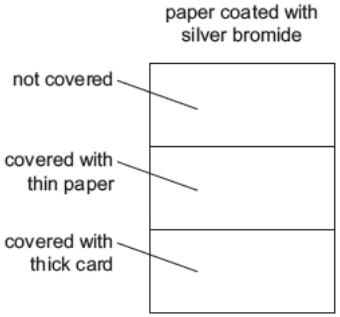
	temperature of acid	concentration of acid	surface area of marble chips
A	decrease	decrease	decrease
B	decrease	decrease	increase
C	increase	decrease	decrease
D	increase	increase	increase

9.8 ESSENTIAL EXAM QUESITONS Paper 3/4 T7.1 & 7.2 139marks

Q# 1/ iGCSE Chemistry/2015/w/Paper 31/Q7

7 The rate of a photochemical reaction is affected by light.

(b) A piece of white paper was coated with silver bromide and exposed to the light. Sections of the paper were covered as shown in the diagram.



Predict the appearance of the different sections of the paper after exposure to the light and the removal of the card. Explain your predictions.

.....

.....

.....

.....

.....

..... [4]

(c) Photosynthesis is another example of a photochemical reaction. Green plants can make simple carbohydrates, such as glucose. These can polymerise to make more complex carbohydrates, such as starch.

(i) Write a word equation for photosynthesis.

..... [2]

(ii) Name the substance which is responsible for the colour in green plants and is essential for photosynthesis.

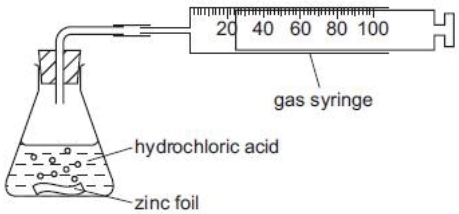
..... [1]

Q# 2/ iGCSE Chemistry/2015/s/Paper 31/

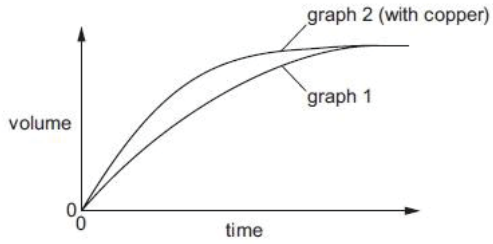
3 **(a)** The reactions between metals and acids are redox reactions.

$$Zn + 2H^+ \rightarrow Zn^{2+} + H_2$$

(b) The rate of reaction between a metal and an acid can be investigated using the apparatus shown below.



A piece of zinc foil was added to 50 cm^3 of hydrochloric acid, of concentration 2.0 mol / dm^3. The acid was in excess. The hydrogen evolved was collected in the gas syringe and its volume measured every minute. The results were plotted and labelled as graph 1.



The experiment was repeated to show that the reaction between zinc metal and hydrochloric acid is catalysed by copper. A small volume of aqueous copper(II) chloride was added to the acid before the zinc was added. The results of this experiment were plotted on the same grid and labelled as graph 2.

(i) Explain why the reaction mixture in the second experiment contains copper metal. Include an equation in your explanation.

.....

..... [2]

(ii) Explain how graph 2 shows that copper catalyses the reaction.

.....

.....

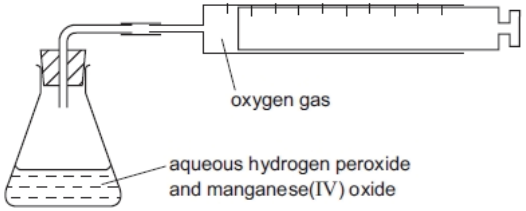
..... [3]

Q# 3/ iGCSE Chemistry/2014/s/Paper 31/

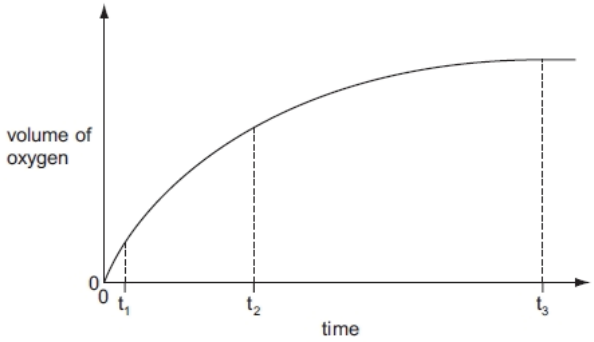
6 Hydrogen peroxide decomposes to form water and oxygen. This reaction is catalysed by manganese(IV) oxide.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

The rate of this reaction can be investigated using the following apparatus.



40 cm³ of aqueous hydrogen peroxide was put in the flask and 0.1 g of small lumps of manganese(IV) oxide was added. The volume of oxygen collected was measured every 30 seconds. The results were plotted to give the graph shown below.



(a) **(i)** How do the rates at times t_1, t_2 and t_3 differ?

.....

..... [2]

(ii) Explain the trend in reaction rate that you described in **(a)(i)**.

.....

.....

..... [2]

(b) The experiment was repeated using 0.1 g of finely powdered manganese(IV) oxide. All the other variables were kept the same.

(i) On the axes opposite, sketch the graph that would be expected. [2]

(ii) Explain the shape of this graph. .....

.....

.....

..... [2]

(c) Describe how you could show that the catalyst, manganese(IV) oxide, was not used up in the reaction. Manganese(IV) oxide is insoluble in water.

.....

.....

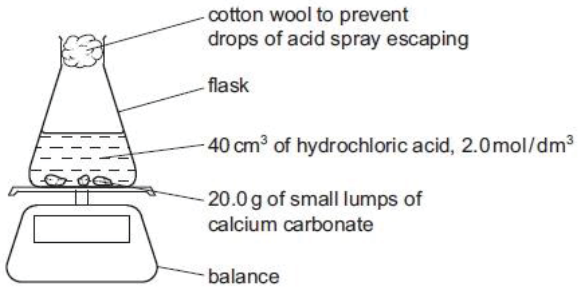
.....

.....

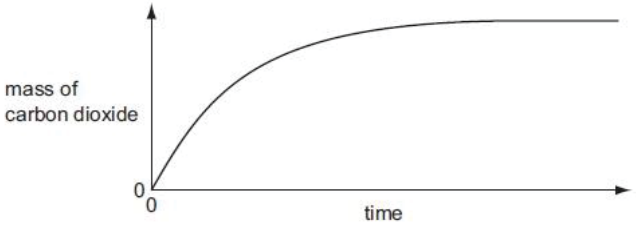
..... [4]

Q# 4/ iGCSE Chemistry/2013/w/Paper 31/

4 20.0 g of small lumps of calcium carbonate and 40 cm³ of hydrochloric acid, concentration 2.0 mol/dm³, were placed in a flask on a top pan balance. The mass of the flask and contents was recorded every minute.



The mass of carbon dioxide given off was plotted against time.



$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

In all the experiments mentioned in this question, the calcium carbonate was in excess.

(a) **(i)** Explain how you could determine the mass of carbon dioxide given off in the first five minutes.

..... [1]

(ii) Label the graph **F** where the reaction rate is the fastest, **S** where it is slowing down and **0** where the rate is zero. [2]

(iii) Explain how the shape of the graph shows where the rate is fastest, where it is slowing down and where the rate is zero.

.....

.....

..... [2]

(b) Sketch on the same graph, the line which would have been obtained if 20.0 g of small lumps of calcium carbonate and 80 cm^3 of hydrochloric acid, concentration 1.0 mol / dm^3, had been used. [2]

(c) Explain in terms of collisions between reacting particles each of the following.

(i) The reaction rate would be slower if 20.0 g of larger lumps of calcium carbonate and 40 cm^3 of hydrochloric acid, concentration 2.0 mol / dm^3, were used.

.....

.....

..... [2]

(ii) The reaction rate would be faster if the experiment was carried out at a higher temperature.

.....

.....

..... [2]

3 A small piece of marble, $CaCO_3$, was added to 5.0 cm^3 of hydrochloric acid, concentration 1.0 mol / dm^3, at 25 °C. The time taken for the reaction to stop was measured. The experiment was repeated using 5.0 cm^3 of different solutions of acids. The acid was in excess in all of the experiments.

Typical results are given in the table.

experiment	temperature / °C	acid solution	time / min
1	25	hydrochloric acid 1.0 mol / dm^3	3
2	25	hydrochloric acid 0.5 mol / dm^3	7
3	25	ethanoic acid 1.0 mol / dm^3	10
4	15	hydrochloric acid 1.0 mol / dm^3	8

(a) **(i)** Explain why it is important that the pieces of marble are the same size and the same shape.

.....

.....

..... [2]

(ii) How would you know when the reaction had stopped?

..... [1]

(c) **(i)** Explain why the reaction in experiment 1 is faster than the reaction in experiment 2.

.....

..... [1]

(iii) Explain in terms of collisions between reacting particles why experiment 4 is slower than experiment 1.

.....

.....

..... [3]

Q# 6/ iGCSE Chemistry/2012/w/Paper 31/

5 Carbonyl chloride, $COCl_2$, is widely used in industry to make polymers, dyes and pharmaceuticals.

(a) Carbonyl chloride was first made in 1812 by exposing a mixture of carbon monoxide and chlorine to bright sunlight. This is a photochemical reaction.

$$CO(g) + Cl_2(g) \rightarrow COCl_2(g)$$

(i) Explain the phrase *photochemical reaction*.

.....

..... [2]

(ii) Give another example of a photochemical reaction and explain why it is important either to the environment or in industry.

.....

.....

..... [3]

Q# 7/ iGCSE Chemistry/2012/w/Paper 31/

5 Carbonyl chloride, $COCl_2$, is widely used in industry to make polymers, dyes and pharmaceuticals.

(iii) Explain why a catalyst is used.

..... [1]

Q# 8/ iGCSE Chemistry/2012/w/Paper 31/

3 The speed (rate) of a chemical reaction depends on a number of factors which include temperature and the presence of a catalyst.

(a) Reaction speed increases as the temperature increases.

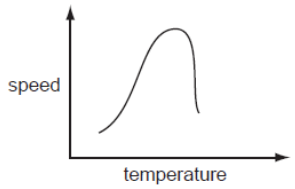
(i) Explain why reaction speed increases with temperature.

.....

.....

..... [3]

(ii) Reactions involving enzymes do not follow the above pattern.
The following graph shows how the speed of such a reaction varies with temperature.



Suggest an explanation why initially the reaction speed increases then above a certain temperature the speed decreases.

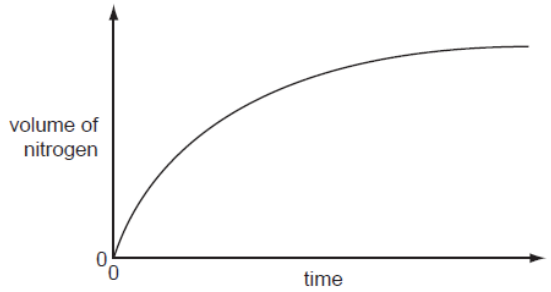
.....

..... [2]

(b) An organic compound decomposes to give off nitrogen.

$$C_6H_5N_2Cl(aq) \rightarrow C_6H_5Cl(l) + N_2(g)$$

The speed of this reaction can be determined by measuring the volume of nitrogen formed at regular intervals. Typical results are shown in the graph below.



(i) The reaction is catalysed by copper.
Sketch the graph for the catalysed reaction on the diagram above. [2]

(ii) How does the speed of this reaction vary with time?

..... [1]

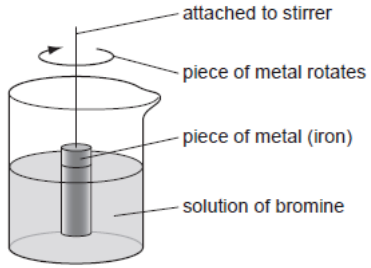
(iii) Why does the speed of reaction vary with time?

.....

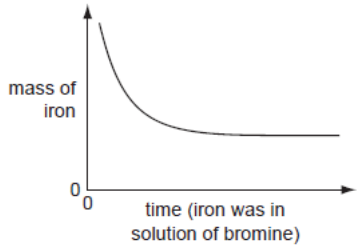
..... [2]

Q# 9/ iGCSE Chemistry/2011/w/Paper 31/

5 The rate of the reaction between iron and aqueous bromine can be investigated using the apparatus shown below.



(a) A piece of iron was weighed and placed in the apparatus. It was removed at regular intervals and the clock was paused. The piece of iron was washed, dried, weighed and replaced. The clock was restarted.
This was continued until the solution was colourless.
The mass of iron was plotted against time. The graph shows the results obtained.



(i) Suggest an explanation for the shape of the graph.

.....

.....

..... [3]

(ii) Predict the shape of the graph if a similar piece of iron with a much rougher surface had been used.
Explain your answer.

.....

..... [2]

(iii) Describe how you could find out if the rate of this reaction depended on the speed of stirring.

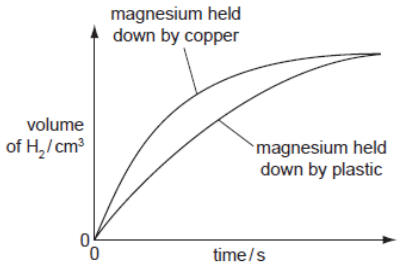
.....

.....

..... [2]

Q# 10/ iGCSE Chemistry/2010/s/Paper 31/ Q4

(b) The only difference in the two experiments was the method used to hold down the magnesium. The results are shown below.



(i) In which experiment did the magnesium react faster?

..... [1]

(ii) Suggest a reason why the experiment chosen in **(i)** had the faster rate.

..... [1]

(d) Give **two** factors which would alter the rate of this reaction.
For each factor explain why it alters the rate.

factor .....

explanation .....

.....

factor .....

explanation .....

..... [4]

Q# 11/ iGCSE Chemistry/2008/s/Paper 31/

6 Three of the factors that can influence the rate of a chemical reaction are:

- physical state of the reactants
- light
- the presence of a catalyst

(a) The first recorded dust explosion was in a flour mill in Italy in 1785. Flour contains carbohydrates. Explosions are very fast exothermic reactions.

(i) Use the collision theory to explain why the reaction between the particles of flour and the oxygen in the air is very fast.

.....

..... [2]

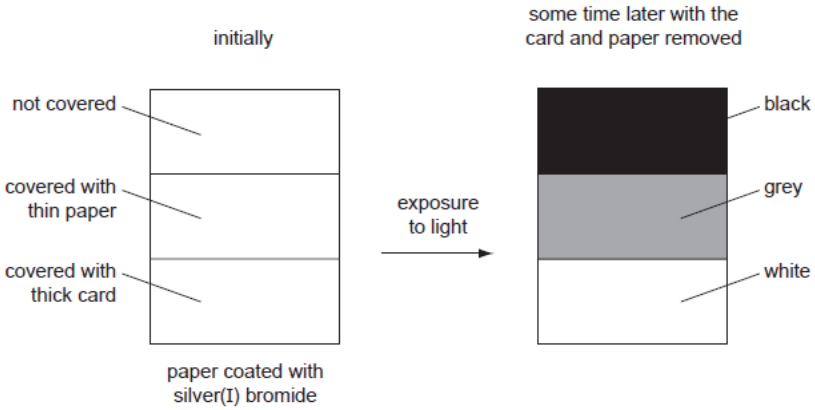
(ii) Write a word equation for this exothermic reaction.

..... [1]

The decomposition of silver(I) bromide is the basis of film photography. The equation for this decomposition is:

$$\underset{\text{white}}{2AgBr} \longrightarrow \underset{\text{black}}{2Ag} + Br_2$$

This reaction is photochemical.
A piece of white paper was coated with silver(I) bromide and the following experiment was carried out.



(b) Explain the results.

.....

.....

..... [3]

Q# 12/ iGCSE Chemistry/2007/w/Paper 3/

7 **(a)** A small piece of marble, calcium carbonate, was added to 5 cm^3 of hydrochloric acid at 25 °C. The time taken for the reaction to stop was measured.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

Similar experiments were performed always using 5 cm^3 of hydrochloric acid.

experiment	number of pieces of marble	concentration of acid in mol / dm^3	temperature / °C	time / min
1	1	1.00	25	3
2	1	0.50	25	7
3	1 piece crushed	1.00	25	1
4	1	1.00	35	2

Explain each of the following in terms of **collisions between reacting particles.**

(i) Why is the rate in experiment 2 slower than in experiment 1?

.....

..... [2]

(ii) Why is the rate in experiment 3 faster than in experiment 1?

.....

..... [2]

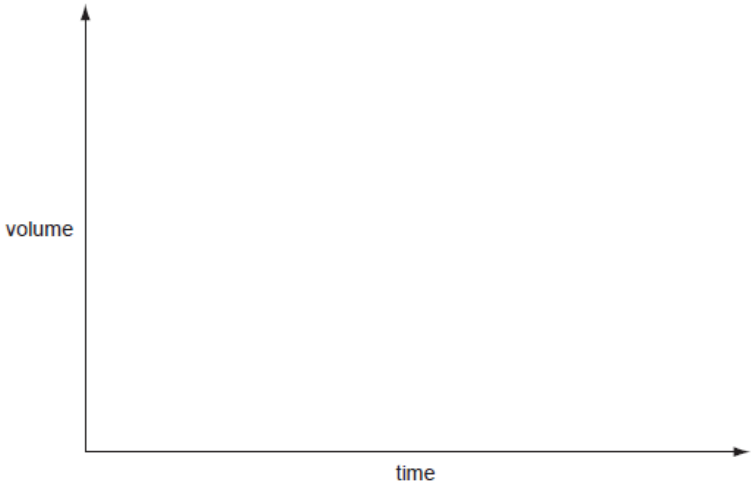
(iii) Why is the rate in experiment 4 faster than in experiment 1?

.....

..... [2]

(b) An alternative method of measuring the rate of this reaction would be to measure the volume of carbon dioxide produced at regular intervals.

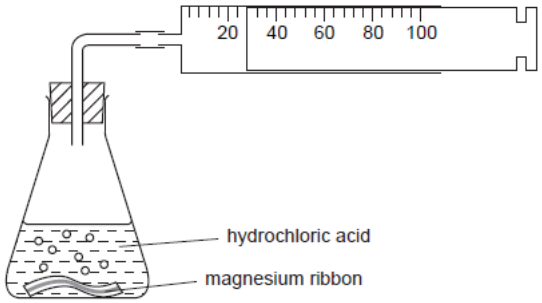
(i) Sketch this graph



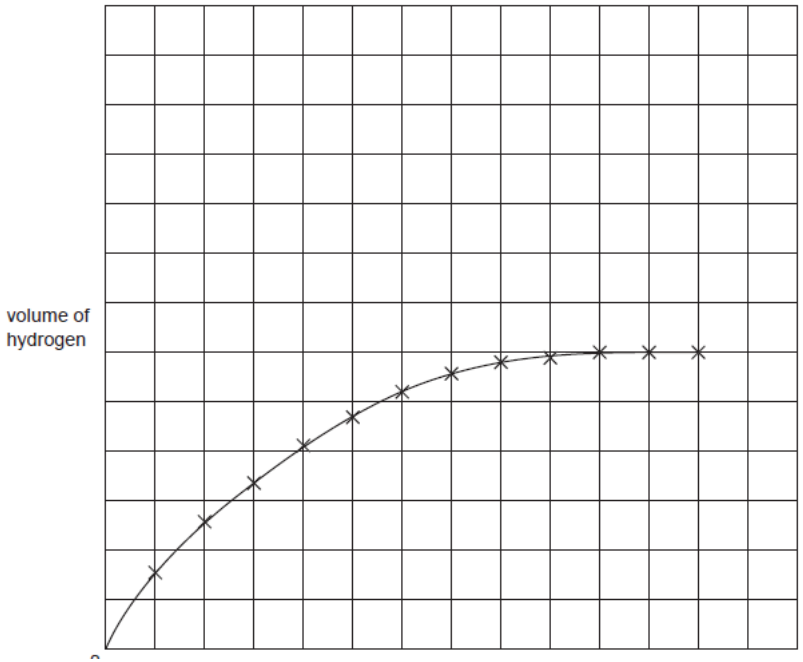
[2]

7 The rate of a reaction depends on concentration of reactants, temperature and possibly a catalyst or light.

(a) A piece of magnesium ribbon was added to 100 cm^3 of 1.0 mol/dm^3 hydrochloric acid. The hydrogen evolved was collected in a gas syringe and its volume measured every 30 seconds.



In all the experiments mentioned in this question, the acid was in excess.
The results were plotted to give a graph.



(i) The experiment was repeated. Two pieces of magnesium ribbon were added to 100 cm^3 of 1.0 mol/dm^3 hydrochloric acid. Sketch this graph on the same grid and label it X.

[2]

(ii) The experiment was repeated using one piece of magnesium ribbon and 100 cm^3 of 1.0 mol/dm^3 ethanoic acid. Describe how the **shape** of this graph would differ from the one given on the grid.

.....

..... [2]

(b) Reaction rate increases when concentration or temperature is increased.
Using the idea of reacting particles, explain why;

increasing concentration increases reaction rate,

.....

..... [2]

increasing temperature increases reaction rate.

.....

..... [2]

(c) The rate of a photochemical reaction is affected by light. A reaction, in plants, between carbon dioxide and water is photochemical.

(i) Name the **two** products of this reaction.

.....

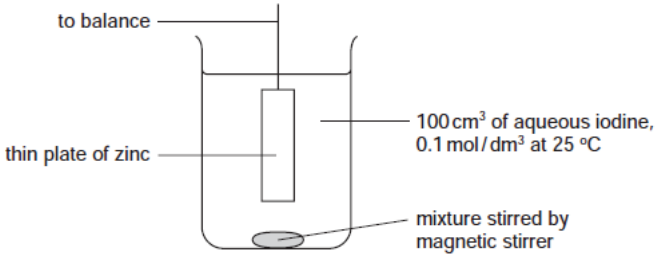
..... [2]

(ii) This reaction will only occur in the presence of light and another chemical. Name this chemical.

..... [1]

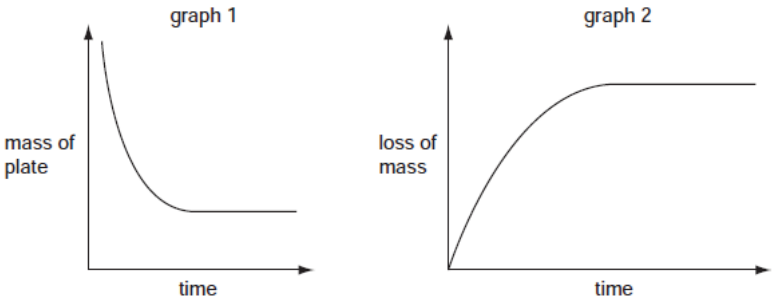
Q# 14/ iGCSE Chemistry/2005/s/Paper 3/

2 The following apparatus was used to measure the rate of the reaction between zinc and iodine.



The mass of the zinc plate was measured every minute until the reaction was complete.

(c) From the results of this experiment two graphs were plotted.



(i) Which reagent iodine or zinc was in excess? Give a reason for your choice.

..... [1]

(ii) Describe how the shape of graph 1 would change if 100cm³ of 0.05 mol/dm³ iodine had been used.

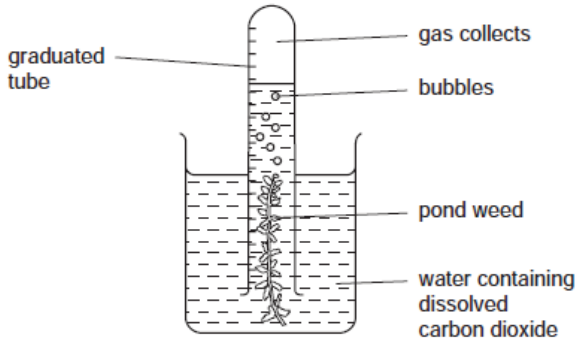
.....

..... [2]

(iii) On graph 2, sketch the shape if the reaction had been carried out using 100 cm³ of 0.1 mol/dm³ iodine at 35 °C instead of at 25 °C. [2]

Q# 15/ iGCSE Chemistry/2004/w/Paper 3/ QiGCSE Chemistry/201

(d) The rate of photosynthesis of pond weed can be measured using the following experiment.



(i) Describe how you could show that the gas collected in this experiment is oxygen.

[1]

(ii) What measurements are needed to calculate the rate of this reaction?

[2]

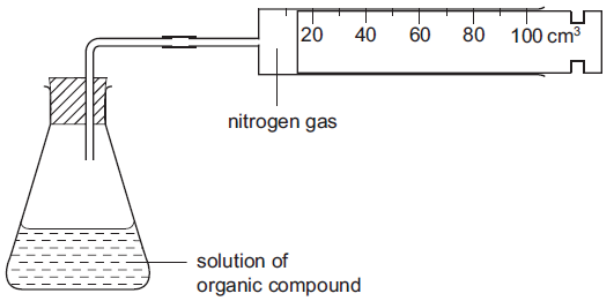
(iii) What would be the effect, and why, of moving the apparatus further away from the light?

.....

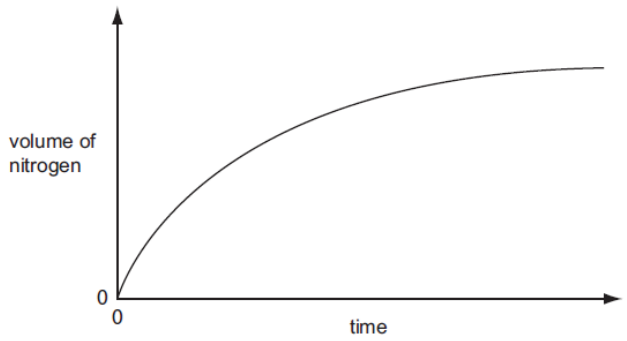
[2]

Q# 16/ iGCSE Chemistry/2004/s/Paper 3/ Q3

(c) The rate of this reaction can be measured using the following apparatus.



The results of this experiment are shown on the graph below.



(i) How does the rate of this reaction vary with time?

.....

..... [1]

(ii) Why does the rate vary?

.....

..... [2]

(iii) The reaction is catalysed by copper powder. Sketch the graph for the catalysed reaction on the same grid. [2]

(iv) Why is copper powder more effective as a catalyst than a single piece of copper?

..... [1]

Q# 17/ iGCSE Chemistry/2003/w/Paper 3/

2 Some of the factors that can determine the rate of a reaction are concentration, temperature and light intensity.

(a) A small piece of calcium carbonate was added to an excess of hydrochloric acid. The time taken for the carbonate to react completely was measured.

$$CaCO_3(s) + 2HCl(aq) \longrightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

The experiment was repeated at the same temperature, using pieces of calcium carbonate of the same size but with acid of a different concentration. In all the experiments an excess of acid was used.

concentration of acid / mol dm^{-3}	4	2	2	.....
number of pieces of carbonate	1	1	2	1
time / s	.....	80	.....	160

(i) Complete the table (assume the rate is proportional to both the acid concentration and the number of pieces of calcium carbonate). [3]

(ii) Explain why the reaction rate would increase if the temperature was increased.

.....

.....[2]

(iii) Explain why the rate of this reaction increases if the piece of carbonate is crushed to a powder.

.....[1]

(iv) Fine powders mixed with air can explode violently. Name an industrial process where there is a risk of this type of explosion.

.....

.....[1]

(b) Sodium chlorate(I) decomposes to form oxygen and sodium chloride. This is an example of a photochemical reaction. The rate of reaction depends on the intensity of the light.

$$2NaClO(aq) \longrightarrow 2NaCl(aq) + O_2(g)$$

(i) Describe how the rate of this reaction could be measured.

.....

.....[2]

(ii) How could you show that this reaction is photochemical?

.....

.....[1]

9.8.1 ESSENTIAL EXAM QUESITONS Paper 3/4 T7.1 & 7.2 139marks Mark Scheme

Q# 1/ iGCSE Chemistry/2015/w/Paper 31/

7(b)	*prediction:* the '*not covered*' section will be black; the '*covered in thick card*' section will be white/ cream; the '*covered in thin card*' section will be grey; *explanation:* the more light, the more silver ions are reduced;	 1 1 1 1
7(c)(i)	carbon dioxide + water → glucose + oxygen reactants correct; products correct;	 1 1
7(c)(ii)	chlorophyll;	1

Q# 2/ iGCSE Chemistry/2015/s/Paper 31/

3(b)(i)	zinc displaces copper or zinc more reactive than copper;		**A** copper less reactive than zinc **I** zinc reacts with copper ions or with Cu^{2+} or with copper chloride **I** zinc reacts with copper **I** Cu^{2+} ions are reduced
	$Zn + CuCl_2 \rightarrow ZnCl_2 + Cu$ **OR** $Zn + Cu^{2+} \rightarrow Cu + Zn^{2+}$;	2	**A** multiples **I** state symbols
3(b)(ii)	steeper (line) or higher gradient; (means an) increased rate;		**A** less time to complete the reaction/same amount of gas in less time/fasterreaction/ more gas in the same time period
	but the same (final) volume;	3	**A** same volume of hydrogen produced **A** 'amount' for volume **A** no extra gas is made

Q# 3/ iGCSE Chemistry/2014/s/Paper 31/

6 **(a)** **(i)** rate at t_2 less than at t_1 **or** the rate decreases (1)

rate at t_3 zero/reaction stopped (1) [2]

(ii) rate at t_2 less than at t_1 because **concentration** of hydrogen peroxide is less at t_2 **or concentration** of hydrogen peroxide is decreasing. (1)

(rate at t_3 zero/reaction stopped because) hydrogen peroxide is used up (1) [2]

(b) **(i)** steeper and must come from the origin (1)
final volumes the same (1) [2]

(ii) Any **two** from: [2]
steeper curve because of a faster rate
faster rate because of increased surface area
same amount/volume/mass/no of mol of hydrogen peroxide
ecf for M1 for a shallower curve because of slower rate.

(c) filter (and rinse/wash) (1)

dry manganese (IV) oxide (1)

weigh/measure mass manganese(IV) oxide after reaction (1)

the mass should be 0.1 g **or** unchanged. (1) [4]

Q# 4/ iGCSE Chemistry/2013/w/Paper 31/

4 **(a)** **(i)** (mass at t =0) – (mass at t = 5) [1]
NOTE: must have mass at t = 5 not final mass

(ii) fastest at origin
slowing down between origin and flat section gradient = 0
where gradrient = 0
three of above in approximately the correct positions [2]

(iii) 3 correct comments about gradient = [2]
2 correct comments about gradient = [1]
1 correct comment about gradient = [0] [2]

(b) start at origin and smaller gradient [1]
same final mass just approximate rather than exact [1]

(c) **(i)** smaller surface area [1]
lower collision rate [1]

(ii) molecules have more energy [1]
collide more frequently / more molecules have enough energy to react [1]

Q# 5/ iGCSE Chemistry/2013/s/Paper 31/

3 **(a)** **(i)** pieces have (same) surface area [1]
same amount / mass / quantity / volume / number of moles of carbonate [1]

(ii) no more bubbles / carbon dioxide **or** piece disappears / dissolves [1]

(b) experiment 1 $Ca^{2+} + CO_2 + H_2O$ [1]

(c) **(i)** more concentrated **or** higher concentration (of acid) (in experiment 1) [1]
accept: arguments based on collision theory

(iii) lower temperature (particles) have less energy [1]
moving more slowly [1]
fewer collisions / lower collision rate [1]
or
lower temperature (particles) have less energy [1]
fewer particles collide [1]
with the necessary energy to react [1]
note: less energy fewer successful collisions gains all 3 marks

Q# 6/ iGCSE Chemistry/2012/w/Paper 31/

5 **(a)** **(i)** rate of reaction; [1]
influenced by light / only happens in light; [1]
or:
turns light into chemical energy = [2]
accept: light is catalyst = [1]

(ii) reduction of silver halides; [1]
they are reduced to silver / $2AgCl \rightarrow 2Ag + Cl_2$; [1]
appropriate importance given; [1]
or:
photosynthesis;
correct comment about chemistry carbon dioxide to carbohydrates / carbon dioxide to oxygen;
anything sensible e.g. its role in the food chain or decrease greenhouse effect or oxygen for respiration;
or:
chlorination;
making chloroalkanes;
appropriate importance given;

Q# 7/ iGCSE Chemistry/2012/w/Paper 31/ Q5

(iii) keeps rate high / increase rate at lower temperatures; [1]

Q# 8/ iGCSE Chemistry/2012/w/Paper 31/

3 (a) (i) any three from:
particles have more energy;
move faster;
collide more frequently;
more successful collisions; [3]
accept: atoms or molecules for particles
not: electrons
not: vibrate more

(ii) reaction faster with temperature increase; [1]
enzymes denatured / destroyed;
not: killed [1]

(b) (i) bigger initial gradient; [1]
same final volume of nitrogen; [1]

(ii) decrease / slows down; [1]

(iii) concentration of organic compound decreases; [2]
compound used up = [1]
or: fewer particles;
collision rate decreases;

Q# 9/ iGCSE Chemistry/2011/w/Paper 31/

5 (a) (i) rate of reaction decreases / gradient decreases [1]
because concentration of bromine decreases [1]
reaction stops because all bromine is used up [1]

(ii) initial rate greater / gradient greater [1]
because bigger surface area / more particles of iron exposed [1]
or:
final mass the same [1]
because mass of bromine is the same so the same mass of iron is used [1]

(iii) increase / decrease / change rate of stirring / not stirred [1]
measure new rate / compare results [1]

Q# 10/ iGCSE Chemistry/2010/s/Paper 31/ Q4

(b) (i) with copper / first experiment [1]

(ii) copper acts as a catalyst [1]

(d) temperature / heat [1]
increase temperature – reaction faster particles have more energy / particles move faster / particles collide more frequently / more particles have enough energy to react
not more excited
accept arguments for a decrease in temperature [1]

powdered
greater surface area
greater collision rate / more particles exposed (to acid)
any **two** [2]
not concentration / light / catalyst / pressure

Q# 11/ iGCSE Chemistry/2008/s/Paper 31/

6 (a) (i) (fine powder) large surface area [1]
high/faster/collision rate/more collisions/fast collisions
(between solid and oxygen in air) [1]

(ii) carbohydrate + oxygen → carbon dioxide + water [1]
ACCEPT flour

(b) rate depends on light
more light more silver **or** blacker
thicker card less light [3]

Q# 12/ iGCSE Chemistry/2007/w/Paper 3/

7 (a) (i) lower concentration [1]
ACCEPT without reference to experiment 2
but higher concentration must be referred to expt 1
COND fewer collisions **or** lower rate of collision [1]

(ii) powdered so larger surface area [1]
COND so more collisions **or** higher rate of collisions [1]

(iii) higher temperature particles move faster
or more particles have enough energy to react **or** have more energy
or more particles have Ea [1]
COND collide more frequently
or more particles have energy to react
or more collisions result in a reaction [1]
NOTE for conformity faster collisions = rate of collisions

(b) (i) from origin [1]
gradient decreases until = 0 [1]
therefore has to be a curve

Q# 13/ iGCSE Chemistry/2006/w/Paper 3/

7 (a) (i) greater initial slope or levels off later [1]
Twice final volume [1]

(ii) smaller slope [1]
same final volume [1]

(b) more particles in same volume/particles closer together [1]
greater collision rate [1]

molecules move faster [1]
greater collision rate [1]

OR molecules have more energy [1]
so more will have sufficient energy to react [1]

(c) (i) glucose [1]
oxygen [1]

(ii) chlorophyll [1]

Q# 14/ iGCSE Chemistry/2005/s/Paper 3/ Q2

(c) (i) zinc and a reason **[1]**
Do not mark conseq to iodine in excess

(ii) final mass of zinc bigger **or** the level section higher **or** less zinc used up **[1]**
gradient less steep **or** longer time **or** falls more slowly **[1]**

(iii) steeper gradient **[1]**
same loss of mass of zinc **[1]**

Q# 15/ iGCSE Chemistry/2004/w/Paper 3/ QiGCSE Chemistry/201

(d) (i) glowing splint burst into flame or rekindled **[1]**
Must have glowing or equivalent idea
OR any similar description that includes the two points glowing and relights.

(ii) measure volume **or** count bubbles **[1]**
time **[1]**
NOT units

(iii) rate slows down **[1]**
Because the reaction is photochemical **or** rate depends on intensity of light **or** light less bright or less light falling on plant **or** light provides energy for photosynthesis etc. **[1]**

Q# 16/ iGCSE Chemistry/2004/s/Paper 3/ Q3

(c) (i) decreases **or** reaction stops **or** rate becomes zero **[1]**

(ii) concentration **or** number of effective collisions **[1]**
decreases **[1]**
used up **or** less chemical **or** less collisions etc **[1]** only

(iii) greater initial slope **[1]**
same final point **[1]**
as long as new curve touches the original curve near the top allocate the mark

(iv) greater surface area **[1]**

Q# 17/ iGCSE Chemistry/2003/w/Paper 3/

2 (a) (i) 40 [1]
80 **or** 40 [1]
1 [1]
(ii) particles have more energy **or** moving faster [1]
collide more frequently
or collide with more energy [1]
(iii) greater surface area [1]
(iv) flour mills **or** coal mines **or** metal powders [1]
or fireworks **or** gunpowder

(b) (i) collect and measure volume of oxygen [1]
or mass **or** count bubbles
time [1]
(ii) measure rate in different light levels and comment [1]
accept if dark no reaction

9.9 ESSENTIAL EXAM QUESTIONS Paper 6 Topic 7.1 and 7.2 151marks

Q# 1/ iGCSE Chemistry/2018/w/Paper 62/Q2

2 A student investigated the rate of reaction between solution **L**, solution **M** and hydrochloric acid. When these chemicals react they form iodine. Sodium thiosulfate solution and starch solution were used to show how fast the reaction proceeded.

Five experiments were done.

Experiment 1

- A measuring cylinder was used to add 10 cm^3 of solution **L** to a conical flask.
- 10 cm^3 of dilute hydrochloric acid, 10 cm^3 of sodium thiosulfate solution and 1 cm^3 of starch solution were then added to the conical flask.
- The reaction was started by using a measuring cylinder to add 10 cm^3 of solution **M** to the conical flask. A timer was started immediately and the mixture was swirled.
- The time taken for the mixture to turn blue-black was measured.
- The conical flask was emptied and rinsed with distilled water.

Experiment 2

- A measuring cylinder was used to add 8 cm^3 of solution **L** and 2 cm^3 of distilled water to the conical flask.
- 10 cm^3 of dilute hydrochloric acid, 10 cm^3 of sodium thiosulfate solution and 1 cm^3 of starch solution were then added to the conical flask.
- The reaction was started by using a measuring cylinder to add 10 cm^3 of solution **M** to the conical flask. The timer was started immediately and the mixture was swirled.
- The time taken for the mixture to turn blue-black was measured.
- The conical flask was emptied and rinsed with distilled water.

Experiment 3

- Experiment 2 was repeated but 6 cm^3 of solution **L** and 4 cm^3 of distilled water were added to the conical flask before adding the other reagents.

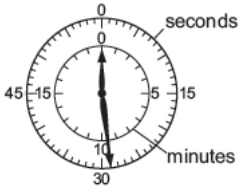
Experiment 4

- Experiment 2 was repeated but 5 cm^3 of solution **L** and 5 cm^3 of distilled water were added to the conical flask before adding the other reagents.

Experiment 5

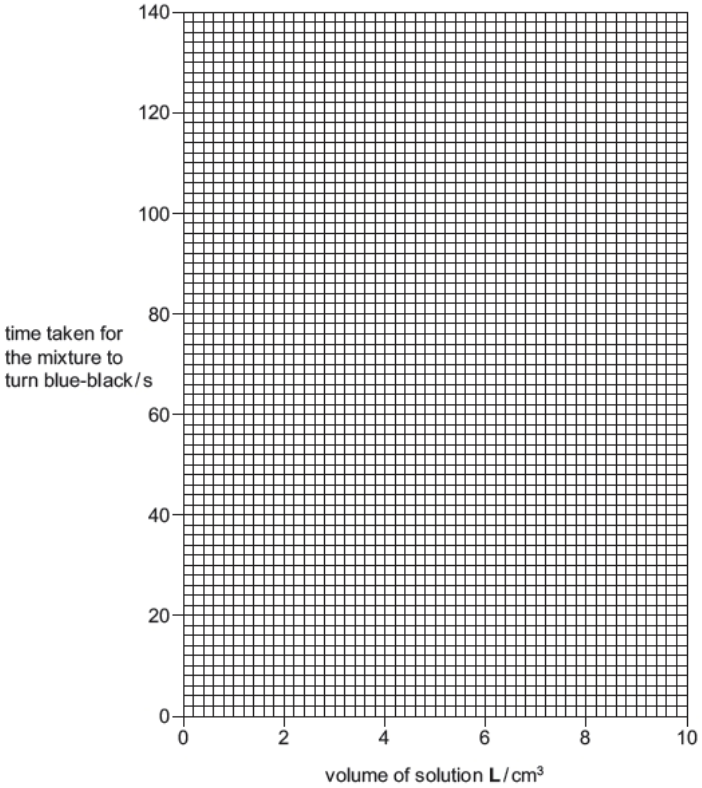
- Experiment 2 was repeated but 3 cm^3 of solution **L** and 7 cm^3 of distilled water were added to the conical flask before adding the other reagents.

(a) Use the stop-clock diagrams to record the time taken for each experiment in the table.

experiment number	volume of solution **L** / cm³	volume of distilled water / cm³	stop-clock diagram	time taken for the mixture to turn blue-black / s
1	10	0		
2	8	2		
3	6	4		
4	5	5		
5	3	7		

[4]

(b) Plot the results for Experiments 1–5 on the grid. Draw a smooth line graph.



[4]

(c) **From your graph**, deduce the time taken for the mixture to turn blue-black if Experiment 2 were repeated using 4 cm³ of solution **L** and 6 cm³ of distilled water.

Show clearly **on the grid** how you worked out your answer.

..... [3]

(d) (i) In which experiment, 1, 2, 3, 4 or 5, was the rate of reaction greatest?

..... [1

(ii) Explain, in terms of particles, why the rate of reaction was greatest in this experiment.

.....

.....

..... [2

(e) (i) Suggest an advantage of using a graduated pipette instead of a measuring cylinder to measure solution **L**.

..... [1

(ii) Suggest and explain a disadvantage of using a graduated pipette instead of a measuring cylinder to measure solution **M**.

.....

..... [2

(f) Suggest **one** way to improve the reliability of the results of these experiments.

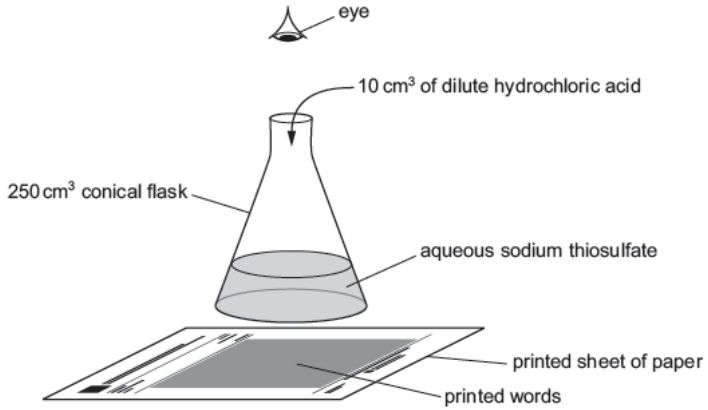
..... [1

[Total: 18

Q# 2/ iGCSE Chemistry/2018/s/Paper 61/Q2

2 A student investigated the rate of reaction between dilute hydrochloric acid and aqueous sodium thiosulfate. When these chemicals react they form a precipitate which makes the solution go cloudy. The formation of this precipitate can be used to show how fast the reaction proceeds.

Five experiments were done using the apparatus shown.



Experiment 1

- A large measuring cylinder was used to pour 50 cm³ of aqueous sodium thiosulfate into a 250 cm³ conical flask. The conical flask was placed on a printed sheet of paper.
- 10 cm³ of dilute hydrochloric acid was added to the solution in the conical flask. A timer was started immediately and the mixture was swirled.
- The time taken for the printed words to disappear from view was measured.

Experiment 2

- The large measuring cylinder was used to pour 40 cm³ of aqueous sodium thiosulfate into a conical flask, followed by 10 cm³ of distilled water. The conical flask was placed on the printed sheet of paper.
- 10 cm³ of dilute hydrochloric acid was added to the solution in the conical flask. The timer was started immediately and the mixture was swirled.
- The time taken for the printed words to disappear from view was measured.

Experiment 3

- Experiment 2 was repeated but using 35 cm³ of aqueous sodium thiosulfate and 15 cm³ of distilled water.

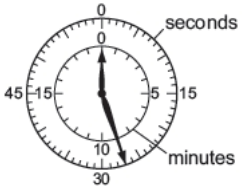
Experiment 4

- Experiment 2 was repeated but using 30 cm³ of aqueous sodium thiosulfate and 20 cm³ of distilled water.

Experiment 5

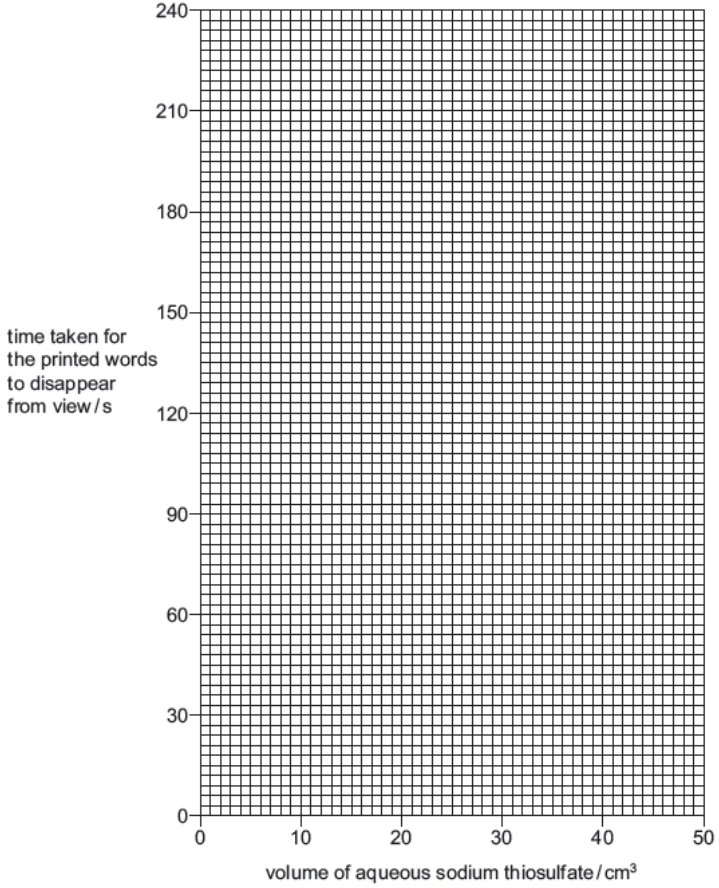
- Experiment 2 was repeated but using 10 cm³ of aqueous sodium thiosulfate and 40 cm³ of distilled water.

(a) Record the volumes of distilled water used in the table. Use the stop-clock diagrams to record the results in the table.

experiment	volume of aqueous sodium thiosulfate / cm³	volume of distilled water / cm³	stop-clock diagram	time taken for the printed words to disappear from view / s
1	50			
2	40			
3	35			
4	30			
5	10			

[3]

(b) Plot the results from Experiments 1–5 on the grid. Draw a smooth line graph.



[3]

(c) **(i)** **From your graph**, deduce the time taken for the printed words to disappear from view if Experiment 2 were repeated using 20 cm³ of aqueous sodium thiosulfate and 30 cm³ of distilled water.

Show clearly **on the grid** how you worked out your answer.

..... s [2]

(ii) The rate of reaction can be calculated using the equation shown.

$$\text{rate of reaction} = \frac{1}{\text{time taken}}$$

Calculate the rate of reaction using your answer from **(c)(i)**.

..... [1]

(d) (i) In which experiment, 1, 2, 3, 4 or 5, was the rate of reaction greatest?

..... [1]

(ii) Explain, in terms of particles, why the rate of reaction was greatest in this experiment.

.....

.....

..... [2]

(e) Give the name of a more accurate piece of apparatus for measuring volumes than a measuring cylinder.

..... [1]

(f) Suggest the effect on the results of using a 100 cm^3 conical flask instead of a 250 cm^3 conical flask. Explain your answer.

.....

..... [2]

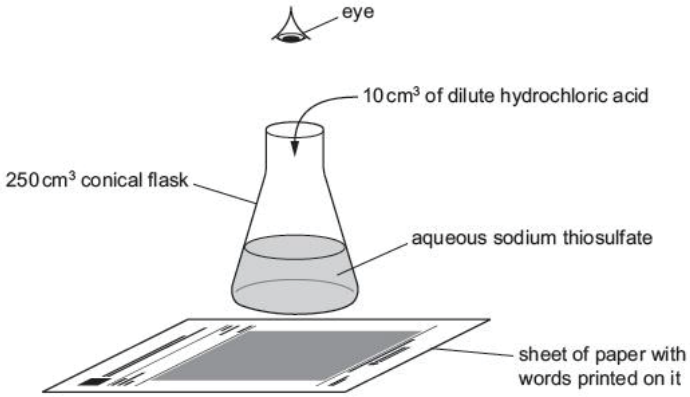
(g) Sketch **on the grid** the graph you would expect if all of the experiments were repeated at a **lower** temperature. Clearly label your graph. [1]

[Total: 16]

Q# 3/ iGCSE Chemistry/2017/w/Paper 61/Q2

2 A student investigated the rate of reaction between dilute hydrochloric acid and aqueous sodium thiosulfate. When these chemicals react they form a precipitate which makes the solution go cloudy. The formation of this precipitate can be used to show how fast the reaction proceeds.

Five experiments were carried out using the apparatus shown.



Experiment 1

- Using a measuring cylinder, 50 cm^3 of aqueous sodium thiosulfate were poured into a conical flask. The initial temperature of the solution was measured. The conical flask was placed on a sheet of paper with words printed on it.
- Using a measuring cylinder, 10 cm^3 of dilute hydrochloric acid were added to the solution in the conical flask and a stopclock was started.
- The time taken for the printed words to disappear from view was measured.
- The final temperature of the mixture was measured.

Experiment 2

- Using a measuring cylinder, 50 cm^3 of aqueous sodium thiosulfate were poured into a conical flask. The solution was heated to about **30 °C** and the temperature was measured. The conical flask was placed on a sheet of paper with words printed on it.
- Using a measuring cylinder, 10 cm^3 of dilute hydrochloric acid were added to the solution in the conical flask and a stopclock was started.
- The time taken for the printed words to disappear from view was measured.
- The final temperature of the mixture was measured.

Experiment 3

- Experiment 2 was repeated but the 50 cm^3 of aqueous sodium thiosulfate were heated to about **40 °C** before adding the dilute hydrochloric acid.

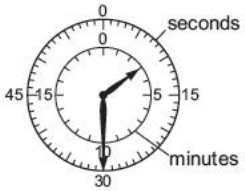
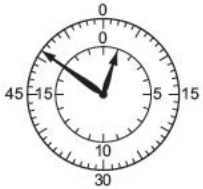
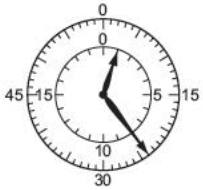
Experiment 4

- Experiment 2 was repeated but the 50 cm^3 of aqueous sodium thiosulfate were heated to about **50 °C** before adding the dilute hydrochloric acid.

Experiment 5

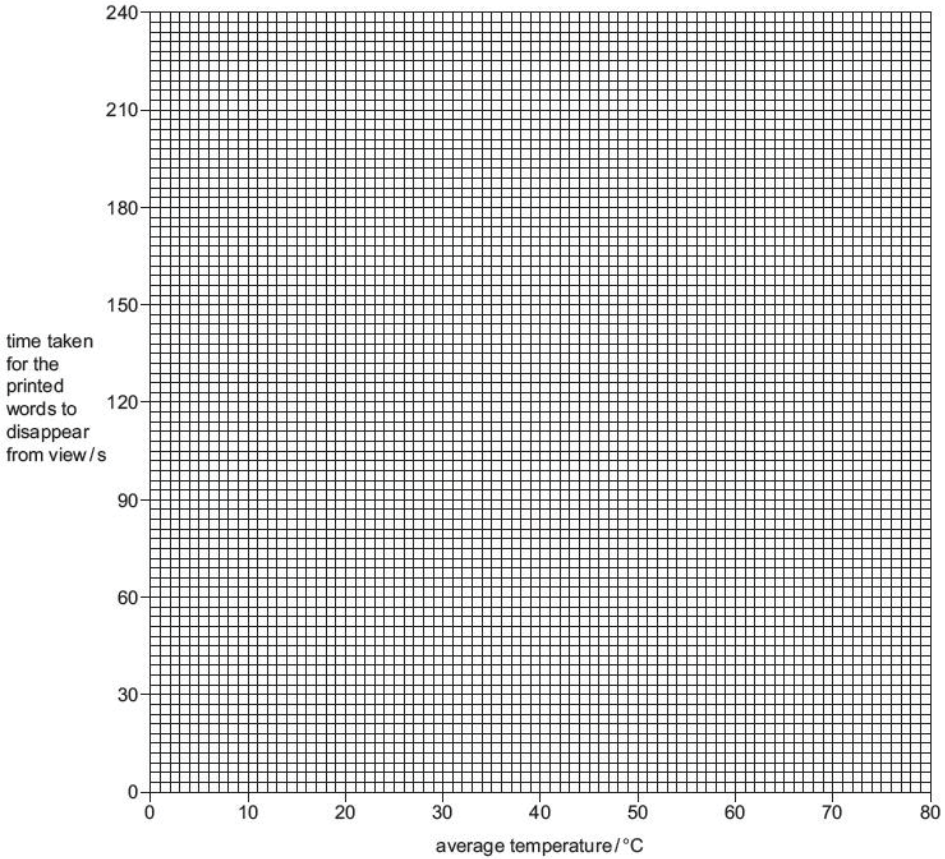
- Experiment 2 was repeated but the 50 cm^3 of aqueous sodium thiosulfate were heated to about **60 °C** before adding the dilute hydrochloric acid.

(a) Calculate the average temperatures and record them in the table.
Use the stopclock diagrams to record the times in the table.

experiment number	initial temperature of the solution / °C	final temperature of the mixture / °C	average temperature / °C	stopclock diagram	time taken for the printed words to disappear from view / s
1	19	17			
2	32	30			
3	42	40			
4	54	52			
5	65	61			

[3]

(b) Plot the results of Experiments 1–5 on the grid. Draw a smooth line graph.



[4]

(c) **From your graph**, deduce the time taken for the printed words to disappear from view when Experiment 2 was repeated at an initial temperature of 73 °C. The final temperature of the mixture was 71 °C.

Show clearly **on the grid** how you worked out your answer.

..... [3]

(d) Sketch **on the grid** the graph you would expect if all of the experiments were repeated using a more dilute solution of aqueous sodium thiosulfate. [1]

(e) **(i)** In which experiment, 1, 2, 3, 4 or 5, was the rate of reaction greatest?

..... [1]

(ii) Explain, in terms of particles, why the rate of reaction was greatest in this experiment.

.....

.....

.....

..... [2]

(f) Suggest and explain the effect on the results of using

(i) a burette to measure the volumes,

.....

.....

..... [2]

(ii) a 100 cm^3 conical flask instead of a 250 cm^3 conical flask.

.....

.....

..... [2]

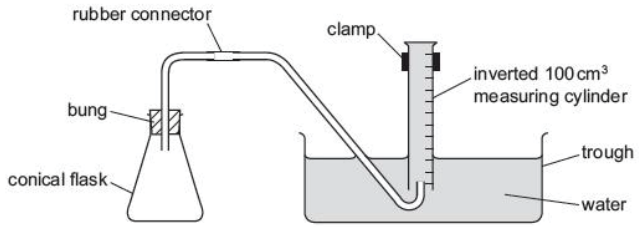
Q# 4/ iGCSE Chemistry/2017/s/Paper 63/Q2

2 A student investigated the rate of reaction between magnesium ribbon and two different solutions of dilute sulfuric acid, solution **G** and solution **H**. The acid was in excess in both experiments.

Two experiments were carried out.

Experiment 1

- The apparatus was set up as shown in the diagram.



- Using a measuring cylinder, 50 cm^3 of solution **G** were poured into the conical flask. A piece of magnesium ribbon was added to the conical flask and the bung replaced.
- The timer was started immediately and the total volume of gas collected in the measuring cylinder was measured every 20 seconds for 180 seconds (3 minutes).

Experiment 2

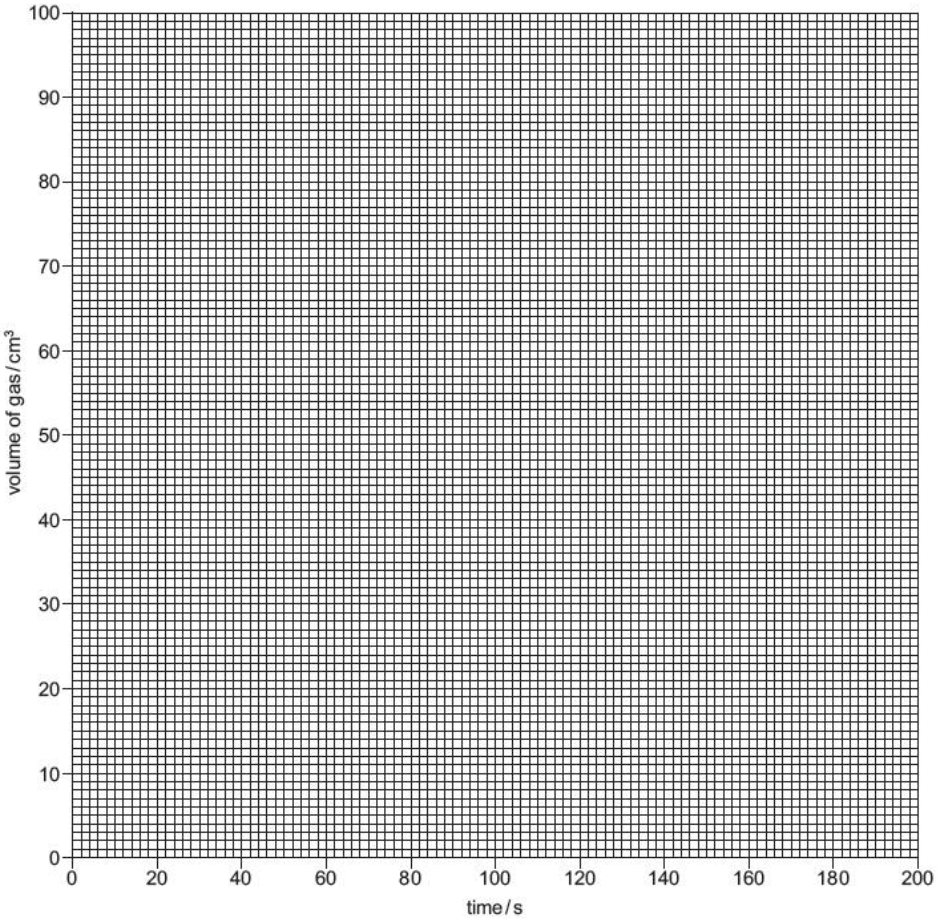
- Experiment 1 was repeated using 50 cm^3 of solution **H** instead of solution **G**.

(a) Use the measuring cylinder diagrams to record the volumes of gas collected in Experiment 1.

	Experiment 1		Experiment 2
time / s	measuring cylinder diagram	volume of gas / cm^3	volume of gas / cm^3
0			0
20			8
40			14
60			21
80			27
100			33
120			39
140			45
160			50
180			55

[3]

(b) Plot the results for Experiments 1 and 2 on the grid and draw **two** smooth line graphs. Clearly label your graphs.



[4]

(c) Which experiment had the faster rate of reaction? Suggest a reason why the rate was faster in this experiment.

.....

..... [2]

(d) The average rate of this reaction can be calculated using the equation shown.

$$\text{average rate} = \frac{\text{volume of gas / cm}^3}{\text{time taken / s}}$$

For Experiment 1, calculate the average rate of reaction for the first 30 seconds of the reaction. Include the units.

rate = ...

units = ...

[3]

(e) Why, eventually, will no more gas be produced?

..... [1]

(f) Suggest the effect on the rate of reaction of using the same mass of magnesium powder instead of magnesium ribbon. Explain your answer.

.....

.....

..... [2]

(g) Give **one** advantage and **one** disadvantage of using a measuring cylinder to measure the volumes of solution **G** and solution **H**.

advantage .....

disadvantage .....

[2]

(h) Suggest **one** improvement to these experiments.

.....

..... [1]

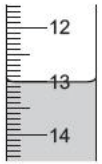
2 A student investigated the reaction between aqueous potassium manganate(VII), solution **A**, and two solutions of iron(II) sulfate, solution **B** and solution **C**, of different concentrations.

Two experiments were carried out.

Experiment 1

- A burette was filled with solution **A** to the 0.0 cm^3 mark.
- A measuring cylinder was used to pour 25 cm^3 of solution **B** into a conical flask.
- Solution **A** was added to the flask, while the flask was swirled, until the mixture just turned permanently pink. The burette reading was recorded.

(a) Use the burette diagram to record the reading in the table and complete the table.



final reading

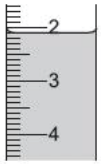
final burette reading / cm^3	
initial burette reading / cm^3	
difference / cm^3	

[2]

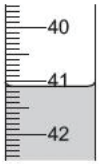
Experiment 2

- Experiment 1 was repeated using 25 cm^3 of solution **C** instead of solution **B**. In Experiment 2 the burette was not filled to the 0.0 cm^3 mark.

(b) Use the burette diagrams to record the readings in the table and complete the table.



initial reading



final reading

final burette reading / cm^3	
initial burette reading / cm^3	
difference / cm^3	

[2]

(c) Why is an indicator **not** added to the conical flask?

..... [1]

(d) (i) Which solution of iron(II) sulfate, solution **B** or solution **C**, is the more concentrated? Explain your answer.

.....

..... [2]

(ii) How many times more concentrated is this solution of iron(II) sulfate?

..... [1]

(e) (i) If Experiment 2 were repeated using 50 cm^3 of solution **C**, what volume of solution **A** would be needed? Explain your answer.

.....

..... [2]

(ii) Suggest a practical problem that using 50 cm^3 of solution **C** in this investigation would cause. Suggest a practical solution to the problem.

problem .....

solution .....

[2]

(f) Give **one** advantage and **one** disadvantage of using a measuring cylinder instead of a 25 cm^3 pipette for solution **B**.

advantage .....

disadvantage .....

[2]

(g) How would the results be improved by taking repeated measurements?

.....

..... [1]

Q# 6/ iGCSE Chemistry/2017/s/Paper 61/Q2

2 A student investigated the reaction between aqueous sodium thiosulfate and two different aqueous solutions of potassium iodate labelled solution **C** and solution **D**.

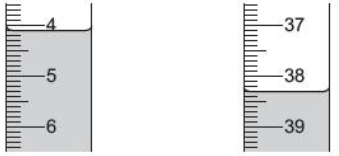
Two experiments were carried out.

Experiment 1

- A burette was filled with aqueous sodium thiosulfate. The initial burette reading was recorded.
- Using a measuring cylinder, 20 cm^3 of solution **C** were poured into a conical flask. 10 cm^3 of dilute sulfuric acid and 1 g of potassium iodide were added to the flask to form a solution of iodine. The flask was swirled to mix the contents.

- Aqueous sodium thiosulfate was slowly added from the burette to the flask and swirled to mix thoroughly.
- When the contents of the flask turned pale yellow, starch solution was added and the solution turned blue-black.
- More aqueous sodium thiosulfate was then added slowly to the flask until the solution just turned colourless. The final burette reading was recorded.

(a) Use the burette diagrams to record the readings in the table and complete the table.



initial reading final reading

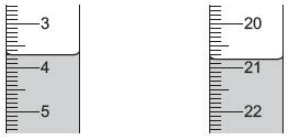
final burette reading / cm^3	
initial burette reading / cm^3	
difference / cm^3	

[2]

Experiment 2

- The conical flask was emptied and rinsed with distilled water.
- Experiment 1 was repeated using solution **D** instead of solution **C**.

(b) Use the burette diagrams to record the readings in the table and complete the table.



initial reading final reading

final burette reading / cm^3	
initial burette reading / cm^3	
difference / cm^3	

[2]

(c) **(i)** Which solution of potassium iodate, solution **C** or solution **D**, is the more concentrated? Explain your answer.

.....

..... [2]

(ii) How many times more concentrated is this solution of potassium iodate?

..... [1]

(d) Predict the volume of aqueous sodium thiosulfate which would be needed to react completely with 30 cm^3 of solution **D**.

.....

..... [2]

(e) **(i)** State **two** sources of error in the experiments.

1. .....

2. .....

[2]

(ii) Suggest **two** improvements to reduce the sources of error in **(e)(i)**.

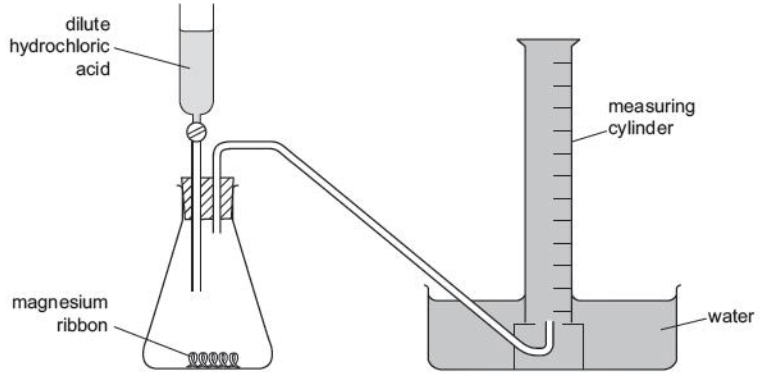
1. .....

2. .....

[2]

Q# 7/ iGCSE Chemistry/2016/w/Paper 62/Q2

2 A student investigated the rate of reaction between dilute hydrochloric acid and excess magnesium at room temperature.
The apparatus was set up as shown in the diagram.



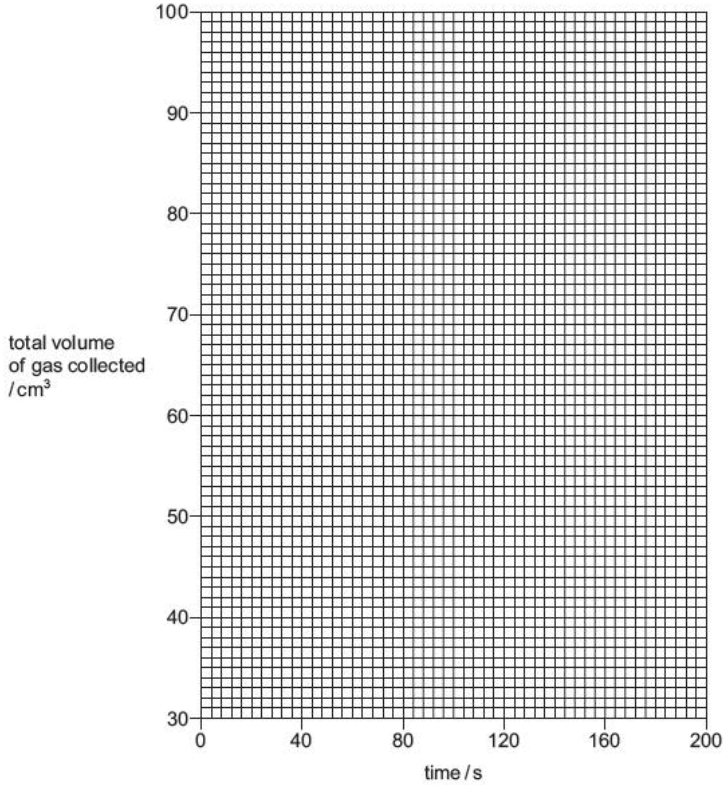
30 cm^3 of dilute hydrochloric acid were added to the conical flask containing magnesium ribbon. The timer was then started and the volume of gas collected in the measuring cylinder was measured every 20 seconds for 180 seconds (3 minutes).

(a) Use the measuring cylinder diagrams to record the total volume of gas collected in the table.

time / s	measuring cylinder diagram	total volume of gas collected / cm^3
0		30
20		
40		
60		
80		
100		
120		
140		
160		
180		

[2]

(b) Plot the results on the grid and draw a smooth line graph.



[3]

(c) **(i)** Which result is anomalous?

..... [1]

(ii) Suggest a possible reason for this anomalous result.

..... [1]

(iii) **Use your graph** to deduce the total volume of gas that you would have expected to collect instead of this anomalous volume.
Show clearly **on the grid** how you worked out your answer.

..... cm^3 [2]

(d) Explain why the total volume of gas collected does **not** increase after 160 seconds.

.....

..... [2]

(e) The average rate of the reaction can be calculated using the equation shown.

$$\text{average rate of reaction} = \frac{\text{volume of gas collected / cm}^3}{\text{time / s}}$$

(i) Calculate the volume of gas collected between 20 seconds and 40 seconds.

..... [1]

(ii) Calculate the average rate of reaction between 20 seconds and 40 seconds.
Include the unit.

average rate of reaction = ... [2]

(f) Room temperature was 20 °C.

Sketch **on the grid** the graph you would expect if the experiment were repeated at 30 °C. [2]

(g) Suggest why the reading on the measuring cylinder was 30 cm^3 after the acid had been added and before the timer had been started.

.....

..... [1]

(h) Suggest and explain **one** improvement to this experiment.

.....

.....

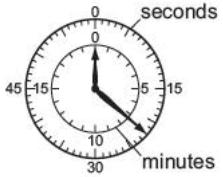
..... [2]

Q# 8/ iGCSE Chemistry/2016/s/Paper 62/Q2

2 A student investigated the rate of reaction between hydrogen peroxide and aqueous potassium iodide. When these chemicals react they form iodine. Sodium thiosulfate solution reacts with iodine and can be used to show how fast the reaction proceeds.

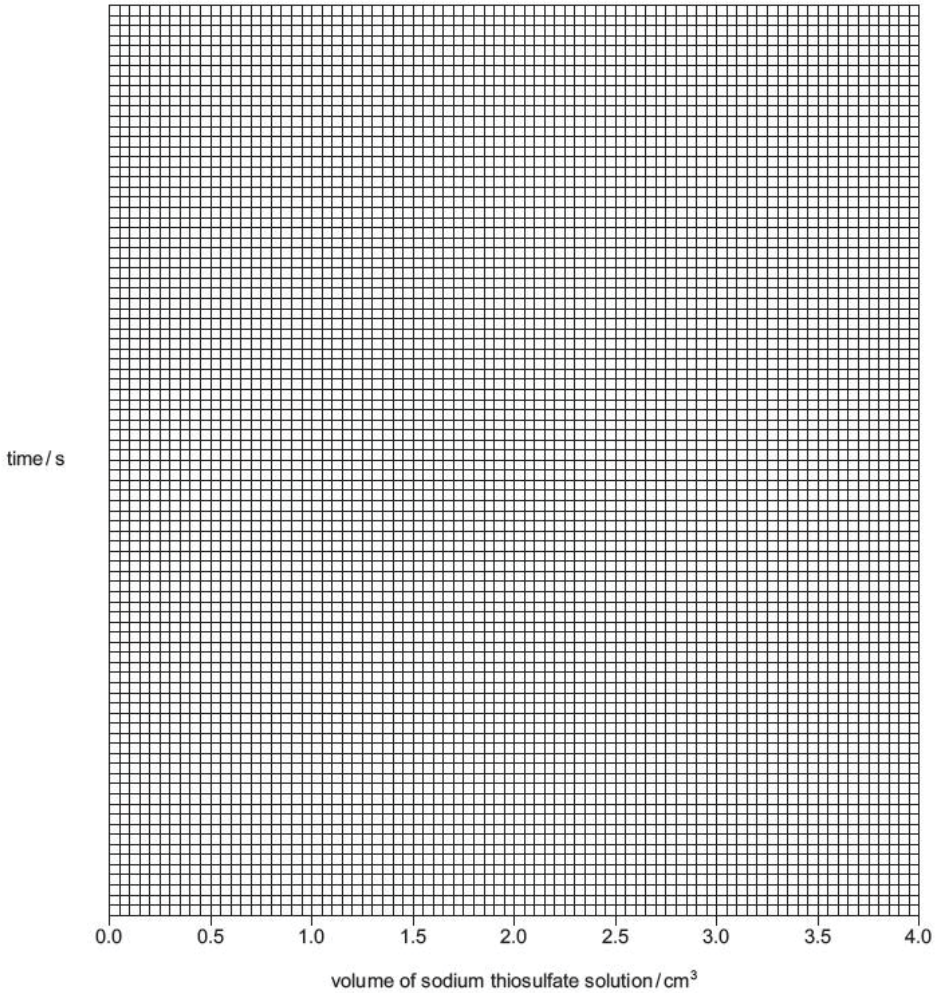
(a) A burette was filled up to the 0.0 cm^3 mark with sodium thiosulfate solution.
Using a large measuring cylinder, 100 cm^3 of distilled water were poured into a conical flask.
Using a small measuring cylinder, 6 cm^3 of sulfuric acid, 1 cm^3 of starch solution and 4 cm^3 of aqueous potassium iodide were added to the flask.
0.5 cm^3 of sodium thiosulfate solution was added from the burette to the mixture in the flask and swirled to mix.
The reaction was then started by adding 3 cm^3 of hydrogen peroxide solution to the mixture, and the timer started.
The time taken for a blue colour to appear was noted.
A further 0.5 cm^3 of sodium thiosulfate solution was added to the mixture in the conical flask, swirled and the blue colour disappeared. The time when the blue colour reappeared was noted.
The experiment continued by adding further 0.5 cm^3 portions of sodium thiosulfate solution until a total of 3.0 cm^3 of sodium thiosulfate solution had been added, noting the times at which the blue colour reappeared.

Use the timer diagrams on page 4 to record the times in seconds in the table.

total volume of sodium thiosulfate solution / cm^3	timer diagram	time at which blue colour appeared / s
0.5		
1.0		
1.5		
2.0		
2.5		
3.0		

[3]

(b) Plot the results you have obtained on the grid and draw a best-fit straight-line graph.



[5]

(c) (i) **From your graph** deduce the time at which the blue colour would appear if a total of 4.0 cm^3 of sodium thiosulfate solution were added to the mixture in the conical flask. Show clearly **on the grid** how you worked out your answer.

..... [3]

(ii) Sketch **on the grid** the graph you would expect if the experiment was repeated at a higher temperature. [1]

(d) Suggest the purpose of the starch solution.

..... [1]

(e) **(i)** Suggest **one** advantage of using a pipette to measure the volume of the hydrogen peroxide.

..... [1]

(ii) Suggest and explain **one** disadvantage of using a pipette to measure the volume of the hydrogen peroxide.

.....

..... [2]

(f) Explain **one** disadvantage of using a beaker instead of a conical flask.

.....

..... [1]

Q# 9/ iGCSE Chemistry/2016/m/Paper 62/Q2

2 A teacher investigated the rate of a reaction between two solutions, **J** and **K**, and sulfuric acid at different temperatures.

Four experiments were carried out.

(a) *Experiment 1*

A large measuring cylinder was used to pour 50 cm^3 of distilled water and 40 cm^3 of sulfuric acid into a 250 cm^3 conical flask.
A small measuring cylinder was used to add 2 cm^3 of methyl orange and 5 cm^3 of solution **J** to the mixture in the conical flask. The temperature of the mixture was measured.
The reaction was started by adding 5 cm^3 of solution **K** to the conical flask, immediately starting the timer and swirling the mixture.
The time taken for the mixture to turn pale yellow was measured. The final temperature of the mixture was measured.

Experiment 2

Experiment 1 was repeated but the mixture in the conical flask was heated to about 30 °C **before** adding the solution **K**. The temperature of the mixture was measured.
5 cm^3 of solution **K** was added to the conical flask. The timer was started and the mixture swirled.
The time taken for the mixture to turn pale yellow was measured. The final temperature of the mixture was measured.

Experiment 3

Experiment 1 was repeated but the mixture in the conical flask was heated to about 40 °C before adding the solution **K** to the flask. The same measurements were taken.

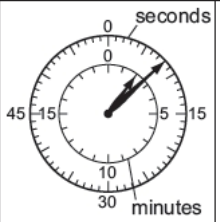
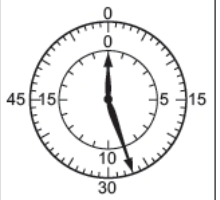
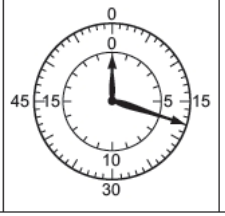
Experiment 4

Experiment 1 was repeated but the mixture in the conical flask was heated to about 50 °C before adding the solution **K** to the flask. The same measurements were taken.

Stop-clock diagrams for these experiments are on page 4.

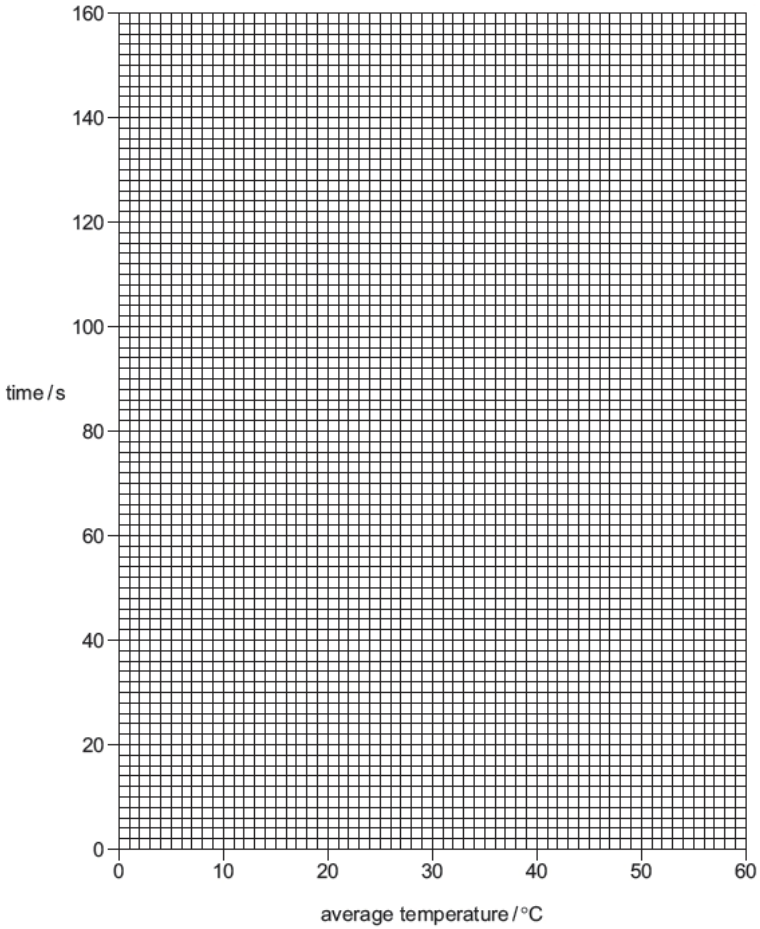
Use the stop-clock diagrams to record the times in the table.

Work out the average temperatures to complete the table.

experiment	stop-clock diagram	time taken for mixture to turn pale yellow / s	initial temperature / °C	final temperature / °C	average temperature / °C
1			17	15	
2			28	26	
3			42	40	
4			51	49	

[4]

(b) Plot the results on the grid and draw a smooth line graph.



[4]

(c) **From your graph** deduce the time taken for the mixture to turn pale yellow if Experiment 1 was repeated at an average temperature of 60 °C.
Show clearly **on the grid** how you worked out your answer.

..... [2]

(d) **(i)** In which experiment was the rate of reaction greatest?

..... [1]

(ii) Explain why the rate of reaction was greatest in this experiment.

.....

.....

..... [2]

(e) **(i)** Suggest and explain the effect **on the results** of using a burette to measure the volume of solution **J**.

.....

..... [2]

(ii) Suggest and explain one **other** improvement to these experiments.

.....

..... [2]

9.9.1 ESSENTIAL EXAM QUESTIONS Paper 6 Topic 7.1 and 7.2 151marks Mark Scheme

Q# 1/ iGCSE Chemistry/2018/w/Paper 62/Q2

2(a)	Table of results for experiments 1–5 Times completed 29, 39, 56, 65, 111	3
	in seconds	1
2(b)	All points plotted correctly	3
	Smooth line graph	1
2(c)	Value from graph	1
	indication on graph	1
	unit	1

2(d)(i)	Experiment 1	1
2(d)(ii)	More particles (of solution L present per unit volume)	1
	more frequent collisions / particles collide more often / higher collision rate	1
2(e)(i)	More accurate	1
2(e)(ii)	Too slow / slower addition of solution / takes longer to add	1
	Measuring time taken less accurate / results less accurate	1
2(f)	Repeat **and** average / compare results	1

Q# 2/ iGCSE Chemistry/2018/s/Paper 61/Q2

2(a)	volume boxes completed correctly in seconds 0, 10, 15, 20, 40	1
	time boxes completed correctly 27, 33, 45, 66, 201	2
2(b)	all points plotted correctly (□ half a small square)	2
	smooth line graph	1
2(c)(i)	value from graph	1
	with clear indication	1
2(c)(ii)	1 □ value from **(c)(i)**	1
2(d)(i)	experiment 1	1
2(d)(ii)	more particles of thiosulfate (in a given volume)	1
	more chance of collision	1
2(e)	use a pipette / burette	1
2(f)	times would be shorter	1
	idea of depth of solution is greater	1
2(g)	sketch curve roughly same shape and above original	1

Q# 3/ iGCSE Chemistry/2017/w/Paper 61/

2(a)	average temperatures completed for all five experiments: 18, 31, 41, 53, 63	1
	times completed for all five experiments: 210, 111, 84, 66, 54	1
	all times in seconds	1
2(b)	all five points plotted	3
	smooth line graph	1
2(c)	value from graph for average temperature 72 °C	1
	unit (s)	1
	shown clearly	1
2(d)	line above experimental line	1
2(e)(i)	Experiment 5	1
2(e)(ii)	particles move faster / particles have more energy	1
	more (frequent) collisions / greater chance of collisions	1
2(f)(i)	more accurate	1
	comparison to measuring cylinder	1
2(f)(ii)	time shorter / cross disappears faster	1
	depth greater	1

Q# 4/ iGCSE Chemistry/2017/s/Paper 63/

2(a)	all volume boxes completed correctly: 0, 13, 25, 38, 48, 59, 70, 79, 88, 96	3
2(b)	origin plotted	1
	other points correctly plotted	1
	two smooth lines	1
	labelled	1
2(c)	Experiment 1	1
	more concentrated / stronger acid / the acid has a lower pH	1

2(d)	volume of gas at 30 s	1
	correct calculation of rate	1
	unit: cm^3/s **OR** $cm^3 s^{-1}$	1
2(e)	all the magnesium will have reacted	1
2(f)	faster reaction / increased rate	1
	magnesium powder has a higher surface area	1
2(g)	advantage: easy to use / quick	1
	disadvantage: not accurate	1
2(h)	use of burette / pipette / gas syringe / weighed amount of magnesium / repeat experiment (and average) / clean the magnesium / remove oxide layer	1

Q# 5/ iGCSE Chemistry/2017/s/Paper 62/

2(a)	initial volume completed correctly: 0.0 final volume completed correctly: 13.0	1
	difference: 13.0	1
2(b)	final volume, initial volume and difference completed correctly: 41.1, 2.1 and 39.0	1
	all readings in **(a)** and **(b)** to 1 d.p.	1
2(c)	there is a colour change at the end-point already	1
2(d)(i)	solution **C**	1
	a greater volume of potassium manganate(VII) / solution **A** was needed	1
2(d)(ii)	3 × as concentrated	1
2(e)(i)	double the volume of solution **C** was used / double the volume of solution **A** was needed	1
	78 cm^3	1
2(e)(ii)	problem: volume of potassium manganate(VII) solution added would be greater than 50 cm^3	1
	solution: use more than one burette / refill burette	1
2(f)	advantage: easy (to use) / quick	1
	disadvantage: not accurate	1
2(g)	can take average or mean / can spot anomalies / more reliable	1

Q# 6/ iGCSE Chemistry/2017/s/Paper 61/

2(a)	initial and final readings completed correctly: 4.1, 38.3	1
	difference completed correctly: 34.2	1
2(b)	initial and final readings completed correctly: 3.7, 20.8	1
	difference completed correctly: 17.1	1
2(c)(i)	solution **C** is more concentrated	1
	a greater volume of thiosulfate was needed	1
2(c)(ii)	2 × as concentrated	1

Q# 7/ iGCSE Chemistry/2016/w/Paper 62/

2(a)	table of results volume boxes completed correctly (30), 44, 57, 62, 78, 85, 88, 89, 90, 90	2
2(b)	all points correctly plotted smooth line graph	2 1
2(c)(i)	point at 60 s / 62 cm^3 / fourth point / measurement 4	1
2(c)(ii)	misread measuring cylinder / read too early	1
2(c)(iii)	value from graph (68–70) shown clearly	1 1
2(d)	the Reaction has finished all the acid has reacted / HCl is the limiting factor	1 1
2(e)(i)	value from graph or table (57–44 = 13 cm^3)	1
2(e)(ii)	13 / 20 = 0.65 cm^3 / s	1 1
2(f)	steeper curve to same level	1 1
2(g)	air is displaced (when the acid is added)	1
2(h)	improvement explanation use a burette / graduated pipette / gas syringe improves accuracy **OR** use cotton thread to hold a test-tube (containing the acid) in the flask no air is collected **OR** repeat the experiment take average / more frequent readings	1 1

Q# 8/ iGCSE Chemistry/2016/s/Paper 62/

2(a)	all 6 times completed correctly (2 marks) (22, 43, 64, 86, 105, 126) 5 times completed correctly (1 mark); in seconds;	3 2 1
2(b)	appropriate scale for *y*-axis / increasing at 20 s per large square; *y*-axis is a linear scale; all 6 points plotted correctly ± half a small square (2 marks); 5 points plotted correctly ± half a small square (1 marks); best-fit straight-line graph;	5 1 1 2 1
2(c)(i)	value from graph ± half a small square (typically 167–170); units / s; extrapolation;	3 1 1 1
2(c)(ii)	sketch line below original line and diverging;	1
2(d)	as an indicator;	1
2(e)(i)	(more) accurate;	1
2(e)(ii)	solution slow to run out of pipette; difficult to know when to start timer / reaction does not start at once / inaccurate time measurement owtte;	2 1 1
2(f)	difficulty in swirling / mixing / shaking;	1

Q# 9/ iGCSE Chemistry/2016/m/Paper 62/

2(a)	In each column: 4 correct = [2] 3 correct = [1] average temperature boxes completed correctly: 16, 27, 41, 50; times completed in seconds correctly: 128, 58, 27, 18;	4
2(b)	all points plotted correctly = [3] smooth line graph;	4
2(c)	value from graph: 12–13 s; extrapolation;	2
2(d)(i)	Experiment 4;	1
2(d)(ii)	any **2** from: highest temperature; more energy; more (chance of) collisions;	2
2(e)(i)	more accurate; than a measuring cylinder;	2
2(e)(ii)	insulation / use a lid; to reduce heat losses; OR repeats; average results; OR measure water or sulphuric acid or methyl orange using a burette / use a 2 d.p. stopwatch / digital thermometer; reference to accuracy;	2

9.10 FUNDAMENTAL Assessed Activity 1 Keyword Test

Topic #	English	Meaning
7	**enzymes**	
7	**photochemical reaction**	
	denature	
7	**photosynthesis**	
7	**reaction rate**	
7	**speed of reaction**	

9.11 ESSENTIAL Assessed Activity 2 Topic 7.1 & 7.2 Paper 2 15marks

Q# 1/

14 Copper(II) carbonate reacts with dilute sulfuric acid.

$$CuCO_3(s) + H_2SO_4(aq) \rightarrow CuSO_4(aq) + CO_2(g) + H_2O(l)$$

The rate of the reaction can be changed by varying the conditions.

Which changes always increase the rate of this chemical reaction?

1 increasing the concentration of sulfuric acid

2 increasing the size of the pieces of copper(II) carbonate

3 increasing the temperature

4 increasing the volume of sulfuric acid

A 1, 3 and 4 **B** 1 and 3 only **C** 2 and 3 **D** 3 and 4 only

15 Which reaction is **not** affected by the presence of light?

A a candle burning

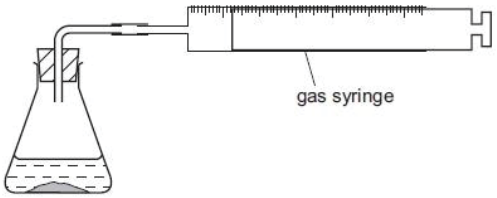
B methane reacting with chlorine

C photosynthesis

D silver bromide decomposing to form silver

Q# 2/

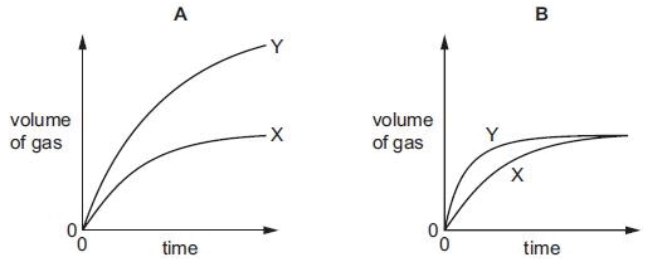
14 An experiment X is carried out between a solid and a solution using the apparatus shown.

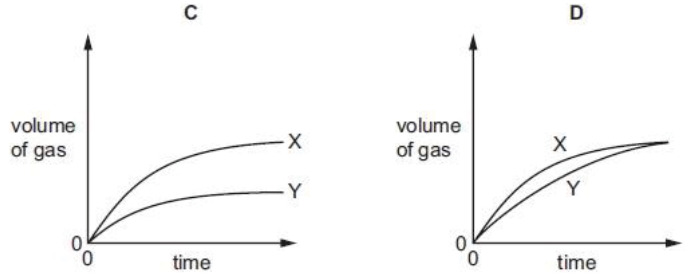


The volume of gas given off is measured at different times and the results plotted on a graph.

In a second experiment Y, the surface area of the solid is increased but all other factors remain the same.

Which graph shows the results of experiments X and Y?





15 Which change in conditions increases the energy of the particles in a reaction?

A addition of a catalyst

B increase in concentration

C increase in surface area

D increase in temperature

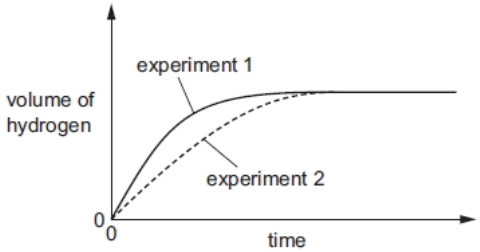
Q# 3/

14 Zinc granules are reacted with excess dilute hydrochloric acid.

The volume of hydrogen given off is measured at different times.

The results are shown on the graph, labelled experiment 1.

The results for a second experiment are also shown on the graph, labelled experiment 2.



Which change to the conditions was made in experiment 2?

A The concentration of the hydrochloric acid was decreased.

B The size of the zinc granules was decreased.

C The surface area of the zinc granules was increased.

D The temperature was increased.

15 In an experiment nitric acid is added to excess marble chips and the volume of carbon dioxide formed is measured.

The experiment is repeated using smaller marble chips. All other conditions remain the same.

Which statement about the second experiment is correct?

A The collisions are more frequent and higher energy.

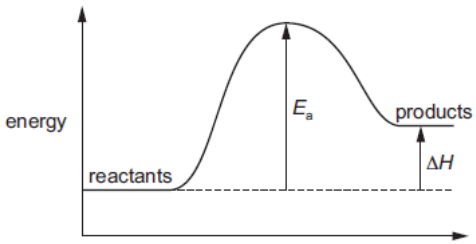
B The collisions are more frequent and the same energy.

C The collisions are the same frequency and the same energy.

D The collisions are the same frequency and higher energy.

Q# 4/

13 The energy level diagram for a reaction is shown.



Which statement is **not** correct for this energy level diagram?

A It could be the energy level diagram for the reaction when petrol is burnt.

B Less energy is released in bond forming than is needed for bond breaking.

C The activation energy, E_a, has a positive value.

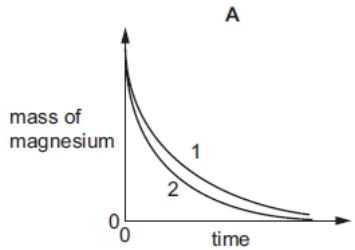
D The energy change, ΔH, for the reaction is positive.

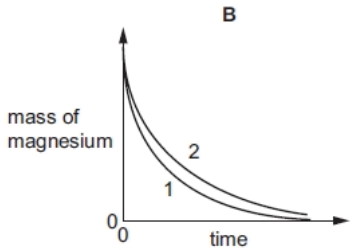
14 The rate of reaction between magnesium and excess dilute hydrochloric acid was followed by measuring the mass of magnesium present at regular time intervals.

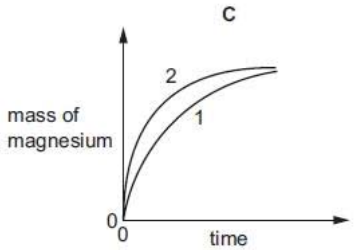
Two experiments were performed.

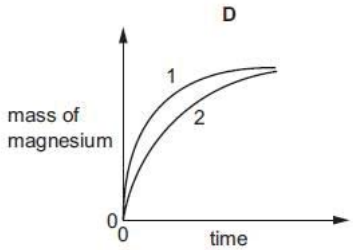
Both experiments used 0.1 g of magnesium ribbon. The acid in experiment 1 was less concentrated than in experiment 2.

Which graph shows the results of the experiments?









15 Which statement explains why coal dust forms an explosive mixture with air?

A Coal dust catalyses the explosion.

B Coal dust has a large surface area.

C Crushing coal increases the concentration of the coal.

D Crushing coal increases the temperature of the coal.

Q# 5/

15 Which row explains why increasing temperature increases the rate of reaction?

	particles collide more often	particles collide with more energy
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

Q# 6/

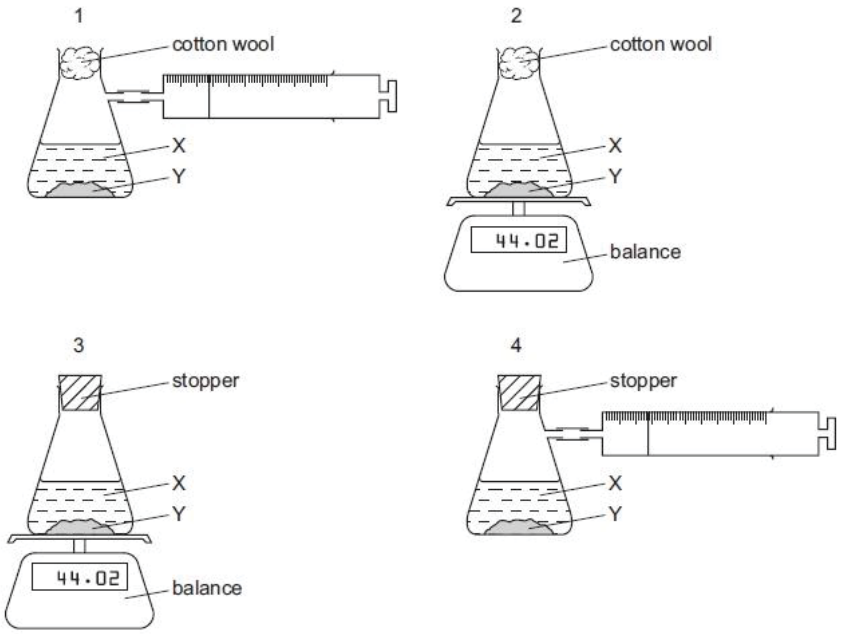
15 Which row describes how the energy of collision between particles changes when concentration and temperature are increased?

	concentration	temperature
A	increases	increases
B	increases	no change
C	no change	increases
D	no change	no change

Q# 7/

14 A liquid X reacts with solid Y to form a gas.

Which two diagrams show suitable methods for investigating the rate (speed) of the reaction?



A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

15 Which statements explain why increasing temperature increases the rate of a chemical reaction?

1 Heat makes the molecules move faster and collide more often.

2 Heat makes the molecules collide with more energy so they are more likely to react.

3 Increasing temperature lowers the activation energy for the reaction.

A 1 and 2 **B** 1 and 3 **C** 1 only **D** 2 only

Q# 8/

15 Which statement about catalysts in chemical reactions is **not** correct?

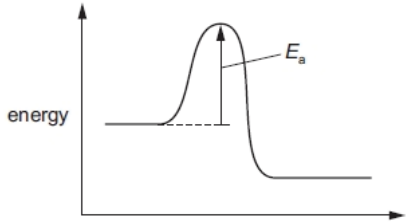
A Catalysts are not used up in the reaction.

B Catalysts increase the energy of the reacting particles.

C Catalysts increase the rate of the reaction.

D Catalysts lower the activation energy.

17 The diagram shows an energy level diagram for a reaction.



The diagram shows that the reaction is .....1..... .

Increasing the temperature increases the rate of reaction. A reason for this is that the .....2..... .

Which words correctly complete gaps 1 and 2?

	1	2
A	endothermic	activation energy decreases
B	endothermic	collision rate increases
C	exothermic	activation energy decreases
D	exothermic	collision rate increases

9.12 Extension Assessed Activity 3 Paper 3/4 17marks

Q# 18/

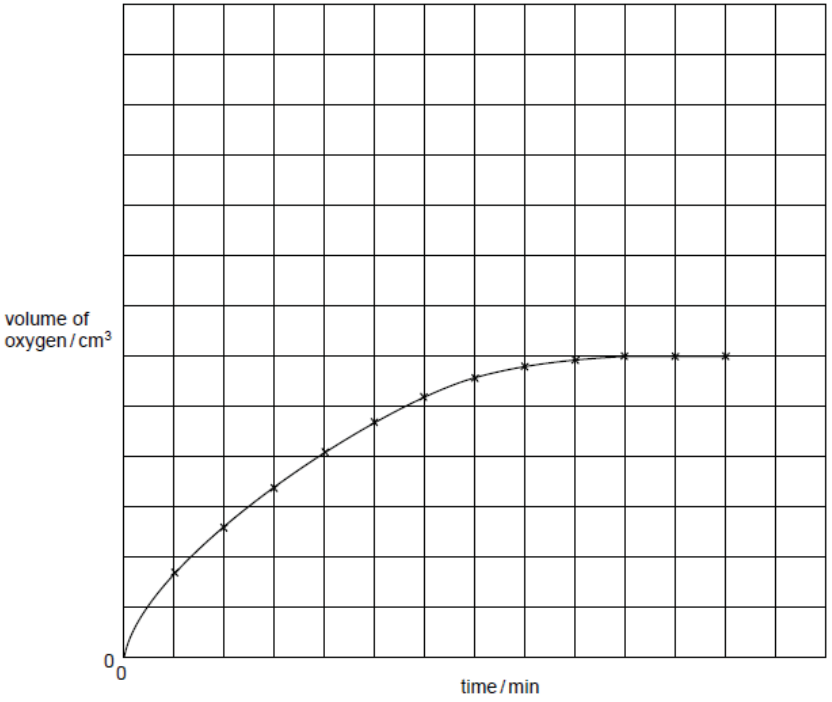
(c) Aqueous hydrogen peroxide decomposes to form water and oxygen.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

This reaction is catalysed by manganese(IV) oxide

The following experiments were carried out to investigate the rate of this reaction.

A 0.1 g sample of manganese(IV) oxide was added to 20 cm^3 of 0.2 M hydrogen peroxide solution. The volume of oxygen produced was measured every minute. The results of this experiment are shown on the graph.



(i) How does the rate of reaction vary with time? Explain why the rate varies.

.....

.....[3]

(ii) The following experiment was carried out at the same temperature.

0.1 g of manganese(IV) oxide and 20 cm^3 of 0.4 M hydrogen peroxide

Sketch the curve for this experiment on the same grid. [2]

(iii) How would the shape of the graph differ if only half the mass of catalyst had been used in these experiments?

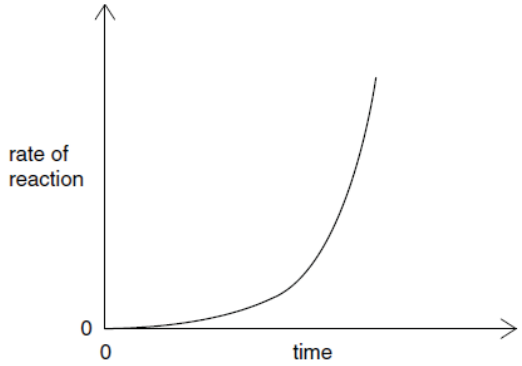
.....

.....

.....[2]

Q# 19/

(d) The graph shows how the rate of the exothermic reaction between aluminium and hydrochloric acid varies with time.



(i) Suggest a reason why the reaction goes slowly at first.

.....[1]

(ii) Suggest **two** reasons for the increase in rate.

.....

.....[2]

Q# 20/

2 Fermentation of sugars is one method of making ethanol. Vines produce glucose by photosynthesis. The glucose collects in the grapes which grow in clusters on the vine.

(b) Explain how the vine produces glucose by photosynthesis.

.....

.....

.....

.....[4]

Q# 21/

(v) Give another example of a reaction that is influenced by light. Describe **one** important application of this reaction.

reaction .....

application .....[3]

9.13 ESSENTIAL End of Topic Review and Reflection

Looking at the goals you could have achieved and the goals you actually achieved try to reflect on your progress.

Try to be as honest and as detailed as possible. Sometimes you may think you have thought about an idea well, but when you talk with someone else, or write it out, it helps you better understand and allows you think more completely and more clearly.

Did you achieve more goals this topic than last topic?

Fill in this table

Level	Number of goals achieved at each level	Success rate, %
FUNDAMENTAL	/5	
ESSENTIAL	/10	
EXTENSION	/13	
EXCEPTIONAL	/10	

Do you feel you tired harder? If yes, what helped you to do so? If not, why not?

_____

_____

What could you do differently next time, in addition to what you are already doing to improve, not only your score in the end of topic tests and other assessed activities, but also in how you learn. How could you become a more effective student to get more learning out of the time you are investing in your studies?

_____

_____

_____

What did you enjoy most about this topic?

_____

What did you find most difficult?

_____

What did you find easiest?

_____

On a scale of 1 being hardest and 5 being most difficult, circle how challenging you found this topic

1 2 3 4 5

What could be done to make this topic easier to understand?

_____

Do you have any questions about this topic?

_____

9.14 EXTENSION Mind Map For Topic 7.1 & 7.2

9.15 EXCEPTIONAL Additional Activities, Further Reading and Exploring Beyond the Syllabus

Possible ideas for a presentation

For extremely unreactive elements check out this information:

- https://13c35962-6df0-4843-9028-c26407054a5a.filesusr.com/ugd/d26cc6_09d1ac89ec85489bbc6d57fb6a437c9d.docx?dn=iG%20Chem%207.2%20INFO%20Wikipedia%20Noble%20metal%209
- https://13c35962-6df0-4843-9028-c26407054a5a.filesusr.com/ugd/d26cc6_a807fc32486a4f7a80ee6d250fc9392b.docx?dn=iG%20Chem%207.2%20INFO%20Wikipedia%20Helium%20Least%20

Some rates are extremely fast, like those involved in the middle of a reaction, these involve things like transition states and intermediates. Try to find out about these very short lived compounds (usually called species) from this website: Chemguide:

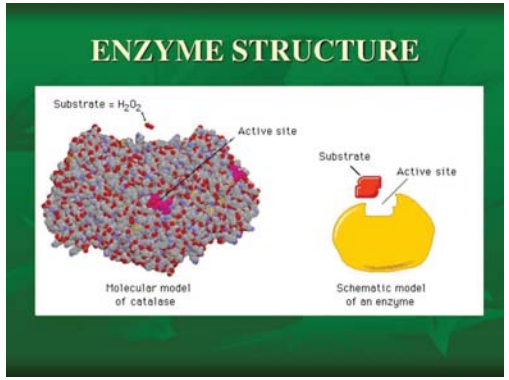
https://www.chemguide.co.uk/physical/basicrates/energyprofiles.html

For a much more complicated introduction to a process known as "Flash Photolysis", be aware though that you might not understand much of this, or anything at all, but it is good to find out where your academic career might take you one day!

https://13c35962-6df0-4843-9028-c26407054a5a.filesusr.com/ugd/d26cc6_302ada967ced4f779fb62f8443008894.pdf?index=true

9.16 Exceptional Extra Credit Science in Context Topic 7.1 and 7.2

Some rates of reaction are very slow, life uses enzymes to carefully control the rates of certain reactions within a cell. A growing field of investigation is creating artificial enzymes, use the links below to find out more about these catalysts which some people think will revolutionise the way we make all of the materials, from our clothes to our buildings in the decades to come:



Enzymes in general: https://13c35962-6df0-4843-9028-c26407054a5a.filesusr.com/ugd/d26cc6_e152e10a08314c70b4eaeeef061c9e5d.docx?dn=iG%20Chem%207.2%20INFO%20Wikipedia%20Enzyme%2028Pgs.

How much faster enzymes speed up a reaction: https://13c35962-6df0-4843-9028-c26407054a5a.filesusr.com/ugd/d26cc6_1ef6e8f0b7f64dcc8197e710137e2443.pdf?index=true

Artificial enzymes: https://13c35962-6df0-4843-9028-c26407054a5a.filesusr.com/ugd/d26cc6_b3e22e817cb74bf9b78ab3a53a4037a4.pdf

This website provides free academic articles about the biosciences, check it out!

https://www.webmedcentral.com/#

10 Topics 7.3 Reversible Reactions, 11.3 Nitrogen & Fertilisers & 12 Sulfur (Equilibria)

10.1 End of Topic 7.3, 11.3 and 12 Goals Checklist

For each topic you ought to try to do as many of the following things to get the most out of your time, the resources available to you and to help you grow as a student. Tick each goal off as you complete it. Growth is difficult and uncomfortable, but you should choose to do these things, and the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win!

Aspect	What you should have done	Yes/No	Level
Interacted with your teacher	Ask your teacher 1 question, about anything, once a week		FUNDAMENTAL
	Try to answer one question asked by your teacher at least once a week		ESSENTIAL
	Ask your teacher one question about something you do not understand in science once a week		ESSENTIAL
	Ask your teacher one question about something to do with science every lesson		EXTENSION
Notes and follow up notes	Complete set of class note		FUNDAMENTAL
	Cornell Notetaking Attempted		ESSENTIAL
	Cornell Notetaking Completed		EXTENSION
	Cornell Notetaking Completed to an exemplary standard		EXCEPTIONAL
	Attempted the Mind Map for this topic		ESSENTIAL
	Completed the Mind Map for this topic		EXTENSION
Textbook	Read ahead before the topic has been started		EXTESNION
	Highlighted key ideas and translate new words		FUNDAMENTAL
	Completed the questions at the end of each 2 page spread in your exercise book		EXTENSION
	Added to your class notes ideas and important information from the textbook that you learnt		EXTENSION
Past Exam Questions	Worked on at least 25% of the exam questions in this workbook		FUNDAMENTAL
	Attempted more than 25% of the questions and those questions you have completed you have marked in a different colour pen		ESSENTIAL
	Completed and marked all questions here		EXTENSION
	Completed, marked and additional key ideas where you have located the most difficult marks added to your notebook		EXCEPTIONAL
	Used the resources available online to answer additional questions not found in this workbook on the current topic.		EXCEPTIONAL
	Ask your teacher about an exam question that they cannot answer		EXCEPTIONALLY SMASHING!!!
Assessed Activities	Complete the word list activity using the word list at the front of each topic as little as possible		FUNDAMENTAL
	Complete 2 assessed activities, either in class or as homework		ESSENTIAL
	Complete 2 assessed activities and scored over 70% on average		ESSENTIAL
	Complete 2 assessed activities and scored over 80% on average		EXTENSION
	Complete 2 assessed activities and scored over 90% on average		EXCEPTIONAL
End of Topic Test	Revised sufficiently well to improve upon your score from the previous test (except if you are scoring over 90%, then just write Y for this goal)		ESSENTIAL
	Scored 10% higher than your current average		EXTENSION
	Scored 15% or more than your previous end of topic average		EXCEPTIONAL
	Scored over 90%		EXTESNION
	Scored over 95%		SMASHING!!!

Aspect	What you should have done	Yes/No	Level
Reading	Spend more than 1 hour a week reading a book **you enjoy** (in any language) about anything.		ESSENTIAL
	Spend more than 3 hours a week reading a book **you enjoy** (in any language) about anything.		EXTENSION
	Spend more than 5 hours a week reading a book **you enjoy** (in any language) about anything.		EXCEPTIONAL
	Spend at least one hour a week reading a book **you enjoy** in English about anything.		EXTENSION
	Spend more than 3 hours a week reading a book **you enjoy** in English about anything.		EXCEPTIONAL
Reflection	You completed this goal setting table		FUNDAMENTAL
	You have looked at the goals you have achieved and the ones you have not and added them up and entered them into the table in the Review and Reflection section		ESSENTIAL
	You have given an answer for every question in the Review and Reflection section at the end of this topic		EXTENSION
	You have Given good and thoughtful answers for every question in the Review and Reflection section at the end of this topic		EXCEPTIONAL

10.2 Topics 7.3, 11.3 & 12 Equilibria Syllabus

Topic 7 Chemical Reactions

7.3 Reversible reactions

Core

- Understand that some chemical reactions can be reversed by changing the reaction conditions. (Limited to the effects of heat and water on hydrated and anhydrous copper(II) sulfate and cobalt(II) chloride.) (Concept of equilibrium is **not** required.)

Supplement

- Predict the effect of changing the conditions (concentration, temperature and pressure) on other reversible reactions
- Demonstrate knowledge and understanding of the concept of equilibrium

7.4 Redox

Core

- Define *oxidation* and *reduction* in terms of oxygen loss/gain. (Oxidation state limited to its use to name ions, e.g. iron(II), iron(III), copper(II), manganate(VII).)

Supplement

- Define *redox* in terms of electron transfer
- Identify redox reactions by changes in oxidation state and by the colour changes involved when using acidified potassium manganate(VII), and potassium iodide. (Recall of equations involving $KMnO_4$ is **not** required.)
- Define *oxidising agent* as a substance which oxidises another substance during a redox reaction. Define *reducing agent* as a substance which reduces another substance during a redox reaction.
- Identify oxidising agents and reducing agents from simple equations

Top 11 Air and Water

11.3 Nitrogen and fertilisers

Core

- Describe the need for nitrogen-, phosphorus- and potassium-containing fertilisers
- Describe the displacement of ammonia from its salts

Supplement

- Describe and explain the essential conditions for the manufacture of ammonia by the Haber process including the sources of the hydrogen and nitrogen, i.e. hydrocarbons or steam and air

12 Sulfur

12.1 Sulfur

Core

- Name some sources of sulfur
- Name the use of sulfur in the manufacture of sulfuric acid
- State the uses of sulfur dioxide as a bleach in the manufacture of wood pulp for paper and as a food preservative (by killing bacteria)

Supplement

- Describe the manufacture of sulfuric acid by the Contact process, including essential conditions and reactions
- Describe the properties and uses of dilute and concentrated sulfuric acid

10.3 ESSENTIAL Glossary for Keywords for this topic

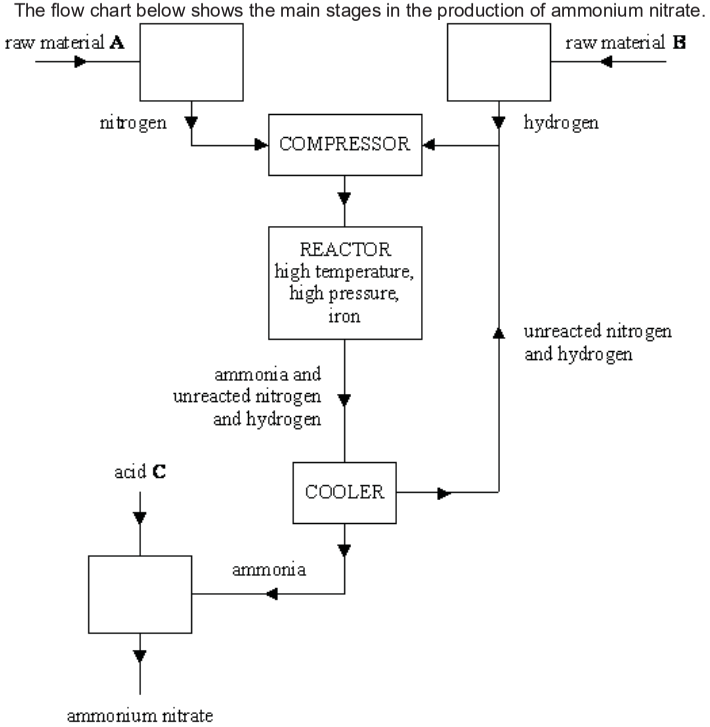
English	英语
dynamic (chemical) equilibrium two chemical reactions, one the reverse of the other, taking place at the same time, where the concentrations of the reactants and products remain constant because the rate at which the forward reaction occurs is the same as that of the back reaction	动态（化学）平衡两个化学反应，一个同时发生，这是同时发生的，反应物和产物的浓度保持恒定，因为发生正向反应的速率与反向发生的速率相同反应
equilibrium a less precise name for dynamic equilibrium	**平衡**动态平衡的较不精确的名称
reversible reaction a chemical reaction which can go either forwards or backwards, depending on the conditions	**可逆反**应，取决于条件，可以向前或向后进行的化学反应
acid rain this has been made more acidic than normal by the presence of dissolved pollutants such as sulfur dioxide (SO2) and nitrogen oxides (NOx)	**酸雨由于溶解的**污染物（例如二氧化硫（SO2）**和氮氧化物**（NOx））**的存在，使酸雨比正常情况下更加酸性**
artificial fertiliser a substance added to soil to increase the amount of elements such as nitrogen, potassium and phosphorus (NPK fertilisers): this enables crops to grow more healthily and produce higher yields	**人工肥料一种添加到土壤中以增加氮**，钾和磷等元素含量的物质（NPK**肥料**）：这可使农作物更健康地生长并产生更高的产量
carbon cycle the system by which carbon and its compounds in the air, oceans and rocks are interchanged	**碳循**环系统，通过该系统可以交换空气，海洋和岩石中的碳及其化合物
Haber process the industrial manufacture of ammonia by the reaction of nitrogen with hydrogen in the presence of an iron catalyst	Haber**通**过在铁催化剂的存在下使氮与氢反应来工业化生产氨
nitrogen cycle the system by which nitrogen and its compounds, both in the air and in the soil, are interchanged	**氮循**环系统，通过该系统可以交换空气和土壤中的氮及其化合物
Contact process the industrial manufacture of sulfuric acid using the raw materials sulfur and air	**使用原料硫和空气**进行接触式工业硫酸生产

10.4 ESSENTIAL Classroom Active Learning Tasks 1 The Haber Process

Write a number next to each of these statement to indicate the order that is needed to make ammonia I the Haber Process

- Steam is reacted with methane to make hydrogen.
- The gases are passed over an iron catalyst.
- The gases are heated to 450ºC.
- Hydrogen is mixed with nitrogen, obtained from air.
- The gases are compressed to 200 atmospheres.
- Ammonia gas is produced, then cooled to a liquid.
- Liquid ammonia is pumped off to be sold.
- Unreacted nitrogen and hydrogen are recycled.

Q6. The flow chart below shows the main stages in the production of ammonium nitrate.



(a) (i) Name the two raw materials shown in the flow chart as **A** and **B**.

Raw material **A** .....

Raw material **B** .....

(2)

(ii) What is the purpose of the iron in the reactor?

.....

.....

(1)

(ii) The table shows how temperature and pressure affect the amount of ammonia produced in this reaction.

TEMPERATURE (°C)	PRESSURE (ATM)	PERCENTAGE OF NITROGEN AND HYDROGEN CONVERTED TO AMMONIA (%)
250	200	75
250	1000	96
1000	1	0.01
1000	1000	1

Explain, as fully as you can, why a temperature of about 450°C and a pressure of about 100 atmospheres are normally used in the industrial process.

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.....

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.....

.....

(6)

10.5 ESSENTIAL Classroom Active Learning Tasks 2 The Contact Process

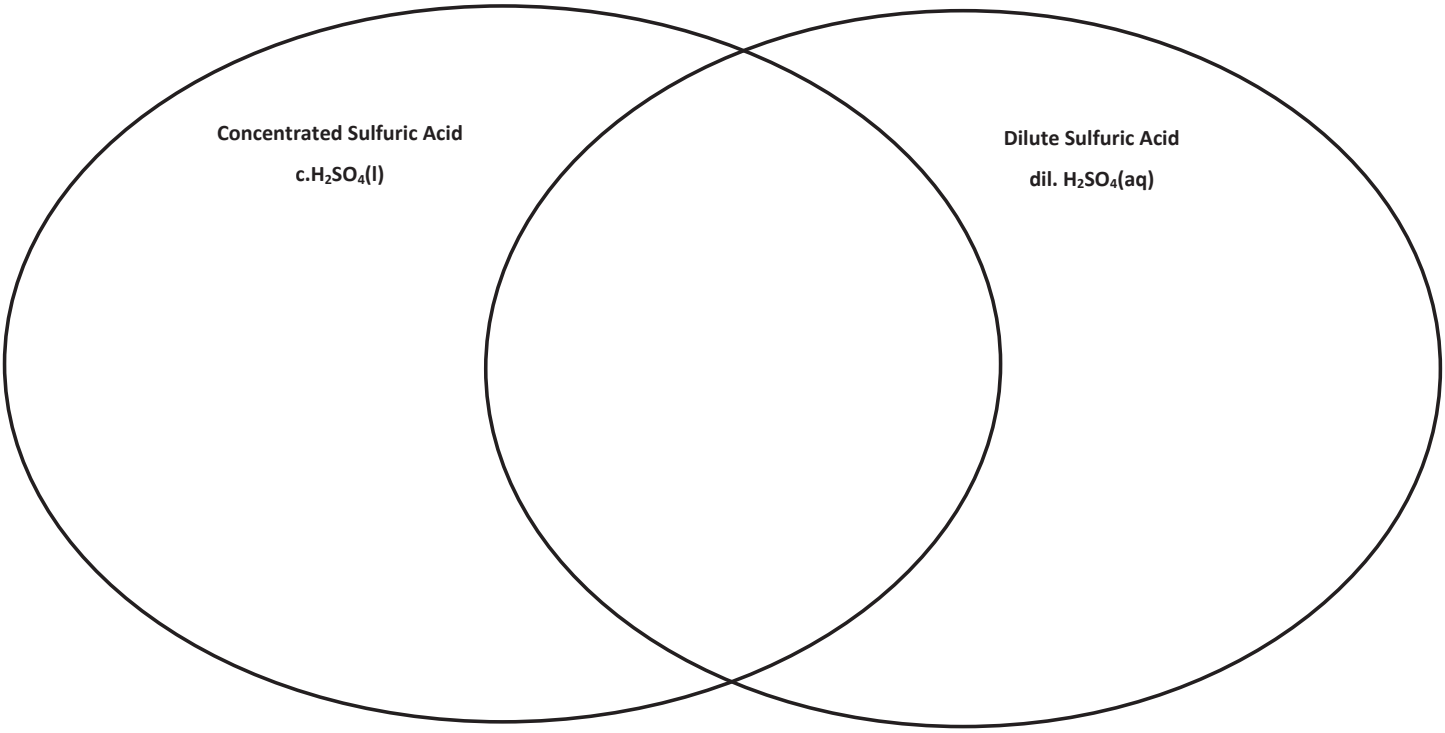
Complete this table

Reagent	Formula	Main Source (and other sources)	Chemical equation (if appropriate)	Reaction conditions, including catalysts, if any
Sulfur				
Sulfur Dioxide				
Sulfur Trioxide				
Oleum				
Sulfuric Acid				

In the space below create a flow diagram, like one used to explain the Haber process in the activity before to show how sulfuric acid is made from sulfur. Include as many chemical equations, with state symbols, as you can

10.6 Extension Classroom Active Learning Task 2 Concentrated and dilute sulfuric acid Venn Diagram

Compare and contrast what these two concentrations of the same acid and show what they have in common and how are they different to each other



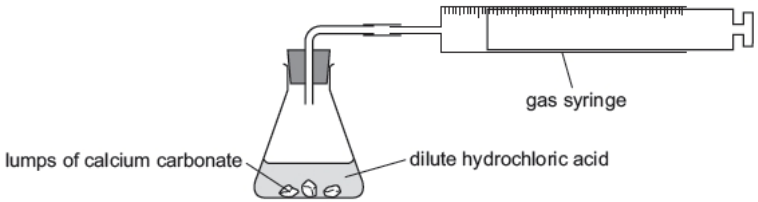
10.7 Extension Classroom Active Learning Tasks 3 Dealing with Multi-mark Questions about Equilibria 84marks

Q# 1/ IGCSE Chemistry/2018/w/Paper 43/Q5

5 A student investigates the rate of reaction between lumps of calcium carbonate and dilute hydrochloric acid using the apparatus shown.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

The calcium carbonate was in excess.



(a) Which measurements should the student make during the reaction to determine the rate of reaction?

.....

..... [2]

(b) What happens to the rate of reaction as the reaction proceeds? Explain your answer.

.....

.....

.....

..... [3]

(c) The student repeated the experiment at a higher temperature. All other conditions were kept the same. The student found that the rate of reaction increased.

Explain, in terms of collisions, why the rate of reaction increased.

.....

.....

.....

.....

..... [4]

Q# 2/ IGCSE Chemistry/2018/w/Paper 42/Q4

(c) The original experiment was repeated at a higher temperature. All other conditions were kept the same.

Describe and explain, in terms of collisions between particles, the effect of using a higher temperature on the time taken for the reaction to finish.

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

Q# 3/ IGCSE Chemistry/2018/w/Paper 41/Q5

(d) A mixture of hydrogen gas and iodine gas is allowed to reach equilibrium.

(i) Increasing the pressure of a gas increases its concentration.

State and explain the effect of increasing the pressure on the **rate** of the forward reaction.

.....

.....

..... [2]

(ii) State and explain the effect of increasing the temperature on the **rate** of the reverse reaction.

.....

.....

.....

.....

..... [3]

Q# 4/ IGCSE Chemistry/2018/s/Paper 43/Q3

(d) Cobalt reacts with dilute hydrochloric acid to make the salt cobalt(II) chloride. Bubbles of hydrogen gas are produced.

(iii) Use collision theory to explain how heating the dilute hydrochloric acid makes the rate of reaction faster.

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.....

..... [3]

Q# 5/ IGCSE Chemistry/2017/w/Paper 43/

(b) The chemical equation shows the equilibrium between dinitrogen tetroxide (N_2O_4, a colourless gas) and nitrogen dioxide (NO_2, a brown gas).

$$\underset{\text{colourless}}{N_2O_4(g)} \rightleftharpoons \underset{\text{brown}}{2NO_2(g)}$$

A mixture of dinitrogen tetroxide and nitrogen dioxide is allowed to reach equilibrium in a closed gas syringe.

(i) In chemistry, what is meant by the term *equilibrium*?

.....

.....

..... [2]

(ii) If the equilibrium mixture is heated at constant pressure, a darker brown colour is seen inside the gas syringe.

What does this information indicate about the decomposition of dinitrogen tetroxide? Explain your answer in terms of the position of the equilibrium.

.....

.....

..... [2]

(iii) Suggest what you would see if the pressure on the equilibrium mixture were increased at constant temperature.
Explain your answer in terms of the position of the equilibrium.

.....

.....

..... [2]

Q# 6/ IGCSE Chemistry/2017/w/Paper 42/

5 Some chemical reactions are reversible.

(a) Aqueous potassium chromate(VI), K_2CrO_4, is a yellow solution.

Aqueous potassium dichromate(VI), $K_2Cr_2O_7$, is an orange solution.

The two compounds interconvert when the pH of the solution changes.

$$\underset{\text{yellow}}{2K_2CrO_4} + H_2SO_4 \rightleftharpoons \underset{\text{orange}}{K_2Cr_2O_7} + K_2SO_4 + H_2O$$

Solution **Y** is a mixture of aqueous potassium chromate(VI) and aqueous potassium dichromate(VI) at equilibrium.

- Explain, in terms of the position of the equilibrium, what you would **see** if sulfuric acid were added to solution **Y**.

  .....

  .....

  .....

- Explain, in terms of the position of the equilibrium, what you would **see** if sodium hydroxide were added to solution **Y**.

  .....

  .....

  .....

  .....

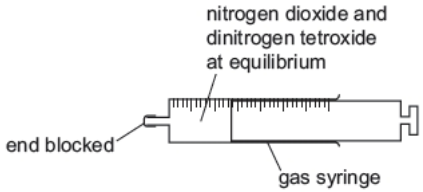
[5]

Q# 7/ IGCSE Chemistry/2017/w/Paper 41/Q5

(c) Nitrogen dioxide, NO_2, exists in equilibrium with dinitrogen tetroxide, N_2O_4.
Nitrogen dioxide is brown and dinitrogen tetroxide is colourless.

$$\underset{\text{brown}}{2NO_2(g)} \rightleftharpoons \underset{\text{colourless}}{N_2O_4(g)}$$

(i) A sample of nitrogen dioxide and dinitrogen tetroxide at equilibrium was placed in a closed gas syringe.
The syringe plunger was pushed in. This increased the pressure in the gas syringe. The temperature was kept constant.



State how the colour of the gas in the syringe changed. Explain your answer in terms of the position of the equilibrium.

.....

.....

.....

..... [3]

(ii) A sealed tube containing nitrogen dioxide and dinitrogen tetroxide at equilibrium was cooled in an ice bath at constant pressure. The contents of the tube became paler.

Suggest an explanation for this observation in terms of the position of the equilibrium.

.....

.....

..... [2]

Q# 8/ IGCSE Chemistry/2017/w/Paper 41/

7 Copper(II) oxide reacts with dilute hydrochloric acid.

$$CuO(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l)$$

6.00 g of copper(II) oxide were added to 50.0 cm^3 of 1.00 mol / dm^3 hydrochloric acid. This was an excess of copper(II) oxide.

(a) The rate of the reaction can be increased by increasing the concentration of the hydrochloric acid or by heating it.

(i) In terms of collisions, explain why increasing the concentration of the hydrochloric acid increases the rate of the reaction.

.....

.....

.....

..... [2]

(ii) In terms of collisions, explain why heating the hydrochloric acid increases the rate of the reaction.

.....

.....

.....

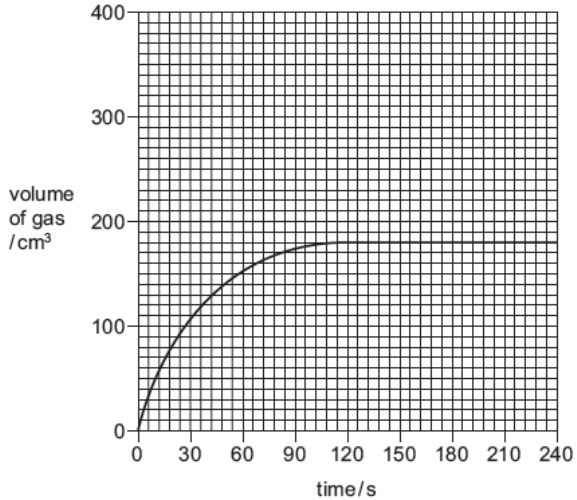
..... [2]

Q# 9/ IGCSE Chemistry/2017/s/Paper 41/

(e) The original graph has been drawn again.

On the grid, draw the graph expected if the concentration of dilute hydrochloric acid is changed from 0.1 mol / dm^3 to 0.2 mol / dm^3. All other conditions are the same as in the original experiment.

Explain, in terms of particles, why your graph is different from the original graph.



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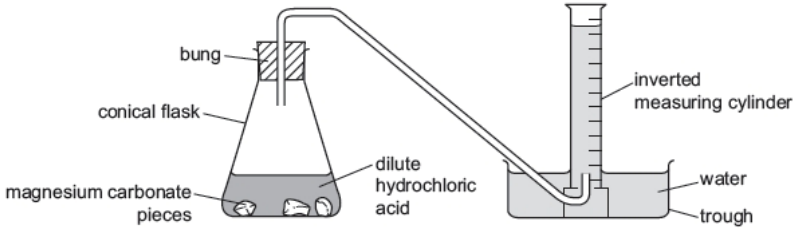
..... [4]

Q# 10/ IGCSE Chemistry/2016/w/Paper 41/

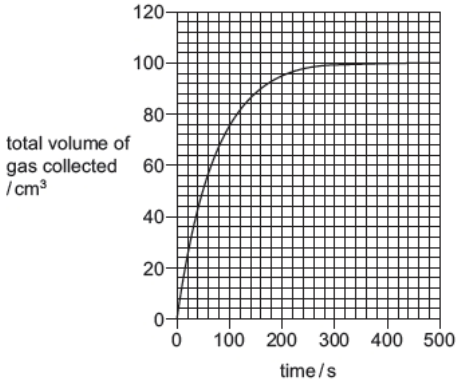
8 Magnesium carbonate reacts with dilute hydrochloric acid.

$$MgCO_3(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l) + CO_2(g)$$

An excess of magnesium carbonate pieces was added to dilute hydrochloric acid. The apparatus in the diagram was used to measure the volume of gas produced. The total volume of gas collected was recorded every 20 seconds.



(a) The results obtained are shown on the graph.



(i) Describe how the rate of this reaction changed during the reaction. Explain why the rate changed in this way.

.....

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.....

.....

..... [4]

(ii) The experiment was repeated using the same mass of **powdered** magnesium carbonate with the same volume and concentration of dilute hydrochloric acid.

Explain how the initial rate of reaction and total volume of gas collected would compare to the first experiment.

initial rate of reaction .....

.....

.....

total volume of gas .....

.....

.....

[4]

(b) A piece of magnesium ribbon was cleaned. The experiment was repeated using this clean magnesium ribbon instead of magnesium carbonate.

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

This reaction is exothermic.
The rate of the reaction gradually increased over the first 2 minutes.

Explain why the rate of the reaction increased.

.....

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.....

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.....

.....

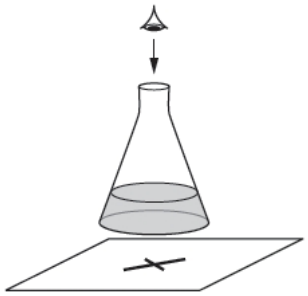
..... [5]

Q# 11/ IGCSE Chemistry/2016/s/Paper 41/

3 When aqueous sodium thiosulfate and dilute hydrochloric acid are mixed, a precipitate of insoluble sulfur is produced. This makes the mixture difficult to see through.

$$Na_2S_2O_3(aq) + 2HCl(aq) \rightarrow S(s) + 2NaCl(aq) + H_2O(l) + SO_2(g)$$

The time taken for the cross to disappear from view is measured.



A student adds the following volumes of aqueous sodium thiosulfate, dilute hydrochloric acid and distilled water to the conical flask.

The time taken for the formation of the precipitate of sulfur to make the cross disappear from view is recorded.

experiment number	volume of sodium thiosulfate / cm^3	volume of hydrochloric acid / cm^3	volume of distilled water / cm^3	time taken for cross to disappear from view / s
1	10	10	40	56
2	20	10	30	28
3				

(ii) Use collision theory to explain why increasing the concentration of sodium thiosulfate would change the rate of reaction.

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..... [2]

(c) The student repeated experiment 1 at a higher temperature.

Use collision theory to explain why the rate of reaction would increase.

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..... [3]

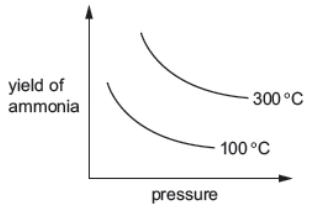
Q# 12/ IGCSE Chemistry/2016/w/Paper 41/

(b) Ammonia is also made when ammonium carbonate decomposes.

$$(NH_4)_2CO_3(s) \rightleftharpoons 2NH_3(g) + H_2O(g) + CO_2(g)$$

The reaction is reversible and can reach a position of equilibrium.

The graph shows how the yield of ammonia at equilibrium changes with temperature and pressure.



(i) What is meant by the term *equilibrium* for a reversible reaction?

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..... [2]

(iii) State and explain the effect of increasing the pressure on the yield of ammonia in this reaction.

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..... [3]

Q# 13/ IGCSE Chemistry/2016/m/Paper 42/

5 This question is about compounds of nitrogen.

(a) (i) Describe the Haber Process giving reaction conditions and a chemical equation. Reference to rate and yield is not required.

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..... [5]

Q# 14/ IGCSE Chemistry/2018/w/Paper 41/Q4

4 (a) Sulfuric acid is made industrially by a four-step process.

step 1 Sulfur is burned in air to produce sulfur dioxide.

step 2 Sulfur dioxide is converted into sulfur trioxide.

step 3 Sulfur trioxide is reacted with concentrated sulfuric acid to produce oleum.

step 4 Oleum is reacted with water to produce concentrated sulfuric acid.

(iii) Describe the conversion of sulfur dioxide into sulfur trioxide in **step 2**.

In your answer, include:
- a chemical equation for the reaction
- the essential reaction conditions.

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..... [5]

Q# 15/ IGCSE Chemistry/2016/s/Paper 41/

5 Sulfuric acid is produced by the Contact process. The steps of the Contact process are shown.

starting material —**step 1**→ sulfur dioxide —**step 2**→ sulfur trioxide —**step 3**→ oleum —**step 4**→ sulfuric acid

(b) Describe **step 2**, giving reaction conditions and a chemical equation. Reference to reaction rate and yield is not required.

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..... [5]

Extension Classroom Active Learning Tasks Dealing with Multi-mark Questions about Equilibria 84marks Mark Scheme

Q# 1/ IGCSE Chemistry/2018/w/Paper 43/

5(a)	**M1** volume of gas **M2** time	2
5(b)	**M1** rate decreases / reaction gets slower **M2** concentration of acid decreases **M3** fewer collisions per unit time	3
5(c)	**M1** particles have **more** kinetic energy **M2** particles move faster **M3 more** collisions **per unit time** **M4 more** of the particles have energy greater than or equal to activation energy / **more** of the collisions have energy greater than or equal to activation energy **OR** **more** of the particles have sufficient energy to react / **more** of the collisions have sufficient energy to react **OR** A greater percentage or greater proportion or greater fraction of collisions are successful	4

Q# 2/ IGCSE Chemistry/2018/w/Paper 42/

4(c)	M1 **Time** taken is less M2 (particles) have more energy M3 (particles) move faster M4 More collisions (of particles) occur per second / per unit time M5 More (of the) particles / collisions have energy greater than activation energy **or** More (of the) particles / collisions have sufficient energy to react **or** A greater percentage / proportion / fraction of collisions (of particles) are successful	5

Q# 3/ IGCSE Chemistry/2018/w/Paper 41/

5(d)(i)	**M1** Faster **and** More particles per unit volume / dm^3 / cm^3 **M2** More collisions per second / unit time or greater collision rate	2
5(d)(ii)	Reaction faster **and** (particles) have more energy **or** (particles) move faster	1
	more collisions per second **or** greater collision rate	1
	more (of the) particles / collisions have energy greater than the activation energy **or** more particles / collisions have sufficient energy to react **or** a greater percentage / proportion / fraction of collisions are successful	1

Q# 4/ IGCSE Chemistry/2018/s/Paper 43/

3(d)(iii)	(particles) have more energy / (particles) move faster	1
	more collisions per second / greater collision rate	1
	more of the colliding molecules have sufficient energy (activation energy) to react	1

Q# 5/ IGCSE Chemistry/2017/w/Paper 43/

5(b)(i)	reversible reaction in which the **rate** of the forward reaction **equals** the **rate** of the backward reaction	1
	concentration of all reactants and products becomes constant / does not change	1
5(b)(ii)	forward reaction is endothermic	1
	(increased temperature) causes equilibrium to shift to the right / to shift in the endothermic direction / to form more nitrogen dioxide / to form more product(s)	1
5(b)(iii)	less brown / lighter / paler / colour fades	1
	more molecules / moles / volume on the right ORA OR equilibrium shifts in the direction of **fewer** molecules / moles / lower volume	1

Q# 6/ IGCSE Chemistry/2017/w/Paper 42/

5(a)	both colours referred to correctly as observations in both parts of the answer	1
	(if sulfuric acid is added to solution Y,) equilibrium moves to the right-hand side	1
	because the concentration of acid has increased	1
	(if sodium hydroxide is added to solution Y,) equilibrium moves to the left-hand side	1
	because sodium hydroxide reacts with / neutralises sulfuric acid	1
5(b)(ii)	fewer moles / molecules / particles (of gas) on the left-hand side	1
5(b)(iii)	endothermic	1
5(b)(iv)	increases rate (of reaction)	1

Q# 7/ IGCSE Chemistry/2017/w/Paper 41/Q5

5(c)(i)	becomes paler	1
	equilibrium moves right	1
	(because) fewer moles (of gas) on right	1
5(c)(ii)	equilibrium moved right / more N_2O_4 / less NO_2	1
	(forward) reaction exothermic	1

Q# 8/ IGCSE Chemistry/2017/w/Paper 41/

7(a)(i)	more particles (of acid) in a given volume / dm^3 / cm^3	1
	more collisions per second / unit time OR greater collision rate	1
7(a)(ii)	particles have more energy / particles move faster / more collisions per second / more collisions per unit time / greater collision rate	1
	more (of the) particles / collisions have energy greater than the activation energy / more particles have sufficient energy to react / more collisions have sufficient energy to react / a greater percentage of collisions are successful	1

Q# 9/ IGCSE Chemistry/2017/s/Paper 41/

5(d)	curve starts from (0,0) and has a lower gradient than the original curve	1
	because lumps have a lower surface area	1

5(d)	curve starts from (0,0) and has a lower gradient than the original curve	1
	because lumps have a lower surface area	1

Q# 10/ IGCSE Chemistry/2016/w/Paper 41/

8(a)(i)	any 4 from: slowed down acid became less concentrated OR fewer particles per unit volume fewer collisions per second OR lower collision rate (then the reaction) stopped all the hydrochloric acid reacted	4
8(a)(ii)	any 4 from: faster (reaction) (powder has) larger surface area more collisions per second OR higher collision rate same volume of gas amount/moles hydrochloric acid is not changed	4
8(b)	any 5 from: temperature increased particles have more energy (particles) move faster more collisions per second OR higher collision rate more particles have sufficient energy to react/activation energy more of the collisions are successful	5

Q# 11/ IGCSE Chemistry/2016/s/Paper 41/

3(b)(ii)	**M1** more particles per unit volume/particles are closer together; **M2** increases the rate of collisions/there are more collisions per unit time;	2 1 1
3(c)	**M1** particles gain more energy **and** move faster; **M2** increasing rate of collisions/more collisions per unit time; **M3** higher proportion of particles have sufficient energy to react/collisions have sufficient energy to react/are above the activation energy;	3 1 1 1

Q# 12/ IGCSE Chemistry/2016/w/Paper 41/

4(b)(i)	**M1** forward and reverse reactions (occur) **M2** amounts/moles/concentrations (of reagents and products) constant OR **M2** rate of forward and reverse reactions equal	1 1
4(b)(ii)	endothermic **AND** yield increases as temperature increases	1
4(b)(iii)	**M1** yield decreases (as pressure increases) **M2** because more moles/molecules (of gas) on the right **M3** so position of equilibrium moves left	1 1 1

Q# 13/ IGCSE Chemistry/2016/m/Paper 42/

5(a)(i)	pressure in range 150–300 atmospheres/atm; temperature in range 370–470 °C; iron (catalyst); balanced equation: $N_2 + 3H_2 \rightarrow 2NH_3$; equilibrium/reversible;	5

Q# 14/ IGCSE Chemistry/2018/w/Paper 41/

4(a)(iii)	**M1** vanadium pentoxide **or** vanadium(V) oxide **or** V_2O_5 (catalyst);	1
	M2 1–5 atmospheres; (Units required)	1
	M3 450°C; units required	1
	M4 $2SO_2 + O_2 \rightarrow 2SO_3$;	1
	M5 equilibrium / reversible reaction in equation or text	1

Q# 15/ IGCSE Chemistry/2016/s/Paper 41/

5(b)	**M1** vanadium pentoxide/vanadium(V) oxide/V_2O_5 (catalyst); **M2** 1–5 atmospheres (units required); **M3** 450°C (units required); **M4** $2SO_2 + O_2 \rightarrow 2SO_3$; **M5** equilibrium/reversible reaction;	5 1 1 1 1 1

10.8 ESSENTIAL EXAM QUESTIONS Paper 2 Topic 7.3

Topic Chem 7 **Q# 1/** iGCSE Chemistry/2016/s/Paper 23/

16 Methanol is manufactured by reacting carbon monoxide and hydrogen together in the presence of an aluminium oxide catalyst.

The equation for the reaction is shown.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

The reaction is a reversible reaction.

The forward reaction is exothermic.

Which change in conditions increases the yield of methanol?

A decreasing the concentration of the carbon monoxide

B increasing the pressure

C increasing the rate of the reaction

D increasing the temperature

Topic Chem 7 **Q# 2/** iGCSE Chemistry/2016/s/Paper 22/

16 Methanol is made by reacting carbon monoxide with hydrogen.

The reaction is exothermic and is a chemical equilibrium.

The equation for the reaction is shown.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

Which changes in temperature and pressure increase the yield of methanol?

	temperature	pressure
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

Topic Chem 7 **Q# 3/** iGCSE Chemistry/2016/s/Paper 21/

16 Steam reacts with carbon in an endothermic reaction.

$$C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g)$$

Which conditions of temperature and pressure would give the largest yield of hydrogen?

	temperature	pressure
A	high	high
B	high	low
C	low	high
D	low	low

Topic Chem 7 **Q# 4/** iGCSE Chemistry/2016/m/Paper 22/

14 A reversible reaction is shown.

$$2NO_2(g) \rightleftharpoons N_2O_4(g) \qquad \Delta H = -58\ kJ/mol$$

Which statement about an equilibrium mixture of NO_2 and N_2O_4 is correct?

A If the pressure is decreased the amount of N_2O_4 increases.

B If the temperature is increased the amount of N_2O_4 increases.

C The rates of formation and decomposition of N_2O_4 are not the same.

D The decomposition of N_2O_4 is an endothermic reaction.

Topic Chem 11 **Q# 5/** iGCSE Chemistry/2018/w/Paper 23/

28 Ammonia is manufactured by the Haber process from nitrogen and hydrogen.

Which row gives the main sources of these two gases?

	hydrogen	nitrogen
A	air	air
B	air	natural gas
C	natural gas	air
D	natural gas	natural gas

Topic Chem 11 **Q# 6/** iGCSE Chemistry/2018/w/Paper 22/

28 Which statement about the Haber process is correct?

A The hydrogen used is obtained from the air.

B The nitrogen used is obtained from nitrates in the soil.

C Nitrogen reacts with hydrogen to make ammonia.

D The reaction takes place at room temperature and pressure.

Topic Chem 11 **Q# 7/** iGCSE Chemistry/2018/w/Paper 21/

28 Which statement describes the role of iron in the Haber process?

A It is used as a catalyst.

B It is used as a reducing agent.

C It is used to condense the ammonia gas into a liquid.

D It is used to increase the yield of ammonia.

Topic Chem 11 **Q# 8/** iGCSE Chemistry/2018/s/Paper 21/

31 Ammonia is manufactured by reacting hydrogen with nitrogen in the Haber process.

Which row describes the sources of hydrogen and nitrogen and the conditions used in the manufacture of ammonia in the Haber process?

	source of hydrogen	source of nitrogen	temperature of reaction / °C	pressure of reaction / atm
A	air	natural gas	250	2
B	air	natural gas	250	200
C	natural gas	air	450	2
D	natural gas	air	450	200

Topic Chem 11 **Q# 9/** iGCSE Chemistry/2018/m/Paper 22/

33 The raw materials for the Haber process are hydrogen and nitrogen.

What are the sources of the hydrogen and nitrogen?

A hydrogen from ethanol and nitrogen from NPK fertilisers

B hydrogen from methane and nitrogen from air

C hydrogen from sulfuric acid and nitrogen from air

D hydrogen from water and nitrogen from ammonium nitrate

Topic Chem 11 **Q# 10/** iGCSE Chemistry/2017/w/Paper 23/

31 The Haber process for making ammonia is carried out at a temperature of 450 °C and a pressure of 200 atmospheres in the presence of a catalyst.

Which statement is **not** correct?

A Lowering the pressure increases the rate at which ammonia is produced.

B Lowering the temperature slows down the rate at which ammonia is produced.

C Maintaining a very high pressure is very difficult and needs expensive equipment.

D The reaction is a reversible reaction which can proceed forwards and backwards.

Topic Chem 11 **Q# 11/** iGCSE Chemistry/2017/w/Paper 21/

31 Ammonia is made by the Haber process.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

What are the sources of the nitrogen and hydrogen used in the Haber process?

	nitrogen	hydrogen
A	fertilisers	reacting methane with steam
B	fertilisers	the air
C	the air	reacting methane with steam
D	the air	the air

Topic Chem 11 **Q# 12/** iGCSE Chemistry/2017/s/Paper 23/

31 Which row gives the catalyst for the Haber process and the sources of the raw materials?

	catalyst	source of hydrogen	source of nitrogen
A	iron	electrolysis	fertiliser
B	iron	methane	air
C	vanadium pentoxide	methane	air
D	vanadium pentoxide	methane	fertiliser

Topic Chem 11 **Q# 13/** iGCSE Chemistry/2017/s/Paper 22/

31 Which statement about the conditions used in the Haber process is **not** correct?

A A high temperature is used because the forward reaction is exothermic.

B A high pressure is used because there are fewer moles of gas in the products than in the reactants.

C An iron catalyst is used to increase the rate of the forward reaction.

D The unreacted hydrogen and nitrogen are recycled to increase the amount of ammonia produced.

Topic Chem 11 **Q# 14/** iGCSE Chemistry/2017/s/Paper 21/

32 Which row gives the conditions for the Haber process?

	temperature / °C	pressure / atm	catalyst
A	200	2	V_2O_5
B	200	450	Fe
C	450	200	Fe
D	500	250	V_2O_5

Topic Chem 11 **Q# 15/** iGCSE Chemistry/2016/w/Paper 23/

32 The Haber process for the manufacture of ammonia occurs at 450 °C and 250 atmospheres. The nitrogen and hydrogen are supplied in a 1:3 ratio by volume. The reaction is exothermic.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92\ \text{kJ/mol}$$

Which change causes an increase in the yield of ammonia?

A decreasing the concentration of nitrogen

B decreasing the pressure

C decreasing the temperature

D using equal amounts of the two reactants

Topic Chem 11 **Q# 16/** iGCSE Chemistry/2016/w/Paper 22/

32 Ammonia is manufactured by the Haber process, using an iron catalyst.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

It is not possible to obtain 100% yield.

What is the reason for this?

A A high pressure is used.

B Ammonia decomposes at high temperature.

C Some of the ammonia is recycled.

D The ammonia reacts with the catalyst.

Topic Chem 11 **Q# 17/** iGCSE Chemistry/2016/w/Paper 21/

32 Ammonia is manufactured by the Haber process. The reaction is exothermic.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92\ \text{kJ/mol}$$

Which statement about the Haber process is correct?

A The reaction is irreversible and produces only one product.

B The reaction is reversible and produces less ammonia at high pressure.

C The reaction is reversible and produces less ammonia at high temperature.

D The reaction is slow because a catalyst is not used in the Haber process.

Topic Chem 11 **Q# 18/** iGCSE Chemistry/2016/s/Paper 23/

32 Ammonia is produced by the Haber process.

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g).$$

Which statement about the Haber process is **not** correct?

A An iron catalyst is used to increase the rate of reaction.

B The reaction is carried out at high temperature to increase the rate of reaction.

C The reaction is carried out at low pressure to increase the yield of ammonia.

D The reaction is reversible.

Topic Chem 11 **Q# 19/** iGCSE Chemistry/2016/s/Paper 22/

32 Ammonia is manufactured by a reversible reaction.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

The forward reaction is exothermic.

What is the effect of increasing the pressure on the percentage yield and rate of formation of ammonia?

	percentage yield	rate of formation
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

Topic Chem 11 **Q# 20/** iGCSE Chemistry/2016/s/Paper 21/

32 Ammonia is formed by a reversible reaction.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

The forward reaction is exothermic.

Which changes in conditions would increase the yield of ammonia?

	increase in pressure	increase in temperature
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

Topic Chem 11 **Q# 21/** iGCSE Chemistry/2016/s/Paper 21/

34 A farmer's soil is very low in both nitrogen (N) and phosphorus (P).

Which fertiliser would improve the quality of this soil most effectively?

	percentage		
	nitrogen (N)	phosphorus (P)	potassium (K)
A	11	11	27
B	12	37	10
C	28	10	10
D	31	29	9

Topic Chem 11 **Q# 22/** iGCSE Chemistry/2016/m/Paper 22/

32 Fertilisers are used to provide three elements needed to increase the yield of crops.

Which two compounds would provide all three of these elements?

A ammonium nitrate and calcium phosphate

B ammonium nitrate and potassium sulfate

C potassium nitrate and calcium phosphate

D potassium nitrate and potassium sulfate

Topic Chem 12 **Q# 23/** iGCSE Chemistry/2018/w/Paper 21/

33 Which statement about sulfur or one of its compounds is correct?

A Sulfur occurs naturally as the element sulfur.

B Sulfur dioxide is used to kill bacteria in drinking water.

C Sulfuric acid is a weak acid.

D Dilute sulfuric acid is a dehydrating agent.

Topic Chem 12 **Q# 24/** iGCSE Chemistry/2018/s/Paper 23/

15 In the Contact process, sulfur dioxide is converted into sulfur trioxide in a reversible reaction.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The forward reaction is exothermic.

Which conditions give the highest yield of sulfur trioxide at equilibrium?

	pressure / atmospheres	temperature
A	0.5	high
B	0.5	low
C	1.5	high
D	1.5	low

Topic Chem 12 **Q# 25/** iGCSE Chemistry/2018/s/Paper 23/

33 Element Z forms an oxide, ZO_2. Three uses of ZO_2 are listed.

- bleaching agent
- killing bacteria
- manufacturing an important acid

What is Z?

A carbon

B lead

C nitrogen

D sulfur

Topic Chem 12 **Q# 26/** iGCSE Chemistry/2018/s/Paper 22/

15 Sulfur dioxide reacts with oxygen at 2 atmospheres pressure. The forward reaction is exothermic.

The equation for the reaction is shown.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The reaction reaches equilibrium. The pressure is then doubled.

How and why does the amount of sulfur trioxide formed change?

	amount of sulfur trioxide	reason
A	decreases	the forward reaction is exothermic
B	decreases	there are fewer molecules on the right
C	increases	the forward reaction is exothermic
D	increases	there are fewer molecules on the right

Topic Chem 12 **Q# 27/** iGCSE Chemistry/2018/s/Paper 22/

33 Which row describes the uses of sulfur and sulfur dioxide?

	sulfur	sulfur dioxide
A	extraction of aluminium	food preservative
B	extraction of aluminium	water treatment
C	manufacture of sulfuric acid	food preservative
D	manufacture of sulfuric acid	water treatment

Topic Chem 12 **Q# 28/** iGCSE Chemistry/2018/s/Paper 21/

33 Which statement about sulfur and its compounds is **not** correct?

A Sulfur dioxide is used as a food preservative.

B Sulfur dioxide turns acidified aqueous potassium manganate(VII) from purple to colourless.

C Sulfur forms a basic oxide.

D Sulfur is used in the manufacture of sulfuric acid.

Topic Chem 12 **Q# 29/** iGCSE Chemistry/2018/m/Paper 22/

35 The Contact process is used to make sulfuric acid.

The steps in the process are listed.

1 Dissolve sulfur trioxide in 98% concentrated sulfuric acid.

2 Heat sulfur strongly in air.

3 Add oleum to water.

4 Pass sulfur dioxide over a vanadium(V) oxide catalyst.

Which sequence of steps is correct?

A $4 \rightarrow 1 \rightarrow 2 \rightarrow 3$

B $4 \rightarrow 2 \rightarrow 3 \rightarrow 1$

C $2 \rightarrow 1 \rightarrow 4 \rightarrow 3$

D $2 \rightarrow 4 \rightarrow 1 \rightarrow 3$

Topic Chem 12 **Q# 30/** iGCSE Chemistry/2017/w/Paper 21/

33 Which row shows the conditions used in the manufacture of sulfuric acid by the Contact process?

	temperature / °C	pressure / atm	catalyst
A	40	200	Fe
B	40	200	V_2O_5
C	400	2	Fe
D	400	2	V_2O_5

Topic Chem 12 **Q# 31/** iGCSE Chemistry/2017/s/Paper 21/

33 Which statement about sulfuric acid is correct?

A It is made by the Haber process.

B It is made in the atmosphere by the action of lightning.

C It reacts with ammonia to produce a fertiliser.

D It reacts with copper metal to produce hydrogen gas.

Topic Chem 12 **Q# 32/** iGCSE Chemistry/2017/m/Paper 22/

33 The ions present in ammonium sulfate are formed from the products of the Contact and Haber processes.

Both of these processes involve the use of a catalyst.

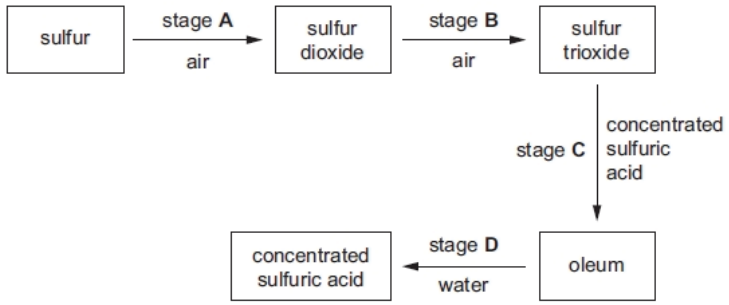
Which row is correct?

	ion	formed from	process	catalyst
A	ammonium	ammonia	Contact	iron
B	ammonium	ammonia	Haber	vanadium(V) oxide
C	sulfate	sulfuric acid	Contact	vanadium(V) oxide
D	sulfate	sulfuric acid	Haber	iron

Topic Chem 12 **Q# 33/** iGCSE Chemistry/2016/w/Paper 23/

33 The following scheme shows four stages in the conversion of sulfur to sulfuric acid.

In which stage is a catalyst used?



Topic Chem 12 **Q# 34/** iGCSE Chemistry/2016/w/Paper 22/

33 Sulfuric acid is manufactured by a series of chemical reactions, one of which is catalysed by vanadium(V) oxide.

What is the equation for the reaction catalysed by vanadium(V) oxide?

A $S + O_2 \rightarrow SO_2$

B $2S + 3O_2 \rightarrow 2SO_3$

C $2SO_2 + O_2 \rightarrow 2SO_3$

D $SO_3 + H_2O \rightarrow H_2SO_4$

Topic Chem 12 **Q# 35/** iGCSE Chemistry/2016/w/Paper 21/

33 Sulfuric acid is manufactured by the Contact process.

The most important reaction takes place in the presence of a catalyst.

What are the reactants and the catalyst for this reaction?

	reactants	catalyst
A	sulfur and oxygen	vanadium(V) oxide
B	sulfur dioxide and oxygen	vanadium(V) oxide
C	sulfur dioxide and steam	iron
D	sulfur trioxide and water	platinum

Topic Chem 12 **Q# 36/** iGCSE Chemistry/2016/s/Paper 23/

33 One step in the manufacture of sulfuric acid is the oxidation of sulfur dioxide to sulfur trioxide.

Which conditions are used for this step?

	temperature /°C	pressure /atmospheres	catalyst
A	450	1.5	iron
B	450	1.5	vanadium(V) oxide
C	450	200	iron
D	450	200	vanadium(V) oxide

Topic Chem 12 **Q# 37/** iGCSE Chemistry/2016/s/Paper 22/

33 The Contact process is used for the manufacture of sulfuric acid.

Which statement about this process is **not** correct?

A A catalyst of iron is used.

B Oxygen from the air is used to react with sulfur dioxide.

C Sulfur trioxide dissolves in sulfuric acid to form oleum.

D The temperature used is around 450 °C.

Topic Chem 12 **Q# 38/** iGCSE Chemistry/2016/s/Paper 21/

33 The equation for an exothermic reaction in the Contact process is shown.

$$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$$

Which effects do increasing the temperature and using a catalyst have on the rate of formation of sulfur trioxide, SO_3?

	increasing the temperature	using a catalyst
A	rate decreases	rate decreases
B	rate decreases	rate increases
C	rate increases	rate decreases
D	rate increases	rate increases

Topic Chem 12 **Q# 39/** iGCSE Chemistry/2016/m/Paper 22/

33 What is a property of concentrated sulfuric acid but **not** of dilute sulfuric acid?

A It is a dehydrating agent.

B It neutralises alkalis.

C It produces a white precipitate with barium nitrate.

D It reacts with metals to give a salt and hydrogen.

10.8.1 ESSENTIAL EXAM QUESTIONS Paper 2 Topic 7.3 Mark Scheme

Q# 1/ iGCSE Chemistry/2016/s/Paper 23/
16 **B**

Q# 2/ iGCSE Chemistry/2016/s/Paper 22/
16 **B**

Q# 3/ iGCSE Chemistry/2016/s/Paper 21/
16 **B**

Q# 4/ iGCSE Chemistry/2016/m/Paper 22/
14 **D**

Q# 5/ iGCSE Chemistry/2018/w/Paper 23/

28	C

Q# 6/ iGCSE Chemistry/2018/w/Paper 22/

28	C

Q# 7/ iGCSE Chemistry/2018/w/Paper 21/

28	A

Q# 8/ iGCSE Chemistry/2018/s/Paper 21/

31	D

Q# 9/ iGCSE Chemistry/2018/m/Paper 22/

33	B

Q# 10/ iGCSE Chemistry/2017/w/Paper 23/

31	A

Q# 11/ iGCSE Chemistry/2017/w/Paper 21/

31	C

Q# 12/ iGCSE Chemistry/2017/s/Paper 23/

31	B

Q# 13/ iGCSE Chemistry/2017/s/Paper 22/

31	A

Q# 14/ iGCSE Chemistry/2017/s/Paper 21/

32	C

Q# 15/ iGCSE Chemistry/2016/w/Paper 23/
32 **C**

Q# 16/ iGCSE Chemistry/2016/w/Paper 22/
32 **B**

Q# 17/ iGCSE Chemistry/2016/w/Paper 21/
32 **C**

Q# 18/ iGCSE Chemistry/2016/s/Paper 23/
32 **C**

Q# 19/ iGCSE Chemistry/2016/s/Paper 22/
32 **D**

Q# 20/ iGCSE Chemistry/2016/s/Paper 21/
32 **B**

Q# 21/ iGCSE Chemistry/2016/s/Paper 21/
34 **D**

Q# 22/ iGCSE Chemistry/2016/m/Paper 22/
32 **C**

Q# 23/ iGCSE Chemistry/2018/w/Paper 21/

29	A

Q# 24/ iGCSE Chemistry/2018/s/Paper 23/

15	D

Q# 25/ iGCSE Chemistry/2018/s/Paper 23/

33	D

Q# 26/ iGCSE Chemistry/2018/s/Paper 22/

15	D

Q# 27/ iGCSE Chemistry/2018/s/Paper 22/

33	C

Q# 28/ iGCSE Chemistry/2018/s/Paper 21/

29	C

Q# 29/ iGCSE Chemistry/2018/m/Paper 22/

35	D

Q# 30/ iGCSE Chemistry/2017/w/Paper 21/

33	D

Q# 31/ iGCSE Chemistry/2017/s/Paper 21/

33	C

Q# 32/ iGCSE Chemistry/2017/m/Paper 22/

33	C

Q# 33/ iGCSE Chemistry/2016/w/Paper 23/
33 **B**

Q# 34/ iGCSE Chemistry/2016/w/Paper 22/
33 **C**

Q# 35/ iGCSE Chemistry/2016/w/Paper 21/
33 **B**

Q# 36/ iGCSE Chemistry/2016/s/Paper 23/
33 **B**

Q# 37/ iGCSE Chemistry/2016/s/Paper 22/
33 **A**

Q# 38/ iGCSE Chemistry/2016/s/Paper 21/
33 **D**

Q# 39/ iGCSE Chemistry/2016/m/Paper 22/
33 **A**
34 **C**

10.9 ESSENTIAL EXAM QUESTIONS Paper 3/4 Topic 7.3 56 marks

Topic Chem 7.3 **Q# 1/** iGCSE Chemistry/2011/w/Paper 31/

4 Reversible reactions can come to equilibrium. The following are three examples of types of gaseous equilibria.

$A_2(g) + B_2(g) \rightleftharpoons 2AB(g)$ **reaction 1**

$A_2(g) + 3B_2(g) \rightleftharpoons 2AB_3(g)$ **reaction 2**

$2AB_2(g) \rightleftharpoons 2AB(g) + B_2(g)$ **reaction 3**

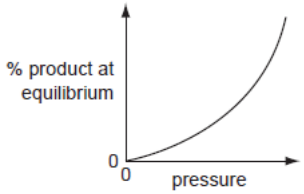
(a) Explain the term *equilibrium*.

.....

..... [2]

(b) The following graphs show how the percentage of products of a reversible reaction at equilibrium could vary with pressure.
For each graph, decide whether the percentage of products decreases, increases or stays the same when the pressure is **increased**, then match each graph to one of the above reactions and give a reason for your choice.

(i)



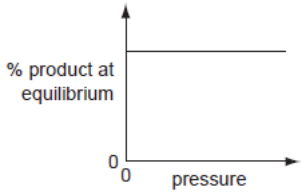
effect on percentage of products .....

reaction .....

reason .....

..... [3]

(ii)



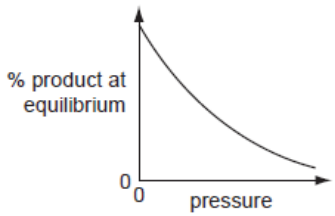
effect on percentage of products .....

reaction .....

reason .....

..... [3]

(iii)



effect on percentage of products .....

reaction .....

reason .....

..... [3]

Topic Chem 7.3 **Q# 2/** iGCSE Chemistry/2010/s/Paper 31/

6 Iodine reacts with chlorine to form dark brown iodine monochloride.

$$I_2 + Cl_2 \rightarrow 2ICl$$

This reacts with more chlorine to give yellow iodine trichloride.
There is an equilibrium between these iodine chlorides.

$$ICl(l) + Cl_2(g) \rightleftharpoons ICl_3(s)$$

dark brown yellow

(a) Explain what is meant by *equilibrium*.

.....

.....

..... [2]

(b) When the equilibrium mixture is heated it becomes a darker brown colour.
Is the reverse reaction endothermic or exothermic? Give a reason for your choice.

.....

.....

..... [2]

(c) The pressure on the equilibrium mixture is decreased.

(i) How would this affect the position of equilibrium and why?

It would move to the ..... [1]

reason .....

..... [1]

(ii) Describe what you would observe.

.....

..... [1]

Topic Chem 7.3 **Q# 3/** iGCSE Chemistry/2009/w/Paper 3/ Q6

(b) Sulfuric acid was first made in the Middle East by heating the mineral, green vitriol, $FeSO_4.7H_2O$. The gases formed were cooled.

$FeSO_4.7H_2O(s) \rightarrow FeSO_4(s) + 7H_2O(g)$
green crystals yellow powder

$2FeSO_4(s) \rightarrow Fe_2O_3(s) + SO_2(g) + SO_3(g)$

On cooling

$SO_3 + H_2O \rightarrow H_2SO_4$ sulfuric acid
$SO_2 + H_2O \rightarrow H_2SO_3$ sulfurous acid

(i) How could you show that the first reaction is reversible?

.....

..... [2]

Topic Chem 7.3 **Q# 4/** iGCSE Chemistry/2008/s/Paper 31/

5 Carbonyl chloride, $COCl_2$, is a colourless gas. It is made by the following reaction.

$$CO(g) + Cl_2(g) \underset{\text{heat}}{\overset{\text{cool}}{\rightleftharpoons}} COCl_2(g)$$

(a) When the pressure on the equilibrium mixture is decreased, the position of equilibrium moves to left.

(i) How does the concentration of each of the three chemicals change?

.....

..... [2]

(ii) Explain why the position of equilibrium moves to left.

.....

..... [2]

(b) Using the information given with the equation, is the forward reaction exothermic or endothermic? Give a reason for your choice.

.....

..... [2]

Topic Chem 7.3 **Q# 5/** iGCSE Chemistry/2007/w/Paper 3/ Q6

(c) Methanol is made from carbon monoxide.

$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$ the forward reaction is exothermic

(iii) Which condition, high or low pressure, would give the maximum yield of methanol? Give a reason for your choice.

pressure .....

reason ..... [2]

Topic Chem 7.3 **Q# 6/** iGCSE Chemistry/2005/w/Paper 3/ Q3

(b) Both of the following reactions are reversible.

reaction 1 $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$

reaction 2 $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$

(i) Suggest a reason why an increase in pressure does not affect the position of equilibrium for reaction 1.

..... [1]

(ii) What effect would an increase in pressure have on the position of equilibrium for reaction 2? Give a reason for your answer.

.....

..... [2]

Topic Chem 7.3 **Q# 7/** iGCSE Chemistry/2005/w/Paper 3/

3 Reversible reactions can come to equilibrium. They have both a forward and a backward reaction.

(a) When water is added to an acidic solution of bismuth(III) chloride, a white precipitate forms and the mixture slowly goes cloudy.

$$\underset{\text{colourless}}{BiCl_3(aq)} + H_2O(l) \underset{\text{backward}}{\overset{\text{forward}}{\rightleftharpoons}} \underset{\text{white}}{BiOCl(s)} + 2HCl(aq)$$

(i) Explain why the rate of the forward reaction decreases with time.

.....

..... [2]

(ii) Why does the rate of the backward reaction increase with time?

.....

..... [1]

(iii) After some time why does the appearance of the mixture remain unchanged?

.....

..... [2]

(iv) When a few drops of concentrated hydrochloric acid are added to the cloudy mixture, it changes to a colourless solution. Suggest an explanation.

.....

..... [2]

Topic Chem 7.3 **Q# 8/** iGCSE Chemistry/2004/w/Paper 3/

3 The simplest alcohol is methanol.

(a) It is manufactured by the following reversible reaction.

$$CO\,(g) + 2H_2\,(g) \underset{\substack{300\,^\circ C \\ 30atm}}{\rightleftharpoons} CH_3OH\,(g)$$

(i) Reversible reactions can come to equilibrium. Explain the term *equilibrium*.

.....

[1]

(ii) At 400 °C, the percentage of methanol in the equilibrium mixture is lower than at 300 °C. Suggest an explanation.

.....

[2]

(iii) Suggest two advantages of using high pressure for this reaction.
Give a reason for each advantage.

advantage	.....
reason	.....

advantage	.....
reason	..... [5]

Topic Chem 7.3 **Q# 9/** iGCSE Chemistry/2001/w/Paper 3/ QiGCSE Chemistry/201

(b) Carbon monoxide is used to purify nickel. Nickel reacts with carbon monoxide to form a gaseous compound.

$$Ni(s) + 4CO(g) \rightleftharpoons Ni(CO)_4(g) \qquad \text{forward reaction is exothermic}$$

(i) What reaction condition will favour the back reaction and reform nickel metal? Explain your choice.

.....

.....[2]

10.10 ESSENTIAL EXAM QUESTIONS Paper 3/4 Haber process and nitrogen chemistry (Topic 11.1) 63 Marks

Topic Chem 11.3 **Q# 1/** iGCSE Chemistry/2013/w/Paper 31/

3 Ammonia is manufactured by the Haber process.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

The forward reaction is exothermic.

(a) Describe how the reactants are obtained.

(i) Nitrogen

.....

..... [2]

(ii) Hydrogen

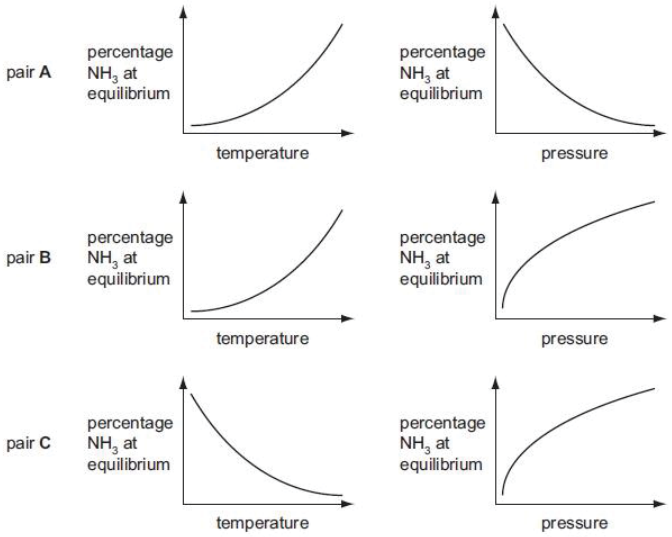
.....

.....

..... [3]

(b) The percentage of ammonia in the equilibrium mixture varies with temperature and pressure.

(i) Which pair of graphs, **A**, **B** or **C**, shows correctly how the percentage of ammonia at equilibrium varies with temperature and pressure?



The pair with **both graphs correct** is ..... [1]

(ii) Give a full explanation of why the pair of graphs you have chosen in **(i)** is correct.

.....

.....

.....

.....

.....

.....

..... [6]

(iii) Catalysts do not alter the position of equilibrium. Explain why a catalyst is used in this process.

.....

.....

.....

..... [2]

Topic Chem 11.3 **Q# 2/** iGCSE Chemistry/2013/s/Paper 31/ Q6

(b) Ammonia is manufactured by the Haber Process. The economics of this process require that as much ammonia as possible is made as quickly as possible.
Explain how this can be done using the following information.

The conditions for the following reversible reaction are:

- 450 °C
- 200 atmospheres pressure
- iron catalyst

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \quad \text{the reaction is exothermic}$$

.....

.....

.....

.....

.....

..... [5]

(b) Ammonia is made by the Haber Process.

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ forward reaction is exothermic

The percentage of ammonia in the equilibrium mixture varies with conditions.

pressure / atmospheres	100	200	300	400
% ammonia at 300 °C	45	65	72	78
% ammonia at 500 °C	9	18	25	31

The conditions actually used are 200 atmospheres, 450 °C and an iron catalyst.

(i) The original catalyst was platinum. Suggest a reason why it was changed to iron.

..... [1]

(ii) Explain why the highest pressure gives the highest percentage of ammonia in the equilibrium mixture.

.....

..... [2]

(iii) What happens to the unreacted nitrogen and hydrogen?

.....

..... [1]

(iv) State **one** advantage and **one** disadvantage of using a lower temperature.

advantage .....

..... [1]

disadvantage .....

..... [1]

6 Ammonia is manufactured by the Haber process.

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ the forward reaction is exothermic

(a) (i) Name the raw materials from which nitrogen and hydrogen are obtained.

nitrogen from ..... [1]

hydrogen from ..... [1]

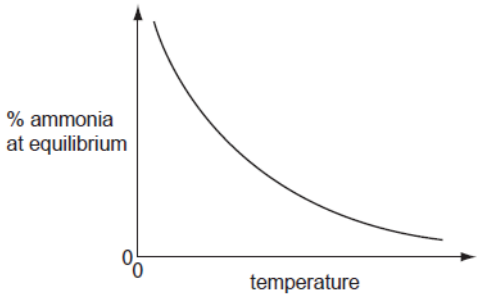
(ii) Name the catalyst used in this process.

..... [1]

(iii) What is the most important use of ammonia?

..... [1]

(b) The following graph shows how the percentage of ammonia in the equilibrium mixture changes with temperature.



(i) Explain the term *equilibrium*.

.....

.....

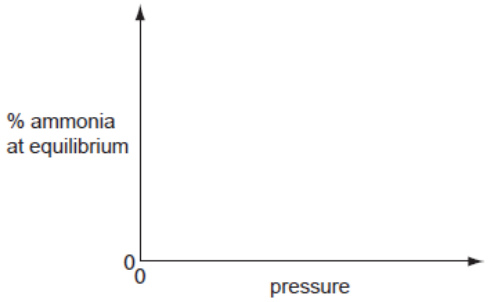
.....

..... [2]

(ii) How does the percentage of ammonia vary with temperature?

..... [1]

(c) (i) Sketch a graph which shows how the percentage of ammonia in the equilibrium mixture varies with pressure.



[1]

(ii) Explain why the graph has the shape shown.

.....

.....

..... [2]

Topic Chem 11.3 **Q# 5/** iGCSE Chemistry/2008/w/Paper 31/ Q5b

(ii) Name an important chemical that is made from hydrogen.

..... [1]

Topic Chem 11.3 **Q# 6/** iGCSE Chemistry/2008/s/Paper 31/

8 Large areas of the Amazon rain forest are cleared each year to grow soya beans. The trees are cut down and burnt.

(a) Why do these activities increase the percentage of carbon dioxide in the atmosphere?

.....

..... [2]

Topic Chem 11.3 **Q# 7/** iGCSE Chemistry/2006/w/Paper 3/

5 Ammonia is manufactured by the Haber Process.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

200 atmospheres
450°C

The forward reaction is exothermic.

(a) (i) What is the catalyst for this reaction?

..... [1]

(ii) Newer catalysts have been discovered for this process. Using these catalysts, the operating temperature is lowered from 450°C to 400°C. What is the advantage of using a lower temperature?
Explain your answer.

advantage .....

explanation .....

..... [2]

(b) After passing over the catalyst, the mixture contains 15% of ammonia. It is cooled and the ammonia liquefies and is separated from the unreacted nitrogen and hydrogen. They are recycled.

(i) How are the gases recycled?

..... [1]

(ii) Only ammonia gas liquefies. Suggest an explanation for this.

..... [1]

(c) Urea, $CO(NH_2)_2$, is one of the fertilisers manufactured from ammonia.
Ammonia is heated with carbon dioxide.

(i) Write an equation for the manufacture of urea.

..... [2]

(ii) Explain why urea on its own might not be very effective in promoting crop growth.

..... [1]

Topic Chem 11.3 **Q# 8/** iGCSE Chemistry/2005/w/Paper 3/

7 In 1909, Haber discovered that nitrogen and hydrogen would react to form ammonia. The yield of ammonia was 8%.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$ the forward reaction is exothermic

catalyst platinum
temperature 600 °C
pressure 200 atm

(a) Describe how hydrogen is obtained for the modern process.

.....

..... [2]

(b) **(i)** What is the catalyst in the modern process?

..... [1]

(ii) Explain why the modern process, which uses a lower temperature, has a higher yield of 15%.

.....

..... [2]

Topic Chem 11.3 **Q# 9/** iGCSE Chemistry/2004/s/Paper 3/ Q2

(b) About one third of this production of acid is used to make nitrogen and phosphorus-containing fertilisers.

(i) Name the third element that is essential for plant growth and is present in most fertilisers.

..... [1]

(ii) Name a nitrogen-containing fertiliser that is manufactured from sulphuric acid.

..... [1]

Topic Chem 11.3 **Q# 10/** iGCSE Chemistry/2003/w/Paper 3/

1 Ammonia contains the elements nitrogen and hydrogen. It is manufactured from these elements in the Haber process.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

The forward reaction is exothermic.

(ii) Name **two** raw materials from which hydrogen is manufactured.

..... [2]

(b) The table shows how the percentage of ammonia in the equilibrium mixture varies with pressure at 600 °C.

percentage ammonia	8	12	15	20
pressure/atm	200	300	400	500

(i) Explain why the percentage of ammonia increases as the pressure increases.

.....

.....[2]

(ii) How would the percentage of ammonia change if the measurements had been made at a lower temperature?
Explain your answer.

.....

.....

.....[2]

(iii) State **two** of the reaction conditions used in the Haber Process.

.....

.....[2]

Topic Chem 11.3 **Q# 11/** iGCSE Chemistry/2002/s/Paper 3/

3 A major food retailer in the UK is going to distribute sandwiches using hydrogen-powered vehicles.

(c) Outline how hydrogen is manufactured from water.

.....

.....[2]

10.10.1 ESSENTIAL EXAM QUESTIONS Paper 3/4 Contact Process and Sulfur Chemistry (Topic 12) 79 Marks

Topic Chem 12 **Q# 1/** iGCSE Chemistry/2014/w/Paper 31/

3 The main use of sulfur dioxide is the manufacture of sulfuric acid.

(a) State **two** other uses of sulfur dioxide.

.....

..... [2]

(b) One source of sulfur dioxide is burning sulfur in air.
Describe how sulfur dioxide can be made from the ore zinc sulfide.

.....

..... [2]

(c) The Contact process changes sulfur dioxide into sulfur trioxide.

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

the forward reaction is exothermic

temperature 400 to 450 °C

low pressure 1 to 10 atmospheres

catalyst vanadium(V) oxide

(i) What is the formula of vanadium(V) oxide?

..... [1]

(ii) Vanadium(V) oxide is an efficient catalyst at any temperature in the range 400 to 450 °C.
Scientists are looking for an alternative catalyst which is efficient at 300 °C.
What would be the advantage of using a lower temperature?

.....

.....

..... [2]

(iii) The process does not use a high pressure because of the extra expense.
Suggest **two** advantages of using a high pressure?
Explain your suggestions.

.....

.....

.....

.....

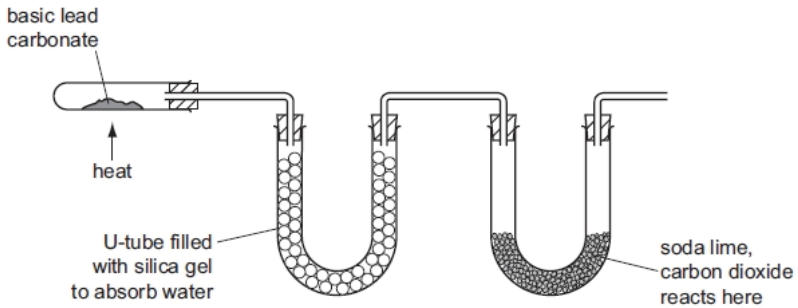
..... [4]

(d) Sulfuric acid is made by dissolving sulfur trioxide in concentrated sulfuric acid to form oleum. Water is reacted with oleum to form more sulfuric acid.
Why is sulfur trioxide not reacted directly with water?

..... [1]

Topic Chem 12 **Q# 2/** iGCSE Chemistry/2013/w/Paper 31/ Q6

(b) Basic lead(II) carbonate is heated in the apparatus shown below. Water and carbon dioxide are produced.



(i) Silica gel absorbs water. Silica gel often contains anhydrous cobalt(II) chloride. When this absorbs water it changes from blue to pink.
Suggest a reason.

..... [1]

(ii) Soda lime is a mixture of sodium hydroxide and calcium oxide. Why do these two substances react with carbon dioxide?

.....

..... [2]

(iii) Name **two** substances formed when soda lime reacts with carbon dioxide.

..... [2]

Topic Chem 12 **Q# 3/** iGCSE Chemistry/2011/s/Paper 31/ Q4

(b) Sulfur dioxide is used to make sulfur trioxide in the Contact Process.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The forward reaction is exothermic. The conditions used are:

temperature: 450 °C
pressure: 2 atmospheres
catalyst: vanadium(V) oxide

Explain, mentioning both position of equilibrium and rate, why these conditions give the most economic yield.

.....

.....

.....

..... [4]

Topic Chem 12 **Q# 4/** iGCSE Chemistry/2009/w/Paper 3/ Q6

(b) Sulfuric acid was first made in the Middle East by heating the mineral, green vitriol, $FeSO_4.7H_2O$. The gases formed were cooled.

$FeSO_4.7H_2O(s) \rightarrow FeSO_4(s) + 7H_2O(g)$
green crystals yellow powder

$2FeSO_4(s) \rightarrow Fe_2O_3(s) + SO_2(g) + SO_3(g)$

On cooling

$SO_3 + H_2O \rightarrow H_2SO_4$ sulfuric acid
$SO_2 + H_2O \rightarrow H_2SO_3$ sulfurous acid

(ii) Sulfurous acid is a reductant. What would you see when acidified potassium manganate(VII) is added to a solution containing this acid?

.....

..... [2]

(iii) Suggest an explanation why sulfurous acid in contact with air changes into sulfuric acid.

..... [1]

Topic Chem 12 **Q# 5/** iGCSE Chemistry/2009/w/Paper 3/

6 **(a)** Sulfuric acid is made by the Contact process.

$$2SO_2 + O_2 \rightleftharpoons 2SO_3$$

This is carried out in the presence of a catalyst at 450 °C and 2 atmospheres pressure.

(i) How is the sulfur dioxide made?

.....

..... [1]

(ii) Give another use of sulfur dioxide.

..... [1]

(iii) Name the catalyst used.

..... [1]

(iv) If the temperature is decreased to 300 °C, the yield of sulfur trioxide increases. Explain why this lower temperature is not used.

.....

..... [1]

(v) Sulfur trioxide is dissolved in concentrated sulfuric acid. This is added to water to make more sulfuric acid. Why is sulfur trioxide not added directly to water?

.....

..... [1]

Topic Chem 12 **Q# 6/** iGCSE Chemistry/2008/s/Paper 31/

1 For each of the following select an element from Period 4, potassium to krypton, that matches the description.

(g) One of its oxides is the catalyst in the Contact Process. ..... [iGCSE Chemistry/201]

Topic Chem 12 **Q# 7/** iGCSE Chemistry/2007/w/Paper 3/

4 Zinc is extracted from zinc blende, ZnS.

(a) Zinc blende is heated in air to give zinc oxide and sulphur dioxide. Most of the sulphur dioxide is used to make sulphur trioxide. This is used to manufacture sulphuric acid. Some of the acid is used in the plant, but most of it is used to make fertilisers.

(i) Give another use of sulphur dioxide.

..... [1]

(ii) Describe how sulphur dioxide is converted into sulphur trioxide.

.....

.....

..... [3]

(iii) Name a fertiliser made from sulphuric acid.

..... [1]

Topic Chem 12 **Q# 8/** iGCSE Chemistry/2006/s/Paper 3/ Q5 (b)

(iii) Explain, mentioning both rate and percentage yield, why the temperature used in the Contact process is 450°C.

.....

..... [2]

(iv) Describe how the sulphur trioxide is changed into concentrated sulphuric acid.

.....

..... [2]

Topic Chem 12 **Q# 9/** iGCSE Chemistry/2006/s/Paper 3/

5 Sulphuric acid is made by the Contact process in the following sequence of reactions.

sulphur → sulphur dioxide → sulphur trioxide → sulphuric acid

(a) (i) How is sulphur dioxide made from sulphur?

..... [1]

(ii) Sulphur dioxide has other uses.
Why is it used in the manufacture of paper?

..... [1]

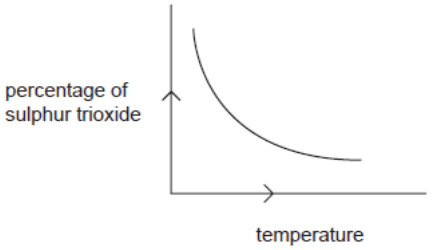
(iii) How does it preserve food?

..... [1]

(b) The equation for a stage of the Contact process is

$$2SO_2 + O_2 \rightleftharpoons 2SO_3$$

The percentage of sulphur trioxide in the equilibrium mixture varies with temperature.



(i) How does the percentage of sulphur trioxide in the equilibrium mixture vary as the temperature increases? Circle the correct answer.

increases **stays the same** **decreases** [1]

(ii) Is the forward reaction in the equilibrium $2SO_2 + O_2 \rightleftharpoons 2SO_3$ exothermic or endothermic? Give a reason for your choice.

.....

..... [2]

Topic Chem 12 **Q# 10/** iGCSE Chemistry/2005/s/Paper 3/Q4

(c) Sulphuric acid is manufactured by the Contact Process. Sulphur dioxide is oxidised to sulphur trioxide by oxygen.

$$2SO_2 + O_2 \longrightarrow 2SO_3$$

(i) Name the catalyst used in this reaction.

..... [1]

(ii) What temperature is used for this reaction?

..... [1]

(iii) Describe how sulphur trioxide is changed into sulphuric acid.

.....

..... [2]

4 The Carlsbad caverns in New Mexico are very large underground caves. Although the walls of these caves are coated with gypsum (hydrated calcium sulphate), the caves have been formed in limestone.

(a) It is believed that the caves were formed by sulphuric acid reacting with the limestone.

(i) Complete the word equation.

calcium carbonate + sulphuric acid ⟶ calcium sulphate + ... + ... [1]

(ii) Describe how you could test the water entering the cave to show that it contained sulphate ions.

test .....

result ..... [2]

(iii) How could you show that the water entering the cave has a high concentration of hydrogen ions?

..... [1]

(b) Hydrogen sulphide gas which was escaping from nearby petroleum deposits was being oxidised to sulphuric acid.

(i) Complete the equation for this reaction forming sulphuric acid.

H_2S + ...O_2 ⟶ ..... [2]

(ii) Explain why all the hydrogen sulphide should be removed from the petroleum before it is used as a fuel.

.....

..... [1]

2 Sulphur is used to make sulphuric acid. In the UK, the annual production of the acid is about 2.5 million tonnes.

(a) The reactions in the manufacture of sulphuric acid by the Contact Process are shown below.

Sulphur	$\longrightarrow$	Sulphur dioxide
S	**reaction 1**	SO_2
Sulphur dioxide + oxygen	$\longrightarrow$	Sulphur trioxide
$2SO_2 + O_2$	**reaction 2**	$2SO_3$
Sulphur trioxide	$\longrightarrow$	Oleum
SO_3	**reaction 3**	$H_2S_2O_7$
Oleum + water	$\longrightarrow$	Sulphuric acid
$H_2S_2O_7$	**reaction 4**	H_2SO_4

(i) Give a large scale source of the element sulphur.

..... [1]

(ii) State another use of sulphur dioxide.

..... [1]

(iii) How is sulphur changed into sulphur dioxide?

..... [1]

(iv) Name the catalyst used in reaction **2**.

..... [1]

(v) Reaction **2** is exothermic. Why is a catalyst, rather than a higher temperature, used to increase the rate of this reversible reaction?

.....

..... [2]

(vi) Write a word equation for reaction **3**.

..... [1]

(vii) Write a symbol equation for reaction **4**.

..... [1]

Topic Chem 12 **Q# 13/** iGCSE Chemistry/2003/w/Paper 3/

5 Sulphur dioxide, SO_2, and sulphur trioxide, SO_3, are the two oxides of sulphur.

(a) Sulphur dioxide can kill bacteria and has bleaching properties. Give a use of sulphur dioxide that depends on each of these properties.

(i) ability to kill bacteria .....[1]

(ii) bleaching properties .....[1]

(b) Sulphur trioxide can be made from sulphur dioxide.

(i) Why is this reaction important industrially?

.....[1]

(ii) Complete the word equation.

sulphur dioxide + ... → sulphur trioxide [1]

(iii) What are the conditions for this reaction?

.....

.....[2]

Topic Chem 12 **Q# 14/** iGCSE Chemistry/2002/w/Paper 3/

1 **(a)** Sulphuric acid is made by the Contact Process.

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ forward reaction is exothermic

(i) What are the reaction conditions for the Contact Process?

.....

.....[3]

(ii) Would the yield of sulphur trioxide increase, decrease or stay the same when the temperature is increased? Explain your answer.

.....

.....

.....[2]

(iii) Describe how sulphur trioxide is changed into concentrated sulphuric acid.

.....

.....[2]

Topic Chem 12 **Q# 15/** iGCSE Chemistry/2001/w/Paper 3/

5 **(a)** In the USA, sulphur is obtained from underground deposits. It burns to form sulphur dioxide. This is used in paper making, to preserve food and in the manufacture of sulphuric acid.

(i) Why is sulphur dioxide needed in paper making?

.....[1]

(ii) How does sulphur dioxide preserve food?

.....[1]

10.10.2 ESSENTIAL EXAM QUESTIONS Paper 3/4 Topic 7.3 56 marks Mark Scheme

Topic Chem 7.3 **Q# 1/** iGCSE Chemistry/2011/w/Paper 31/

4 **(a)** rate of forward reaction equals rate of back reaction [1]
concentrations do not change / macroscopic properties remain constant (with time) [1]
accept: amounts

(b) **(i)** increase [1]
reaction 2 [1]
Vr > Vp [1]

(ii) same [1]
reaction 1 [1]
Vr = Vp [1]

(iii) decrease [1]
reaction 3 [1]
Vp > Vr [1]
accept: moles of gas / molecules of gas as an alternative to volume

Topic Chem 7.3 **Q# 2/** iGCSE Chemistry/2010/s/Paper 31/

6 **(a)** rates equal [1]
concentrations do not change / macroscopic properties remain constant [1]
accept amounts do not change

(b) endothermic [1]
cond favoured by high temperatures [1]

(c) **(i)** move to left [1]
cond bigger volume / more moles etc [1]
do not insist on "gas"

(ii) less yellow solid / more brown liquid [1]
accept yellow to brown / less solid more liquid / goes brown

Topic Chem 7.3 **Q# 3/** iGCSE Chemistry/2009/w/Paper 3/ Q6

(b) **(i)** add water to yellow powder **or** to anhydrous salt [1]
it would go green [1]

Topic Chem 7.3 **Q# 4/** iGCSE Chemistry/2008/s/Paper 31/

5 (a) (i) (concentration) of reactants/CO and Cl_2 increases [1]
(concentration) of product decreases/$COCl_2$) [1]

(ii) (decrease in pressure favours side)
with more molecules **or** moles **or** side with bigger volume (of gas) [2]
NB [2] or [0]

(b) forward reaction is exothermic [1]
COND because it is favoured by low temperatures **or** cool [1]
ACCEPT argument re back reaction

Topic Chem 7.3 **Q# 5/** iGCSE Chemistry/2007/w/Paper 3/ 6 (c)

(iii) high pressure [1]
COND forward reaction volume decrease
or volume of reactants greater than that of products
or fewer moles of gas on the right
or fewer gas molecules on right [1]
NOTE accept correct arguments about either reactants **or** products

Topic Chem 7.3 **Q# 6/** iGCSE Chemistry/2005/w/Paper 3/ Q3

(b)(i) No change in volume **or** same number of moles on both sides **[1]**

(ii) move to right **[1]**
Increase in pressure favour side with smaller volume **or** smaller number of moles (of gas) **or** moves to side that tends to reduce pressure **[1]**

Topic Chem 7.3 **Q# 7/** iGCSE Chemistry/2005/w/Paper 3/

(a)(i) because concentration of $BiCl_3$ decreases **[2]**
bismuth chloride used up **ONLY [1]**

(ii) products are being formed **or** concentration of products increases. Concentration mark given either **(i) or (ii)** **[1]**

(iii) reaction has come to equilibrium **[1]**
rates equal **or** no change in concentration **[1]**

(iv) equilibrium to left **or** favours backward reaction **or** equilibrium moves to use up hydrochloric acid **[1]**
$BiOCl$ used up **or** $BiCl_3$ formed **[1]**

Topic Chem 7.3 **Q# 8/** iGCSE Chemistry/2004/w/Paper 3/

3 (a) (i) no change in concentration of reagents **or** rates equal [1]
Accept no change in amounts or it is as if the reaction has Stopped

(ii) back reaction is endothermic **or** the forward reaction is exothermic [1]
Increase in temperature favours the endothermic reaction which is the back reaction or vice versa. [1]
NB look for correct conclusion re thermicity and comment re position of equilibrium.

(iii) increased rate **[1]**
because molecules collide more frequently **or** concentration of molecules is increased **or** molecules are closer **[1]**
NOT they have more KE
increased yield **[1]**
high pressure favours side with few molecules **or** smaller volume **or** moves to reduce the pressure **[1]**
this is product side this can be implied **[1]**

Topic Chem 7.3 **Q# 9/** iGCSE Chemistry/2001/w/Paper 3/ QiGCSE Chemistry/201

(b) (i) high temperature **or** heat [1]
back reaction endothermic **or** moves to left [1]

OR low pressure
left side has higher volume of gases or more moles of gas

OR remove carbon monoxide
reaction try to replace it

OR energy needed
bonds breaking **or** to decompose $Ni(CO)_4$

10.10.2.1 ESSENTIAL EXAM QUESTIONS Haber process and nitrogen chemistry 63 Marks

Mark Scheme

Topic Chem 11.3 **Q# 1/** iGCSE Chemistry/2013/w/Paper 31/

3 (a) (i) fractional distillation [1]
(liquid) air [1]

(ii) cracking / heat in presence of catalyst [1]
of alkane / petroleum [1]
to give an alkene and hydrogen [1]

OR: electrolysis (1)
named electrolyte (1)
hydrogen at cathode (1)

OR: from methane (1)
react water / steam (1)
heat catalyst (1)
only **ACCEPT:** water with methane **or** electrolysis

(b) (i) the pair with both graphs correct is C [1]
NOTE: mark **(b)(ii)** independent of **(b)(i)**

(ii) high pressure favours side with lower volume / fewer moles [1]
this is RHS / product / ammonia [1]
$\%NH_3$ / yield increases as pressure increases [1]

the forward reaction is exothermic [1]
exothermic reactions favoured by low temperatures [1]
$\%NH_3$ / yield decreases as temperature increases [1]
ACCEPT: reverse arguments

(iii) increases reaction rate [1]
ACCEPT: reduces activation energy [1]
OR: decreases the amount of energy particles need to react
OR: economic rate at lower temperature so higher yield

[Total: 14]

Topic Chem 11.3 **Q# 2/** iGCSE Chemistry/2013/s/Paper 31/ Q6

(b) any five from:

- high pressure favours lower volume side / movement to right / ammonia side, **or** high pressure increases the yield
- high pressure increases rate
- low temperature favours exothermic reaction / increases yield / favours the forward reaction
- low temperature gives low rate or vice versa
- catalyst increases rate or lowers activation energy
- 450 °C low enough to give an economic yield but with catalyst gives a fast enough rate note need whole concept to get this compromise temperature point [5]

Topic Chem 11.3 **Q# 3/** iGCSE Chemistry/2010/w/Paper 31/ Q4

(b) (i) expensive metal / iron cheaper / better catalyst [1]

(ii) high pressure favours side with smaller volume / fewer moles [1]
this is right hand side / product / ammonia side [1]

(iii) recycled / sent over catalyst again [1]
accept used again

(iv) advantage high yield [1]
disadvantage slow reaction rate etc [1]

Topic Chem 11.3 **Q# 4/** iGCSE Chemistry/2009/s/Paper 31/

6 (a) (i) air (liquid) [1]
petroleum **or** crude oil **or** alkanes **or** methane **or** water **or** steam **or** steam reforming **or** suitable aqueous solution e.g. brine or sea water [1]
NOTE: cannot crack methane

(ii) iron [1]

(iii) (as a) fertiliser **or** to make fertilisers **or** to make nitric acid [1]

(b) (i) concentrations/macroscopic properties do not change [1]
accept amounts stay the same
NOT no change

rate of forward and back reactions equal [1]

(ii) it decreases with increase temperature [1]
or it increases with decrease temperature

(c) (i) shows an increase either a line **or** curve [1]
(any decrease = 0)

(ii) increase pressure favours the side with lower volume or molecules or moles [1]
that is RHS **or** products side [1]
ignore any mention of rates

Topic Chem 11.3 **Q# 5/** iGCSE Chemistry/2008/w/Paper 31/ Q5

(ii) ammonia **or** methanol **or** hydrogen chloride **or** margarine [1]
NOT nylon

Topic Chem 11.3 **Q# 6/** iGCSE Chemistry/2008/s/Paper 31/

8 (a) burning wood produces carbon dioxide [1]
less photosynthesis **or** trees take up carbon dioxide [1]

Topic Chem 11.3 **Q# 7/** iGCSE Chemistry/2006/w/Paper 3/

5 (a) (i) iron [1]

(ii) advantage higher yield [1]
explanation lower temperature favours the exothermic reaction (that is the forward reaction) [1]

(b) (i) Sent over the catalyst again **or** used to make more ammonia [1]
NOT just reused

(ii) It has the highest boiling point [1]

(c) (i) $CO_2 + 2NH_3 = CO(NH_2)_2 + H_2O$ [2]
Not balanced [1]

(ii) Any comment based on deficiency of PK/or ONLY provides Nitrogen as a nutrient [1]
NOT soil pH

Topic Chem 11.3 **Q# 8/** iGCSE Chemistry/2005/w/Paper 3/

Question 7

(a) from methane **[1]**
and water **[1]**

OR electrolysis **[1]**
suitable electrolyte **[1]**

OR alkane **[1]**
cracking **[1]** **[2]**

(b)(i) iron **[1]**

(ii) lower temperature moves equilibrium to right **[1]**
because forward reaction is exothermic **[1]**

Topic Chem 11.3 **Q# 9/** iGCSE Chemistry/2004/s/Paper 3/ Q2

(b) (i) potassium **[1]**

(ii) ammonium sulphate **[1]**

Topic Chem 11.3 **Q# 10/** iGCSE Chemistry/2003/w/Paper 3/

1 (a) (i) different boiling points [1]
(ii) methane **or** water **or** petroleum **or** named petroleum fraction **or** alkane
Any TWO [2]

(b) (i) volume decrease for forward reaction **or** fewer moles of gas on products side [1]
favoured by increase in pressure [1]
or increase in pressure moves position of equilibrium to right

(ii) increase [1]
exothermic reaction favoured by lower temperature [1]

(iii) 300 to 600 ^{0}C
1:3 volume ratio
iron (catalyst)
150 to 300 atm
Any TWO [2]

Topic Chem 11.3 **Q# 11/** iGCSE Chemistry/2002/s/Paper 3/ Q3

(c) (steam) and alkane [1]
heat or catalyst or details of chemistry – forms carbon monoxide/dioxide and (hydrogen) [1]

OR electrolysis [1]
brine or acidified water
or hydrogen forms at cathode [1]

OR carbon/coke [1]
heat or details of chemistry – forms carbon monoxide/dioxide and (hydrogen) [1]

10.10.2.1 ESSENTIAL EXAM QUESTIONS Contact Process and Sulfur Chemistry 79 Marks Mark Scheme

Topic Chem 12 **Q# 1/** iGCSE Chemistry/2014/w/Paper 31/

3 (a) Any **two** from:
bleach/making wood pulp/making paper
food/fruit juice/wine preservative
fumigant/sterilising/insecticide [2]

(b) heating/roasting/burning (zinc sulfides) [1]
in air/oxygen COND on M1 [1]

(c) (i) V_2O_5 [1]

(ii) position of equilibrium shifts right/yield increases [1]
to save energy [1]

(iii) faster reaction/rate [1]

more collisions per second/higher collision frequency [1]

fewer moles/molecules (of gas) on right [1]

(so) position of equilibrium shifts right/yield increases [1]

(d) (the reaction is) too violent/too exothermic **or** produces mist/fumes (of acid) [1]

Topic Chem 12 **Q# 2/** iGCSE Chemistry/2013/w/Paper 31/ Q6

(b) (i) anhydrous cobalt chloride becomes hydrated [1]
ACCEPT: hydrous

(ii) carbon dioxide is acidic [1]
sodium hydroxide and calcium oxide are bases / alkalis [1]

(iii) Any two of:
water, calcium carbonate and sodium carbonate [2]
ACCEPT: sodium bicarbonate

Topic Chem 12 **Q# 3/** iGCSE Chemistry/2011/s/Paper 31/ Q4

(b) for a high yield need low temperature [1]
then rate would be too slow or uneconomic [1]
a discussion of optimum temperature could score mark 1 and 2

presence of catalyst would increase rate (at same temperature) [1]
does not alter the yield (at that temperature) [1]
/ economic rate at lower temperature, therefore higher yield

higher pressure which would increase yield / rate [1]
yield high enough / high pressure expensive [1]
max [4]

accept reverse arguments
note increase yield ≡ position of equilibrium to right

Topic Chem 12 **Q# 4/** iGCSE Chemistry/2009/w/Paper 3/ Q6

(ii) change from purple **or** pink [1]
to colourless **NOT** clear [1]

(iii) reacts with oxygen in air [1]

Topic Chem 12 **Q# 5/** iGCSE Chemistry/2009/w/Paper 3/

6 (a) (i) burn sulfur in air **or** oxygen [1]
or heat a metal sulfide in air

(ii) bleach for wood pulp/cloth/straw **or** preserve food **or** sterilising
or making wine **or** fumigant **or** refrigerant [1]
Accept making paper

(iii) vanadium(V) oxide **accept** vanadium oxide **or** V_2O_5
or vanadium pentoxide [1]
oxidation state not essential but if given it has to be (V)

(iv) rate too slow **or** rate not economic [1]

(v) reaction too violent **or** forms a mist [1]

Topic Chem 12 **Q# 6/** iGCSE Chemistry/2008/s/Paper 31/ QiGCSE Chemistry/201

(g) vanadium [1]

ACCEPT name or symbol

Topic Chem 12 **Q# 7/** iGCSE Chemistry/2007/w/Paper 3/

4 (a) (i) bleach for wood pulp **or** preserving food **or** sterilising
or in wine making **or** as a refrigerant **or** in metallurgy **or**
(liquid) sulphur dioxide is used in the petroleum industry
or kill microbes(etc) **or** insecticide [1]

(ii) (react with) oxygen **or** air [1]
NOT burnt/burn in air/oxygen
450°C [1]
vanadium oxide catalyst (if oxidation state given has to be correct) **or** platinum [1]
If four conditions are given which include high pressure then **MAX** [2]
High pressure is incorrect **MAX** 10 atm.

(iii) ammonium sulphate **or** superphosphate [1]
or potassium sulphate **or** magnesium sulphate

Topic Chem 12 **Q# 8/** iGCSE Chemistry/2006/s/Paper 3/Q5 (b)

(iii) Low enough for good yield **[1]**
High enough for (economic) rate **[1]**
Any similar explanation will be awarded the mark
NOT just that it is the optimum temperature

(iv) bubble into (conc) sulphuric acid **[1]**
add water **[1]**
NOT consequential

Topic Chem 12 **Q# 9/** iGCSE Chemistry/2006/s/Paper 3/

5 (a) (i) Burn sulphur in air (or oxygen) **[1]**

(ii) as a bleach **[1]**

(iii) kill bacteria/micro-organisms **[1]**
NOT prevents food going bad or rotten or decaying

(b) (i) decrease **[1]**

(ii) exothermic **[1]**
COND increase temperature favours back reaction so it is endothermic, so forward reaction must be exothermic **[1]**
OR any similar explanation will be awarded the mark, for example
The forward reaction is not favoured by an increase in temperature so it is exothermic (rather than endothermic)

(iii) Low enough for good yield **[1]**
High enough for (economic) rate **[1]**
Any similar explanation will be awarded the mark
NOT just that it is the optimum temperature

Topic Chem 12 **Q# 10/** iGCSE Chemistry/2005/s/Paper 3/

(c) (i) vanadium oxide **or** vanadium(V) oxide **or** vanadium pentoxide or V_2O_5
Must be correct oxidation state if one given **[1]**

(ii) 400 to 500° C **[1]**

(iii) add to (concentrated) sulphuric acid **NOT** dilute **[1]**
COND (upon sulphuric acid) above then add water **[1]**

Topic Chem 12 **Q# 11/** iGCSE Chemistry/2005/s/Paper 3/

4 (a) (i) correct word equation (carbon dioxide and water) **[1]**
Accept correct symbol equation

(ii) Must have a correct reagent otherwise wc = 0
add (acidified) barium chloride(aq) **or** nitrate **or** add barium ions **[1]**
COND white precipitate **[1]**
NOT lead(II) compounds

(iii) low pH **or** universal indicator turns red(aq) **[1]**
pH 3 **or** less

(b) (i) $H_2S + 2O_2 = H_2SO_4$ **[2]**
unbalanced [1]

(ii) unpleasant smell **or** it is poisonous **or** when burnt forms acid rain **or** forms sulphur dioxide **or** forms sulphuric acid **[1]**
NOT it is a pollutant

(iii) 2H to 1S
COND 8e around sulphur atom
2e per hydrogen atom
THREE correct **[2]**
TWO from above [1]
Ionic structure = [0]

Topic Chem 12 **Q# 12/** iGCSE Chemistry/2004/s/Paper 3/

2. (a) (i) USA **or** Texas **or** Poland **or** Mexico **or** Japan **or** Ethiopia
Australia **or** Sicily **[1]**
accept other sources of sulphur eg petroleum
or natural gas **or** metal sulphides **or** volcanoes
NOT coal, **NOT** underground

(ii) Preserving food **or** bleaching **or** sterilising **or** disinfecting **or** making paper **or** bleaching wood pulp
or wine **or** jam **or** fumigation **or** making paper **[1]**
NOT making wood pulp

(iii) burnt/roast in oxygen **or** air **[1]**

(iv) vanadium(V) oxide **or** vanadium oxide **or** platinum **[1]**
ignore oxidation state of vanadium

(v) Increase temperature (increases rate) but reduces yield **[1]**
catalyst only increases rate **or** a catalyst does not influence position of equilibrium **[1]**
NOT a definition of a catalyst

(vi) sulphur trioxide + sulphuric acid = oleum **[1]**
correct symbol equation acceptable

(vii) $H_2S_2O_7 + H_2O = 2H_2SO_4$ **[1]**

Topic Chem 12 **Q# 13/** iGCSE Chemistry/2003/w/Paper 3/

5 (a) (i) preserve food **or** sterilising [1]
(ii) making paper [1]

(b) (i) making sulphuric acid **or** Contact Process [1]
(ii) oxygen [1]
(iii) vanadium oxide as catalyst (ignore oxidation state)
400 to 500 °C
pressure less than 10 atm
Any TWO [2]

Topic Chem 12 **Q# 14/** iGCSE Chemistry/2002/w/Paper 3/

1 (a) (i) vanadium(V) oxide as catalyst - ignore oxidation state
and accept no oxidation state
temperature 300 to 600 ^{0}C
pressure up to 10 atmos, accept atmospheric pressure
volume ratio of gases either 2:1 **or** slight excess of oxygen
ANY three [3]

(ii) decrease [1]
COND back reaction is endothermic or same argument based on
forward reaction is exothermic [1]
or increase in temp favours back reaction

(iii) dissolve in (conc) sulphuric acid **NOT** dilute [1]
add water **or** dilute [1]

Topic Chem 12 **Q# 15/** iGCSE Chemistry/2001/w/Paper 3/Q4
5 (a) (i) bleach [1]

(ii) kills bacteria or germs or micro organisms [1]

10.11 FUNDAMENTAL Assessed Activity 1 Keyword Test

English	Meaning
reversible reaction	
carbon cycle	
acid rain this	
dynamic (chemical) equilibrium	
equilibrium	
artificial fertiliser	
Contact process	
nitrogen cycle	

Haber process	

10.12 ESSENTIAL Assessed Activity 2 Topic 7.4, 11.3 and 12 Paper 2 15 marks

Topic Chem 7 **Q# 1/**

15 The reversible reaction between methane and steam is shown.

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$$

The forward reaction is endothermic.

Which changes in pressure and temperature move the equilibrium to the right?

	pressure	temperature
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

Topic Chem 7 **Q# 2/**

15 Methanol is prepared by the reversible reaction shown.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

The forward reaction is exothermic.

Which conditions produce the highest equilibrium yield of methanol?

	temperature	pressure
A	high	high
B	high	low
C	low	high
D	low	low

Topic Chem 7 **Q# 3/**

15 When $BiCl_3$ reacts with water, a white precipitate of $BiOCl$ is formed. The equation for the reaction is shown.

$$BiCl_3(aq) + H_2O(l) \rightleftharpoons BiOCl(s) + 2HCl(aq)$$

Which statements are correct?

1 The reaction is reversible.

2 When dilute hydrochloric acid is added to the reaction mixture, more of the white precipitate forms.

3 When aqueous sodium hydroxide is added to the reaction mixture, more of the white precipitate forms.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

Topic Chem 7 **Q# 4/**

15 The formation of sulfur trioxide is a reversible reaction.

The equation is shown.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The forward reaction is exothermic.

Which conditions produce the highest equilibrium yield of sulfur trioxide?

	pressure	temperature
A	high	high
B	high	low
C	low	high
D	low	low

Topic Chem 7 **Q# 5/**

17 Some nitrogen dioxide gas was put in a gas syringe. The end of the gas syringe is sealed.

A reversible reaction occurs. The reaction reaches equilibrium.

$$\underset{\text{dark brown}}{2NO_2(g)} \rightleftharpoons \underset{\text{light yellow}}{N_2O_4(g)}$$

The forward reaction is exothermic.

Which statement about the reaction is correct?

A If the gas syringe is placed in a cold water bath, the colour becomes darker.

B If the gas syringe is placed in a hot water bath, the colour becomes lighter.

C If the volume in the gas syringe is increased, the colour becomes lighter.

D If the volume in the gas syringe is decreased, the colour becomes lighter.

Topic Chem 7 **Q# 6/**

16 The following reaction has reached equilibrium in a closed system.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The forward reaction is exothermic.

Which row shows the effect of increasing the pressure on the equilibrium mixture?

	reaction rate	amount of SO_2	amount of SO_3
A	increases	decreases	increases
B	increases	increases	decreases
C	unchanged	decreases	increases
D	unchanged	increases	decreases

Topic Chem 7 **Q# 7/**

16 The formation of sulfur trioxide from sulfur dioxide is a reversible reaction.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The forward reaction is exothermic.

Which changes would increase the equilibrium yield of SO_3?

1 increasing the pressure

2 lowering the temperature

3 decreasing the concentration of oxygen

A 1, 2 and 3 **B** 1 and 2 only **C** 1 only **D** 2 and 3 only

Topic Chem 7 **Q# 8/**

16 Methane reacts with steam to produce hydrogen and carbon monoxide.

The equation for the reaction is shown.

$$CH_4(g) + H_2O(g) \rightleftharpoons 3H_2(g) + CO(g)$$

The reaction is reversible. The forward reaction is endothermic.

Which changes in temperature and pressure increase the equilibrium yield of carbon monoxide?

	temperature	pressure
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

Topic Chem 7 **Q# 9/**

16 Hydrogen is produced when methane reacts with steam.

The equation for the reaction is shown.

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$$

The forward reaction is endothermic.

Which conditions produce the highest yield of hydrogen?

	pressure	temperature
A	high	high
B	high	low
C	low	high
D	low	low

Topic Chem 7 **Q# 10/**

16 The reaction used to manufacture ammonia from nitrogen and hydrogen is reversible.

An equilibrium can be established between ammonia, nitrogen and hydrogen.

Which statement describes the equilibrium?

A Both the forward reaction and the backward reaction have the same rate.

B The rate of the backward reaction is greater than the rate of the forward reaction.

C The rate of the forward reaction is greater than the rate of the backward reaction.

D The forward and backward reactions have both stopped.

Topic Chem 7 **Q# 11/**

16 Nitrogen, hydrogen and ammonia gases are placed inside a container. The container is then sealed. After some time, an equilibrium forms.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

Which statement describes the equilibrium in this container?

A The amount of ammonia remains constant from the moment the container is sealed.

B The amounts of ammonia, nitrogen and hydrogen in the container are always equal.

C The rate of formation of ammonia is equal to the rate of decomposition of ammonia.

D The rate of formation of ammonia is faster than the rate of decomposition of ammonia.

Topic Chem 7 **Q# 12/**

16 The equation for the reversible reaction between hydrogen and iodine to form hydrogen iodide is shown.

The colours of the reactants and products are shown.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

colourless purple colourless

The forward reaction is exothermic.

Which statement is correct?

A An increase in pressure has no effect on the equilibrium position.

B The purple colour fades when the reaction mixture is heated.

C When equilibrium is reached, both forward and reverse reactions stop.

D When more hydrogen gas is added, the purple colour increases.

Topic Chem 7 **Q# 13/**

16 Chlorine can be manufactured by the following reaction. The reaction is exothermic.

$$4HCl(g) + O_2(g) \rightleftharpoons 2H_2O(g) + 2Cl_2(g)$$

Which change increases the yield of chlorine at equilibrium?

A adding more $HCl(g)$

B adding more $H_2O(g)$

C decreasing the pressure

D increasing the temperature

Topic Chem 7 **Q# 14/**

16 At 400 °C the reaction between hydrogen and iodine reaches an equilibrium. The reaction is exothermic.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \qquad \Delta H = -13\,kJ/mol$$

Which change in conditions would increase the percentage of hydrogen iodide in the equilibrium mixture?

A a decrease in pressure

B a decrease in temperature

C an increase in pressure

D an increase in temperature

Topic Chem 7 **Q# 15/**

16 The following reversible reaction takes place in a closed vessel at constant temperature.

$$P(g) + Q(g) + R(g) \rightleftharpoons S(g) + T(g)$$

When the system has reached equilibrium, more T is added.

After the addition of T, which substances increase in concentration?

A P, Q, R and S

B P and Q only

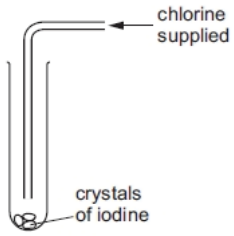
C P, Q and R only

D S only

10.13 ESSENTIAL Assessed Activity 3 Topic 7.3 15 marks

Chem 7.3 **Q# 1/**

(c) Iodine reacts with chlorine to form a dark brown liquid, iodine monochloride.



$$I_2(s) + Cl_2(g) \rightarrow \underset{\text{dark brown}}{2ICl(l)}$$

When more chlorine is added and the tube is sealed, a reversible reaction occurs and the reaction comes to equilibrium.

$$\underset{\text{dark brown}}{ICl(l)} + Cl_2(g) \rightleftharpoons \underset{\text{yellow}}{ICl_3(s)}$$

(i) Give another example of a reversible reaction.

..... [1]

(ii) Explain the term *equilibrium*.

.....

..... [2]

(d) Chlorine is removed from the tube and a new equilibrium is formed.

Explain why there is less of the yellow solid and more dark brown liquid in the new equilibrium mixture.

.....

.....

..... [2]

(e) A sealed tube containing the equilibrium mixture is placed in ice-cold water. There is an increase in the amount of yellow solid in the equilibrium mixture.

What can you deduce about the forward reaction in this equilibrium?

$$ICl(l) + Cl_2(g) \rightleftharpoons ICl_3(s)$$

Explain your deduction.

.....

.....

.....

..... [3]

Chem 7.3 **Q# 2/**

5 Carbonyl chloride, $COCl_2$, is widely used in industry to make polymers, dyes and pharmaceuticals.

(b) Carbonyl chloride is now made by the reversible reaction given below.

$$CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$$

The forward reaction is exothermic.
The reaction is catalysed by carbon within a temperature range of 50 to 150 °C.

(i) Predict the effect on the yield of carbonyl chloride of increasing the pressure. Explain your answer.

.....

..... [2]

(ii) If the temperature is allowed to increase to above 200 °C, very little carbonyl chloride is formed. Explain why.

.....

..... [2]

(iii) Explain why a catalyst is used.

..... [1]

Chem 7.3 **Q# 3/**

4 Vanadium is a transition element. It has more than one oxidation state. The element and its compounds are often used as catalysts.

(c) Vanadium(V) oxide is used to catalyse the exothermic reaction between sulfur dioxide and oxygen in the Contact Process.

$$2SO_2 + O_2 \rightleftharpoons 2SO_3$$

The rate of this reaction can be increased either by using a catalyst or by increasing the temperature. Explain why a catalyst is used and not a higher temperature.

.....

.....

..... [2]

10.14 EXTENSION Mind Map For Topics 7.3 Reversible Reactions, 11.3 Nitrogen & Fertilisers & 12 Sulfur (Equilibria)

10.15 ESSENTIAL End of Topic Review and Reflection

Looking at the goals you could have achieved and the goals you actually achieved try to reflect on your progress.

Try to be as honest and as detailed as possible. Sometimes you may think you have thought about an idea well, but when you talk with someone else, or write it out, it helps you better understand and allows you think more completely and more clearly.

Did you achieve more goals this topic than last topic?

Fill in this table

Level	Number of goals achieved at each level	Success rate, %
FUNDAMENTAL	/5	
ESSENTIAL	/10	
EXTENSION	/13	
EXCEPTIONAL	/10	

Do you feel you tired harder? If yes, what helped you to do so? If not, why not?

What could you do differently next time, in addition to what you are already doing to improve, not only your score in the end of topic tests and other assessed activities, but also in how you learn. How could you become a more effective student to get more learning out of the time you are investing in your studies?

What did you enjoy most about this topic?

What did you find most difficult?

What did you find easiest?

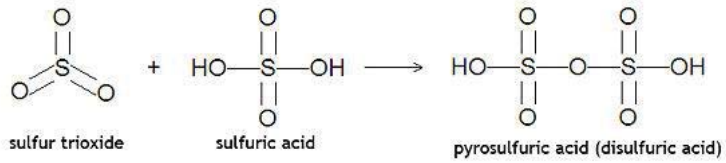
On a scale of 1 being hardest and 5 being most difficult, circle how challenging you found this topic

1 2 3 4 5

What could be done to make this topic easier to understand?

Do you have any questions about this topic?

10.16 Exceptional Additional Activities, Further Reading and Exploring Beyond the Syllabus



10.16.1 EXCEPTIONAL Active Learning Activity Can you think of why these molecules look wrong?

What rules do they break that you have learnt at iGCSE?
Try to find as many reasons these molecules should not exist as possible and explain why in the space below.

Now go online to try to find out why they exist, and if there are any additional problems that these chemical structures ignore or get wrong

……

10.17 Exceptional Extra Credit Science in Context

May have saved more lives than any other person in human history, but his contribution to society did not only save lives, he also helped develop and introduce a variety of weapons that many feel have made the world a less safe place. Using the internet, and the resources that are available in this section of my website (under Topic 11):

https://www.smashingsciencecn.org/igcse-chem-additional-resources

Find out about the man and create a short presentation about one aspect of his life or his contribution to society.

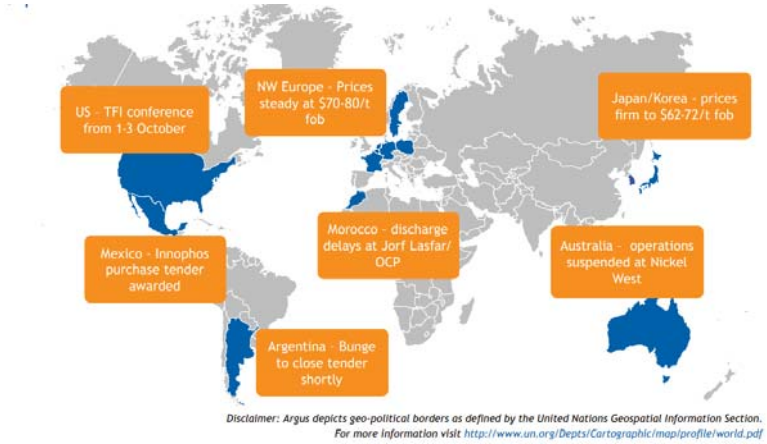
You can find out more about how to make a lasting impression with your presentation here:

https://13c35962-6df0-4843-9028-c26407054a5a.filesusr.com/ugd/d26cc6_c85f76e6275141b1b2b98fc6530a5753.pptx?dn=Basics%20to%20a%20good%20presentation.pptx

And what kinds of things that matter in the best presentations here:

https://13c35962-6df0-4843-9028-c26407054a5a.filesusr.com/ugd/d26cc6_9a753109001c4ad5a6b630adb8e64ccc.pdf?index=true

Alternatively, you could look at the Contact Process. Why do you think it is included in the syllabus? About 30 years ago it used to be suggested that the more sulfuric acid a country uses the more developed it is. Is this still true? If not, why not? Why is this chemical so important to society?



https://13c35962-6df0-4843-9028-c26407054a5a.filesusr.com/ugd/d26cc6_9038cccb606643c889dc09c257e5dbb4.pdf?index=true

To find out more, you could buy this book, which is just $5,000 US (or about 36,000RMB); maybe an interesting career?:
https://www.researchandmarkets.com/reports/4793190/global-sulfuric-acid-market-by-raw-material-by

11 Topic 8.1 & 8.2 Acids & Bases

11.1 End of Topic 8.1 & 8.2 Goals Checklist

For each topic you ought to try to do as many of the following things to get the most out of your time, the resources available to you and to help you grow as a student. Tick each goal off as you complete it. Growth is difficult and uncomfortable, but you should choose to do these things, and the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win!

Aspect	What you should have done	Yes/No	Level
Interacted with your teacher	Ask your teacher 1 question, about anything, once a week		FUNDAMENTAL
	Try to answer one question asked by your teacher at least once a week		ESSENTIAL
	Ask your teacher one question about something you do not understand in science once a week		ESSENTIAL
	Ask your teacher one question about something to do with science every lesson		EXTENSION
Notes and follow up notes	Complete set of class note		FUNDAMENTAL
	Cornell Notetaking Attempted		ESSENTIAL
	Cornell Notetaking Completed		EXTENSION
	Cornell Notetaking Completed to an exemplary standard		EXCEPTIONAL
	Attempted the Mind Map for this topic		ESSENTIAL
	Completed the Mind Map for this topic		EXTENSION
Textbook	Read ahead before the topic has been started		EXTESNION
	Highlighted key ideas and translate new words		FUNDAMENTAL
	Completed the questions at the end of each 2 page spread in your exercise book		EXTENSION
	Added to your class notes ideas and important information from the textbook that you learnt		EXTENSION
Past Exam Questions	Worked on at least 25% of the exam questions in this workbook		FUNDAMENTAL
	Attempted more than 25% of the questions and those questions you have completed you have marked in a different colour pen		ESSENTIAL
	Completed and marked all questions here		EXTENSION
	Completed, marked and additional key ideas where you have located the most difficult marks added to your notebook		EXCEPTIONAL
	Used the resources available online to answer additional questions not found in this workbook on the current topic.		EXCEPTIONAL
	Ask your teacher about an exam question that they cannot answer		EXCEPTIONALLY SMASHING!!!
Assessed Activities	Complete the word list activity using the word list at the front of each topic as little as possible		FUNDAMENTAL
	Complete 2 assessed activities, either in class or as homework		ESSENTIAL
	Complete 2 assessed activities and scored over 70% on average		ESSENTIAL
	Complete 2 assessed activities and scored over 80% on average		EXTENSION
	Complete 2 assessed activities and scored over 90% on average		EXCEPTIONAL
End of Topic Test	Revised sufficiently well to improve upon your score from the previous test (except if you are scoring over 90%, then just write Y for this goal)		ESSENTIAL
	Scored 10% higher than your current average		EXTENSION
	Scored 15% or more than your previous end of topic average		EXCEPTIONAL
	Scored over 90%		EXTESNION
	Scored over 95%		SMASHING!!!
Reading	Spend more than 1 hour a week reading a book **you enjoy** (in any language) about anything.		ESSENTIAL

Aspect	What you should have done	Yes/No	Level
	Spend more than 3 hours a week reading a book **you enjoy** (in any language) about anything.		EXTENSION
	Spend more than 5 hours a week reading a book **you enjoy** (in any language) about anything.		EXCEPTIONAL
	Spend at least one hour a week reading a book **you enjoy** in English about anything.		EXTENSION
	Spend more than 3 hours a week reading a book **you enjoy** in English about anything.		EXCEPTIONAL
Reflection	You completed this goal setting table		FUNDAMENTAL
	You have looked at the goals you have achieved and the ones you have not and added them up and entered them into the table in the Review and Reflection section		ESSENTIAL
	You have given an answer for every question in the Review and Reflection section at the end of this topic		EXTENSION
	You have Given good and thoughtful answers for every question in the Review and Reflection section at the end of this topic		EXCEPTIONAL

8 Acids, bases and salts

8.1 The characteristic properties of acids and bases

Core

- Describe the characteristic properties of acids as reactions with metals, bases, carbonates and effect on litmus and methyl orange
- Describe the characteristic properties of bases as reactions with acids and with ammonium salts and effect on litmus and methyl orange
- Describe neutrality and relative acidity and alkalinity in terms of pH measured using universal indicator paper (whole numbers only)
- Describe and explain the importance of controlling acidity in soil

Supplement

- Define *acids* and *bases* in terms of proton transfer, limited to aqueous solutions
- Describe the meaning of weak and strong acids and bases

8.2 Types of oxides

Core

- Classify oxides as either acidic or basic, related to metallic and non-metallic character

Supplement

- Further classify other oxides as neutral or amphoteric

11.2 ESSENTIAL Glossary for Keywords for this topic

English	Chinese
acid a substance that dissolves in water, producing H_+(aq) ions – a solution of an acid turns litmus red and has a pH below 7; in their reactions acids act as proton donors	**酸溶解在水中的物**质，产生H＋（aq）**离子–酸溶液使石**蕊变成红色，且pH值低于7；**在它**们的反应中，酸充当质子供**体**
acidic oxides these are compounds of non-metals which will react with bases and dissolve in water to produce acid solutions	**酸性氧化物，它**们是非金属的化合物，会与碱反应并溶解在水中以产生酸性溶**液**
alkalis soluble bases which produce OH-(aq) ions in water – a solution of an alkali turns litmus blue and has a pH above 7	**碱溶性碱，在水中**产生OH-（aq）**离子–碱溶液**变成石蕊蓝，pH值超过7
amphoteric hydroxides these can react with both acids and alkalis to produce salts; for example, zinc hydroxide; certain metal oxides can also be amphoteric	**两性**氢氧化物可与酸和碱反应生成盐；例如，氢氧化锌；某些金属氧化物也可以是两性**的**
base a substance that neutralises an acid, producing a salt and water as the only products; in their reactions bases act as proton acceptors	**以中和酸的物**质为基础，产生盐和水作为唯一产物；在反应中碱充当质子受**体**
basic oxide these are of a metal that will react with acids to neutralise the acid	**碱性氧化物，属于金属，会与酸反**应中和酸
corrosive a corrosive substance (an acid, for example) is one that can dissolve or 'eat away' at other materials (wood, metals, or human skin, for instance)	**腐**蚀性腐蚀性物质（例如酸）**是一种可以溶解或"吞噬"其他物**质（例如木材，金属或人体皮肤）的物质
indicator a substance which changes colour when added to acidic or alkaline solutions; for example, litmus or phenolphthalein	**指示一种添加到酸性或碱性溶液中会**变色的物质；例如石蕊或酚酞
litmus the most common indicator; turns red in acid and blue in alkali	**石蕊是最常**见的指标；在酸中变成红色，在碱中变成蓝**色**
neutralisation a chemical reaction between an acid and a base to produce a salt and water only; summarised by the ionic equation H_+(aq) + OH-(aq) → H_2O(l)	**中和酸和碱之**间的化学反应，仅产生盐和水；由离子方程式H＋（aq）＋OH-（aq）→H2O（l）总结
pH scale a scale running from below 0 to 14, used for expressing the acidity or alkalinity of a solution; a neutral solution has a pH of 7	pH刻度，范围从0到14，**用于表示溶液的酸度或碱度**；pH为7**的中性溶液**
precipitation reaction a reaction in which an insoluble salt is prepared from solutions of two suitable soluble salts	**沉淀反**应一种反应，其中由两种合适的可溶性盐的溶液制备不溶性盐
strong acid an acid that is completely ionised when dissolved in water – this produces the highest possible concentration of H_+(aq) ions in solution; for example, hydrochloric acid	强酸，一**种溶于水**时会完全电离的酸–**在溶液中**产生最高浓度的H＋（aq）**离子**；**例如**盐酸
strong alkali an alkali that is completely ionised when dissolved in water – this produces the highest possible concentration of OH-(aq) ions in solution; for example, sodium hydroxide	强碱：**一种溶于水**时会完全离子化的碱-这会在溶液中产生最高浓度的OH-（aq）**离子**；**例如**氢氧化钠
suspension a mixture containing small particles of an insoluble solid, or droplets of an insoluble liquid, spread (suspended) throughout a liquid	**将含有不溶性固体小**颗粒或不溶性液体小滴的混合物悬浮（散布）在整个液体**中**
Universal Indicator a mixture of indicators which has different colours in solutions of different pH	**通用指示**剂**在不同**pH值的溶液中具有不同颜色的指示剂混合**物**
weak acid an acid which is only partially dissociated into ions in water – usually this produces a low concentration of H_+(aq) in the solution; for example, ethanoic acid	**弱酸一种**仅在水中部分分解成离**子的酸-通常在溶液中**产生低浓度的H＋（aq）；**例如**，乙酸
weak alkali an alkali which is only partially dissociated into ions in water – usually this produces a low concentration of OH-(aq) in the solution; for example, ammonia solution	**弱碱一种**仅在水中部分分解成离子的碱-**通常会在溶液中**产生低浓度的OH-（aq）；**例如氨水**

11.3 ESSENTIAL Classroom Active Learning Tasks 1 Naming Acids and Bases

Name the following acids and bases:

90) NaOH _____

91) H_2SO_3 _____

92) H_2S _____

93) H_3P _____

94) H_3PO_4 _____

95) NH_3 _____

96) HCN _____

97) $Ca(OH)_2$ _____

98) $Fe(OH)_3$ _____

Write the formulas of the following acids and bases:

99) hydrobromic acid	
100) hydrofluoric acid	
101) carbonic acid	
102) lithium hydroxide	
103) nitrous acid	
104) cobalt (II) hydroxide	
105) sulfuric acid	
106) beryllium hydroxide	

11.4 Extension Classroom Active Learning Tasks 1 Naming Salts

Name or write the formula for the following ionic compounds

21) NaBr _____

22) $Sc(OH)_3$ _____

23) $V_2(SO_4)_3$ _____

24) NH_4F _____

25) $CaCO_3$ _____

26) $NiPO_4$ _____

27) Li_2SO_3 _____

28) Zn_3P_2 _____

29) $Sr(C_2H_3O_2)_2$ _____

30) Cu_2O _____

31) Ag_3PO_4 _____

33) SnS_2 _____

34) $Ti(CN)_4$ _____

35) $KMnO_4$ _____

36) Pb_3N_2 _____

37) $CoCO_3$ _____

38) $CdSO_3$ _____

39) $Cu(NO_2)_2$ _____

40) $Fe(HCO_3)_2$ _____

Write the formulas for the following ionic compounds:

42) iron (II) phosphate _____

43) titanium (II) selenide _____

44) calcium bromide _____

45) gallium chloride _____

46) sodium hydride _____

47) beryllium hydroxide _____

48) zinc carbonate _____

49) manganese (VII) arsenide _____

52) ammonium oxide _____

53) potassium hydroxide _____

54) lead (IV) sulfate _____

55) silver cyanide _____

56) vanadium (V) nitride _____

58) molybdenum sulfate _____

59) platinum (II) sulfide _____

60) ammonium sulfate _____

61) NaBr _____

63) P_2O_5 _____

64) $Ti(SO_4)_2$ _____

65) $FePO_4$ _____

66) K_3N _____

67) SO_2 _____

68) CuOH _____

69) $Zn(NO_2)_2$ _____

70) V_2S_3 _____

Mark Scheme For Naming Acids, Bases and Salts

Be careful, some examples have been removed because they go beyond the syllabus, so make sure you check the question number with the answer number!

Name the following acids and bases:

90) NaOH sodium hydroxide
91) H_2SO_3 sulfurous acid
92) H_2S hydrosulfuric acid
93) H_3P hydrophosphoric acid
94) H_3PO_4 phosphoric acid
95) NH_3 ammonia
96) HCN hydrocyanic acid
97) $Ca(OH)_2$ calcium hydroxide
98) $Fe(OH)_3$ iron (III) hydroxide

Write the formulas of the following acids and bases:

99) hydrobromic acid HBr
100) hydrofluoric acid HF
101) carbonic acid H_2CO_3
102) lithium hydroxide LiOH
103) nitrous acid HNO_2
104) cobalt (II) hydroxide $Co(OH)_2$
105) sulfuric acid H_2SO_4
106) beryllium hydroxide $Be(OH)_2$

Naming Ionic Compounds

21) NaBr **sodium bromide**
22) $Sc(OH)_3$ **scandium (III) hydroxide**
23) $V_2(SO_4)_3$ **vanadium (III) sulfate**
24) NH_4F **ammonium fluoride**
25) $CaCO_3$ **calcium carbonate**
26) $NiPO_4$ **nickel (III) phosphate**
27) Li_2SO_3 **lithium sulfite**
28) Zn_3P_2 **zinc phosphide**
29) $Sr(C_2H_3O_2)_2$ **strontium acetate**
30) Cu_2O **copper (I) oxide**
31) Ag_3PO_4 **silver phosphate**
32) $YClO_3$ **yttrium (I) chlorate**
33) SnS_2 **tin (IV) sulfide**
34) $Ti(CN)_4$ **titanium (IV) cyanide**
35) $KMnO_4$ **potassium permanganate**
36) Pb_3N_2 **lead (II) nitride**
37) $CoCO_3$ **cobalt (II) carbonate**
38) $CdSO_3$ **cadmium sulfite**
39) $Cu(NO_2)_2$ **copper (II) nitrite**
40) $Fe(HCO_3)_2$ **iron (II) bicarbonate**

Name the following chemical compounds:

41) lithium acetate **$LiC_2H_3O_2$**
42) iron (II) phosphate **$Fe_3(PO_4)_2$**
43) titanium (II) selenide **TiSe**
44) calcium bromide **$CaBr_2$**
45) gallium (III) chloride **$GaCl_3$**
46) sodium hydride **NaH**
47) beryllium hydroxide **$Be(OH)_2$**
48) zinc carbonate **$ZnCO_3$**
49) manganese (VII) arsenide **Mn_3As_7**
50) copper (II) chlorate **$Cu(ClO_3)_2$**
51) cobalt (III) chromate **$Co_2(CrO_4)_3$**
52) ammonium oxide **$(NH_4)_2O$**
33) potassium hydroxide **KOH**
54) lead (IV) sulfate **$Pb(SO_4)_2$**
55) silver cyanide **AgCN**
56) vanadium (V) nitride **V_3N_5**
57) strontium acetate **$Sr(C_2H_3O_2)_2$**
58) molybdenum (VI) sulfate **$Mo(SO_4)_3$**
59) platinum (II) sulfide **PtS**
60) ammonium sulfate **$(NH_4)_2SO_4$**
61) NaBr **sodium bromide**
62) $Ca(C_2H_3O_2)_2$ **calcium acetate**
63) P_2O_5 **diphosphorus pentoxide**
64) $Ti(SO_4)_2$ **titanium(IV) sulfate**
65) $FePO_4$ **iron (III) phosphate**
66) K_3N **potassium nitride**
67) SO_2 **sulfur dioxide**
68) CuOH **copper (I) hydroxide**
69) $Zn(NO_2)_2$ **zinc nitrite**
70) V_2S_3 **vanadium (III) sulfide**

11.5 Essential Classroom Active Learning Tasks 3 Reactions between acids and bases

Reaction of Metal Oxides with Acids

Metal Oxide + Acid ⟶ Salt + Water

For example,

Copper Oxide + Sulfuric Acid ⟶ Copper Sulfate + Water

1. **Magnesium Oxide + NItric Acid ⟶ _____ + _____**
2. **Silver Oxide + Hydrochloric Acid ⟶ _____ + _____**
3. **Lead Oxide + Sulfuric Acid ⟶ _____ + _____**
4. **Copper Oxide + Nitric Acid ⟶ _____ + _____**
5. **$SnO + H_2SO_4$ ⟶ _____ + H_2O**
6. **CuO + _____ ⟶ $CuCl_2 + H_2O$**
7. **$CaO + 2HNO_3$ ⟶ _____ + H_2O**

Reaction of Acids with Metals

Complete the equations (remember hydrochloric acid makes chloride salts, sulfuric acid makes sulfate salts and nitric acid makes nitrate salts)

Metals + Acid → Salt + Hydrogen

For example,

Lithium + Sulfuric Acid → Lithium Sulfate + Hydrogen

1. **Calcium + Hydrochloric Acid → _____ + _____**
2. **Magnesium + Sulfuric Acid → _____ + _____**

3. **Lead + Nitric Acid → _____ + _____**
4. **Iron + _____ → Iron Chloride + _____**
5. **Zinc + Sulfuric Acid → _____ + Hydrogen**
6. **Tin + _____ → Tin Nitrate + Hydrogen**
7. **$Ca + 2HCl$ → _____ + H_2**
8. **Mg + _____ → $MgSO_4 + H_2$**

Reaction of Metal Carbonates with Acids

Metal Carbonate + Acid → Salt + Water + Carbon Dioxide

For example,

Calcium Carbonate + Nitric Acid → Calcium Nitrate + Water + Carbon Dioxide

1. **Magnesium carbonate + Hydrochloric Acid → _____ + _____ + _____**
2. **Sodium Carbonate + Nitric Acid → _____ + _____ + _____**
3. **Calcium Carbonate + Sulfuric Acid → _____ + _____ + _____**
4. **Potassium Carbonate + Hydrochloric Acid → _____ + _____ + _____**
5. **Lithium Carbonate + _____ → Lithium Sulfate + _____ + _____**
6. **$CaCO_3 + H_2SO_4$ → _____ + $H_2O + CO_2$**
7. **Na_2CO_3 + _____ → $2NaCl + H_2O + CO_2$**

Reactions of acids with metal oxides, metals, and carbonates Answers

Reaction of Metal Oxides with Acids

Metal Oxide + Acid → Salt + Water
For example,
Copper Oxide + Sulfuric Acid → Copper Sulfate + Water
8. Magnesium Oxide + Nitric Acid → Magnesium Nitrate + Water
9. Silver Oxide + Hydrochloric Acid → Silver Chloride + Water
10. Lead Oxide + Sulfuric Acid → Lead Sulfate + Water
11. Copper Oxide + Nitric Acid → Copper Nitrate + Water
12. $SnO + H_2SO_4 \rightarrow SnSO_4 + H_2O$
13. $CuO + 2HCl \rightarrow CuCl_2 + H_2O$
14. $CaO + 2HNO_3 \rightarrow Ca(NO_3)_2 + H_2O$

Reaction of Acids with Metals

Complete the equations (remember hydrochloric acid makes chloride salts, sulfuric acid makes sulfate salts and nitric acid makes nitrate salts)

Metals + Acid → Salt + Hydrogen

For example,
Lithium + Sulfuric Acid → Lithium Sulfate + Hydrogen

1. Calcium + Hydrochloric Acid → Calcium Chloride + Hydrogen
2. Magnesium + Sulfuric Acid → Magnesium Sulfate + Hydrogen
3. Lead + Nitric Acid → Lead Nitrate + Hydrogen
4. Iron + Hydrochloric Acid → Iron Chloride + Hydrogen
5. Zinc + Sulfuric Acid → Zinc Sulfate + Hydrogen
6. Tin + Nitric Acid → Tin Nitrate + Hydrogen
7. $Ca + 2HCl \rightarrow CaCl_2 + H_2$
8. $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$

Reaction of Metal Carbonates with Acids

Metal Carbonate + Acid → Salt + Water + Carbon Dioxide

For example,
Calcium Carbonate + Nitric Acid → Calcium Nitrate + Water + Carbon Dioxide
1. Magnesium carbonate + Hydrochloric Acid → Magnesium Chloride + Water + Carbon Dioxide
2. Sodium Carbonate + Nitric Acid → Sodium Nitrate + Water + Carbon Dioxide
3. Calcium Carbonate + Sulfuric Acid → Calcium Sulfate + Water + Carbon Dioxide
4. Potassium Carbonate + Hydrochloric Acid → Potassium Chloride + Water + Carbon Dioxide
5. Lithium Carbonate + Sulfuric Acid → Lithium Sulfate + Water + Carbon Dioxide
6. $CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + H_2O + CO_2$
7. $Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$

11.6 ESSENTIAL EXAM QUESTIONS Paper 3/4 111 marks Topic 8.1 & 8.2

Topic Chem 8.1 **Q# 1/** iGCSE Chemistry/2014/w/Paper 31/

1 **(a)** Match the following pH values to the solutions given below.

1 3 7 10 13

The solutions all have the same concentration.

solution	**pH**
aqueous ammonia, a weak base	.....
dilute hydrochloric acid, a strong acid	.....
aqueous sodium hydroxide, a strong base	.....
aqueous sodium chloride, a salt	.....
dilute ethanoic acid, a weak acid	.....

[5]

(b) Explain why solutions of hydrochloric acid and ethanoic acid with the same concentration, in mol/dm³, have a different pH.

.....

.....

..... [2]

(c) Measuring pH is one way of distinguishing between a strong acid and a weak acid. Describe another method.

method .....

.....

results .....

.....

[2]

Topic Chem 8.1 **Q# 2/** iGCSE Chemistry/2013/s/Paper 31/

3 A small piece of marble, $CaCO_3$, was added to 5.0 cm³ of hydrochloric acid, concentration 1.0 mol / dm³, at 25 °C. The time taken for the reaction to stop was measured. The experiment was repeated using 5.0 cm³ of different solutions of acids. The acid was in excess in all of the experiments.

Typical results are given in the table.

experiment	temperature / °C	acid solution	time / min
1	25	hydrochloric acid 1.0 mol / dm³	3
2	25	hydrochloric acid 0.5 mol / dm³	7
3	25	ethanoic acid 1.0 mol / dm³	10
4	15	hydrochloric acid 1.0 mol / dm³	8

(ii) The acids used for experiment 1 and experiment 3 have the same concentration. Explain why experiment 3 is slower than experiment 1.

.....

.....

..... [2]

Topic Chem 8.1 **Q# 3/** iGCSE Chemistry/2013/s/Paper 31/

6 Ammonia is a compound which only contains the elements nitrogen and hydrogen. It is a weak base.

(a) (i) Define the term *base*.

..... [1]

(ii) Given aqueous solutions of ammonia and sodium hydroxide, both having a concentration of 0.1 mol / dm³, how could you show that ammonia is the weaker base?

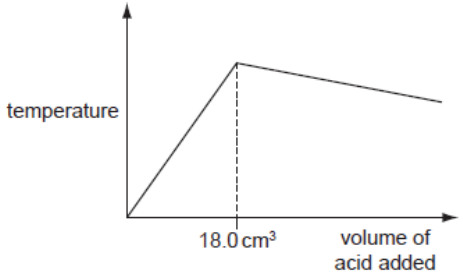
.....

.....

..... [2]

Topic Chem 8.1 **Q# 4/** iGCSE Chemistry/2011/s/Paper 31/ Q5

(d) 20.0 cm³ of aqueous sodium hydroxide, 2.00 mol / dm³, was placed in a beaker. The temperature of the alkali was measured and 1.0 cm³ portions of hydriodic acid were added. After each addition, the temperature of the mixture was measured. Typical results are shown on the graph.



$$NaOH(aq) + HI(aq) \rightarrow NaI(aq) + H_2O(l)$$

(iii) In another experiment, it was shown that 15.0 cm³ of the acid neutralised 20.0 cm³ of aqueous sodium hydroxide, 1.00 mol / dm³. Calculate the concentration of the acid.

.....

..... [2]

Topic Chem 8.1 **Q# 5/** iGCSE Chemistry/2011/s/Paper 31/ Q2

(c) The selenide ion reacts with water.

$$Se^{2-} + H_2O \rightarrow HSe^- + OH^-$$

What type of reagent is the selenide ion in this reaction? Give a reason for your choice.

.....

..... [3]

Topic Chem 8.1 **Q# 6/** iGCSE Chemistry/2011/s/Paper 31/ NOT w/ith Q5(a)

5 (a) (i) $2Li + 2HI \rightarrow 2LiI + H_2$

(ii) zinc carbonate + hydriodic acid → zinc iodide + carbon dioxide + water

(iii) $MgO + 2HI \rightarrow MgI_2 + H_2O$

(b) Two of the reactions in **(a)** are acid/base and one is redox. Which one is redox? Explain your choice.

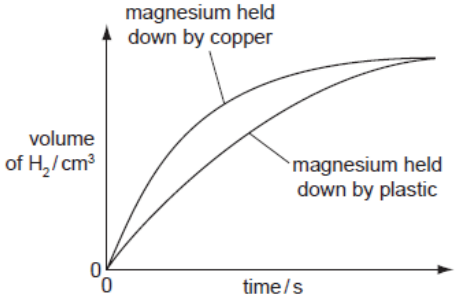
.....

.....

..... [2]

Topic Chem 8.1 **Q# 7/** iGCSE Chemistry/2010/s/Paper 31/ Q4

(b) The only difference in the two experiments was the method used to hold down the magnesium. The results are shown below.



(c) The experiment was repeated using 1.0 mol / dm^3 propanoic acid instead of 1.0 mol / dm^3 hydrochloric acid. Propanoic acid is a weak acid.

(i) How would the graph for propanoic acid **differ** from the graph for hydrochloric acid?

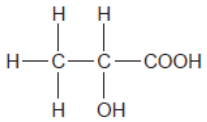
..... [1]

(ii) How would the graph for propanoic acid be the **same** as the graph for hydrochloric acid?

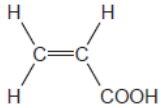
..... [1]

Topic Chem 8.1 **Q# 8/** iGCSE Chemistry/2009/s/Paper 31/Q8

(c) When lactic acid is heated, acrylic acid is formed.



lactic acid



acrylic acid

(iii) Describe a test, other than using an indicator, which would show that both chemicals contain an acid group.

test .....

result .....

..... [2]

Topic Chem 8.1 **Q# 9/** iGCSE Chemistry/2009/s/Paper 31/ Q7

(b) They react with water to form acidic solutions.

$$HCl + H_2O \rightleftharpoons H_3O^+ + Cl^-$$

$$HF + H_2O \rightleftharpoons H_3O^+ + F^-$$

(i) Explain why water behaves as a base in both of these reactions.

.....

..... [2]

(ii) At equilibrium, only 1% of the hydrogen chloride exists as molecules, the rest has formed ions. In the other equilibrium, 97% of the hydrogen fluoride exists as molecules, only 3% has formed ions.

What does this tell you about the strength of each acid?

.....

..... [2]

(iii) How would the pH of these two solutions differ?

..... [1]

Topic Chem 8.1 **Q# 10/** iGCSE Chemistry/2008/s/Paper 31/

5 Carbonyl chloride, $COCl_2$, is a colourless gas. It is made by the following reaction.

$$CO(g) + Cl_2(g) \underset{\text{heat}}{\overset{\text{cool}}{\rightleftharpoons}} COCl_2(g)$$

(c) Carbonyl chloride reacts with water to form two acidic compounds.
Suggest which acidic compounds are formed.

1. .....

2. ..... [2]

Topic Chem 8.1 **Q# 11/** iGCSE Chemistry/2007/w/Paper 3/

5 Methylamine, CH_3NH_2, is a weak base. Its properties are similar to those of ammonia.

(a) When methylamine is dissolved in water, the following equilibrium is set up.

$$\underset{\text{base}}{CH_3NH_2} + \underset{\text{acid}}{H_2O} \rightleftharpoons CH_3NH_3^+ + OH^-$$

(i) Suggest why the arrows are not the same length.

..... [1]

(ii) Explain why water is stated to behave as an acid and methylamine as a base.

.....

..... [2]

(b) An aqueous solution of the strong base, sodium hydroxide, is pH 12. Predict the pH of an aqueous solution of methylamine which has the same concentration. Give a reason for your choice of pH.

.....

..... [2]

(c) Methylamine is a weak base like ammonia.

(i) Methylamine can neutralise acids.

$$2CH_3NH_2 + H_2SO_4 \rightarrow \underset{\text{methylammonium sulphate}}{(CH_3NH_3)_2SO_4}$$

Write the equation for the reaction between methylamine and hydrochloric acid.
Name the salt formed.

.....

..... [2]

(ii) When aqueous methylamine is added to aqueous iron(II) sulphate, a green precipitate is formed. What would you see if iron(III) chloride solution had been used instead of iron(II) sulphate?

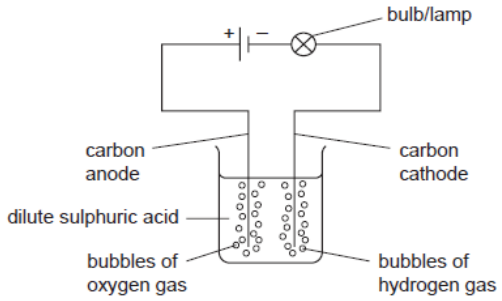
..... [1]

(iii) Suggest the name of a reagent that will displace methylamine from one of its salts, for example methylammonium sulphate.

..... [1]

Topic Chem 8.1 **Q# 12/** iGCSE Chemistry/2006/s/Paper 3/ Q3

(b) The following apparatus was set up to investigate the electrical conductivity of dilute acids.



Dilute sulphuric acid is a strong acid. If it was replaced by a weak acid, what **two** differences in the observations would you expect to make?

.....

.....

..... [2]

Topic Chem 8.1 **Q# 13/** iGCSE Chemistry/2006/s/Paper 3/ Q2

(c) The equation for the reaction of **X** with cold water is given below.

$$2X(s) + 2H_2O(l) \longrightarrow 2XOH(aq) + H_2(g)$$

(i) Describe the test you would use to show that the gas evolved is hydrogen.

.....

..... [1]

(ii) How could you show that the water contained a compound of the type **X**OH?

.....

[2]

(c) The equation for the reaction of **X** with cold water is given below.

$$2X(s) + 2H_2O(l) \longrightarrow 2XOH(aq) + H_2(g)$$

(i) Describe the test you would use to show that the gas evolved is hydrogen.

.....

..... [1]

(ii) How could you show that the water contained a compound of the type **X**OH?

.....

..... [2]

(iii) In which group of the Periodic Table does metal **X** belong?

..... [1]

(iv) The ore of **X** is its chloride. Suggest how metal **X** could be extracted from its chloride.

..... [2]

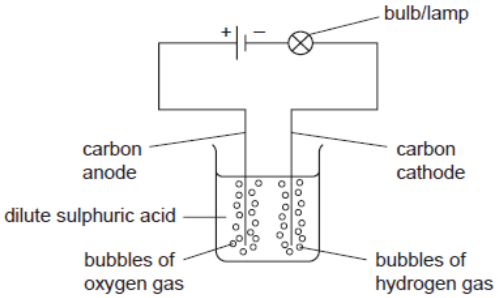
3 **(a)** Four bottles were known to contain aqueous ammonia, dilute hydrochloric acid, sodium hydroxide solution and vinegar, which is dilute ethanoic acid. The bottles had lost their labels. The pH values of the four solutions were 1, 4, 10 and 13.

Complete the table.

solution	pH
aqueous ammonia	
dilute hydrochloric acid	
sodium hydroxide solution	
vinegar	

[2]

(b) The following apparatus was set up to investigate the electrical conductivity of dilute acids.



Dilute sulphuric acid is a strong acid. If it was replaced by a weak acid, what **two** differences in the observations would you expect to make?

.....

.....

..... [2]

(c) When nitric acid is added to water the following reaction occurs.

$$HNO_3 + H_2O \longrightarrow NO_3^- + H_3O^+$$

Give the name and the formula of the particle which is transferred from nitric acid to water.

name .....

formula ..... [2]

Topic Chem 8.1 **Q# 15/** iGCSE Chemistry/2005/s/Paper 3/Q3

(d) Propanoic acid is a weak acid.

(i) The following equation represents its reaction with ammonia.

$$CH_3-CH_2-COOH + NH_3 \longrightarrow CH_3-CH_2-COO^- + NH_4^+$$

Explain why propanoic acid behaves as an acid and ammonia as a base.

.....

..... [3]

(ii) Explain the expression *weak acid.*

..... [1]

Topic Chem 8.1 **Q# 16/** iGCSE Chemistry/2004/s/Paper 3/ Q2 (b)

(iii) Rock phosphate (calcium phosphate) is obtained by mining. It reacts with concentrated sulphuric acid to form the fertiliser, superphosphate. Predict the formula of each of these phosphates.

fertiliser	ions	formula
calcium phosphate	Ca^{2+} and PO_4^{3-}	.....
calcium superphosphate	Ca^{2+} and $H_2PO_4^-$	..... [2]

(iv) The ionic equation for the reaction between the phosphate ion and sulphuric acid is shown below.

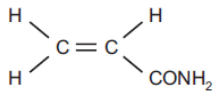
$$PO_4^{3-} + 2H_2SO_4 \rightarrow H_2PO_4^- + 2HSO_4^-$$

Explain why the phosphate ion is described as acting as a base in this reaction.

..... [2]

Topic Chem 8.1 **Q# 17/** iGCSE Chemistry/2004/s/Paper 3/

6 In 2002, Swedish scientists found high levels of acrylamide in starchy foods that had been cooked above 120 °C. Acrylamide, which is thought to be a risk to human health, has the following structure.



(ii) Given an aqueous solution, concentration 0.1 mol / dm^3, how could you show that acrylic acid is a weak acid.

.....

..... [2]

Topic Chem 8.1 **Q# 18/** iGCSE Chemistry/2003/w/Paper 3/ QiGCSE Chemistry/201

(c) Ammonia is a base.

(i) Name a particle that an ammonia molecule can accept from an acid.

.....

(ii) Write an equation for ammonia acting as a base.

.....[3]

(d) Given aqueous solutions, 0.1mol/dm^3, of sodium hydroxide and ammonia, describe how you could show that ammonia is the weaker base.

.....

.....[2]

Topic Chem 8.1 **Q# 19/** iGCSE Chemistry/2002/s/Paper 3/

4 Bromine is one of the halogens in Group VII.

(d) Phosphorus tribromide reacts with water to form two acids.

(i) Balance the equation for this reaction.

$$PBr_3 + ...H_2O \longrightarrow .....HBr + H_3PO_3$$

[1]

(ii) Describe by giving essential details how you could show that phosphorous acid, H_3PO_3, is a weaker acid than hydrogen bromide.

.....

.....

.....[2]

(e) Hydrogen bromide is an acid. When it is dissolved in water the following reaction occurs.

$$HBr + H_2O \longrightarrow H_3O^+ + Br^-$$

(i) Name the particle lost by the hydrogen bromide molecule.

.....[1]

(ii) What type of reagent is the water molecule in this reaction?

.....[1]

Topic Chem 8.2 **Q# 20/** iGCSE Chemistry/2015/w/Paper 31/

6 Carbon and silicon are elements in Group IV. They both form oxides of the type XO_2.

(iii) How could you show that silicon(IV) oxide is acidic and not basic or amphoteric?

.....

.....

..... [2]

Topic Chem 8.2 **Q# 21/** iGCSE Chemistry/2015/w/Paper 31/

2 Describe how to separate the following. In each example, give a description of the procedure used and explain why this method works.

(d) Magnesium hydroxide from a mixture of magnesium hydroxide and zinc hydroxide.

procedure .....

.....

explanation .....

.....

[3]

Topic Chem 8.2 **Q# 22/** iGCSE Chemistry/2015/s/Paper 31/

3 **(a)** The reactions between metals and acids are redox reactions.

$$Zn + 2H^+ \rightarrow Zn^{2+} + H_2$$

(c) If the first experiment was repeated using ethanoic acid, CH_3COOH, instead of hydrochloric acid, how and why would the graph be different from graph 1?

.....

.....

.....

..... [4]

Topic Chem 8.2 **Q# 23/** iGCSE Chemistry/2014/s/Paper 31/ Q4

(b) Across a period, the elements change from metallic to non-metallic.

(i) Describe how the type of oxide changes across this period.

.....

..... [2]

Topic Chem 8.2 **Q# 24/** iGCSE Chemistry/2013/s/Paper 31/

2 An element, **M**, has the electron distribution 2 + 8 + 18 + 3.

(e) The hydroxide of **M** is a white powder which is insoluble in water.
Describe how you could show that this hydroxide is amphoteric.

.....

.....

..... [2]

Topic Chem 8.2 **Q# 25/** iGCSE Chemistry/2012/w/Paper 31/

4 Silicon(IV) oxide, SiO_2, and zirconium(IV) oxide, ZrO_2, are both macromolecules.
They have similar physical properties but silicon(IV) oxide is acidic and zirconium(IV) oxide is amphoteric.

(c) **(i)** Name a reagent that reacts with the oxides of both elements.

..... [1]

(ii) Name a reagent that reacts with only one of the oxides.

reagent .....

oxide which reacts ..... [2]

Topic Chem 8.2 **Q# 26/** iGCSE Chemistry/2011/w/Paper 31/

1 This question is concerned with the following oxides.

sulfur dioxide
carbon monoxide
lithium oxide
aluminium oxide
nitrogen dioxide
strontium oxide

(a) **(i)** Which of the above oxides will react with hydrochloric acid but not with aqueous sodium hydroxide?

..... [1]

(ii) Which of the above oxides will react with aqueous sodium hydroxide but not with hydrochloric acid?

..... [1]

(iii) Which of the above oxides will react with both hydrochloric acid and aqueous sodium hydroxide?

..... [1]

(iv) Which of the above oxides will not react with hydrochloric acid or with aqueous sodium hydroxide?

..... [1]

Topic Chem 8.2 **Q# 27/** iGCSE Chemistry/2010/w/Paper 31/ Q6

(b) Beryllium hydroxide, a white solid, is an amphoteric hydroxide.

(i) Name another metal which has an amphoteric hydroxide.

..... [1]

(ii) Suggest what you would observe when an excess of aqueous sodium hydroxide is added gradually to aqueous beryllium sulfate.

.....

..... [2]

Topic Chem 8.2 **Q# 28/** iGCSE Chemistry/2006/s/Paper 3/ Q3

(d) This question is concerned with the following oxides.

aluminium oxide	Al_2O_3
calcium oxide	CaO
carbon dioxide	CO_2
carbon monoxide	CO
magnesium oxide	MgO
sulphur dioxide	SO_2

(i) Which of the above oxides will react with hydrochloric acid but not with aqueous sodium hydroxide?

..... [1]

(ii) Which of the above oxides will react with aqueous sodium hydroxide but not with hydrochloric acid?

..... [1]

(iii) Which of the above oxides will react both with hydrochloric acid and with aqueous sodium hydroxide?

..... [1]

(iv) Which of the above oxides will react neither with hydrochloric acid nor with aqueous sodium hydroxide?

..... [1]

Topic Chem 8.2 **Q# 29/** iGCSE Chemistry/2005/s/Paper 3/Q6

(c) Complete the following table by writing "reaction" or "no reaction" in the spaces provided.

oxide	type of oxide	reaction with acid	reaction with alkali
magnesium	basic	.....	.....
aluminium	amphoteric	.....	.....

[2]

Topic Chem 8.2 **Q# 30/** iGCSE Chemistry/2002/w/Paper 3/ Q3

(c) Choose a different element from Period 3 that matches each description.

(ii) It reacts violently with cold water to form a solution pH = 14.

.....[1]

(iii) It has a gaseous oxide of the type XO_2, which is acidic.

.....[1]

Topic Chem 8.2 **Q# 31/** iGCSE Chemistry/2002/w/Paper 3/

2 Manganese is a transition element. It has more than one valency and the metal and its compounds are catalysts.

(b) It has several oxides, three of which are shown below.
Manganese(II) oxide, which is basic.
Manganese(III) oxide, which is amphoteric.
Manganese(IV) oxide, which is acidic.

(i) Complete the word equation.

manganese(II) oxide + hydrochloric acid → ..... + ... [2]

(ii) Which, if any, of these oxides will react with sodium hydroxide?

.....[1]

11.6.1 ESSENTIAL EXAM QUESTIONS Paper 3/4 111 marks Topic 8.1 & 8.2 Mark Scheme

Q# 1/ iGCSE Chemistry/2014/w/Paper 31/

1 (a) Match the following pH values to the solutions given below.

1 3 7 10 13

The solutions all have the same concentration.

solution	**pH**
aqueous ammonia, weak base	10
dilute hydrochloric acid, a strong acid	1
aqueous sodium hydroxide, a strong base	13
aqueous sodium chloride, a salt	7
dilute ethanoic acid, a weak acid	3

[5]

(b) Hydrochloric acid strong acid **or** ethanoic acid weak acid [1]
OR: hydrochloric acid completely ionised **or** ethanoic acid partially ionised
hydrochloric acid greater concentration of/more H^+ ions (than ethanoic acid) [1]

(c) Rate of reaction with Ca, Mg, Zn, Fe [1]

Strong (hydrochloric) acid bubbles faster **or** more bubbles **or** dissolves faster [1]

OR: rate of reaction with (metal) carbonate [1]
strong (hydrochloric) acid faster **or** more bubbles **or** dissolves faster (only if carbonate insoluble) [1]

OR: electrical conductivity [1]
strong (hydrochloric) acid better conductor [1]

Q# 2/ iGCSE Chemistry/2013/s/Paper 31/

(ii) ethanoic acid is a weak acid **or** hydrochloric acid is a strong acid [1]
accept: stronger or weaker

ethanoic acid less ionised / dissociated / lower / smaller concentration of hydrogen ions [1]
accept: less hydrogen ions and vice versa argument but not dissociation of ions

Q# 3/ iGCSE Chemistry/2013/s/Paper 31/

6 (a) (i) proton or H^+ acceptor [1]

(ii) (measure) pH or (use) UI indicator [1]
note: can be implied need not be explicit
sodium hydroxide has higher pH / ammonia(aq) has lower pH [1]
(this sentence would score 2 marks)
or
appropriate colours with UI / appropriate numerical values [1]
ammonia is closer to green, blue-green, turquoise or lighter blue
sodium hydroxide is darker blue / purple / violet [1]
or
measure electrical conductivity [1]
can be implied need not be explicit
ammonia (aq) is the poorer conductor/ sodium hydroxide is the better conductor [1]

Q# 4/ iGCSE Chemistry/2011/s/Paper 31/ Q5(d)

(iii) 1.33 / 1.3 / 1.3333 (mol/dm^3) scores both marks [2]
not 1.34
for a correct method – $M_1 V_1$ / moles of NaOH = 0.02
with an incorrect answer **only** [1]

Q# 5/ iGCSE Chemistry/2011/s/Paper 31/ Q2

(c) base [1]
not alkali
accepts a proton [2]
accepts hydrogen ion / H^+ **only** [1]
proton and H^+ [2]

Q# 6/ iGCSE Chemistry/2011/s/Paper 31/ Q5

(b) reaction 1 is redox / Li/2HI reaction [1]
cond reason either oxidation number/state / electron transfer [1]

Q# 7/ iGCSE Chemistry/2010/s/Paper 31/ Q4

(c) (i) smaller gradient [1]
not rate is slower

(ii) same final volume of hydrogen / same level (on graph) [1]

Q# 8/ iGCSE Chemistry/2009/s/Paper 31/Q8c

(iii) reagent [1]
observable result [1]

suitable named metal (**NOT** sodium, lead, any metal below magnesium etc.)
if un-named metal [0] result can score [1]
hydrogen evolved or bubbles/effervescence/fizzing

insoluble metal oxide
colour change or dissolves

any carbonate or bicarbonate
gas/carbon dioxide/bubbles/effervescence/fizzing

sodium hydroxide or alkali
temperature increase **or** accept indicator to show neutralisation
unspecified base scores [1] only
NOT alcohol

Q# 9/ 7iGCSE Chemistry/2009/s/Paper 31/ Q7

(b) (i) because it accepts a proton [2]
accepts hydrogen ion **or** H^+ **ONLY** [1]
proton and H^+ [2]

(ii) hydrogen chloride is a strong acid [1]
hydrogen fluoride is a weak acid [1]
weaker **or** stronger correctly applied for [2]

(iii) hydrogen chloride (aqueous) would have lower pH [1]
OR hydrogen fluoride (aqueous) would have higher pH
If values suggested, not over 7

Q# 10/ iGCSE Chemistry/2008/s/Paper 31/Q5

(c) hydrogen chloride **or** hydrochloric acid [1]
carbon dioxide **or** carbonic acid **or** hydrogen carbonate [1]

Q# 11/ iGCSE Chemistry/2007/w/Paper 3/

5 **(a)** **(i)** equilibrium to left **or** many molecules and few ions **or**
partially ionised **or** reverse reaction favoured [1]

(ii) Water donates proton [1]
methylamine accepts a proton [1]
NOTE If hydrogen ion then **ONLY** [1] provided both are correct

(b) less than 12 more than 7 [1]
smaller concentration of hydroxide ions **or** partially dissociated **or**
poor proton acceptor **or** poor H^+ acceptor [1]
NOT it is a weak base

(c) **(i)** $CH_3NH_2 + HCl = CH_3NH_3Cl$ [1]
methylammonium chloride [1]
NOTE the equation must be as written, the equation with sulphuric acid has been given as guidance.

(ii) brown precipitate [1]
ACCEPT orange **or** red/brown **or** brick red **or** brown/red

(iii) sodium hydroxide **or** any named strong base [1]

Q# 12/ iGCSE Chemistry/2006/s/Paper 3/ Q3

(b) With strong acid bulb brighter **[1]**
faster rate of bubbles **[1]**
OR corresponding comments for weak acid

Q# 13/ iGCSE Chemistry/2006/s/Paper 3/ Q2

(c) **(i)** goes "pop" with burning splint **[1]**
or mixed with air and ignited goes pop
NOT glowing splint

(ii) test and observable result **[1]**
universal indicator goes blue
or pH paper goes blue
or high pH, accept 13, 14
or ammonium ion gives off ammonia
or with metallic cations forms a precipitate **[1]**
NOT litmus
ONLY accept - neutralises acids with an observable result,
e.g. becomes warm.

(iii) Group 1 **[1]**

(iv) electrolysis **[1]**
COND molten **[1]**

Q# 14/ iGCSE Chemistry/2006/s/Paper 3/

3 (a) ammonia 10
hydrochloric acid 1
sodium hydroxide 13
ethanoic acid 4
All correct **[2]**
Two correct [1]

(b) With strong acid bulb brighter **[1]**
faster rate of bubbles **[1]**
OR corresponding comments for weak acid

(c) proton **NOT** hydrogen ion **[1]**
H^+ not conditional on proton **[1]**
Only way for [2] is proton and H^+

Q# 15/ iGCSE Chemistry/2005/s/Paper 3/Q3

(d) (i) acid loses a proton **[2]**
base accepts a proton **[1]**

OR same explanation but acid loses a hydrogen ion (1)
and base gains hydrogen ion (1)

(ii) only partially ionised **or** poor hydrogen ion donor **or** poor proton donor **[1]**
NOT does not form many hydrogen ions in water **or** low concentration of hydrogen ions
NOT pH

Q# 16/ iGCSE Chemistry/2004/s/Paper 3/ Q2 (b)

(iii) $Ca_3(PO_4)_2$ **[1]**

$Ca(H_2PO_4)_2$ **[1]**

(iv) only acceptable responses are:
accepts a proton **[2]**
accepts H^+ **[1]** only

Q# 17/ iGCSE Chemistry/2004/s/Paper 3/

(ii) measure pH **[1]**
more than 1 and less than 7 **or**
correct colour eg orange **or** yellow **NOT** red
NOT green **[1]**
OR add magnesium **or** calcium carbonate **[1]**
weak acid reacts slowly

Q# 18/ iGCSE Chemistry/2003/w/Paper 3/ QiGCSE Chemistry/201

(c) (i) proton [2]
hydrogen ion **or** H^+ **ONLY** [1]
(ii) correct equation molecular **or** ionic [1]
$NH_3 + HCl = NH_4Cl$
$NH_3 + H^+ = NH_4^+$ accept NH_4OH

(d) measure pH **or** add universal indicator **or** pH meter [1]
ammonia has lower pH if numerical values given

must be appropriate that is above 7 with ammonia having the lower value **or** correct colours, green and blue are acceptable [1]
OR measure conductivity [1]
ammonia has poorer conductivity [1]

Q# 19/ iGCSE Chemistry/2002/s/Paper 3/ Q4

(d) (i) balanced **[1]**

(ii) pH **[1]**
phosphorous acid has higher pH **[1]**

OR electrical conductivity **[1]**
phosphorous acid poorer **[1]**

OR reaction with named metal **or** carbonate **[1]**
hydrobromic faster **[1]**

OR pH indicator **[1]**
correct colours **[1]**

(e) (i) proton **or** hydrogen ion **[1]**

(ii) base **or** proton acceptor **or** electron pair donor **[1]**

Q# 20/ iGCSE Chemistry/2015/w/Paper 31/

6(a)(iii)	SiO_2 reacts with or dissolves in or neutralises an acid or acidic oxide; SiO_2 does not react or dissolve in or neutralise an alkali or base or basic oxide;	1 1

Q# 21/ iGCSE Chemistry/2015/w/Paper 31/

2(d)	add sodium hydroxide solution; filter; zinc hydroxide (is amphoteric it) will reactor will dissolve / magnesium hydroxide does not react or does not dissolve;	1 1 1

Q# 22/ iGCSE Chemistry/2015/s/Paper 31/ Q3

3(c)	M1 less steep (line) or lower gradient;		**A** alternative phrases e.g. 'shallower'
	M2 (because of) decreased rate;		**A** more time to complete the reaction **A** same amount of gas in more time **A** slower rate or slower reaction
	M3 ethanoic is a weak(er) acid;		ORA
	M4 only partially ionised or dissociated **OR** lower concentration of hydrogen ions;	4	**A** not fully dissociated or ionised **A** ionises less (than HCl) **I** less hydrogen ions

Q# 23/ iGCSE Chemistry/2014/s/Paper 31/ Q4

(b) (i) Assume change is from L to R unless clearly stated:
basic to amphoteric to acidic (2) [2]

Q# 24/ iGCSE Chemistry/2013/s/Paper 31/ Q2

(e) it would react with/dissolves in a named strong acid [1]
it would react with/dissolves in a named alkali [1]
it shows both basic and acid properties =1 [1]
it reacts with both acids and bases/alkalis =1 [1]
[max 2]

Q# 25/ iGCSE Chemistry/2012/w/Paper 31/ Q4

(c) (i) sodium hydroxide / any named alkali / reactive metal; [1]

(ii) named acid; [1]
zirconium oxide; [1]

Q# 26/ iGCSE Chemistry/2011/w/Paper 31/

1 (a) (i) lithium oxide / strontium oxide [1]

(ii) sulfur dioxide / nitrogen dioxide [1]

(iii) aluminium oxide [1]

(iv) carbon monoxide [1]
accept: correct formulae

Q# 27/ iGCSE Chemistry/2010/w/Paper 31/ Q6

(b) (i) zinc / aluminium / lead / tin / chromium [1]

(ii) white precipitate [1]
precipitate dissolves / colourless solution forms / forms a clear solution / soluble in excess [1]

Q# 28/ iGCSE Chemistry/2006/s/Paper 3/ Q3

(d) (i) CaO and MgO **[1]**

(ii) CO_2 and SO_2 **[1]**

(iii) Al_2O_3 **[1]**

(iv) CO **[1]**

Q# 29/ iGCSE Chemistry/2005/s/Paper 3/Q6

(c) reaction no reaction **[1]**
reaction reaction **[1]**

Q# 30/ iGCSE Chemistry/2002/w/Paper 3/ Q3 (c)

(ii) sodium [1]

(iii) sulphur or chlorine [1]

Q# 31/ iGCSE Chemistry/2002/w/Paper 3/ Q2

(b) (i) manganese chloride [1]
water [1]

(ii) manganese(III) **and** (IV) oxides [1]

11.7 FUNDAMENTAL Assessed Activity 1 Keyword Test

English	Meaning
litmus	
amphoteric hydroxides	
acidic oxides	
neutralisation	
pH scale	
precipitation reaction	
weak acid	
acid	
indicator	
base	
strong alkali	
strong acid	
weak alkali	
corrosive	
Universal Indicator	

English	Meaning
alkalis 7	
basic oxide	
suspension	

11.8 FUNDAMENTAL Assessed Activity 2 Paper 1 Topic 8.1 and 8.2 18marks

Q# 1/

14 Three chemicals, P, Q and R, were each dissolved in water. The table shows some of the reactions of these solutions.

solution	reaction when solid sodium carbonate is added	reaction when heated with solid ammonium chloride
P	gas evolved	no reaction
Q	no reaction	gas evolved
R	no reaction	no reaction

The pH of the three solutions was also measured.

What are the correct pH values of these solutions?

	P	Q	R
A	2	7	13
B	2	13	7
C	7	2	13
D	13	7	2

15 The oxide of element X forms a solution with pH4.

The oxide of element Y forms a solution that turns Universal Indicator blue.

Which row correctly classifies elements X and Y?

	element X	element Y
A	metal	metal
B	metal	non-metal
C	non-metal	metal
D	non-metal	non-metal

16 Which two processes are involved in the preparation of magnesium sulfate from dilute sulfuric acid and an excess of magnesium oxide?

A neutralisation and filtration

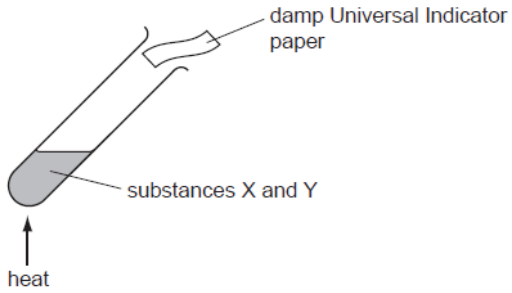
B neutralisation and oxidation

C thermal decomposition and filtration

D thermal decomposition and oxidation

Q# 2/

32 The diagram shows two substances, X and Y, being heated together.



The Universal Indicator paper turns blue during the experiment.

What are substances X and Y?

A ammonium nitrate and hydrochloric acid

B ammonium nitrate and sodium hydroxide

C sodium carbonate and hydrochloric acid

D sodium carbonate and sodium hydroxide

Q# 3/

17 Element X forms an acidic, covalent oxide.

Which row shows how many electrons there could be in the outer shell of an atom of X?

	1	2	6	7
A	✓	✓	✗	✗
B	✓	✗	✓	✗
C	✗	✗	✓	✓
D	✗	✓	✗	✓

18 Barium hydroxide is an alkali. It reacts with hydrochloric acid.

How does the pH of the hydrochloric acid change as an excess of aqueous barium hydroxide is added?

A The pH decreases from 14 and becomes constant at 7.

B The pH decreases from 14 to about 1.

C The pH increases from 1 and becomes constant at 7.

D The pH increases from 1 to about 14.

19 A compound is a salt if it

A can neutralise an acid.

B contains more than one element.

C dissolves in water.

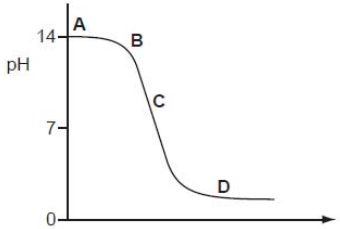
D is formed when an acid reacts with a base.

Q# 5/

17 The graph shows how the pH changes as an acid is added to an alkali.

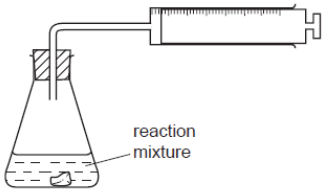
acid + alkali → salt + water

Which letter represents the area of the graph where both acid and salt are present?



Q# 6/

15 An experiment to determine the rate of a chemical reaction could be carried out using the apparatus shown.



Which reaction is being studied?

A $Cl_2 + 2KBr \rightarrow 2KCl + Br_2$

B $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$

C $NaCl + AgNO_3 \rightarrow NaNO_3 + AgCl$

D $NaOH + HCl \rightarrow NaCl + H_2O$

16 Copper(II) carbonate reacts with dilute sulfuric acid.

$$CuCO_3(s) + H_2SO_4(aq) \rightarrow CuSO_4(aq) + CO_2(g) + H_2O(l)$$

The speed of the reaction can be changed by varying the conditions.

Which conditions would always increase the speed of this chemical reaction?

1 Increase the concentration of the reactants.

2 Increase the size of the pieces of copper(II) carbonate.

3 Increase the temperature.

4 Increase the volume of sulfuric acid.

A 1, 3 and 4 **B** 1 and 3 only **C** 2 and 3 **D** 3 and 4 only

17 Which type of reaction always forms a salt and water?

A exothermic

B neutralisation

C oxidation

D polymerisation

18 Which property is **not** characteristic of a base?

A It reacts with a carbonate to form carbon dioxide.

B It reacts with an acid to form a salt.

C It reacts with an ammonium salt to form ammonia.

D It turns universal indicator paper blue.

19 An alloy contains copper and zinc.

Some of the zinc has become oxidised to zinc oxide.

What is the result of adding an excess of dilute sulfuric acid to the alloy?

A A blue solution and a white solid remains.

B A colourless solution and a pink/brown solid remains.

C The alloy dissolves completely to give a blue solution.

D The alloy dissolves completely to give a colourless solution.

Q# 7/

17 Carbon dioxide is an acidic oxide that reacts with aqueous calcium hydroxide.

Which type of reaction takes place?

A decomposition

B fermentation

C neutralisation

D oxidation

18 Which is **not** a typical property of an acid?

A They react with alkalis producing water.

B They react with all metals producing hydrogen.

C They react with carbonates producing carbon dioxide.

D They turn litmus paper red.

Q# 8/

20 Which reaction will result in a decrease in pH?

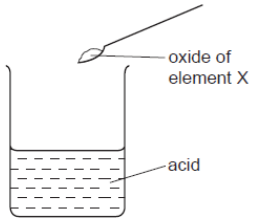
A adding calcium hydroxide to acid soil

B adding citric acid to sodium hydrogen carbonate solution

C adding sodium chloride to silver nitrate solution

D adding sodium hydroxide to hydrochloric acid

21 The oxide of element X was added to an acid. It reacted to form a salt and water.



What is the pH of the acid before the reaction and what type of element is X?

	pH	type of element X
A	greater than 7	metal
B	greater than 7	non-metal
C	less than 7	metal
D	less than 7	non-metal

11.9 ESSENTIAL Assessed Activity 3 Topic 8.1 & 8.2 Paper 3/4 18 marks

6 Acid-base reactions are examples of proton transfer.

(a) Ethylamine is a weak base and sodium hydroxide is a strong base.

(i) In terms of proton transfer, explain what is meant by the term *weak base*.

.....

..... [2]

(ii) Given aqueous solutions of both bases, describe how you could show that sodium hydroxide is the stronger base. How could you ensure a 'fair' comparison between the two solutions?

.....

.....

.....

..... [3]

(b) Ethylamine reacts with acids to form salts.

$$CH_3CH_2NH_2 + HCl \rightarrow \underset{\text{ethylammonium chloride}}{CH_3CH_2NH_3Cl}$$

(i) Complete the equation for the reaction between sulfuric acid and ethylamine. Name the salt formed.

.....$CH_3CH_2NH_2$ + ... → .....

name of salt ..... [3]

(ii) Amines and their salts have similar chemical properties to ammonia and ammonium salts.

Suggest a reagent that could be used to displace the weak base, ethylamine, from its salt ethylammonium chloride.

..... [1]

2 Oxides are classified as acidic, basic, neutral and amphoteric.

(a) Complete the table.

type of oxide	pH of solution of oxide	example
acidic		
basic		
neutral		

[6]

(b) **(i)** Explain the term *amphoteric*.

.....

..... [1]

(ii) Name two reagents that are needed to show that an oxide is amphoteric.

.....

..... [2]

11.10 Essential End of Topic Review and Reflection

Looking at the goals you could have achieved and the goals you actually achieved try to reflect on your progress.

Try to be as honest and as detailed as possible. Sometimes you may think you have thought about an idea well, but when you talk with someone else, or write it out, it helps you better understand and allows you think more completely and more clearly.

Did you achieve more goals this topic than last topic?

Fill in this table

Level	Number of goals achieved at each level	Success rate, %
FUNDAMENTAL	/5	
ESSENTIAL	/10	
EXTENSION	/13	
EXCEPTIONAL	/10	

Do you feel you tired harder? If yes, what helped you to do so? If not, why not?

What could you do differently next time, in addition to what you are already doing to improve, not only your score in the end of topic tests and other assessed activities, but also in how you learn. How could you become a more effective student to get more learning out of the time you are investing in your studies?

What did you enjoy most about this topic?

What did you find most difficult?

What did you find easiest?

On a scale of 1 being hardest and 5 being most difficult, circle how challenging you found this topic

1 2 3 4 5

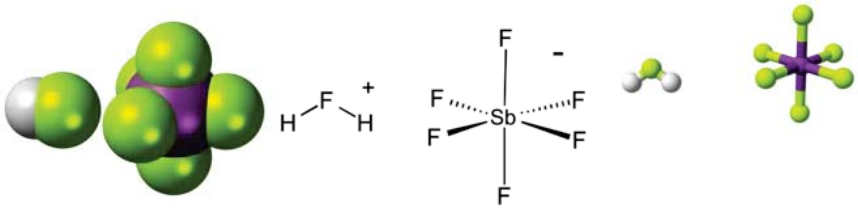
What could be done to make this topic easier to understand?

Do you have any questions about this topic?

11.11 Exceptional Additional Activities, Further Reading and Exploring Beyond the Syllabus

To find out about the strongest acids click here, and for more information about the least reactive metals by going to this website:

https://www.smashingsciencecn.org/igcse-chem-additional-resources



Definitions in science change with time, you could also use ChemGuide to find out about the various definitions of acids and bases through time. Is there likely to be a better definition in the future? If not, why not?

Fluoroantimonic acid

From Wikipedia, the free encyclopedia

Fluoroantimonic acid is an inorganic compound with the chemical formula H_2FSbF_6 (also written $H_2F[SbF_6]$, $2HF{\cdot}SbF_5$, or simply $HF\text{-}SbF_5$). It is an extremely strong acid, easily qualifying as a superacid. The Hammett acidity function, H_0, has been measured for different ratios of $HF{:}SbF_5$. While the H_0 of pure HF is −15, addition of just 1 mol % of SbF_5 lowers it to around −20. However, further addition of SbF_5 results in rapidly diminishing returns, with the H_0 reaching −21 at 10 mol %. The use of an extremely weak base as indicator shows that the lowest attainable H_0, even with > 50 mol % SbF_5, is somewhere between −21 and −23.[1][2][3]

The "canonical" composition of fluoroantimonic acid is prepared by treating liquid hydrogen fluoride (HF) with liquid antimony pentafluoride (SbF_5) in a stoichiometric ratio of 2:1. It is the strongest superacid based on measured H_0 value. Only the carborane acids, whose H_0 could not be directly determined due to their high melting points, may be stronger acids than fluoroantimonic acid.[4] It has been shown to protonate even hydrocarbons to afford pentacoordinate carbocations (carbonium ions).[5][6] It is exceptionally corrosive and can only be stored in containers lined with Teflon.

Fluoroantimonic acid thermally decomposes when heated, generating free hydrogen fluoride gas and liquid antimony pentafluoride. At temperatures as low as 40 C, fluoroantimonic acid will release HF into the gas phase. Antimony pentafluoride liquid can be recovered from fluoroantimonic acid by heating and releasing HF into the gas phase [7].

The reaction to produce fluoroantimonic acid results in formation of the fluoronium ion as a major species in equilibrium:

$$SbF_5 + 2\,HF \rightleftarrows SbF^-_6 + H_2F^+$$

12 Topic 8.3 & 8.4 Making Salts & Testing for Ions and Gases

12.1 End of Topic 8.3 & 8.4 Goals Checklist

For each topic you ought to try to do as many of the following things to get the most out of your time, the resources available to you and to help you grow as a student. Tick each goal off as you complete it. Growth is difficult and uncomfortable, but you should choose to do these things, and the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win!

Aspect	What you should have done	Yes/No	Level
Interacted with your teacher	Ask your teacher 1 question, about anything, once a week		FUNDAMENTAL
	Try to answer one question asked by your teacher at least once a week		ESSENTIAL
	Ask your teacher one question about something you do not understand in science once a week		ESSENTIAL
	Ask your teacher one question about something to do with science every lesson		EXTENSION
Notes and follow up notes	Complete set of class note		FUNDAMENTAL
	Cornell Notetaking Attempted		ESSENTIAL
	Cornell Notetaking Completed		EXTENSION
	Cornell Notetaking Completed to an exemplary standard		EXCEPTIONAL
	Attempted the Mind Map for this topic		ESSENTIAL
	Completed the Mind Map for this topic		EXTENSION
Textbook	Read ahead before the topic has been started		EXTESNION
	Highlighted key ideas and translate new words		FUNDAMENTAL
	Completed the questions at the end of each 2 page spread in your exercise book		EXTENSION
	Added to your class notes ideas and important information from the textbook that you learnt		EXTENSION
Past Exam Questions	Worked on at least 25% of the exam questions in this workbook		FUNDAMENTAL
	Attempted more than 25% of the questions and those questions you have completed you have marked in a different colour pen		ESSENTIAL
	Completed and marked all questions here		EXTENSION
	Completed, marked and additional key ideas where you have located the most difficult marks added to your notebook		EXCEPTIONAL
	Used the resources available online to answer additional questions not found in this workbook on the current topic.		EXCEPTIONAL
	Ask your teacher about an exam question that they cannot answer		EXCEPTIONALLY SMASHING!!!
Assessed Activities	Complete the word list activity using the word list at the front of each topic as little as possible		FUNDAMENTAL
	Complete 2 assessed activities, either in class or as homework		ESSENTIAL
	Complete 2 assessed activities and scored over 70% on average		ESSENTIAL
	Complete 2 assessed activities and scored over 80% on average		EXTENSION
	Complete 2 assessed activities and scored over 90% on average		EXCEPTIONAL
End of Topic Test	Revised sufficiently well to improve upon your score from the previous test (except if you are scoring over 90%, then just write Y for this goal)		ESSENTIAL
	Scored 10% higher than your current average		EXTENSION
	Scored 15% or more than your previous end of topic average		EXCEPTIONAL

Aspect	What you should have done	Yes/No	Level
	Scored over 90%		EXTESNION
	Scored over 95%		SMASHING!!!
Reading	Spend more than 1 hour a week reading a book **you enjoy** (in any language) about anything.		ESSENTIAL
	Spend more than 3 hours a week reading a book **you enjoy** (in any language) about anything.		EXTENSION
	Spend more than 5 hours a week reading a book **you enjoy** (in any language) about anything.		EXCEPTIONAL
	Spend at least one hour a week reading a book **you enjoy** in English about anything.		EXTENSION
	Spend more than 3 hours a week reading a book **you enjoy** in English about anything.		EXCEPTIONAL
Reflection	You completed this goal setting table		FUNDAMENTAL
	You have looked at the goals you have achieved and the ones you have not and added them up and entered them into the table in the Review and Reflection section		ESSENTIAL
	You have given an answer for every question in the Review and Reflection section at the end of this topic		EXTENSION
	You have Given good and thoughtful answers for every question in the Review and Reflection section at the end of this topic		EXCEPTIONAL

Tests for anions

anion	test	test result
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
bromide (Br^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
iodide (I^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate (NO_3^-) [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate (SO_4^{2-}) [in solution]	acidify, then add aqueous barium nitrate	white ppt.
sulfite (SO_3^{2-})	add dilute hydrochloric acid, warm gently and test for the presence of sulfur dioxide	sulfur dioxide produced will turn acidified aqueous potassium manganate(VII) from purple to colourless

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
aluminium (Al^{3+})	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium (NH_4^+)	ammonia produced on warming	–
calcium (Ca^{2+})	white ppt., insoluble in excess	no ppt. or very slight white ppt.
chromium(III) (Cr^{3+})	green ppt., soluble in excess	grey-green ppt., insoluble in excess
copper(II) (Cu^{2+})	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II) (Fe^{2+})	green ppt., insoluble in excess	green ppt., insoluble in excess
iron(III) (Fe^{3+})	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc (Zn^{2+})	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

Tests for gases

gas	test and test result
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	turns limewater milky
chlorine (Cl_2)	bleaches damp litmus paper
hydrogen (H_2)	'pops' with a lighted splint
oxygen (O_2)	relights a glowing splint
sulfur dioxide (SO_2)	turns acidified aqueous potassium manganate(VII) from purple to colourless

Flame tests for metal ions

metal ion	flame colour
lithium (Li^+)	red
sodium (Na^+)	yellow
potassium (K^+)	lilac
copper(II) (Cu^{2+})	blue-green

8.3 Preparation of salts

Core

- Demonstrate knowledge and understanding of preparation, separation and purification of salts as examples of some of the techniques specified in section 2.2.2 and the reactions specified in section 8.1

Supplement

- Demonstrate knowledge and understanding of the preparation of insoluble salts by precipitation
- Suggest a method of making a given salt from a suitable starting material, given appropriate information

8.4 Identification of ions and gases

Core

- Describe the following tests to identify:

  aqueous cations:

  aluminium, ammonium, calcium, chromium(III), copper(II), iron(II), iron(III) and zinc (using aqueous sodium hydroxide and aqueous ammonia as appropriate). (Formulae of complex ions are **not** required.)

  cations:

  use of the flame test to identify lithium, sodium, potassium and copper(II)

  anions:

  carbonate (by reaction with dilute acid and then limewater), chloride, bromide and iodide (by reaction under acidic conditions with aqueous silver nitrate), nitrate (by reduction with aluminium), sulfate (by reaction under acidic conditions with aqueous barium ions) and sulfite (by reaction with dilute acids and then aqueous potassium manganate(VII))

  gases:

  ammonia (using damp red litmus paper), carbon dioxide (using limewater), chlorine (using damp litmus paper), hydrogen (using lighted splint), oxygen (using a glowing splint), and sulfur dioxide (using aqueous potassium manganate(VII))

12.2 ESSENTIAL Glossary for Keywords for this topic

All of these keywords are covered in the first part of this topic in the previous chapter.

12.3 ESSENTIAL Classroom Active Learning Tasks Learning About Mnemonics

Cats (cations) are Pawsitive This cat (who is world famous as "Buff Cat") does not need to be positive because he is extremely buff. But all of the other cats are positively charged.

What makes a good mnemonic?

Usually it is an image or idea that stands out, that is able to make an impression on your emotions.

Not all things are as easy to remember: often, if it is hard to remember than it is usually a result of hesitation or nervousness when you are learning. The only way for many years I was able to know the charge of a cation was as a result of this mnemonic, I still only know the difference between left and right because if look at my left hand and extend my thumb and index finger, it makes an "L". Other more complex ideas I can learn and use with relative ease, there is a famous saying "only the average person is good at everything". Another useful phrase is "if you're not railing it means you are not trying hard enough". I still don't know, instinctively, left from right. What you know and what you don't know is a very poor measure of intelligence, it's what you do and who you help that, I think, defines the value of a mind.

12.3.1 Reflection and Investigation

What is IQ (Intelligence Qoutient)? When was it invented and why? Has it helped us better understand ourselves? Are there any negatives to IQ and what people have done as a result? Does having a higher IQ make you a better person?

What is EQ (there are two very different versions)?

Some people are professional (they earn a living) memory specialists, are they born with that ability or is it a skill set they have learnt?

12.4 Extension Classroom Active Learning Tasks Thinking deeper about mnemonics.

For a Zoom tutorial on ions tests scan this code:

Or click here

Ions tests mnemonics:

The chemistry behind these ideas is genuinely, almost, interesting. However, it goes into A2 Level and beyond, so this is just a collection of facts that you ought to memorise.

FINDAMENTAL ANSWER: If you are struggling with this subject and would be happy with a B grade, then this answer would most likely be the best way forward. For all ion test questions simply write "white ppt". Do not include anything else, this one answer can sometimes be up to 60% of the marks, and nearly always it is at least 25% of the marks. I twill also allow you to spend longer on the other questions, especially question 2 which is a straightforward graph question.

ESSENTIAL ANSWER: Learn the colour of these transition metals

Iron (II) Chloride (Fe^{2+}): Green

Rust (Iron (III) oxide: red brown),

Copper (II) sulphate (hydrated) blue

Chromium (III) chloride (Cr^{3+}) – Gray green

Extension Answer Learn all of the different conditions and tests:

Cation	NaOH		NH_3	
	Drops	Excess	Drops	Excess
Al^{3+}				
Ca^{3+}				
Zn^{3+}				

White squares represent conditions which return white ppt (7/12 squares)

Along the top row, use the alphabet for the order of NaOH and NH_3 as well as Drops and Excess.

Along the first column, again use the alphabet, which goes from A to Z to order the cations.

The shape of the soluble squares is a lot like a cat, which this fantastic drawing above shows, which is positive, but colourless!!! You could draw whatever you wanted that would better help you remember

For the transition metals:

Cation	NaOH		NH_3	
	Drops	Excess	Drops	Excess
Cr^{3+}	Green ppt		GrayGreen ppt	
Cu^{2+}	LightBlue ppt		LB ppt	DarkB solution
Fe^{2+}	Green ppt			
Fe^{3+}	Red-brown ppt			

For the flame tests I use a system base on Left and Right:

Flame Tests:

	1. LEFT Li		R (red)	2. RIGHT	
Memorise:	Na	Yellow		Cu	Blue-green
	K	L (lilac)	3. LEFT		

Lithium is the first element in the series, which matches to Left, which matches to Right, which is red, so it burns with a red flame. Below red (or Right) is Left, #3, which matches to Lilac which is the colour of potassium's flame. Sodium is yellow (it's a really strong colour and why wood, which contains a lot of sodium chloride has a yellow flame, and copper is blue green as a compound, usually, and also in a flame test. There are lots of different ways to create a mnemonic, usually by the time you've created it you'll have momorised the content, so you won't need it. But getting better able to memorise things, especially boring things, is an essential part of science, and the more complicated and interesting jobs which require incredible attention to detail.

REMEMBER!!! Whenever you answer a question about ions while you are working on past exam papers, draw out these tables, it will help you to build habits which will be very useful in the exam later on.

12.5 Extension Classroom Active Learning Tasks 2Thinking deeper about mnemonics

In the space below try to think of your own mnemonics to help you memorise these important, but extremely boring, facts.

12.6 ESSENTIAL EXAM QUESTIONS Paper 2 66 marks Topic 8

Q# 1/ iGCSE Chemistry/2018/m/Paper 22/

20 Barium hydroxide is an alkali. It reacts with hydrochloric acid.

How does the pH of the hydrochloric acid change as an excess of aqueous barium hydroxide is added?

A The pH decreases from pH 14 and becomes constant at pH 7.

B The pH decreases from pH 14 to about pH 1.

C The pH increases from pH 1 and becomes constant at pH 7.

D The pH increases from pH 1 to about pH 14.

21 Which statement describes a chemical property of aluminium oxide, Al_2O_3?

A It reacts with acids but not with bases.

B It reacts with acids and bases.

C It reacts with bases but not with acids.

D It reacts with water.

22 The results of two tests on an aqueous solution of X are shown.

test	observation
aqueous sodium hydroxide added	green precipitate formed
acidified aqueous silver nitrate added	yellow precipitate formed

What is X?

A copper(II) chloride

B copper(II) iodide

C iron(II) chloride

D iron(II) iodide

23 Four stages used to prepare an insoluble salt are listed.

1 drying
2 filtration
3 precipitation
4 washing

In which order are the stages done?

A $2 \rightarrow 1 \rightarrow 3 \rightarrow 4$
B $3 \rightarrow 2 \rightarrow 4 \rightarrow 1$
C $3 \rightarrow 4 \rightarrow 1 \rightarrow 2$
D $4 \rightarrow 3 \rightarrow 2 \rightarrow 1$

Q# 2/ iGCSE Chemistry/2017/w/Paper 23/

19 Three solids, P, Q and R, all react with dilute sulfuric acid to produce zinc sulfate.

P and R produce gases during the reaction.

The gas produced when P reacts will not burn. The gas produced when R reacts will burn.

What are P, Q and R?

	P	Q	R
A	zinc	zinc hydroxide	zinc carbonate
B	zinc carbonate	zinc	zinc oxide
C	zinc carbonate	zinc hydroxide	zinc
D	zinc oxide	zinc carbonate	zinc

20 Which ion forms a green precipitate with aqueous sodium hydroxide that dissolves in an excess of aqueous sodium hydroxide?

A Ca^{2+} **B** Cr^{3+} **C** Cu^{2+} **D** Fe^{2+}

Q# 3/ iGCSE Chemistry/2017/w/Paper 22/

19 Copper(II) sulfate can be prepared by adding excess copper(II) carbonate to sulfuric acid.

Why is an **excess** of copper(II) carbonate added?

A to ensure all the copper(II) carbonate has reacted
B to ensure all the sulfuric acid has reacted
C to increase the rate of reaction
D to increase the yield of copper(II) sulfate

20 Compound P reacts with hydrochloric acid to produce a gas that turns limewater milky.

What is P?

A sodium carbonate
B sodium chloride
C sodium hydroxide
D sodium sulfate

Q# 4/ iGCSE Chemistry/2017/w/Paper 21/

17 Some properties of four oxides are listed.

Oxide 1 reacts with both acids and alkalis to form salts.

Oxide 2 reacts with acids to form salts but does not react with alkalis.

Oxide 3 reacts with alkalis to form salts but does not react with acids.

Oxide 4 does not react with acids or alkalis.

Which row describes the oxides?

	oxide 1	oxide 2	oxide 3	oxide 4
A	amphoteric	acidic	basic	neutral
B	amphoteric	basic	acidic	neutral
C	neutral	acidic	basic	amphoteric
D	neutral	basic	acidic	amphoteric

18 What is **not** a typical characteristic of acids?

A They react with alkalis producing water.

B They react with **all** metals producing hydrogen.

C They react with carbonates producing carbon dioxide.

D They turn blue litmus paper red.

19 Zinc sulfate is made by reacting an excess of zinc oxide with dilute sulfuric acid.

The excess zinc oxide is then removed from the solution.

Which process is used to obtain solid zinc sulfate from the solution?

A crystallisation

B dissolving

C filtration

D fractional distillation

20 What is used to test for chlorine?

A a glowing splint

B damp litmus paper

C limewater

D potassium manganate(VII) solution

Q# 5/ iGCSE Chemistry/2017/s/Paper 23/

18 Which oxide is amphoteric?

A Al_2O_3 **B** CaO **C** Na_2O **D** SO_2

19 Chloric(I) acid, $HClO$, is formed when chlorine dissolves in water. It is a weak acid.

What is meant by the term *weak acid*?

A It contains fewer hydrogen atoms than a strong acid.

B It is easily neutralised by a strong alkali.

C It is less concentrated than a strong acid.

D It is only partially ionised in solution.

20 Silver nitrate reacts with sodium chloride to produce silver chloride and sodium nitrate. The equation for the reaction is shown.

$$AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$$

How is silver chloride separated from the reaction mixture?

A crystallisation

B distillation

C evaporation

D filtration

21 Aqueous sodium hydroxide reacts with an aqueous solution of compound Y to give a green precipitate.

Aqueous ammonia also reacts with an aqueous solution of compound Y to give a green precipitate.

In each case the precipitate is insoluble when an excess of reagent is added.

Which ion is present in Y?

A chromium(III)

B copper(II)

C iron(II)

D iron(III)

Q# 6/ iGCSE Chemistry/2017/s/Paper 22/

18 Which type of oxide is aluminium oxide?

A acidic

B amphoteric

C basic

D neutral

19 Which statements about a weak acid, such as ethanoic acid, are correct?

1 It reacts with a carbonate.

2 It does not neutralise aqueous sodium hydroxide solution.

3 It turns red litmus blue.

4 It is only partially ionised in aqueous solution.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

20 Silver chloride is a white solid which is insoluble in water.

Which statement describes how a sample of pure silver chloride can be made?

A Add aqueous silver nitrate to aqueous sodium chloride and then filter.

B Add aqueous silver nitrate to dilute hydrochloric acid, evaporate and then crystallise.

C Add silver carbonate to dilute hydrochloric acid, evaporate and then crystallise.

D Add silver to dilute hydrochloric acid, filter and then wash the residue.

21 Dilute sulfuric acid is added to two separate aqueous solutions, X and Y. The observations are shown.

solution X	white precipitate
solution Y	bubbles of a colourless gas

Which row shows the ions present in the solutions?

	solution X	solution Y
A	Ba^{2+}	CO_3^{2-}
B	Ca^{2+}	Cl^-
C	Cu^{2+}	CO_3^{2-}
D	Fe^{2+}	NO_3^-

Q# 7/ iGCSE Chemistry/2017/s/Paper 21/

18 Zinc oxide is amphoteric.

Which row describes the reactions of zinc oxide?

	reaction with hydrochloric acid	reaction with aqueous sodium hydroxide
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

key

✓ = reaction occurs

✗ = reaction does not occur

19 Which row shows how the hydrogen ion concentration and pH of ethanoic acid compare to those of hydrochloric acid of the same concentration?

	ethanoic acid compared to hydrochloric acid	
	hydrogen ion concentration	pH
A	higher	higher
B	higher	lower
C	lower	higher
D	lower	lower

20 A pure sample of the insoluble salt barium carbonate can be made using the method given.

step 1 Dissolve barium chloride in water.

step 2 Separately dissolve sodium carbonate in water.

step 3 Mix the two solutions together.

step 4 Filter the mixture.

step 5

step 6 Dry the residue between two sheets of filter paper.

Which instruction is missing from step 5?

A Heat the residue to dryness.

B Heat the residue to the point of crystallisation.

C Place the filtrate in an evaporating basin.

D Wash the residue with water.

21 Substance X reacts with warm dilute hydrochloric acid to produce a gas which decolourises acidified aqueous potassium manganate(VII).

Substance X gives a yellow flame in a flame test.

What is X?

A potassium chloride

B potassium sulfite

C sodium chloride

D sodium sulfite

Q# 8/ iGCSE Chemistry/2017/m/Paper 22/

18 Beryllium oxide reacts with both sulfuric acid and aqueous sodium hydroxide.

Which type of oxide is beryllium oxide?

A acidic

B amphoteric

C basic

D neutral

19 A student investigates two acids W and X.

The same volumes of W and X are reacted separately with excess magnesium.

The student makes the following observations.

1 Hydrogen gas is produced at a faster rate with W than with X.

2 The total volume of hydrogen gas produced is the same for both acids.

Which statement explains these observations?

A The pH of W is higher than the pH of X.

B W is an organic acid.

C W is a stronger acid than X.

D W is more concentrated than X.

20 A student is given an unknown solution.

Which two tests provide evidence that the solution is copper(II) sulfate?

1 adding dilute hydrochloric acid

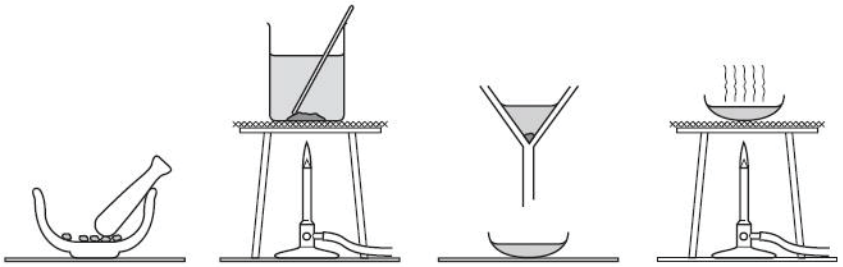
2 adding aqueous sodium hydroxide

3 adding dilute nitric acid, then silver nitrate solution

4 adding dilute nitric acid, then barium nitrate solution

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

21 The diagram shows the steps in the preparation of a salt.



step 1 step 2 step 3 step 4

Which salt is prepared by this method?

A barium sulfate

B copper(II) sulfate

C potassium sulfate

D sodium sulfate

Q# 9/ iGCSE Chemistry/2016/w/Paper 23/

23 Compound T is added to dilute hydrochloric acid and warmed gently.

The mixture gives off a gas which turns acidified aqueous potassium manganate(VII) from purple to colourless.

A flame test on compound T gives a lilac flame.

What is compound T?

A sodium sulfate

B sodium sulfite

C potassium sulfate

D potassium sulfite

Q# 10/ iGCSE Chemistry/2016/w/Paper 22/

23 Aqueous sodium hydroxide was added slowly, until in excess, to separate solutions of W, X, Y and Z.

The results are shown.

solution	initial observation with aqueous sodium hydroxide	final observation with excess aqueous sodium hydroxide
W	white precipitate formed	precipitate dissolves
X	white precipitate formed	no change
Y	pale blue precipitate formed	no change
Z	green precipitate formed	no change

Which row identifies the metal ions in the solutions?

	metal ion in solution W	metal ion in solution X	metal ion in solution Y	metal ion in solution Z
A	aluminium	calcium	copper(II)	iron(II)
B	aluminium	calcium	iron(II)	copper(II)
C	aluminium	iron(II)	calcium	copper(II)
D	calcium	aluminium	copper(II)	iron(II)

Q# 11/ iGCSE Chemistry/2016/w/Paper 21/

18 Germanium oxide is a white powder.

Germanium oxide reacts with concentrated hydrochloric acid.

Germanium oxide reacts with concentrated aqueous sodium hydroxide.

Germanium oxide does not dissolve when added to water.

Which type of oxide is germanium oxide?

A acidic

B amphoteric

C basic

D neutral

19 Hydrogen chloride gas reacts with water to produce an acidic solution. The equation for the reaction is shown.

$$HCl + H_2O \rightarrow Cl^- + H_3O^+$$

Which statement describes what happens during the reaction?

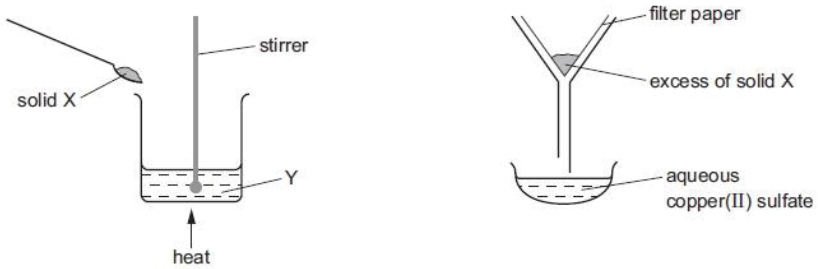
A The chloride ion is formed by accepting an electron from the water.

B The hydrogen chloride loses an electron to form the chloride ion.

C The water accepts a proton from the hydrogen chloride.

D The water donates a proton to the hydrogen chloride.

20 The apparatus shown is used to prepare aqueous copper(II) sulfate.



What are X and Y?

	X	Y
A	copper	aqueous iron(II) sulfate
B	copper(II) chloride	sulfuric acid
C	copper(II) oxide	sulfuric acid
D	sulfur	aqueous copper(II) chloride

21 Information about some silver compounds is shown in the table.

compound	formula	solubility in water
silver carbonate	Ag_2CO_3	insoluble
silver chloride	$AgCl$	insoluble
silver nitrate	$AgNO_3$	soluble
silver oxide	Ag_2O	insoluble

Which equation shows a reaction which **cannot** be used to make a silver salt?

A $AgNO_3(aq) + HCl(aq) \rightarrow AgCl(s) + HNO_3(aq)$

B $Ag_2O(s) + 2HNO_3(aq) \rightarrow 2AgNO_3(aq) + H_2O(l)$

C $Ag_2CO_3(s) + 2HNO_3(aq) \rightarrow 2AgNO_3(aq) + H_2O(l) + CO_2(g)$

D $2Ag(s) + 2HCl(aq) \rightarrow 2AgCl(s) + H_2(g)$

Q# 12/ iGCSE Chemistry/2016/w/Paper 21/

23 Four substances, P, Q, R and S, are tested as shown.

test	substance			
	P	Q	R	S
dilute hydrochloric acid added	gas given off which 'pops' with a lighted splint	gas given off which turns limewater milky	no reaction	no reaction
dilute aqueous sodium hydroxide added and warmed gently	no reaction	no reaction	gas given off which turns damp, red litmus paper blue	no reaction

What are P, Q, R and S?

	P	Q	R	S
A	Mg	Na_2CO_3	NH_4Cl	$NaCl$
B	Mg	NH_4Cl	Na_2CO_3	$NaCl$
C	Mg	Na_2CO_3	$NaCl$	NH_4Cl
D	Na_2CO_3	Mg	$NaCl$	NH_4Cl

Q# 13/ iGCSE Chemistry/2016/s/Paper 23/

20 Barium sulfate is an insoluble salt.

It can be made by reacting copper(II) sulfate solution with barium nitrate solution.

$$CuSO_4(aq) + Ba(NO_3)_2(aq) \rightarrow Cu(NO_3)_2(aq) + BaSO_4(s)$$

What is the correct order of steps to obtain a pure, dry sample of barium sulfate from the reaction mixture?

	step 1	step 2	step 3
A	filter	evaporate the filtrate to dryness	leave the solid formed to cool
B	filter	evaporate the filtrate to the point of crystallisation	leave the filtrate to cool
C	filter	leave the residue in a warm place to dry	wash the residue with water
D	filter	wash the residue with water	leave the residue in a warm place to dry

Q# 14/ iGCSE Chemistry/2016/s/Paper 22/

20 Silver chloride is insoluble in water and is prepared by precipitation.

Which two substances can be used to make silver chloride?

A barium chloride and silver nitrate

B hydrochloric acid and silver

C hydrochloric acid and silver bromide

D sodium chloride and silver iodide

Q# 15/ iGCSE Chemistry/2016/s/Paper 21/

18 Which statements are properties of an acid?

1 reacts with ammonium sulfate to form ammonia

2 turns red litmus blue

	1	2
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

19 Which row describes whether an amphoteric oxide reacts with acids and bases?

	reacts with acids	reacts with bases
A	no	no
B	no	yes
C	yes	no
D	yes	yes

20 Which substance reacts with dilute sulfuric acid to form a salt that can be removed from the resulting mixture by filtration?

A aqueous barium chloride

B aqueous sodium hydroxide

C copper

D copper(II) carbonate

Q# 16/ iGCSE Chemistry/2016/m/Paper 22/

18 Concentrated hydrochloric acid is a *strong acid*.

What is meant by the terms 'strong' and 'acid'?

	strong	acid
A	contains a low proportion of water	accepts protons
B	contains a low proportion of water	donates protons
C	fully ionised	accepts protons
D	fully ionised	donates protons

19 Which oxide is amphoteric?

A aluminium oxide

B calcium oxide

C carbon monoxide

D sodium oxide

20 A salt is made by adding an excess of an insoluble metal oxide to an acid.

How is the excess metal oxide removed from the mixture?

A chromatography

B crystallisation

C distillation

D filtration

21 A substance is heated with aluminium foil in aqueous sodium hydroxide. A gas is produced which turns damp, red litmus paper blue.

Which anion is present in the substance?

A carbonate

B iodide

C nitrate

D sulfate

12.6.1 ESSENTIAL EXAM QUESTIONS Paper 2 66 marks Topic 8 Mark Scheme

Q# 1/iGCSE Chemistry/2018/m/Paper 22/

20	D
21	B
22	D
23	B

Q# 2/iGCSE Chemistry/2017/w/Paper 23/

17	B
18	B
19	C
20	B
21	B
22	A
23	A

Q# 3/iGCSE Chemistry/2017/w/Paper 22/

17	B
18	B
19	B
20	A

Q# 4/iGCSE Chemistry/2017/w/Paper 21/

17	B
18	B
19	A
20	B

Q# 5/iGCSE Chemistry/2017/s/Paper 23/

18	A
19	D
20	D
21	C

Q# 6/iGCSE Chemistry/2017/s/Paper 22/

18	B
19	B
20	A
21	A

Q# 7/iGCSE Chemistry/2017/s/Paper 21/

18	A
19	C
20	D
21	D

Q# 8/iGCSE Chemistry/2017/m/Paper 22/

18	B
19	C
20	D
21	B

Q# 9/iGCSE Chemistry/2016/w/Paper 23/

23 **D**

Q# 10/iGCSE Chemistry/2016/w/Paper 22/

23 **A**

Q# 11/iGCSE Chemistry/2016/w/Paper 21/

18 **B**
19 **C**
20 **C**

Q# 12/iGCSE Chemistry/2016/w/Paper 21/

23 **A**

Q# 13/iGCSE Chemistry/2016/s/Paper 23/

18 **D**
19 **D**
20 **D**

Q# 14/iGCSE Chemistry/2016/s/Paper 22/

20 **A**

Q# 15/iGCSE Chemistry/2016/s/Paper 21/

18 **D**
19 **D**
20 **A**

Q# 16/iGCSE Chemistry/2016/m/Paper 22/

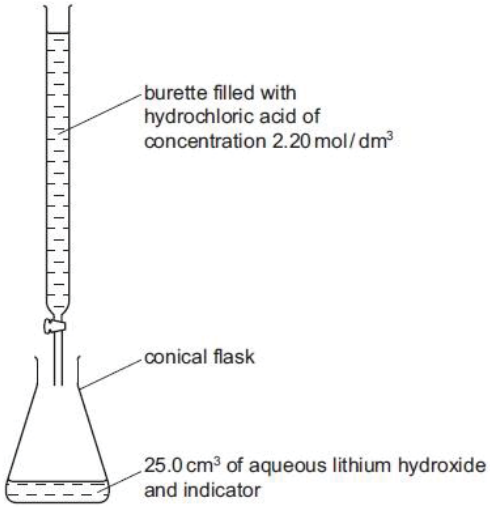
18 **D**
19 **A**
20 **D**
21 **C**

12.7 ESSENTIAL EXAM QUESTIONS Paper 3/4 Topic 8.3 & 8.4 116Marks

Topic Chem 8.3 **Q# 1/** iGCSE Chemistry/2013/s/Paper 31/

7 The hydroxides of the Group I metals are soluble in water. Most other metal hydroxides are insoluble in water.

(a) (i) Crystals of lithium chloride can be prepared from lithium hydroxide by titration.



25.0 cm^3 of aqueous lithium hydroxide is pipetted into the conical flask.
A few drops of an indicator are added. Dilute hydrochloric acid is added slowly to the alkali until the indicator just changes colour. The volume of acid needed to neutralise the lithium hydroxide is noted.

A neutral solution of lithium chloride, which still contains the indicator, is left. Describe how you could obtain a neutral solution of lithium chloride which does **not** contain an indicator.

.....

..... [2]

(ii) You cannot prepare a neutral solution of magnesium chloride by the same method. Describe how you could prepare a neutral solution of magnesium chloride.

.....

.....

..... [3]

Topic Chem 8.3 **Q# 2/** iGCSE Chemistry/2012/w/Paper 31/ Q7

(b) Strontium chloride-6-water can be made from the insoluble compound, strontium carbonate, by the following reactions.

$SrCO_3(s) + 2HCl(aq) \rightarrow SrCl_2(aq) + CO_2(g) + H_2O(l)$

$SrCl_2(aq) + 6H_2O(l) \rightarrow SrCl_2.6H_2O(s)$

The following method was used to prepare the crystals.

1 Add excess strontium carbonate to hot hydrochloric acid.
2 Filter the resulting mixture.
3 Partially evaporate the filtrate and allow to cool.
4 Filter off the crystals of $SrCl_2.6H_2O$.
5 Dry the crystals between filter papers.

(i) How would you know when excess strontium carbonate had been added in step 1?

.....

..... [1]

(ii) Why is it necessary to filter the mixture in step 2?

..... [1]

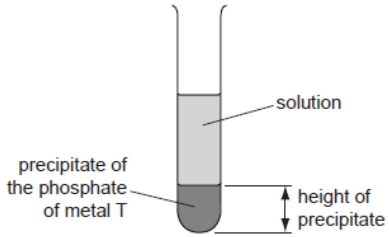
(iii) In step 3, why partially evaporate the filtrate rather than evaporate to dryness?

..... [1]

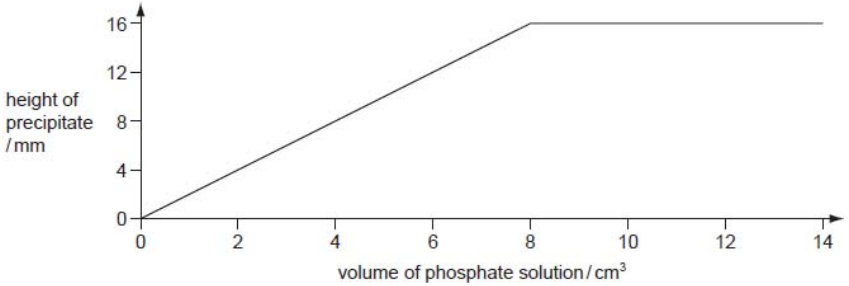
Topic Chem 8.3 **Q# 3/** iGCSE Chemistry/2009/s/Paper 31/ Q5

(b) The formulae of insoluble compounds can be found by precipitation reactions.

To 12.0 cm^3 of an aqueous solution of the nitrate of metal T was added 2.0 cm^3 of aqueous sodium phosphate, Na_3PO_4. The concentration of both solutions was 1.00 mol / dm^3. When the precipitate had settled, its height was measured.



The experiment was repeated using different volumes of the phosphate solution. The results are shown on the following graph.



What is the formula of the phosphate of metal T? Give your reasoning.

.....

.....

.....

..... [3]

5 Insoluble salts are made by precipitation.

(a) A preparation of the insoluble salt calcium fluoride is described below.

To 15 cm^3 of aqueous calcium chloride, 30 cm^3 of aqueous sodium fluoride is added. The concentration of both solutions is 1.00 mol / dm^3. The mixture is filtered and the precipitate washed with distilled water. Finally, the precipitate is heated in an oven.

(i) Complete the equation.

Ca^{2+} + ...F^- ⟶ ..... [2]

(ii) Why is the volume of sodium fluoride solution double that of the calcium chloride solution?

.....

..... [1]

(iii) Why is the mixture washed with distilled water?

.....

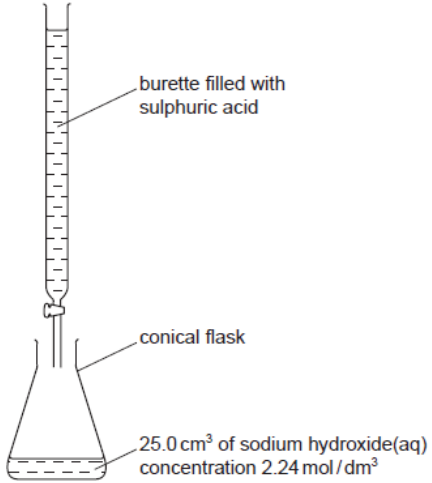
..... [1]

(iv) Why is the solid heated?

.....

..... [1]

7 Crystals of sodium sulphate-10-water, $Na_2SO_4.10H_2O$, are prepared by titration.



(a) 25.0 cm^3 of aqueous sodium hydroxide is pipetted into a conical flask.
A few drops of an indicator are added. Using a burette, dilute sulphuric acid is slowly added until the indicator just changes colour. The volume of acid needed to neutralise the alkali is noted.

Suggest how you would continue the experiment to obtain pure, dry crystals of sodium sulphate-10-water.

.....

.....

.....

..... [4]

4 Sulphuric acid is a typical strong acid.

(a) Change the equations given into a different format.

(i) $Mg + H_2SO_4 \longrightarrow MgSO_4 + H_2$
Change into a word equation.

..... [1]

(ii) lithium oxide + sulphuric acid ⟶ lithium sulphate + water
Change into a symbol equation.

..... [2]

(iii) $CuO + 2H^+ \longrightarrow Cu^{2+} + H_2O$
Change the ionic equation into a symbol equation.

..... [2]

(iv) $Na_2CO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + CO_2 + H_2O$
Change into a word equation.

..... [1]

(b) When sulphuric acid dissolves in water, the following reaction occurs.
$H_2SO_4 + H_2O \longrightarrow HSO_4^- + H_3O^+$
Explain why water is behaving as a base in this reaction.

..... [2]

(c) Sulphuric acid is a strong acid, ethanoic acid is a weak acid.
Explain the difference between a strong acid and a weak acid.

.....

..... [2]

3 There are three methods of preparing salts.

Method **A** – use a burette and an indicator.

Method **B** – mix two solutions and obtain the salt by precipitation.

Method **C** – add an excess of base or a metal to a dilute acid and remove the excess by filtration.

For each of the following salt preparations, choose one of the methods **A**, **B** or **C**, name any additional reagent needed and then write or complete the equation.

(i) the soluble salt, zinc sulphate, from the insoluble base, zinc oxide

method .....

reagent .....

word equation ..... [3]

(ii) the soluble salt, potassium chloride, from the soluble base, potassium hydroxide

method .....

reagent .....

equation ..... + ... → $KCl + H_2O$ [3]

(iii) the insoluble salt, lead(II) iodide, from the soluble salt, lead(II) nitrate

method .....

reagent .....

equation Pb^{2+} + ... → ..... [4]

[Total: 10]

Topic Chem 8.3 **Q# 8/** iGCSE Chemistry/2005/w/Paper 3/ Q6

(b) In the above method, a soluble salt was prepared by neutralising an acid with an insoluble base. Other salts have to be made by different methods.

(i) Give a brief description of how the soluble salt, rubidium sulphate could be made from the soluble base, rubidium hydroxide.

.....

.....

.....

..... [3]

(ii) Suggest a method of making the insoluble salt, calcium fluoride.

.....

.....

.....

..... [3]

Topic Chem 8.3 **Q# 9/** iGCSE Chemistry/2005/w/Paper 3/ Q5

(c) The major ore of strontium is its carbonate, $SrCO_3$. Strontium is extracted by the electrolysis of its molten chloride.

(i) Name the reagent that will react with the carbonate to form the chloride.

..... [1]

Topic Chem 8.3 **Q# 10/** iGCSE Chemistry/2004/w/Paper 3/

2 The salt copper(II) sulphate can be prepared by reacting copper(II) oxide with sulphuric acid.

Complete the list of instructions for making copper(II) sulphate using **six** of the words below.

blue cool dilute filter

saturated sulphate white oxide

Instructions

1 Add excess copper(II) oxide to [ ] sulphuric acid in a beaker and boil it.

2 [ ] to remove the unreacted copper(II) oxide.

3 Heat the solution until it is [ ].

4 [ ] the solution to form [ ]

coloured crystals of copper (II) [ ]. [6]

Topic Chem 8.3 **Q# 11/** iGCSE Chemistry/2004/s/Paper 3/

4 **(a)** Insoluble compounds are made by precipitation.

(i) Complete the word equation for the preparation of zinc carbonate.

..... + sodium carbonate → zinc carbonate + ...
....

[2]

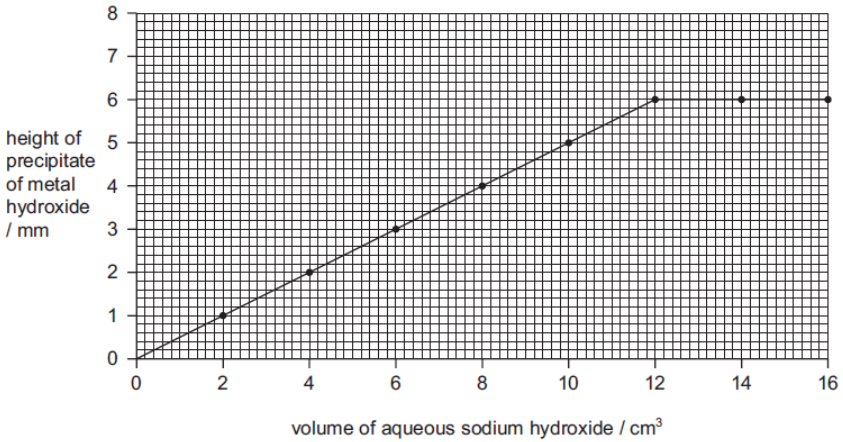
(ii) Complete the following symbol equation.

$Pb(NO_3)_2$ + ... $NaCl$ → ..... + ... [2]

(iii) Write an ionic equation for the precipitation of the insoluble salt, silver(I) chloride.

..... [2]

(b) 2.0 cm^3 portions of aqueous sodium hydroxide were added to 4.0 cm^3 of aqueous iron(III) chloride. Both solutions had a concentration of 1.0 mol/dm^3. After each addition, the mixture was stirred, centrifuged and the height of the precipitate of iron(III) hydroxide was measured. The results are shown on the following graph.



(i) Complete the ionic equation for the reaction.

Fe^{3+} + ...OH^- → ..... [1]

(ii) On the same grid, sketch the graph that would have been obtained if iron(II) chloride had been used instead of iron(III) chloride? [2]

(iii) If aluminium chloride had been used instead of iron(III) chloride, the shape of the graph would be different. How are the shapes of these two graphs different and why?

difference in shape .....

.....

reason for difference .....

..... [2]

Topic Chem 8.3 **Q# 12/** iGCSE Chemistry/2003/s/Paper 3/ Q3

(d) Nitrogen dioxide, oxygen and water react to form dilute nitric acid.
Describe how lead(II) nitrate crystals could be prepared from dilute nitric acid and lead(II) oxide.

.....

.....

.....[3]

Topic Chem 8.3 **Q# 13/** iGCSE Chemistry/2002/w/Paper 3/ QiGCSE Chemistry/201

(b) There are three ways of making salts from sulphuric acid.
titration using a burette and indicator
precipitation by mixing the solutions and filtering
neutralisation of sulphuric acid using an excess of an insoluble base

Complete the following table of salt preparations.

method	reactant 1	reactant 2	salt
titration	sulphuric acid		sodium sulphate
neutralisation	sulphuric acid		zinc sulphate
precipitation	sulphuric acid		barium sulphate
	sulphuric acid	copper(II) oxide	copper(II) sulphate

[4]

Topic Chem 8.3 **Q# 14/** iGCSE Chemistry/2001/w/Paper 3/ Q5

(d) Sulphuric acid is a typical strong acid.

(i) Explain the term *strong acid*.

.....[2]

(ii) Write a word equation for the reaction between zinc carbonate and sulphuric acid.

.....[2]

(iii) Write an equation for the reaction between sodium hydroxide and sulphuric acid.

.....[2]

(iv) Write an ionic equation for the reaction between magnesium and sulphuric acid.

.....[2]

Topic Chem 8.3 **Q# 15/** iGCSE Chemistry/2001/w/Paper 3/ Q4

(b) Zinc oxide is used to make aqueous zinc chloride. This can be used to preserve wood. Describe how this solution could be made.

.....

.....

.....[3]

Topic Chem 8.4 **Q# 16/** iGCSE Chemistry/2011/w/Paper 31/ Q5

(c) Describe how you could test the solution to find out which ion, Fe^{2+} or Fe^{3+}, is present.

.....

.....

..... [3]

Topic Chem 8.4 **Q# 17/** iGCSE Chemistry/2008/w/Paper 31/

1 Complete the following table.

gas	test for gas
ammonia	
	bleaches damp litmus paper
hydrogen	
	relights a glowing splint
	turns limewater milky

[Total: 5]

Topic Chem 8.4 **Q# 18/** iGCSE Chemistry/2005/s/Paper 3/ Q2

(b) Describe how you could show by adding aqueous sodium hydroxide and aqueous ammonia that a solution contained zinc ions.

result with sodium hydroxide .....

excess sodium hydroxide .....

result with aqueous ammonia .....

excess aqueous ammonia ..... [3]

Topic Chem 8.4 **Q# 19/** iGCSE Chemistry/2005/s/Paper 3/

3 A South Korean chemist has discovered a cure for smelly socks. Small particles of silver are attached to a polymer, poly(propene), and this is woven into the socks.

(b) To show that the polymer contains silver the following test was carried out.

The polymer fibres were chopped into small pieces and warmed with nitric acid. The silver atoms were oxidised to silver(I) ions. The mixture was filtered. Aqueous sodium chloride was added to the filtrate and a white precipitate formed.

(i) Why was the mixture filtered?

..... [1]

(ii) Explain why the change of silver atoms to silver ions is oxidation.

..... [1]

(iii) Give the name of the white precipitate.

..... [1]

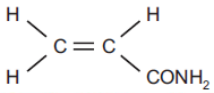
Topic Chem 8.4 **Q# 20/** iGCSE Chemistry/2004/w/Paper 3/ QiGCSE Chemistry/201 (d)

(i) Describe how you could show that the gas collected in this experiment is oxygen.

[1]

Topic Chem 8.4 **Q# 21/** iGCSE Chemistry/2004/s/Paper 3/

6 In 2002, Swedish scientists found high levels of acrylamide in starchy foods that had been cooked above 120 °C. Acrylamide, which is thought to be a risk to human health, has the following structure.



(b) Acrylamide hydrolyses to form acrylic acid and ammonium ions.

(i) Describe the test for the ammonium ion.

test .....

.....

result ..... [2]

Topic Chem 8.4 **Q# 22/** iGCSE Chemistry/2003/w/Paper 3/ Q5 (c)

(ii) To aqueous sulphur dioxide, acidified barium chloride solution is added. The mixture remains clear. When bromine is added, a thick white precipitate forms. What is the white precipitate? Explain why it forms.

.....

.....[3]

Topic Chem 8.4 **Q# 23/** iGCSE Chemistry/2003/w/Paper 3/ Q5

(c) Sulphur dioxide is easily oxidised in the presence of water.

$$SO_2 + 2H_2O - 2e^- \longrightarrow SO_4^{2-} + 4H^+$$

(i) What colour change would be observed when an excess of aqueous sulphur dioxide is added to an acidic solution of potassium manganate(VII)?

.....[2]

Topic Chem 8.4 **Q# 24/** iGCSE Chemistry/2003/s/Paper 3/

2 Calcium and other minerals are essential for healthy teeth and bones. Tablets can be taken to provide these minerals.

(b) Describe the reactions, if any, of zinc and copper(II) ions with an excess of aqueous sodium hydroxide.

(i) zinc ions

addition of aqueous sodium hydroxide .....

.....

excess sodium hydroxide .....

.....

(ii) copper(II) ions

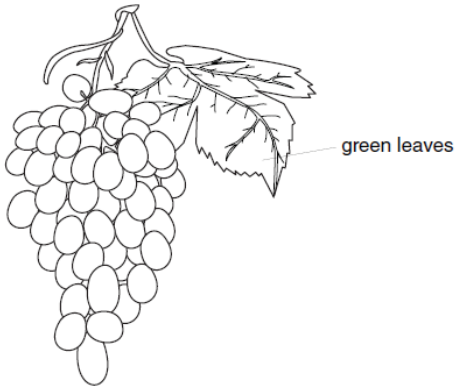
addition of aqueous sodium hydroxide .....

.....

excess sodium hydroxide .....

.....[4]

2 Fermentation of sugars is one method of making ethanol. Vines produce glucose by photosynthesis. The glucose collects in the grapes which grow in clusters on the vine.



(a) Vines are attacked by a fungus that ruins the grapes. In 1882 it was discovered that spraying the vines with Bordeaux mixture killed the fungus.

The fungicide, Bordeaux mixture, contains water, calcium hydroxide and copper(II) sulphate.

(i) Name the raw material from which calcium hydroxide is made.

.....[1]

(ii) The mixture contains four ions. Complete the list of ions.

Cu^{2+}, OH^-, ... and ..... [2]

(iii) A different fungicide can be made by the reaction between an excess of aqueous ammonia and a copper(II) salt. Describe the **observations** for this reaction.

addition of aqueous ammonia .....

.....

then excess aqueous ammonia .....

.....[3]

Q# 1/ iGCSE Chemistry/2013/s/Paper 31/

7 **(a)** **(i)** add carbon / animal charcoal [1]
filter [1]

OR

repeat experiment without indicator [1]
using same quantity / volume of acid [1]

(ii) add magnesium metal / carbonate / oxide / hydroxide
to (hot) (hydrochloric) acid [1]

cond: until in excess **or** no more dissolves **or** reacts [1]

cond: filter (to remove unreacted solid) [1]

(b) number of moles of HCl = 0.020 x 2.20 = 0.044 [1]
number of moles of LiOH = 0.044
concentration of LiOH = 0.044/0.025 = 1.769 (mol / dm^3) [1]
accept 1.75 to 1.77 need 2 dp
correct answer scores = 2

(c) (for $LiCl.2H_2O$)
mass of one mole = 78.5 [1]
percentage water = 36 / 78.5 x 100 [1]
45.9 so is $LiCl.2H_2O$ [1]
only award the marks if you can follow the reasoning and it gives 45.9% of water

note: if correct option given mark this and ignore the rest of the response

allow: max 2 for applying a correct method to another hydrate, [1] for the method and [1] for the correct value, working essential

Q# 2/ iGCSE Chemistry/2012/w/Paper 31/ Q7

(b) **(i)** strontium carbonate does not dissolve / no effervescence; [1]
note: not just reaction is complete

(ii) to remove excess / unreacted / undissolved strontium carbonate; [1]

(iii) water of crystallisation needed / $6H_2O$ in crystals / would get anhydrous salt / would not get hydrated salt / crystals dehydrate; [1]
not: just to obtain crystals

Q# 3/ iGCSE Chemistry/2009/s/Paper 31/ Q5

(b) $T_3(PO_4)_2$ allow correct example [1]
explain why 8 cm^3 react fully [1]
comment about mole ratio [1]

Q# 4/ iGCSE Chemistry/2009/s/Paper 31/

5 (a) (i) $Ca^{2+} + 2F^- \rightarrow CaF_2$ [2]
Not balanced **ONLY** [1]
Both species must be correct for first mark. Second mark is for correct balancing.

(ii) Mole ratio Ca^{2+}: F^- is 1:2 [1]
Answer must mention moles
accept argument based on charges or number of ions
accept 2 moles of NaF react with 1 mole of $CaCl_2$
NOT just "2" in equation
If fluorine must specify atoms or ions

(iii) to remove traces of solutions **or** to remove soluble impurities **or** to remove a named salt sodium chloride **or** sodium fluoride **or** calcium chloride [1]
To remove impurities is not enough

(iv) to dry (precipitate) **or** to remove water **or** to evaporate water [1]
NOT to evaporate some of water **NOT** to crystallise salt

Q# 5/ iGCSE Chemistry/2008/s/Paper 31/

7 (a) repeat experiment without indicator **or** use carbon to remove indicator [1]
(partially) evaporate **or** boil **or** heat [1]
allow to cool **or** crystallise **or** crystals [1]
dry crystals [1]
MUST be in correct order
NB evaporate to dryness, marks one and two **ONLY**

Q# 6/ iGCSE Chemistry/2008/s/Paper 31/

4 (a) (i) magnesium + sulphuric acid = magnesium sulphate + hydrogen [1]
ACCEPT hydrogen sulphate

(ii) $Li_2O + H_2SO_4 \rightarrow Li_2SO_4 + H_2O$ [2]
formulae correct but not balanced [1]

(iii) $CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$ [2]
OR $CuO + 2HCl \rightarrow CuCl_2 + H_2O$
OR $CuO + 2HNO_3 \rightarrow Cu(NO_3)_2 + H_2O$
formulae correct but not balanced [1]

(iv) sodium carbonate + sulphuric acid → sodium sulphate + carbon dioxide + water [1]

(b) it accepts a proton [2]
it accepts a hydrogen ion [1] **ONLY**

(c) sulphuric acid is completely ionised [1]
or few molecules and many ions
ethanoic acid is partially ionised [1]
or many molecules and few ions

Q# 7/ iGCSE Chemistry/2008/s/Paper 31/

3 (i) method C [1]
sulphuric acid (allow if given in equation) [1]
zinc oxide + sulphuric acid = zinc sulphate + water [1]

(ii) method A [1]
hydrochloric acid [1]
$KOH + HCl = KCl + H_2O$ [1]

(iii) method B [1]
potassium iodide **or** any soluble iodide [1]
$Pb^{2+} + 2I^- = PbI_2$ accept a correct equation even if soluble iodide is wrong [2]
Not balanced - $Pb^{2+} + I^- = PbI_2$ ONLY [1]

Q# 8/ iGCSE Chemistry/2005/w/Paper 3/ Q6

(b)(i) sulphuric acid
COND description of titration
repeat without indicator **or** with carbon
evaporation
any **TWO** **[3]**

(ii) suitable reactants calcium chloride and sodium fluoride **[1]**
COND upon correct reagents
filter **[1]**
wash and dry precipitate **[1]**

OR Accept synthesis
calcium **[1]**
fluorine **[1]**
burn **or** heat **[1]** **[3]**

Q# 9/ iGCSE Chemistry/2005/w/Paper 3/ Q5

(c)(i) hydrochloric acid **[1]**

Q# 10/ iGCSE Chemistry/2004/w/Paper 3/

2 dilute
filter
saturated
cool
blue
sulphate **[6]**

Q# 11/ iGCSE Chemistry/2004/s/Paper 3/

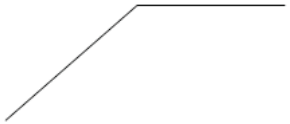
4 **(a)** **(i)** Named soluble zinc salt **[1]**
corresponding sodium salt **[1]**
If hydroxide **or** oxide then 0/2

(ii) Correct equation **[2]**
not balanced **[1]** only

(iii) Correct equation **[2]**

(b) **(i)** $Fe^{3+} + 3OH^- = Fe(OH)_3$ **[1]**

(ii) Max at $8cm^3$ **[1]**
Same shape of graph



Just the above shape, the height of the precipitate and the volume of sodium hydroxide are irrelevant **[1]**

(iii) Maximum then height of precipitate decreases **[1]**
or graph slopes down to x axis **or** comes to zero

hydroxide dissolves in excess **or** it is amphoteric **[1]**

Q# 12/ iGCSE Chemistry/2003/s/Paper 3/ Q4

(d) Add excess lead oxide to nitric acid [1]
can imply excess
filter NOT if residue is lead nitrate [1]
evaporate **or** heat solution [1]

Q# 13/ iGCSE Chemistry/2002/w/Paper 3/ QiGCSE Chemistry/201

(b) **sodium hydroxide or carbonate or hydrogencarbonate** [1]

zinc oxide or hydroxide or carbonate [1]
NOT zinc

barium nitrate or chloride or hydroxide or barium ions [1]

neutralisation NOT acid/base [1]

Q# 14/ iGCSE Chemistry/2001/w/Paper 3/ Q5

(d) (i) completely ionized **or** good proton donor [2]
for explanation based on high concentration of H^+ **or** low pH or proton donor **ONLY** [1]

(ii) word equation correct [2]
water missing **ONLY** [1]
accept correct symbol equation

(iii) $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$ [2]
unbalanced [1] **NOT** word equation
or $NaOH + H_2SO_4 \rightarrow NaHSO_4 + H_2O$

(iv) $Mg + 2H^+ \rightarrow Mg^{2+} + H_2$ [2]
molecular equation ONLY [1] **NOT** word equation

Q# 15/ iGCSE Chemistry/2001/w/Paper 3/ Q4

(b) hydrochloric acid [1]
excess zinc oxide [1]
filter [1]

OR add hydrochloric acid forms (zinc chloride and) water

[Max 2]

Q# 16/ iGCSE Chemistry/2011/w/Paper 31/ Q5

(c) add sodium hydroxide solution / ammonia(aq) [1]
Fe^{2+} green precipitate [1]
Fe^{3+} brown precipitate [1]

Q# 17/ iGCSE Chemistry/2008/w/Paper 31/

1 red litmus paper blue [1]
OR white fumes/smoke with HCl (g) **or** (aq)

chlorine [1]

"pop" with a lighted splint **or** burn with a pop **or** goes pop and extinguishes flame [1]
NOT glowing splint

oxygen [1]

carbon dioxide [1]
ACCEPT correct formulae

[Total: 5]

Q# 18/ iGCSE Chemistry/2005/s/Paper 3/ Q2

(b) for zinc and sodium hydroxide white precipitate **[1]**
dissolves in excess (only if precipitate mentioned) **[1]**

for zinc and ammonia same results **[1]**
Mark either first (sodium hydroxide **or** aqueous ammonia), if completely correct, then an additional [1] can be awarded for stating that the other has the same results.

Q# 19/ iGCSE Chemistry/2005/s/Paper 3/Q3

(b) (i) to remove fibres **or** remove solid
NOT precipitate, **NOT** impurities, **NOT** to obtain a filtrate **[1]**

(ii) because silver atoms have lost electrons **[1]**
OR oxidation number increased

(iii) silver chloride **[1]**

Q# 20/ iGCSE Chemistry/2004/w/Paper 3/ QiGCSE Chemistry/201

(d) (i) glowing splint burst into flame or rekindled **[1]**
Must have glowing or equivalent idea
OR any similar description that includes the two points glowing and relights.

Q# 21/ iGCSE Chemistry/2004/s/Paper 3/

(b) (i) sodium hydroxide **[1]**
COND ammonia **or** alkaline gas **or** litmus red to blue **[1]**
If aluminium added wc =0

Q# 22/ iGCSE Chemistry/2003/w/Paper 3/ Q5 (c)

(ii) barium sulphate [1]
cond bromine oxidises **or** reacts with [1]
sulphur dioxide to form sulphate ion [1]

Q# 23/ iGCSE Chemistry/2003/w/Paper 3/ Q5

(c) (i) pink **or** purple [1]
colourless **NOT** clear [1]

Q# 24/ iGCSE Chemistry/2003/s/Paper 3/ Q2

(b) (i) white precipitate [1]
COND upon a precipitate
dissolves in excess or forms solution [1]
(ii) blue precipitate [1]
COND upon a precipitate
does not dissolve in excess [1]

Q# 25/ iGCSE Chemistry/2002/s/Paper 3/

2 (a) (i) limestone **or** quicklime **or** calcium oxide [1]
or marble **or** chalk **or** calcium carbonate
NOT just lime

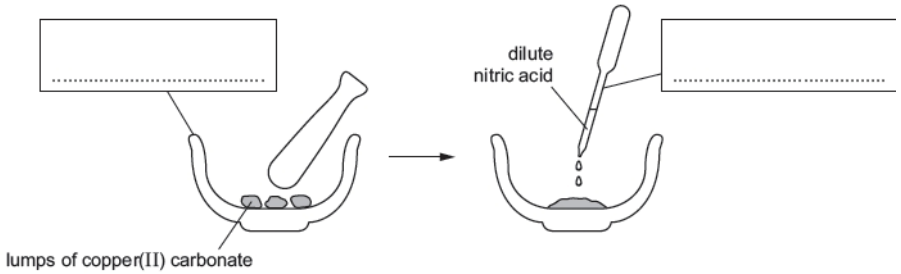
(ii) Ca^{2+} and SO_4^{2-} [2]

(iii) blue precipitate accept light blue precipitate
then blue solution [1]
dissolves **or** solution [1]
deep blue [1]

12.8 ESSENTIAL EXAM QUESTIONS Paper 6 272 Marks Topic 8.3 & 8.4

Q# 1/ iGCSE Chemistry/2018/w/Paper 63/Q1

1 A sample of copper was prepared from lumps of copper(II) carbonate. The first step was to make a solution of copper(II) nitrate as shown. Carbon dioxide was produced.



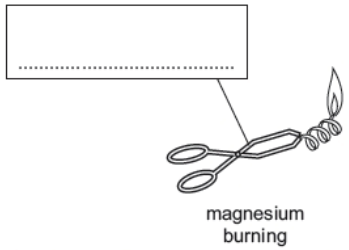
(b) Describe a test for carbon dioxide.

test .....

result .....
[2]

Q# 2/ iGCSE Chemistry/2018/w/Paper 62/Q1

1 Magnesium ribbon was burned in air.



(e) Suggest the pH value shown when Universal Indicator was added to the mixture.

..... [1]

Q# 3/ iGCSE Chemistry/2018/s/Paper 62/Q1

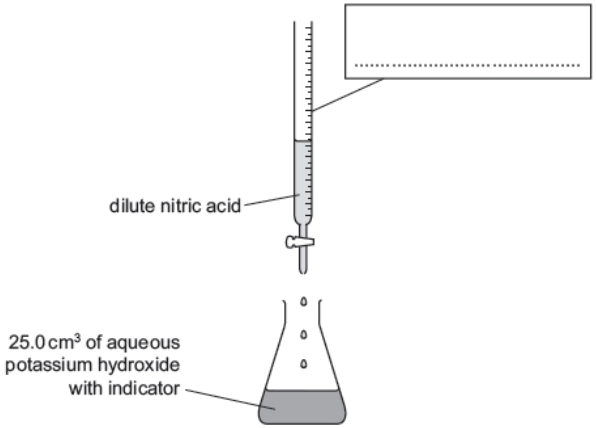
(d) Describe a test for carbon dioxide.

test .....

result .....
[2]

Q# 4/ iGCSE Chemistry/2018/s/Paper 61/Q1

1 The volume of dilute nitric acid that reacts with 25.0 cm³ of aqueous potassium hydroxide can be found by titration using the apparatus shown.



(b) Name a suitable indicator that could be used.

..... [1]

A student did the titration four times and recorded the following results.

titration number	volume of dilute nitric acid / cm³
1	18.1
2	18.9
3	18.3
4	18.2

(c) (i) Which **one** of the results is anomalous?

..... [1]

(ii) Suggest what might have caused this result to be anomalous.

..... [1]

(iii) Use the **other** results to calculate the average volume of dilute nitric acid that reacted with the aqueous potassium hydroxide.

..... [2]

(d) The equation for the reaction taking place in the titration is shown.

$$HNO_3 + KOH \rightarrow KNO_3 + H_2O$$

The student concluded that the aqueous potassium hydroxide was more concentrated than the dilute nitric acid.

Explain whether or not the student's conclusion was correct.

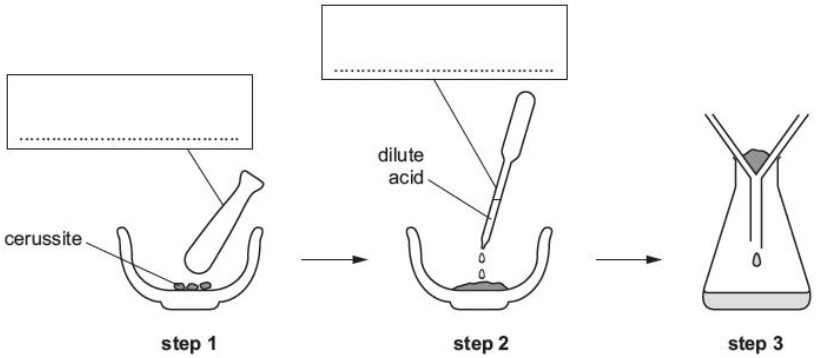
.....

.....

..... [2]

Q# 5/ iGCSE Chemistry/2017/w/Paper 63/Q1

1 Cerussite is a lead ore which contains lead(II) carbonate. A student obtained a solution of lead(II) nitrate from cerussite using the apparatus shown.



(c) Name the dilute acid used in **step 2**.

..... [1]

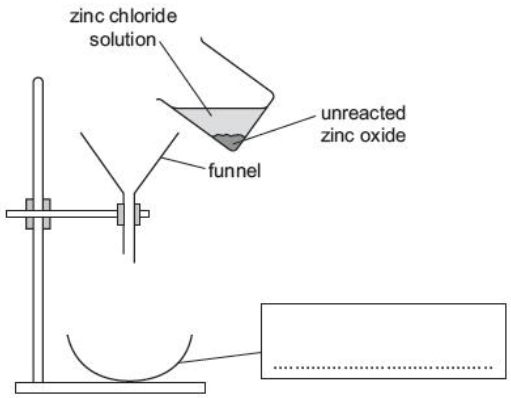
Q# 6/ iGCSE Chemistry/2017/w/Paper 62/Q1

(ii) State the effect of a lighted splint on the hydrogen produced.

..... [1]

Q# 7/ iGCSE Chemistry/2017/w/Paper 61/Q1

1 A student reacted dilute hydrochloric acid with zinc oxide to prepare zinc chloride solution. The diagram shows part of the procedure.



(d) Describe how crystals of zinc chloride could be obtained from the zinc chloride solution.

.....

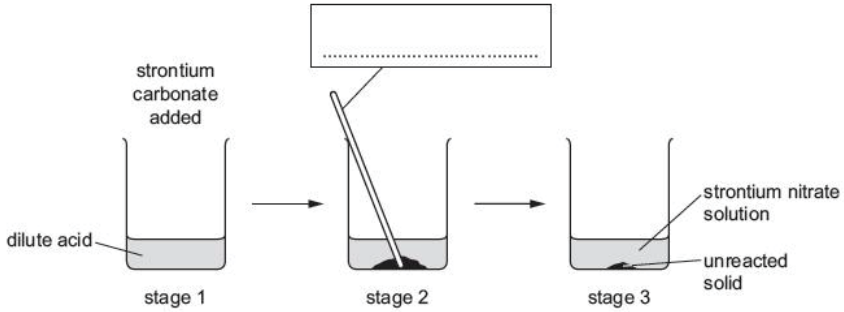
.....

..... [3]

Q# 8/ iGCSE Chemistry/2017/s/Paper 61/Q1

1 A student prepared strontium nitrate crystals.

The diagram shows some of the stages in this preparation.



(a)

(iii) Name the dilute acid used.

..... [1]

(iv) Give **one** expected observation in stage 2.

..... [1]

(b) Why is heat **not** necessary in stage 2?

..... [1]

(c) Which of the reactants is in excess? Explain your answer.

.....

..... [2]

(d) Describe how crystals of strontium nitrate could be obtained from the mixture in stage 3.

.....

.....

..... [3]

Q# 9/ iGCSE Chemistry/2017/m/Paper 62/Q1

(c) Give a test for oxygen.

test .....

result .....

[1]

(d) The gas collected at the positive side turned limewater milky.

(i) Based on this observation, what gas was present?

..... [1]

Q# 10/ iGCSE Chemistry/2016/w/Paper 61/Q1

(d) Give **one** test to distinguish between oxygen and hydrogen.

test .....

result with oxygen .....

result with hydrogen .....

[2]

Q# 11/ iGCSE Chemistry/2018/m/Paper 62/Q2

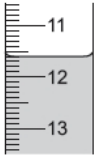
2 A student investigated the reaction between dilute hydrochloric acid and an aqueous solution of sodium carbonate labelled solution **L**.

Three experiments were done.

Experiment 1

- A measuring cylinder was used to pour 25 cm^3 of solution **L** into a conical flask.
- Ten drops of thymolphthalein indicator were added to the conical flask.
- A burette was filled up to the 0.0 cm^3 mark with dilute hydrochloric acid.
- Dilute hydrochloric acid was added from the burette to the conical flask until the solution just changed to colourless at the end-point of the titration.

(a) Use the burette diagram to record the final burette reading in the table and complete the table.



final burette reading

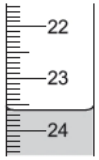
	Experiment 1
final burette reading / cm^3	
initial burette reading / cm^3	0.0
difference / cm^3	

[1]

Experiment 2

- Ten drops of methyl orange indicator were added to the solution in the conical flask from Experiment 1.
- Dilute hydrochloric acid was added from the burette to the conical flask until the solution just changed colour.

(b) Use the burette diagram to record the final burette reading in the table and complete the table.



final burette reading

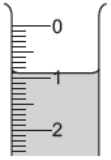
	Experiment 2
final burette reading / cm^3	
initial burette reading / cm^3	12.0
difference / cm^3	

[1]

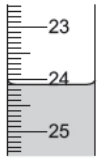
Experiment 3

- The conical flask was emptied and rinsed with distilled water.
- Experiment 1 was repeated using methyl orange indicator instead of thymolphthalein indicator and adding dilute hydrochloric acid from the burette to the conical flask until the solution just changed colour.

(c) Use the burette diagrams to record the burette readings in the table and complete the table.



initial burette reading



final burette reading

	Experiment 3
final burette reading / cm^3	
initial burette reading / cm^3	
difference / cm^3	

[3]

(d) What colour change was observed in the conical flask in Experiment 3?

from ..... to .....
[1]

(e) Why was the conical flask emptied and rinsed with distilled water at the start of Experiment 3?

..... [1]

(f) Complete the sentence.

Experiment ..... needed the largest volume of dilute hydrochloric acid to change the colour of the indicator. [1]

(g) Give the name of a more accurate piece of apparatus for measuring the volume of solution **L**.

..... [1]

(h) What would be the effect on the results if solution **L** were warmed before adding the dilute hydrochloric acid? Give a reason for your answer.

effect on the results .....

reason .....
[2]

(i) **(i)** Determine the simplest whole number ratio of volumes of dilute hydrochloric acid used in Experiments 1 and 3.

..... [1]

(ii) Suggest why the volumes of dilute hydrochloric acid used in Experiments 1 and 3 are different.

..... [1]

(j) Suggest why Universal Indicator **cannot** be used in these experiments.

.....

..... [1]

(k) Suggest how the reliability of the results could be checked.

.....

..... [2]

[Total: 16]

Q# 12/ iGCSE Chemistry/2017/m/Paper 62/Q2

2 A student investigated the reaction between dilute hydrochloric acid and two different aqueous solutions of sodium hydroxide labelled solution **O** and solution **P**.

Two experiments were carried out.

Experiment 1

- A burette was filled with dilute hydrochloric acid. The initial burette reading was recorded.
- Using a measuring cylinder, 20 cm^3 of solution **O** were poured into a conical flask.
- Thymolphthalein indicator was added to the conical flask.
- The dilute hydrochloric acid was added from the burette, while swirling the flask, until the solution just changed colour. The final burette reading was recorded.

(a) Use the burette diagrams to record the readings in the table and complete the table.

initial reading final reading

final burette reading / cm^3	
initial burette reading / cm^3	
difference / cm^3	

[2]

Experiment 2

- The conical flask was emptied and rinsed with distilled water.
- Experiment 1 was repeated using solution **P** instead of solution **O**.

(b) Use the burette diagrams to record the readings in the table and complete the table.

initial reading final reading

final burette reading / cm^3	
initial burette reading / cm^3	
difference / cm^3	

[2]

(c) What type of chemical reaction occurs when dilute hydrochloric acid reacts with sodium hydroxide solution?

..... [1]

(d) **(i)** Which solution of sodium hydroxide, solution **O** or solution **P**, is the more concentrated? Explain your answer.

.....

..... [2]

(ii) How many times more concentrated is this solution of sodium hydroxide than the other solution of sodium hydroxide?

..... [1]

(e) If Experiment 2 were repeated using 10 cm^3 of solution **P**, what volume of dilute hydrochloric acid would be needed?

..... [2]

(f) What would be the effect, if any, on the volume of dilute hydrochloric acid used in Experiment 1 if the solution of sodium hydroxide were **warmed** before adding the dilute hydrochloric acid? Give a reason for your answer.

effect on volume .....

reason .....
[2]

(g) **(i)** What would be a more accurate method of measuring the volume of the aqueous sodium hydroxide solution?

..... [1]

(ii) Suggest how the reliability of the results could be checked.

..... [1]

(h) Aqueous sodium hydroxide reacts with aqueous calcium chloride to form a precipitate of calcium hydroxide.

Use this information to suggest a **different** method of finding out which of the solutions of sodium hydroxide is the more concentrated.

.....

.....

.....

..... [3]

Q# 13/ iGCSE Chemistry/2016/w/Paper 61/Q2

2 A student investigated what happened when dilute nitric acid reacted with aqueous solutions of two different alkalis, solution **N** and solution **O**.

Two experiments were carried out.

(a) *Experiment 1*

A measuring cylinder was used to pour 50 cm^3 of solution **N** into a polystyrene cup. The initial temperature of the solution was measured.
A burette was filled with nitric acid to the 0.0 cm^3 mark.
5.0 cm^3 of nitric acid were added to solution **N** in the polystyrene cup and the solution stirred. The maximum temperature of the solution was measured.
A further 5.0 cm^3 of nitric acid were added to the polystyrene cup and the solution stirred. The maximum temperature of the solution was measured.
The student continued to add 5.0 cm^3 portions of nitric acid to the polystyrene cup, until a total volume of 40 cm^3 of nitric acid had been added. After each addition, the solution was stirred and the maximum temperature measured.

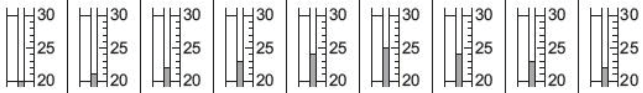
Use the thermometer diagrams to record the maximum temperatures in the table.

volume of nitric acid added / cm^3	0.0	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0
thermometer diagram									
maximum temperature of the solution in the polystyrene cup / °C									

[2]

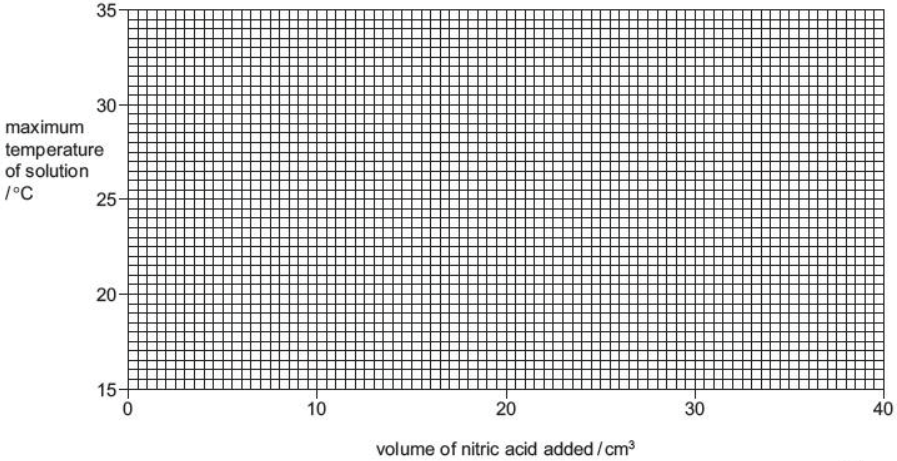
(b) *Experiment 2*

Experiment 1 was repeated using solution **O** instead of solution **N**.
Use the thermometer diagrams to record the maximum temperatures in the table.

volume of nitric acid added / cm^3	0.0	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0
thermometer diagram									
maximum temperature of the solution in the polystyrene cup / °C									

[2]

(c) Plot the results for Experiments 1 and 2 on the grid and draw **two** smooth line graphs.
Clearly label your graphs.



[4]

(d) **Use your graph** to estimate the maximum temperature of the solution when 13 cm^3 of nitric acid were added to 50 cm^3 of solution **N** in Experiment 1.
Show clearly **on the grid** how you worked out your answer.

..... °C [2]

(e) Name a suitable indicator that could be used in Experiment 1.

..... [1]

(f) Solution **N** and solution **O** were the same concentration.

In which experiment is the temperature change greater? Suggest why the temperature change is greater in this experiment.

.....

..... [2]

(g) How would the results differ in Experiment 1 if 100 cm^3 of solution **N** were used?

.....

..... [1]

(h) Suggest why a polystyrene cup was used in these experiments and **not** a copper can.

..... [1]

(i) State **one** source of error in the experiments. Suggest an improvement to reduce this source of error.

source of error .....

improvement .....

[2]

Q# 14/ iGCSE Chemistry/2016/s/Paper 63/Q2

(b) The gas produced in experiment 3 was tested with a lighted splint and the result recorded below.

test ...lighted splint.....
result ...popped.....

Name the gas given off in experiment 3.

..... [1]

Q# 17/ iGCSE Chemistry/2018/s/Paper 63/Q3

3 Solution **T** and liquid **U** were analysed. Solution **T** was aqueous sodium hydroxide.
Tests were done on solution **T** and liquid **U**.

tests on solution T

Complete the expected observations.

Solution **T** was divided into four portions in three test-tubes and one boiling tube.

(a) (i) A flame test was done on the first portion of solution **T**.

observations ..... [1]

(ii) The pH of the first portion of solution **T** was tested.

pH = ... [1]

(b) • A few drops of aqueous zinc sulfate were added to the second portion of solution **T** in a test-tube. The test-tube was shaken to mix the solutions.

observations .....

• An excess of aqueous zinc sulfate was then added to the mixture.

observations .....
[3]

(c) Ammonium chloride was added to the third portion of solution **T** in a boiling tube. The mixture was heated and the gas produced was tested.

test .....

observations .....
[2]

(d) An excess of aqueous chromium(III) chloride was added to the fourth portion of solution **T** in a test-tube.

observations ..... [2]

tests on liquid U

Some of the tests and observations are shown.

tests on liquid **U**	observations
The appearance of liquid **U** was studied.	colourless, pleasant smelling
A few drops of liquid **U** were placed on to a watch glass. The surface of the liquid was touched with a lighted splint.	burned with a blue flame

(e) What conclusion can you draw about liquid **U**?

..... [1]

[Total: 10]

Q# 18/ iGCSE Chemistry/2018/s/Paper 62/Q3

3 Two substances, solid **E** and solution **F**, were analysed. Solid **E** was iron(II) sulfate. Tests were done on solid **E** and solution **F**.

tests on solid E

Complete the expected observations.

(a) Describe the appearance of solid **E**.

..... [1]

Solid **E** was added to distilled water in a test-tube. The test-tube was shaken to dissolve solid **E** and form solution **E**. Solution **E** was divided into four equal portions in four test-tubes.

(b) Dilute nitric acid and aqueous silver nitrate were added to the first portion of solution **E**.

observations ..... [1]

(c) Dilute nitric acid and aqueous barium nitrate were added to the second portion of solution **E**.

observations ..... [1]

(d) An excess of aqueous sodium hydroxide was added to the third portion of solution **E**.

observations ..... [2]

(e) An excess of aqueous ammonia was added to the fourth portion of solution **E**.

observations ..... [1]

tests on solution F

Solution **F** was an aqueous salt solution.

Some of the tests and observations are shown.

tests on solution **F**	observations
Solution **F** was divided into two equal portions in two test-tubes. **test 1** Drops of aqueous sodium hydroxide were added to the first portion of solution **F**. An excess of aqueous sodium hydroxide was then added to the mixture.	 white precipitate formed white precipitate was insoluble
test 2 An excess of aqueous ammonia was added to the second portion of solution **F**.	no precipitate formed

(f) What conclusion can you draw about the cation present in solution **F**?

.....

..... [1]

[Total: 7]

3 Two substances, solution **A** and solid **B**, were analysed.

tests on solution A

Some of the tests and observations are shown.

tests on solution **A**	observations
Solution **A** was divided into three equal portions in three test-tubes. **test 1** The pH of the first portion of solution **A** was tested.	 pH = 1
test 2 Magnesium ribbon was added to the second portion of solution **A**. The gas produced was tested.	 effervescence gas 'popped' with a lighted splint
test 3 Dilute nitric acid and aqueous barium nitrate were added to the third portion of solution **A**.	 white precipitate formed

(a) Identify the gas produced in **test 2**.

..... [1]

(b) Identify solution **A**.

..... [2]

tests on solid B

Solid **B** was zinc carbonate.

Complete the expected observations.

(c) Dilute nitric acid was added to solid **B**. The gas produced was tested.

observations .....

..... [2]

The zinc nitrate solution formed in the test in **(c)** was divided into two portions in two test-tubes.

(d) (i) Drops of aqueous sodium hydroxide were added to the first portion of the zinc nitrate solution.

observations ..... [2]

(ii) An excess of aqueous sodium hydroxide was then added to the mixture.

observations ..... [1]

(e) (i) Drops of aqueous ammonia were added to the second portion of the zinc nitrate solution.

observations ..... [1]

(ii) An excess of aqueous ammonia was then added to the mixture.

observations ..... [1]

[Total: 10]

Q# 20/ iGCSE Chemistry/2017/w/Paper 63/Q3

3 Two solutions, **Y** and **Z**, were analysed.
Solution **Y** was aqueous chromium(III) nitrate.
Tests were carried out on both solutions.

tests on solution Y

Complete the expected observations.

The solution was divided into two equal portions in two test-tubes.

(a) (i) A few drops of aqueous sodium hydroxide were added to the first portion of solution **Y** and the test-tube shaken to mix the solutions.

observations ..... [2]

(ii) An excess of aqueous sodium hydroxide was then added to the mixture.

observations ..... [1]

(iii) The mixture from **(a)(ii)** was poured into a boiling tube and a small piece of aluminium foil was added.
The mixture was heated and the gas produced was tested.

observations .....

..... [3]

(b) Identify the gas produced in **(a)(iii)**.

..... [1]

tests on solution Z

Tests were carried out and the following observations made.

tests on solution **Z**	observations
Solution **Z** was divided into three equal portions in three test-tubes. **test 1** The pH of the first portion of solution **Z** was tested.	pH 10
test 2 A few drops of aqueous copper(II) sulfate were added to the second portion of solution **Z**. An excess of aqueous copper(II) sulfate was then added to the mixture.	dark blue solution formed light blue precipitate formed
test 3 The second portion of solution **Y** was added to the third portion of solution **Z**.	grey-green precipitate formed

(c) Identify solution **Z**.

..... [1]

Q# 21/ iGCSE Chemistry/2017/w/Paper 62/Q3

3 Two solid salts, **U** and **W**, were analysed. Solid **U** was sodium carbonate.
Tests were carried out on each solid.

tests on solid U

Complete the expected observations.

(a) Describe the appearance of solid **U**.

..... [1]

About half of solid **U** was dissolved in distilled water to produce solution **U**. Solution **U** was divided into two equal portions in two test-tubes.

(b) Dilute hydrochloric acid was added to the first portion of solution **U**.
The gas produced was tested.

observations .....

..... [3]

(c) Name the gas produced in **(b)**.

..... [1]

(d) A flame test was carried out on solid **U**.

observations ..... [1]

tests on solid W

Tests were carried out and the following observations made.

tests on solid **W**	observations
Appearance of solid **W**.	white crystals
Solid **W** was dissolved in distilled water to produce solution **W**. The solution was divided into two equal portions in two test-tubes. **test 1** Dilute nitric acid and aqueous silver nitrate were added to the first portion of solution **W**.	white precipitate formed
test 2 The second portion of solution **U** was added to the second portion of solution **W**.	white precipitate formed
An excess of dilute hydrochloric acid was then added to the mixture.	rapid effervescence white precipitate dissolved

(e) What conclusions can you draw about solid **W**?

..... [2]

Q# 22/ iGCSE Chemistry/2017/w/Paper 61/Q3

3 Two solid salts, **F** and **G**, were analysed. Solid **F** was iron(III) nitrate.
Tests were carried out on each solid.

tests on solid F

Complete the expected observations.

Solid **F** was dissolved in distilled water to produce solution **F**. Solution **F** was divided into three equal portions in three test-tubes.

(a) (i) A few drops of aqueous sodium hydroxide were added to the first portion of solution **F** until a change was seen.

observations ..... [2]

(ii) An excess of aqueous sodium hydroxide was then added to the mixture from **(a)(i)**.

observations ..... [1]

(b) An excess of aqueous ammonia was added to the second portion of solution **F** until a change was seen.

observations ..... [1]

(c) Aluminium foil and aqueous sodium hydroxide were added to the third portion of solution **F**.
The mixture was heated and the gas which was produced was tested.

test for gas .....

test result .....
[2]

(d) Identify the gas produced in **(c)**.

..... [1]

tests on solid G

Tests were carried out and the following observations made.

tests on solid **G**	observations
test 1 A flame test was carried out on solid **G**.	red colour
test 2 Dilute nitric acid was added to solid **G**. The gas produced was passed through limewater.	rapid effervescence limewater turned milky

(e) Identify solid **G**.

..... [2]

Q# 23/ iGCSE Chemistry/2017/s/Paper 63/Q3

3 Two substances, solid **J** and solution **K**, were analysed. Solution **K** was hydrogen peroxide. Tests on each substance were carried out. The observations are shown.

tests	observations
tests on solid J Appearance of solid **J**.	black solid
test 1 Dilute hydrochloric acid was added to solid **J**. The mixture was heated and the gas given off was tested with damp litmus paper.	blue litmus turned white
tests on solution K Solution **K** was divided into two equal portions in two test-tubes. **test 2** Iron(II) sulfate crystals were added to the first portion of the solution. The mixture was shaken and aqueous sodium hydroxide was added to the mixture.	red-brown precipitate formed

test 3 Solid **J** was added to the second portion of the solution. The gas given off was tested with a splint.	glowing splint relit solid **J** was unchanged

(a) Name the gas given off in **test 1**.

..... [1]

(b) (i) Name the precipitate formed in **test 2**.

..... [2]

(ii) A new **test 2** was carried out. Iron(II) sulfate crystals were added to **water**, the mixture was shaken and then aqueous sodium hydroxide was added.

What would be observed?

..... [2]

Q# 24/ iGCSE Chemistry/2017/s/Paper 61/Q3

3 Two solids, **E** and **F**, were analysed. Solid **F** was potassium iodide. Tests were carried out on each solid. Some of the observations on solid **E** are shown.

tests on solid **E**	observations
Appearance of solid **E**.	green solid
test 1 Solid **E** was heated gently then strongly.	the solid turned black
test 2 Dilute sulfuric acid was added to solid **E**. The gas given off was tested. Excess aqueous ammonia was then added to the mixture in the test-tube.	rapid effervescence limewater turned milky a pale blue precipitate formed, which then dissolved to form a dark blue solution

test 3 A flame test was carried out on solid **E**.	blue-green colour

(a) **Test 1** states that the solid should be heated gently then strongly.

In terms of safety, explain why it is necessary to heat gently at first.

.....

..... [1]

(b) Identify the gas given off in **test 2**.

..... [1]

(c) Identify solid **E**.

..... [2]

tests on solid F

Complete the expected observations.

(d) Describe the appearance of solid **F**.

..... [1]

Distilled water was added to solid **F** in a test-tube and shaken to dissolve solid **F**.

(e) **(i)** To the first portion of the solution, an excess of aqueous sodium hydroxide was added.

observations ..... [1]

(ii) To the second portion of the solution, dilute nitric acid and aqueous silver nitrate were added.

observations ..... [2]

(f) A flame test was carried out on solid **F**.

observations ..... [1]

(g) Describe how you would carry out a flame test.

.....

.....

..... [2]

Q# 25/ iGCSE Chemistry/2017/m/Paper 62/Q3

3 Two solids, **Q** and **R**, which are both salts, were analysed. Solid **Q** was zinc bromide.
Tests were carried out on each solid.

tests on solid Q

Solid **Q** was dissolved in distilled water.
The solution was divided into three equal portions in three test-tubes, and the following tests were carried out.

Complete the expected observations.

(a) **(i)** Drops of aqueous sodium hydroxide were added to the first portion of the solution until a change was seen.

observations ..... [2]

(ii) Excess aqueous sodium hydroxide was then added to the mixture.

observations ..... [1]

(b) **(i)** Drops of aqueous ammonia were added to the second portion of the solution until a change was seen.

observations ..... [1]

(ii) Excess aqueous ammonia was then added to the mixture.

observations ..... [1]

(c) Dilute nitric acid and aqueous silver nitrate were added to the third portion of the solution.

observations ..... [2]

tests on solid R

Tests were carried out and the following observations made.

tests on solid **R**	observations
test 1 A flame test was carried out on solid **R**.	yellow colour
Solid **R** was dissolved in distilled water. The solution was divided into two equal portions in two test-tubes. **test 2** Dilute nitric acid and aqueous barium nitrate were added to the first portion of the solution.	no change
test 3 Dilute nitric acid and aqueous silver nitrate were added to the second portion of the solution.	yellow precipitate formed

(d) Identify solid **R**.

..... [2]

Q# 26/ iGCSE Chemistry/2016/w/Paper 63/Q3

3 Two solutions, solution **Q** and solution **R**, were analysed. Solution **Q** was aqueous sulfuric acid.

tests on solution Q

(a) Solution **Q** was divided into four equal portions in four test-tubes. The following tests were carried out.

Complete the observations for **tests 1–4**.

(i) test 1

The pH of the first portion of solution **Q** was measured.

pH ..... [1]

(ii) test 2

Magnesium ribbon was added to the second portion of solution **Q**. The gas given off was tested.

observations .....

..... [3]

(iii) test 3

Sodium carbonate was added to the third portion of solution **Q**. The gas given off was tested.

observations .....

..... [3]

(iv) test 4

Dilute nitric acid and aqueous barium nitrate were added to the fourth portion of solution **Q**.

observations ..... [1]

tests on solution R

Solution **R** was divided into three equal portions in three test-tubes.
The following tests were carried out.

tests	observations
test 5 The pH of the first portion of solution **R** was measured.	pH = 10
test 6 Drops of aqueous sodium hydroxide were added to the second portion of solution **R** and the test-tube shaken. Excess aqueous sodium hydroxide was then added to the test-tube.	white precipitate no visible change
test 7 Aqueous iron(II) sulfate was added to the third portion of solution **R** and the mixture shaken.	green precipitate formed

(b) Identify solution **R**.

.....

..... [2]

Q# 27/ iGCSE Chemistry/2016/w/Paper 62/Q3

3 Two solutions, solution **S** and solution **T**, were analysed. Solution **S** was dilute hydrochloric acid. The tests on solution **S** and solution **T**, and some of the observations, are shown.

tests on solution S

(a) Solution **S** was divided into four equal portions in four test-tubes. The following tests were carried out.

Complete the observations for **tests 1–4**.

(i) test 1

The pH of the first portion of solution **S** was tested.

pH ..... [1]

(ii) test 2

Copper(II) oxide was added to the second portion of the solution. The mixture was heated.

observations .....

.....

..... [2]

(iii) test 3

Solid sodium carbonate was added to the third portion of the solution. The gas given off was tested.

observations .....

..... [3]

(iv) test 4

Dilute nitric acid and aqueous silver nitrate were added to the fourth portion of the solution.

observations ..... [1]

tests on solution T

(b) Tests were carried out on solution **T** and the following observations made.

tests	observations
Solution **T** was divided into three equal portions in three test-tubes. Appearance of the solution.	 yellow solution
Drops of aqueous sodium hydroxide were added to the second portion of the solution and the test-tube shaken. Excess aqueous sodium hydroxide was then added to the test-tube.	red-brown precipitate no visible change
Aqueous sodium hydroxide and aluminium foil were added to the third portion of the solution and the mixture heated. The gas given off was tested with pH indicator paper.	pungent gas formed, pH 10

Identify solution **T**.

.....

..... [2]

3 Solid **P**, which is an aluminium salt, was analysed.
The tests on solid **P**, and some of the observations, are shown.

tests on solid P

(a) test 1

Solid **P** was divided into three portions. The first portion of solid **P** was heated.

observations *condensation formed on the sides of the test-tube*

Any gases given off were tested with cobalt(II) chloride paper.

observations *cobalt(II) chloride paper turned from blue to pink*

What does **test 1** tell you about solid **P**?

..... [1]

(b) test 2

A flame test was carried out on the second portion of solid **P**.

observations ..... [1]

tests on a solution of P

Distilled water was added to the rest of solid **P** in a test-tube and shaken to dissolve.

(c) The solution was divided into four equal portions in four test-tubes. The following tests were carried out.

(i) test 3

Several drops of aqueous sodium hydroxide were added to the first portion of the solution.

Excess aqueous sodium hydroxide was then added to the mixture.

observations .....

.....

..... [3]

(ii) test 4

Several drops of aqueous ammonia were added to the second portion of the solution.

Excess aqueous ammonia was then added to the mixture.

observations .....

..... [2]

Two further tests were carried out and the following observations made.

tests on a solution of **P**	observations
test 5 Dilute nitric acid and aqueous silver nitrate were added to the third portion of the solution.	no visible reaction
test 6 Dilute nitric acid and aqueous barium nitrate were added to the fourth portion of the solution.	white precipitate formed

(d) What does **test 5** tell you about solid **P**?

..... [1]

(e) Identify solid **P**.

..... [1]

(f) Describe the appearance of solid **P**.

..... [1]

Q# 29/ iGCSE Chemistry/2016/s/Paper 63/Q3

3 A mixture of two solids, **G** and **H**, was analysed. Solid **G** was zinc nitrate, which is water soluble, and solid **H** is insoluble in water.
The tests on the mixture, and some of the observations, are shown.

Distilled water was added to the mixture in a boiling tube and shaken. The contents of the boiling tube were filtered keeping the filtrate and the residue.

tests on filtrate

(a) The filtrate was divided into four test-tubes and the following tests carried out.

(i) Drops of aqueous sodium hydroxide were added to the first portion of the solution.
Excess aqueous sodium hydroxide was then added to the test-tube.

observations .....

.....

..... [3]

(ii) Using the second portion of the solution, the test in **(a)(i)** was repeated using aqueous ammonia instead of aqueous sodium hydroxide.

observations .....

..... [2]

(iii) Dilute nitric acid was added to the third portion of the solution followed by aqueous silver nitrate.

observations ..... [1]

(iv) Aqueous sodium hydroxide and aluminium foil were added to the fourth portion of the solution.
The mixture was warmed and the gas given off was tested.

observations .....

.....

..... [3]

tests on residue

Two tests are carried out and the following observations made.

tests	observations
A spatula was used to transfer some of the residue into a test-tube. Dilute hydrochloric acid was added to the residue. The gas given off was tested.	rapid effervescence, limewater turned milky
A flame test was carried out on the residue.	red flame colour

(b) Identify solid **H**.

.....

..... [2]

Q# 30/ iGCSE Chemistry/2016/s/Paper 62/Q3

3 Two solids, **E** and **F**, were analysed. Solid **E** was sodium sulfite. Both solids were found to be water soluble.
The tests on the solids, and some of the observations, are shown below.

tests on solid E

(a) Describe the appearance of the solid.

..... [1]

(b) Distilled water was added to solid **E** in a test-tube and shaken to dissolve.

The solution was divided into two portions in two test-tubes and the following tests carried out.

(i) Aqueous sodium hydroxide was added to the first portion of the solution.

observations ..... [1]

(ii) Dilute hydrochloric acid was added to the second portion of the solution. The mixture was warmed. The gas given off was tested with a piece of filter paper soaked in aqueous acidified potassium manganate(VII) solution.

observations .....

..... [2]

(c) A flame test was carried out on solid **E**.

observations ..... [1]

tests on solid F

tests	observations
The solid was heated. The gas given off was tested with damp, red litmus paper.	pungent gas evolved red litmus paper turned blue
Aqueous sodium hydroxide was added to solid **F** and the mixture heated. The gas given off was tested.	pungent gas evolved Universal Indicator paper showed pH 10

(d) Identify the gas given off in the tests on solid **F**.

..... [1]

(e) Identify **one** of the ions in solid **F**.

..... [1]

Q# 31/ iGCSE Chemistry/2016/s/Paper 61/Q3

3 Two substances, **C** and **D**, were analysed. Solid **C** was a salt and solution **D** was an aqueous solution of chromium(III) chloride.
The tests on solid **C**, and some of the observations, are in the following table.

tests	observations
tests on solid **C** Solid **C** was added to distilled water in a test-tube and shaken to dissolve. The solution was divided into two portions in test-tubes, and the following tests carried out. Appearance of the solution. The pH of the first portion of the solution was tested.	 colourless liquid pH = 7
Dilute nitric acid was added to the second portion of the solution followed by aqueous silver nitrate.	cream precipitate
A flame test was carried out on solid **C**.	yellow flame colour

(a) Identify solid **C**.

..... [2]

(b) Describe the appearance of solution **D**.

..... [1]

(c) Tests were carried out on solution **D**.

Complete the observations for tests 1, 2 and 3.

(i) test 1

Drops of aqueous sodium hydroxide were added to solution **D**.

Excess aqueous sodium hydroxide was then added to the mixture.

observations .....

..... [3]

(ii) test 2

Excess aqueous ammonia was added to solution **D**.

observations ..... [2]

(iii) test 3

Dilute nitric acid was added to solution **D** followed by aqueous silver nitrate.

observations ..... [1]

(d) Chromium(III) can be converted to chromium(VI). Chromium(VI) is hazardous.

Suggest **one** safety precaution when using chromium(VI).

..... [1]

3 Two solids, **L** and **M**, were analysed. Solid **L** was copper(II) chloride and solid **M** was a different salt.
The tests on the solids, and some of the observations, are shown.

tests on solid L

(a) Describe the appearance of solid **L**.

observation ..... [1]

(b) Distilled water was added to solid **L** and shaken to dissolve.

The solution was divided into four equal portions in four test-tubes and the following tests carried out.

(i) Drops of aqueous ammonia were added to the first portion of the solution.

Excess ammonia solution was then added to the mixture and shaken.

observation .....

.....

.....

..... [4]

(ii) Excess aqueous sodium hydroxide was added to the second portion of the solution.

observation .....

..... [1]

(iii) Dilute nitric acid was added to the third portion of the solution followed by aqueous silver nitrate.

observation ..... [1]

(iv) Dilute nitric acid was added to the fourth portion of the solution followed by aqueous barium nitrate.

observation ..... [1]

tests on solid M

Tests are carried out and the following observations made.

tests on solid **M**	observations
Appearance of the solid.	white crystals
The solid was heated and the gas given off was tested with damp red litmus paper.	a sublimate formed on the sides of the test-tube litmus paper turned blue
Solid **M** was dissolved in water to form a solution. Aqueous sodium hydroxide was added to the solution and the mixture heated. The gas given off was tested.	pungent gas evolved pH paper showed pH 10
Dilute nitric acid was added to the solution followed by aqueous silver nitrate.	yellow precipitate

(c) Identify solid **M**.

.....

..... [2]

Q# 33/ I GCSE Chemistry/2017/s/Paper 62/Q3

3 Two solids, **E** and **F**, which are both salts, were analysed. Solid **F** was lithium chloride.
Tests were carried out on each solid.
Some of the tests and observations are shown.

tests on solid E

tests on solid **E**	observations
test 1 A flame test was carried out on solid **E**.	yellow colour

test 2

10 cm^3 of distilled water were poured into a boiling tube. The initial temperature of the water was measured.
Solid **E** was added to the boiling tube and the boiling tube was shaken to dissolve solid **E**. The temperature of the solution was measured after 1 minute.

(a) Use the thermometer diagrams in the table to record the temperatures and complete the table.

temperature of the solution after 1 minute / °C		
initial temperature of the water / °C		
temperature difference / °C		

[2]

The solution was divided into two equal portions in two test-tubes and the following tests carried out.

tests on solid **E**	observations
test 3 Dilute hydrochloric acid was added to the first portion of the solution. The gas given off was tested with filter paper dipped into acidified aqueous potassium manganate(VII).	filter paper turned from purple to colourless
test 4 An excess of aqueous sodium hydroxide was added to the second portion of the solution.	no change

(b) What does the temperature change tell you about the process occurring in **test 2**?

..... [1]

(c) Name the gas given off in **test 3**.

..... [1]

(d) Identify solid **E**.

..... [2]

tests on solid F

Complete the expected observations.

(e) A flame test was carried out on solid **F**.

observations ..... [1]

Solid **F** was added to distilled water in a test-tube and the test-tube shaken to dissolve solid **F**.

(f) Dilute nitric acid and aqueous silver nitrate were added to the solution.

observations ..... [2]

Q# 35/ iGCSE Chemistry/2017/s/Paper 61/Q4

4 A sample of furniture cleaner contains aqueous sodium chloride, aqueous ammonia and sand.

(a) Give a test to show the presence of ammonia in the mixture.

..... [1]

Q# 36/ iGCSE Chemistry/2017/m/Paper 62/Q4

4 When solid barium hydroxide is added to solid ammonium chloride a reaction takes place.

(b) How could you show whether or not the final mixture contains ammonium ions?

.....

.....

.....

..... [2]

Q# 37/ iGCSE Chemistry/2016/w/Paper 61/Q4

4 Agri Limes are mixtures of calcium carbonate and calcium oxide. Farmers use Agri Limes on fields to neutralise acidity.

Plan an investigation to find out which of **two** different Agri Limes, **Q** or **R**, will neutralise more acid. You are provided with common laboratory apparatus and chemicals, including dilute nitric acid.

.....

.....

.....

.....

.....

.....

.....

..... [6]

Q# 38/ iGCSE Chemistry/2016/s/Paper 62/Q4

4 Potassium sulfate is the salt produced when sulfuric acid is neutralised by potassium hydroxide solution.
The correct amount of potassium hydroxide solution must be added to neutralise all of the sulfuric acid.
Plan an experiment to obtain pure crystals of potassium sulfate from sulfuric acid and potassium hydroxide solution.
You are provided with common laboratory apparatus.

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

Q# 1/ iGCSE Chemistry/2018/w/Paper 63/Q1

1(b)	**M1** Limewater	1
	M2 milky	1

Q# 2/ iGCSE Chemistry/2018/w/Paper 62/Q1

1(e)	>7 and not >14	1

Q# 3/ iGCSE Chemistry/2018/s/Paper 62/Q1

1(d)	limewater / calcium hydroxide solution	1
	milky / cloudy / white ppt.	1

Q# 4/ iGCSE Chemistry/2018/s/Paper 61/Q1

1(b)	methyl orange / thymolphthalein / litmus	1
1(c)(i)	number 2 / 18.9 cm^3	1
1(c)(ii)	overshot end point / more than 25 cm^3 KOH in flask	1
1(c)(iii)	18.2	1
	cm^3	1
1(d)	(wrong conclusion) nitric acid more concentrated / stronger	1
	smaller volume of acid needed	1

Q# 5/ iGCSE Chemistry/2017/w/Paper 63/

1(c)	nitric (acid)	1

Q# 6/ iGCSE Chemistry/2017/w/Paper 62/

1(d)(ii)	'pops'	1

Q# 7/ iGCSE Chemistry/2017/w/Paper 61/

1(d)	heat / boil / evaporate	1
	to crystallising point	1
	cool / leave to stand	1

Q# 8/ iGCSE Chemistry/2017/s/Paper 61/

1(a)(iii)	nitric (acid)	1
1(a)(iv)	bubbles / fizz / effervescence	1
1(b)	the reaction is (fast) at room temperature	1
1(c)	strontium carbonate	1
	solid is left behind	1
1(d)	filter	1
	heat / evaporate	1
	to crystallising point / glass rod test / until saturation point	1

Q# 9/ iGCSE Chemistry/2017/m/Paper 62/

1(c)	test: glowing splint result: relights	1
1(d)(i)	carbon dioxide	1

Q# 10/ iGCSE Chemistry/2016/w/Paper 61/

1(d)	*lighted splint* no effect / brighter light for oxygen 'pops' for hydrogen **OR** *glowing splint* relights for oxygen no effect for hydrogen	 1 1 1 1

Q# 11/ iGCSE Chemistry/2018/m/Paper 62/Q2

2(a)	*table of results final reading and difference completed correctly* 11.6	1
2(b)	*table of results with final reading and difference completed* correctly 23.6 **and** 11.6	1
2(c)	*final reading completed correctly* 24.1	1
	initial reading completed correctly 0.9	1
	difference correct 23.2	1
2(d)	yellow to orange	1
2(e)	to remove impurities / chemicals / residue / solution / owtte	1
2(f)	3	1
2(g)	pipette / burette	1
2(h)	*effect* no effect	1
	reason no change in reactant concentrations / owtte	1
2(i)(i)	1:2	1
2(i)(ii)	different indicators used / owtte	1
2(j)	more than one colour change / cannot find end point	1
2(k)	repeat (experiments)	1
	compare / average / check spread of results	1

Q# 12/ iGCSE Chemistry/2017/m/Paper 62/

2(a)	initial and final readings completed correctly: 29.6; 4.1	1
	difference completed correctly: 25.5	1
2(b)	initial and final readings and difference completed correctly: 29.1; 24.0; 5.1	1
	all readings to 1 d.p.	1
2(c)	neutralisation	1
2(d)(i)	solution **O**	1
	greater volume of acid was used in the titration	1

2(d)(ii)	five times as concentrated	1
2(e)	2.5–2.6	1
	unit: cm^3	1
2(f)	effect on volume: no effect	1
	reason: temperature would only affect the rate	1
2(g)(i)	use a pipette / burette	1
2(g)(ii)	repeat experiments (and compare / average)	1
2(h)	**M1** *fair test* to equal volumes of each sodium hydroxide solution / solutions **O** and **P** add an equal volume / measured volumes of aqueous calcium chloride	1
	M2 *dependent variable measured* measure mass / height of precipitate formed / volume of calcium chloride used	1
	M3 *conclusion* the more concentrated sodium hydroxide solution would form the most precipitate (mass / height) / would require a smaller volume of calcium chloride	1

Q# 13/ iGCSE Chemistry/2016/w/Paper 61/

2(a)	table of results for Experiment 1 all temperature boxes completed correctly 22, 24, 26, 28, 30, 31, 30, 29, 28	2
2(b)	table of results for Experiment 2 initial and other temperature boxes completed correctly 20, 21, 22, 23, 24, 25, 24, 23, 22	2
2(c)	all points correctly plotted best-fit smooth line graphs labels	2 1 1
2(d)	value from graph (27 °C) shown clearly	1 1
2(e)	phenolphthalein / litmus / suitable named indicator	1
2(f)	Experiment 1 / solution **N** solution **N** is a stronger acid / has a higher pH	1 1
2(g)	measured results / temperature changes / results would be smaller **OR** larger / double volume needed to reach same temperature changes	1
2(h)	polystyrene is an insulator / copper is a (good) conductor	1
2(i)	source of error: heat losses / using a measuring cylinder improvement: lag or insulate / use burette	1 1

Q# 14/ iGCSE Chemistry/2016/s/Paper 63/

2(b)	hydrogen;	1

Q# 17/ iGCSE Chemistry/2018/s/Paper 63/Q3

2(e)(ii)	half volume of acid	1
	less / half as many moles of sodium hydroxide present	1
2(f)	exothermic / heat given out	1
2(g)(i)	to remove traces of acid / clean / remove impurities	1
2(g)(ii)	to remove traces of water	1
2(h)	sources of error using a measuring cylinder or heat losses	1
	improvement use a pipette / use a burette / lag / insulation / lid	1

Question	Answer	Marks
3(a)(i)	yellow	1
3(a)(ii)	pH 11–14	1
3(b)	white precipitate	1
	clears / dissolves	1
	white precipitate	1
3(c)	pH / litmus paper	1
	turns pH >7 / turns blue	1
3(d)	grey-green	1
	precipitate	1

3(e)	organic / fuel / flammable	1

Question	Answer	Marks
4	any **6** from: ☐ cut leaves into small pieces ☐ grind / crush with sand / ethanol ☐ using pestle/mortar ☐ decant / pour-off / filter liquid ☐ chromatography ☐ apply extract to paper (in correct location) ☐ description of separating colours	Max 6

Q# 18/ iGCSE Chemistry/2018/s/Paper 62/Q3

3(a)	(pale) green (solid / crystals)	1
3(b)	no change / no reaction / no precipitate / no observation	1
3(c)	white precipitate	1
3(d)	green	1
	precipitate	1
3(e)	green precipitate	1
3(f)	calcium	1

Q# 19/ iGCSE Chemistry/2018/s/Paper 61/Q3

2(d)(ii)	more particles of thiosulfate (in a given volume)	1
	more chance of collision	1
2(e)	use a pipette / burette	1
2(f)	times would be shorter	1
	idea of depth of solution is greater	1
2(g)	sketch curve roughly same shape and above original	1

Question	Answer	Marks
3(a)	hydrogen / H_2	1
3(b)	sulfuric	1
	acid	1
3(c)	limewater	1
	milky / cloudy / white ppt.	1
3(d)(i)	white	1
	precipitate	1
3(d)(ii)	dissolves / clears / goes colourless	1
3(e)(i)	white precipitate	1
3(e)(ii)	dissolves / clears / goes colourless	1

Q# 20/ iGCSE Chemistry/2017/w/Paper 63/

3(a)(i)	green	1
	precipitate	1
3(a)(ii)	green solution / precipitate dissolves	1
3(a)(iii)	bubbles / fizzing / effervescence	1
	(red) litmus paper / Universal Indicator paper	1
	(red litmus paper) turns blue / (Universal Indicator paper) turns purple	1
3(b)	ammonia / NH_3	1
3(c)	(aqueous) ammonia / NH_3	1

Q# 21/ iGCSE Chemistry/2017/w/Paper 62/

3(a)	white (crystals)	1
3(b)	bubbles / fizz	1
	limewater	1
	(turns) milky	1
3(c)	carbon dioxide	1
3(d)	yellow	1
3(e)	non-transition metal / Group II metal / barium / calcium / magnesium	1
3(e)	chloride	1

Q# 22/ iGCSE Chemistry/2017/w/Paper 61/

3(a)(i)	red-brown	1
	precipitate	1
3(a)(ii)	insoluble / no change	1
3(b)	red-brown precipitate	1
3(c)	(red) litmus paper	1
	turns blue	1
3(d)	ammonia	1
3(e)	lithium	1
	carbonate	1

Q# 23/ iGCSE Chemistry/2017/s/Paper 63/

3(a)	chlorine	1
3(b)(i)	iron(III)	1
	hydroxide	1
3(b)(ii)	green	1
	precipitate	1
3(c)	oxygen	1
3(d)	catalyst	1
	transition element compound / manganese oxide	1

Q# 24/ iGCSE Chemistry/2017/s/Paper 61/

3(a)	solid spits out of the tube / the tube might crack	1
3(b)	carbon dioxide	1
3(c)	copper / Cu^{2+}	1
	carbonate / CO_3^{2-}	1
3(d)	white	1
3(e)(i)	no reaction / change	1
3(e)(ii)	yellow	1
	precipitate	1
3(f)	lilac	1

Q# 25/ iGCSE Chemistry/2017/m/Paper 62/

3(a)(i)	white	1
	precipitate	1
3(a)(ii)	(white precipitate) dissolves	1
3(b)(i)	white precipitate	1
3(b)(ii)	(white precipitate) dissolves	1
3(c)	cream	1
	precipitate	1
3(d)	sodium	1
	iodide	1

Q# 26/ iGCSE Chemistry/2016/w/Paper 63/

3(a)(i)	pH 1–3	1
3(a)(ii)	effervescence / fizzing / bubbling / solid disappears / dissolves lighted splint 'pops'	1 1 1
3(a)(iii)	effervescence / fizzing / bubbling / solid disappears / dissolves limewater milky	1 1 1
3(a)(iv)	white precipitate	1
3(b)	calcium / Ca^{2+} hydroxide / OH^-	1 1

Q# 27/ iGCSE Chemistry/2016/w/Paper 62/

3(a)(i)	pH 1–3	1
3(a)(ii)	solid disappears / dissolves blue / green colour	1 1
3(a)(iii)	solid dissolves limewater turns milky	1 1 1
3(a)(iv)	white precipitate	1
3(b)	iron(III) nitrate	1 1

Q# 28/ iGCSE Chemistry/2016/w/Paper 61/

3(a)	water present / hydrated	1
3(b)	no change / colour	1
3(c)(i)	white precipitate dissolves	1 1 1
3(c)(ii)	white precipitate no change	1 1
3(d)	not a halide	1
3(e)	(aluminium) sulfate	1
3(f)	white (crystals)	1

Q# 29/ iGCSE Chemistry/2016/s/Paper 63/

3(a)(i)	white; precipitate; dissolves;	3 1 1 1
3(a)(ii)	white precipitate; dissolves;	2 1 1
3(a)(iii)	no reaction / change / precipitate;	1
3(a)(iv)	any 3 from: effervescence / fizz / bubbles; red litmus / pH paper; blue / pH > 7; pungent smell;	3
3(b)	lithium; carbonate;	2 1 1

Q# 30/ iGCSE Chemistry/2016/s/Paper 62/

3(a)	white (solid / crystals / powder);	1
3(b)(i)	no change;	1
3(b)(ii)	turns from purple / pink; 1 to colourless / white; 1	2
3(c)	yellow / orange (flame);	1
3(d)	ammonia / NH_3;	1
3(e)	ammonium / NH_4^+;	1

Q# 31/ iGCSE Chemistry/2016/s/Paper 61/

3(a)	sodium; 1 bromide; 1	2
3(b)	green;	1
3(c)(i)	green; 1 precipitate; 1 with excess, green solution / clear / dissolves; 1	3
3(c)(ii)	grey-green; 1 precipitate; 1	2
3(c)(iii)	white precipitate;	1
3(d)	fume cupboard / protective clothing, e.g. gloves or goggles;	1

Q# 32/ iGCSE Chemistry/2016/m/Paper 62/

3(a)	blue / green (solid / crystals);	1
3(b)(i)	(pale) blue; precipitate; royal / deep blue; dissolves / solution;	4
3(b)(ii)	(pale) blue precipitate;	1
3(b)(iii)	white precipitate;	1
3(b)(iv)	no reaction / change / precipitate;	1
3(c)	ammonium; iodide;	2

Q# 33/ iGCSE Chemistry/2017/s/Paper 62/Q3

3(a)	initial temperature and final temperature recorded correctly: 19, 23	1
	temperature difference correctly calculated: 4	1
3(b)	endothermic	1
3(c)	sulfur dioxide	1
3(d)	sodium / Na^+	1
	sulfite / SO_3^{2-}	1
3(e)	red	1
3(f)	white	1
	precipitate	1

Q# 35/ iGCSE Chemistry/2017/s/Paper 61/

4(a)	(red) litmus turns blue	1

Q# 36/ iGCSE Chemistry/2017/m/Paper 62/

4(b)	**M1** add (aqueous) sodium hydroxide (and warm)	1
	M2 gas produced turns (red) litmus blue	1

Q# 37/ iGCSE Chemistry/2016/w/Paper 61/

4	**method adding Agri Lime to acid** add weighed amount / known mass of Agri Lime **Q** to a known volume of acid with a named indicator added to the acid until the indicator changes colour note the mass of Agri Lime **Q** added repeat with Agri Lime **R** conclusion, e.g. 'the experiment using the smaller amount of Agri Lime is better' **OR** **method adding acid to Agri Lime** use weighed amount / known mass of Agri Lime **Q** add acid to it gradually / from a burette with a named indicator added to the acid until the indicator changes colour note volume of acid added repeat with Agri Lime **R** conclusion, e.g. 'the experiment using the larger volume of acid is better'	6

Q# 38/ iGCSE Chemistry/2016/s/Paper 62/

4	**making the salt** any 4 from: • known volume sulfuric acid; • add named indicator; • add potassium hydroxide solution to the acid until the indicator changes colour / is neutralised; • note / measure the volume of potassium hydroxide solution added; • repeat without indicator **OR** add (decolourising) charcoal; **obtaining crystals** any 2 from: • heat / evaporate solution to crystallising point until half evaporated **OR** until crystals (start to) form **OR** until saturated; • leave to cool; • filter to get crystals; • dry crystals (on filter paper) / leave to dry;	6

12.9 FUNDAMENTAL Assessed Activity 1 Keyword Test

English	Meaning
litmus	
amphoteric hydroxides	
acidic oxides	
neutralisation	
pH scale	
precipitation reaction	
weak acid	
acid	
indicator	
base	
strong alkali	
strong acid	
weak alkali	
corrosive	
Universal Indicator	
alkalis 7	
basic oxide	
suspension	

12.10 ESSENTIAL Assessed Activity Topic 8 2 Paper 2 16marks

Q# 1/

17 The results of some experiments with sulfur dioxide are shown.

experiment	description	result
1	mix with dilute hydrochloric acid	does not react
2	mix with concentrated sodium hydroxide	a salt forms
3	add Universal Indicator	Universal Indicator turns purple
4	add acidified aqueous potassium manganate(VII)	purple solution turns colourless

Which results are correct?

A 1, 2 and 4 **B** 2, 3 and 4 **C** 1 and 2 only **D** 3 and 4 only

18 A white precipitate is produced when small amounts of two colourless solutions are mixed together.

Which pairs of solutions produce a white precipitate?

1 sodium hydroxide and zinc nitrate

2 sodium hydroxide and aluminium chloride

3 barium chloride and sulfuric acid

4 acidified barium nitrate and potassium sulfate

A 1, 2, 3 and 4

B 1, 2 and 4 only

C 1 and 2 only

D 2 only

19 Solution Q is warmed with ammonium chloride.

In a separate experiment, solution Q is added to methyl orange.

Which observations show that solution Q is basic?

	warmed with ammonium chloride	added to methyl orange
A	gas is produced	turns red
B	gas is produced	turns yellow
C	no reaction	turns red
D	no reaction	turns yellow

Q# 2/

17 In which row are the oxides correctly identified?

	acidic	basic
A	magnesium oxide, calcium oxide	sulfur dioxide, carbon dioxide
B	magnesium oxide, sulfur dioxide	carbon dioxide, calcium oxide
C	sulfur dioxide, carbon dioxide	calcium oxide, magnesium oxide
D	sulfur dioxide, magnesium oxide	calcium oxide, carbon dioxide

18 When dilute sulfuric acid is added to solid X, a colourless solution is formed and a gas is produced.

What is X?

A copper(II) oxide

B sodium oxide

C copper(II) carbonate

D sodium carbonate

19 A few drops of methyl orange are added to a reaction mixture.

During the reaction, a gas is produced and the methyl orange turns from red to orange.

What are the reactants?

A aqueous sodium hydroxide and ammonium chloride

B aqueous sodium hydroxide and calcium carbonate

C dilute hydrochloric acid and magnesium

D dilute hydrochloric acid and aqueous sodium hydroxide

Q# 3/

18 The equation represents an equilibrium in aqueous ammonia.

$$NH_3(aq) + H_2O(l) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$$

How does aqueous ammonia behave in this reaction?

A as a strong acid

B as a strong base

C as a weak acid

D as a weak base

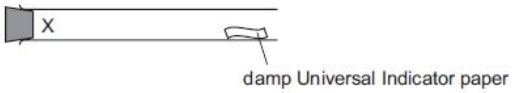
19 An excess of aqueous sodium sulfate was added to aqueous barium chloride and the mixture was filtered.

Which row shows the identity of the residue and the substances present in the filtrate?

	residue	substances in filtrate
A	barium sulfate	barium chloride and sodium chloride
B	barium sulfate	sodium chloride and sodium sulfate
C	sodium chloride	barium chloride and sodium sulfate
D	sodium chloride	barium sulfate and sodium sulfate

Q# 4/

1 A gas is released at point X in the apparatus shown.



Which gas turns the damp Universal Indicator paper red most quickly?

A ammonia, NH_3

B chlorine, Cl_2

C hydrogen chloride, HCl

D sulfur dioxide, SO_2

Q# 5/

18 Which statement about acids and bases is correct?

A A base is a donor of hydrogen ions.

B An acid is an acceptor of protons.

C A strong acid is fully ionised in aqueous solution.

D A weak acid cannot be used to neutralise a strong base.

19 The solubility of some salts is shown.

	chloride	nitrate	sulfate	carbonate
barium	soluble	soluble	insoluble	insoluble
lead(II)	insoluble	soluble	insoluble	insoluble
potassium	soluble	soluble	soluble	soluble
zinc	soluble	soluble	soluble	insoluble

Which two aqueous solutions produce an insoluble salt when mixed together?

A barium chloride and zinc nitrate

B barium nitrate and lead(II) nitrate

C lead(II) nitrate and potassium carbonate

D potassium nitrate and zinc sulfate

20 Which methods are suitable for preparing **both** zinc sulfate and copper(II) sulfate?

1 reacting the metal oxide with warm dilute aqueous sulfuric acid

2 reacting the metal with dilute aqueous sulfuric acid

3 reacting the metal carbonate with dilute aqueous sulfuric acid

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

Q# 6/

17 Which statement about oxides is correct?

A A solution of magnesium oxide has a pH less than pH 7.

B A solution of sulfur dioxide has a pH greater than pH 7.

C Magnesium oxide reacts with nitric acid to make a salt.

D Sulfur dioxide reacts with hydrochloric acid to make a salt.

18 Which solution has the lowest pH?

A 0.1 mol / dm^3 ammonia solution

B 0.1 mol / dm^3 ethanoic acid

C 0.1 mol / dm^3 lithium hydroxide

D 0.1 mol / dm^3 nitric acid

19 A student mixes silver nitrate and barium chloride to form a white precipitate of silver chloride.

The equation is shown.

$$2AgNO_3 + BaCl_2 \rightarrow 2AgCl + Ba(NO_3)_2$$

Which row describes the solubility of the salts?

	soluble	insoluble
A	silver nitrate	barium chloride, barium nitrate and silver chloride
B	silver nitrate and barium chloride	barium nitrate and silver chloride
C	silver nitrate, barium chloride and barium nitrate	silver chloride
D	silver nitrate, barium chloride and silver chloride	barium nitrate

20 Which methods are suitable for preparing **both** zinc sulfate and copper(II) sulfate?

1 reacting the metal oxide with warm dilute aqueous sulfuric acid

2 reacting the metal with dilute aqueous sulfuric acid

3 reacting the metal carbonate with dilute aqueous sulfuric acid

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

12.11 ESSENTIAL Assessed Activity 3 Paper 3/4 Topic 8.2 & 8.2 17 Marks

Q# 1/

2 Three ways of making salts are

- titration using a soluble base or carbonate
- neutralisation using an insoluble base or carbonate
- precipitation.

(a) Complete the following table of salt preparations.

method	reagent 1	reagent 2	salt
titration	....	....	sodium nitrate
neutralisation	nitric acid	....	copper(II) nitrate
precipitation	....	....	silver(I) chloride
neutralisation	sulfuric acid	zinc(II) carbonate	....

[6]

(b) (i) Write an ionic equation with state symbols for the preparation of silver(I) chloride.

..... [2]

(ii) Complete the following equation.

$ZnCO_3 + H_2SO_4 \rightarrow$ ..... + ... + ...

[2]

Q# 2/ iGCSE Chemistry/2011/s/Paper 31/

5 Hydriodic acid, HI(aq), is a strong acid. Its salts are iodides.

(a) It has the reactions of a typical strong acid. Complete the following equations.

(i) .....Li + ...HI → ..... + ... [1]

(ii) zinc carbonate + hydriodic acid → .... + ... + ...

[1]

(iii) MgO + ...HI → ..... + ... [1]

Q# 3/ /

8 Soluble salts can be made using a base and an acid.

(a) Complete this method of preparing dry crystals of the soluble salt cobalt(II) chloride-6-water from the insoluble base cobalt(II) carbonate.

Step 1
Add an excess of cobalt(II) carbonate to hot dilute hydrochloric acid.

Step 2

.....

.....

Step 3

.....

.....

Step 4

.....

..... [4]

12.12 ESSENTIAL Assessed Activity4 Paper 6 Topic 8.2 & 8.2 Tests for Ions 24marks

Q# 34/

4 Aqueous solutions of barium hydroxide are alkaline.
Plan an investigation to find the concentration of an aqueous solution of barium hydroxide.

You are provided with an aqueous solution of barium hydroxide, dilute hydrochloric acid of known concentration and common laboratory apparatus.

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 6]

Q# 15/

3 Solid **P** and solid **Q** were analysed. Solid **P** was lithium nitrate. Tests were done on each solid.

tests on solid P

Complete the expected observations.

(a) Describe the appearance of solid **P**.

..... [1]

Solid **P** was divided into three portions.

(b) Aqueous sodium hydroxide and a small piece of aluminium foil were added to the first portion of solid **P**. The mixture was heated and the gas produced was tested.

observations .....

.....

..... [3]

(c) The second portion of solid **P** was dissolved in distilled water. Dilute nitric acid and aqueous barium nitrate were then added to the solution.

observations ..... [1]

(d) A flame test was done on the third portion of solid **P**.

observations ..... [1]

3 Solid **P** and solid **Q** were analysed. Solid **P** was lithium nitrate. Tests were done on each solid.

tests on solid P

Complete the expected observations.

(a) Describe the appearance of solid **P**.

..... [1]

Solid **P** was divided into three portions.

(b) Aqueous sodium hydroxide and a small piece of aluminium foil were added to the first portion of solid **P**. The mixture was heated and the gas produced was tested.

observations .....

.....

..... [3]

(c) The second portion of solid **P** was dissolved in distilled water. Dilute nitric acid and aqueous barium nitrate were then added to the solution.

observations ..... [1]

(d) A flame test was done on the third portion of solid **P**.

observations ..... [1]

tests on solid Q

Some of the tests and observations are shown.

tests on solid **Q**	observations
The appearance of solid **Q** was studied.	pink crystals
Solid **Q** was heated in a hard glass test-tube.	condensation formed at the top of the test-tube
Dilute nitric acid and aqueous silver nitrate were added to an aqueous solution of solid **Q**.	white precipitate

(e) What conclusions can you draw about the identity of solid **Q**?

.....

..... [2]

[Total: 8]

Q# 16/

3 Two solid salts, solid **G** and solid **H**, were analysed. Tests were done on each solid.

tests on solid G

Some of the tests and observations are shown.

tests on solid **G**	observations
test 1 A flame test was done on solid **G**.	lilac colour
Solid **G** was dissolved in distilled water. **test 2** Dilute hydrochloric acid was added to the solution. The solution was warmed gently. The gas produced was tested with filter paper which had been dipped in acidified aqueous potassium manganate(VII).	filter paper turned from purple to colourless

(a) Name the gas produced in **test 2**.

..... [1]

(b) Identify solid **G**.

.....

..... [2]

tests on solid H

Solid **H** was calcium nitrate.

Complete the expected observations.

Solid **H** was added to distilled water in a test-tube. The test-tube was shaken to dissolve solid **H**. The solution was divided into four portions in four test-tubes.

(c) (i) Drops of aqueous sodium hydroxide were added to the first portion of the solution.

observations ..... [2]

(ii) An excess of aqueous sodium hydroxide was then added to the mixture from **(c)(i)**.

observations ..... [1]

(d) An excess of aqueous ammonia was added to the second portion of the solution.

observations ..... [1]

(e) Dilute nitric acid and aqueous silver nitrate were added to the third portion of the solution.

observations ..... [1]

(f) Aluminium foil and aqueous sodium hydroxide were added to the fourth portion of the solution. The mixture was warmed and the gas produced was tested.

observations .....

..... [2]

[Total: 10]

12.13 Essential End of Topic 8.3 & 8.4 Review and Reflection

Looking at the goals you could have achieved and the goals you actually achieved try to reflect on your progress.

Try to be as honest and as detailed as possible. Sometimes you may think you have thought about an idea well, but when you talk with someone else, or write it out, it helps you better understand and allows you think more completely and more clearly.

Did you achieve more goals this topic than last topic?

Fill in this table

Level	Number of goals achieved at each level	Success rate, %
FUNDAMENTAL	/5	
ESSENTIAL	/10	
EXTENSION	/13	
EXCEPTIONAL	/10	

Do you feel you tired harder? If yes, what helped you to do so? If not, why not?

What could you do differently next time, in addition to what you are already doing to improve, not only your score in the end of topic tests and other assessed activities, but also in how you learn. How could you become a more effective student to get more learning out of the time you are investing in your studies?

What did you enjoy most about this topic?

What did you find most difficult?

What did you find easiest?

On a scale of 1 being hardest and 5 being most difficult, circle how challenging you found this topic

1 2 3 4 5

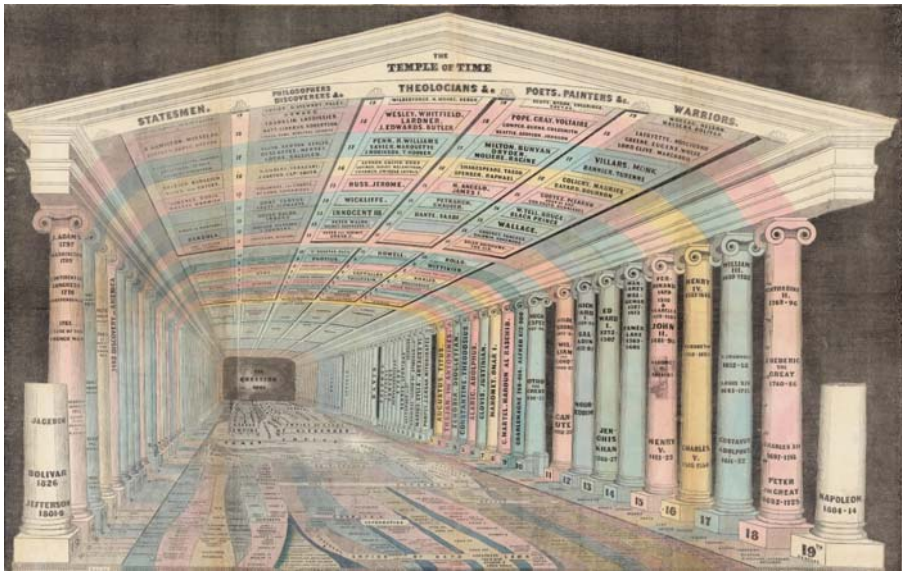
What could be done to make this topic easier to understand?

Do you have any questions about this topic?

12.14 Exceptional Additional Activities, Further Reading and Exploring Beyond the Syllabus

This is a unit which is particularly well suited to learning how to create and use mnemonics. The more often you practice anything, like creating mnemonics the better you will get at d

Mnemonics. Find out about different ways to memorise facts by reading articles about memory techniques which are available here: https://www.smashingsciencecn.org/igcse-chem-additional-resources:



Another helpful technique includes Cornell Notetaking, by the way!!!

13 Topic 10 Metals

13.1 End of Topic 10 Goals Checklist

For each topic you ought to try to do as many of the following things to get the most out of your time, the resources available to you and to help you grow as a student. Tick each goal off as you complete it. Growth is difficult and uncomfortable, but you should choose to do these things, and the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win!

Aspect	What you should have done	Yes/No	Level
Interacted with your teacher	Ask your teacher 1 question, about anything, once a week		FUNDAMENTAL
	Try to answer one question asked by your teacher at least once a week		ESSENTIAL
	Ask your teacher one question about something you do not understand in science once a week		ESSENTIAL
	Ask your teacher one question about something to do with science every lesson		EXTENSION
Notes and follow up notes	Complete set of class note		FUNDAMENTAL
	Cornell Notetaking Attempted		ESSENTIAL
	Cornell Notetaking Completed		EXTENSION
	Cornell Notetaking Completed to an exemplary standard		EXCEPTIONAL
	Attempted the Mind Map for this topic		ESSENTIAL
	Completed the Mind Map for this topic		EXTENSION
Textbook	Read ahead before the topic has been started		EXTESNION
	Highlighted key ideas and translate new words		FUNDAMENTAL
	Completed the questions at the end of each 2 page spread in your exercise book		EXTENSION
	Added to your class notes ideas and important information from the textbook that you learnt		EXTENSION
Past Exam Questions	Worked on at least 25% of the exam questions in this workbook		FUNDAMENTAL
	Attempted more than 25% of the questions and those questions you have completed you have marked in a different colour pen		ESSENTIAL
	Completed and marked all questions here		EXTENSION
	Completed, marked and additional key ideas where you have located the most difficult marks added to your notebook		EXCEPTIONAL
	Used the resources available online to answer additional questions not found in this workbook on the current topic.		EXCEPTIONAL
	Ask your teacher about an exam question that they cannot answer		EXCEPTIONALLY SMASHING!!!
Assessed Activities	Complete the word list activity using the word list at the front of each topic as little as possible		FUNDAMENTAL
	Complete 2 assessed activities, either in class or as homework		ESSENTIAL
	Complete 2 assessed activities and scored over 70% on average		ESSENTIAL
	Complete 2 assessed activities and scored over 80% on average		EXTENSION
	Complete 2 assessed activities and scored over 90% on average		EXCEPTIONAL
End of Topic Test	Revised sufficiently well to improve upon your score from the previous test (except if you are scoring over 90%, then just write Y for this goal)		ESSENTIAL
	Scored 10% higher than your current average		EXTENSION
	Scored 15% or more than your previous end of topic average		EXCEPTIONAL

Aspect	What you should have done	Yes/No	Level
	Scored over 90%		EXTESNION
	Scored over 95%		SMASHING!!!
Reading	Spend more than 1 hour a week reading a book **you enjoy** (in any language) about anything.		ESSENTIAL
	Spend more than 3 hours a week reading a book **you enjoy** (in any language) about anything.		EXTENSION
	Spend more than 5 hours a week reading a book **you enjoy** (in any language) about anything.		EXCEPTIONAL
	Spend at least one hour a week reading a book **you enjoy** in English about anything.		EXTENSION
	Spend more than 3 hours a week reading a book **you enjoy** in English about anything.		EXCEPTIONAL
Reflection	You completed this goal setting table		FUNDAMENTAL
	You have looked at the goals you have achieved and the ones you have not and added them up and entered them into the table in the Review and Reflection section		ESSENTIAL
	You have given an answer for every question in the Review and Reflection section at the end of this topic		EXTENSION
	You have Given good and thoughtful answers for every question in the Review and Reflection section at the end of this topic		EXCEPTIONAL

13.2 ESSENTIAL Topic 10 Syllabus

10 Metals

10.1 Properties of metals

Core

- List the general physical properties of metals
- Describe the general chemical properties of metals, e.g. reaction with dilute acids and reaction with oxygen
- Explain in terms of their properties why alloys are used instead of pure metals
- Identify representations of alloys from diagrams of structure

10.2 Reactivity series

Core

- Place in order of reactivity: potassium, sodium, calcium, magnesium, zinc, iron, (hydrogen) and copper, by reference to the reactions, if any, of the metals with:
  - water or steam
  - dilute hydrochloric acid

  and the reduction of their oxides with carbon
- Deduce an order of reactivity from a given set of experimental results

Supplement

- Describe the reactivity series as related to the tendency of a metal to form its positive ion, illustrated by its reaction, if any, with:
  - the aqueous ions
  - the oxides

  of the other listed metals
- Describe and explain the action of heat on the hydroxides, carbonates and nitrates of the listed metals
- Account for the apparent unreactivity of aluminium in terms of the oxide layer which adheres to the metal

10.3 Extraction of metals

Core

- Describe the ease in obtaining metals from their ores by relating the elements to the reactivity series
- Describe and state the essential reactions in the extraction of iron from hematite
- Describe the conversion of iron into steel using basic oxides and oxygen
- Know that aluminium is extracted from the ore bauxite by electrolysis
- Discuss the advantages and disadvantages of recycling metals, limited to iron/steel and aluminium

Supplement

- Describe in outline, the extraction of zinc from zinc blende
- Describe in outline, the extraction of aluminium from bauxite including the role of cryolite and the reactions at the electrodes

10.4 Uses of metals

Core

- Name the uses of aluminium:
  - in the manufacture of aircraft because of its strength and low density
  - in food containers because of its resistance to corrosion
- Name the uses of copper related to its properties (electrical wiring and in cooking utensils)
- Name the uses of mild steel (car bodies and machinery) and stainless steel (chemical plant and cutlery)

Supplement

- Explain the uses of zinc for galvanising and for making brass
- Describe the idea of changing the properties of iron by the controlled use of additives to form steel alloys

13.3 ESSENTIAL Glossary for Keywords for this topic

Topic #	English	Chinese
10	**alloy steels** are made when iron is mixed with other transition metals (and a small amount of carbon)	铁与其他过渡金属（和少量碳）混合后制成合金钢
10	**alloys** mixtures of elements (usually metals) designed to have the properties useful for a particular purpose; for example, solder (an alloy of tin and lead) has a low melting point	具有特定目的有用特性的元素（通常为金属）混合物的合金；例如，焊料（锡和铅的合金）的熔点低
10	**basic oxygen process** the process used to make steel from iron from the blast furnace: oxygen is blown into the molten iron using an 'oxygen lance' and lime is added to remove non-metallic impurities	基本氧气工艺：用于从高炉中的铁制造钢的工艺：使用"氧气喷枪"将氧气吹入铁水中，并添加石灰以去除非金属杂质
10	**blast furnace** a furnace for smelting iron ores such as hematite (Fe2O3) with carbon to produce pig (or cast) iron (in a modified form the furnace can be used to extract metals such as zinc)	高炉：用碳冶炼赤铁矿（Fe2O3）等铁矿石以生产生铁（或铸铁）的炉子（该炉的改进形式可用于提取锌等金属）
10	**carbon steel** alloys of iron and carbon only; the amount of carbon in steels can vary between 0.2% and 1.5%	仅含铁和碳的碳钢合金；钢中的碳含量可以在0.2%至1.5%之间变化
10	**galvanising** the protection of iron and steel objects by coating with a layer of zinc	通过镀锌层来保护钢铁物体
10	**ore** a naturally occurring mineral from which a metal can be extracted	矿石天然矿物，可以从中提取金属
10	**reactivity series of metals** an order of reactivity, giving the most reactive metal first, based on results from a range of experiments involving metals reacting with oxygen, water, dilute hydrochloric acid and metal salt solutions	根据一系列涉及金属与氧气，水，稀盐酸和金属盐溶液反应的实验结果，金属的一系列反应性是反应性的顺序，从而使金属具有最高的活性

13.4 ESSENTIAL Classroom Active Learning Tasks 1 Reactivity of Metals

Fill in this table, first with the metals English name, then with how they react with oxygen, water and dilute acids. Use the Table on the next page to help you fill this in.

Use the syllabus above to circle the elements and reactions that you must know.

Metal	Symbol	Reaction with Oxygen	Reaction with water	Reaction with dilute acids
P	K			
S	Na			
C	Ca			
M	Mg			
A	Al			
Z	Zn			
I	Fe			
L	Pb			
C	Cu			
S	Ag			
G	Au			

13.5 EXTENSION INFORMATION Reactivity of Metals with Water, Steam, Dilute Acids and Air

The reaction of some metals with air and water was investigated these were our results.

Metal	Cold Water	Hot Water	Steam	Air (O_2 & H_2O)
Calcium	Vigorous	Very Vigorous	Violent	Rapid
Sodium	Very Violent	Explosive	Explosive	Very rapid even when cold.
Potassium	Very Violent, Explosive	Explosive	Explosive	Very rapid even when cold.
Iron	Slow (days)	Slow (days)	Slow (hours)	
Lead	Slow (Many Years)	Slow (Many Years)	Slow (Months)	No reaction
Gold	None	None	None	None
Copper	Slow (decades)	Slow (decades)	Slow (decades)	Slow (decades)
Aluminium	Fast (hours) once coated in oxide reaction stops	Fast (hours) once coated in oxide reaction stops	Fast (hours) once coated in oxide reaction stops	Fast (hours) once coated in oxide reaction stops
Lithium	Very Vigorous	Very Fast (Burns)	Violent	Rapid
Zinc	Fast (hours) once coated in oxide reaction stops	Fast (hours) once coated in oxide reaction stops	Fast (hours) once coated in oxide reaction stops	Fast (hours) once coated in oxide reaction stops
Silver	Slow (Centuries)	Slow (decades)	Slow (decades)	Slow (decades)
Magnesium	Fast (hours)	Fast (minutes)	Fast (burns)	Fast

The metals can be placed in this order of reactivity (1=most reactive):

1	7
2	8
3	9
4	10
5	11
6	12

13.6 Extension Classroom active learning task 2 Comparing the Reactivity of Two Metals

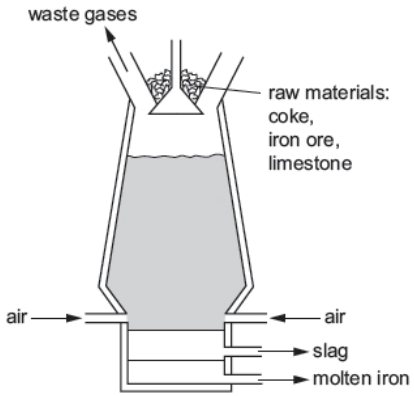
We can use a voltmeter to measure how hard a metal is able to push electrons around a circuit draw a labelled diagram of a galvanic (voltaic) cell that would allow you to test which element is more reactive, iridium or platinum

Exceptional Task – Why can't we simply look at how these metals react with acids or oxygen?

13.7 Extension Classroom active learning task 3 Extracting Metals Multi-mark questions about extracting Iron, Aluminium and Zinc

Q# 1/ IGCSE Chemistry/2017/w/Paper 43/

3 Iron is extracted from its ore using coke in a blast furnace.



(b) Describe the reactions occurring in the blast furnace.

In your answer, include
- **two** reasons for using coke in the blast furnace,
- a chemical equation for the reduction of iron(III) oxide,
- an explanation for using limestone in the blast furnace.

..... [6]

Q# 2/ IGCSE Chemistry/2016/w/Paper 42/

6 Aluminium is a very important metal.

Aluminium is extracted from its ore, bauxite, by electrolysis. Bauxite is an impure form of aluminium oxide, Al_2O_3.

(a) Describe how aluminium is extracted from **bauxite**. Include an ionic half-equation for the reaction at each electrode.

description .....

.....

.....

ionic half-equation for the anode reaction .....

ionic half-equation for the cathode reaction.....

[5]

Q# 3/ IGCSE Chemistry/2016/s/Paper 42/

(b) Zinc oxide is converted into zinc. Zinc oxide and coke are fed into a furnace. Hot air is blown into the bottom of the furnace.

Zinc has a melting point of 420 °C and a boiling point of 907 °C. The temperature inside the furnace is over 1000 °C.

(i) Explain how zinc oxide is converted into zinc. Your answer should include details of how the heat is produced and equations for all the reactions you describe.

.....

.....

.....

.....

..... [3]

Mark Scheme for T10 Multi-mark questions

Q# 1/ IGCSE Chemistry/2017/w/Paper 43/

3(b)	(coke reacts with oxygen / air) to produce heat / increase temperature / exothermically	1
	coke is reducing agent / produces reducing agent / produces carbon monoxide OR coke reduces Fe_2O_3 / (iron) ore / hematite (producing iron)	1
	$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ OR $Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$ OR $2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$ M1 species correct M2 balanced	2
	limestone (decomposes to calcium oxide which) reacts with / removes acidic impurities / SiO_2 / sand / silica / silicon(IV) oxide / silicon dioxide	1
	limestone / calcium oxide / lime is involved in the production of slag / calcium silicate	1

Q# 2/ IGCSE Chemistry/2016/w/Paper 42/

6(a)	bauxite/Alumina is dissolved in molten cryolite cryolite lowers the melting temperature molten aluminium forms *anode reaction*: $2O^{2-} \rightarrow O_2 + 4e^-$ *cathode reaction:* $Al^{3+} + 3e^- \rightarrow Al$	5

Q# 3/ IGCSE Chemistry/2016/s/Paper 42/

6(b)(i)		3
	M1 heat produced by carbon / coke (burning in) oxygen / air; **OR** $C + O_2 \rightarrow CO_2$ produces heat / exothermic; **OR** $2C + O_2 \rightarrow 2CO$ produces heat / exothermic (scores **M1** and **M2**);	1
	M2 $C + CO_2 \rightarrow 2CO$; **OR** $2C + O_2 \rightarrow 2CO$;	1
	M3 $ZnO + CO \rightarrow Zn + CO_2$; **OR** $ZnO + C \rightarrow Zn + CO$; **OR** $2ZnO + C \rightarrow 2Zn + CO_2$;	1

13.8 Exceptional Analysis Classroom active learning task 4 Comparing the Reactivity of Two Metals

Look at the next question and the mark scheme.

How is it different to the previous question about the extraction of iron ore? Do you thick it is harder or easier? Why?

Are there any similarities between these two questions? Can you find any other questions from previous years about the extraction of iron using the blast furnace? If so, can you see any trends or patterns in what the examiners are interested in and how the same question changes with time.

IGCSE Chemistry/2018/s/Paper 41/

(b) A series of reactions occurs in a blast furnace during the extraction of iron from hematite.

Describe these reactions.
Include:

- **one** chemical equation for the reduction of hematite
- **one** chemical equation for the formation of slag.

.....

.....

.....

.....

.....

.....

.....

..... [5]

IGCSE Chemistry/2018/s/Paper 41/

3(b)	coke is burned (to form carbon dioxide) **OR** $C + O_2 \rightarrow CO_2$	1
	carbon dioxide is reduced by (more) coke to form **carbon monoxide** or **CO** **OR** $C + CO_2 \rightarrow 2CO$	1
	$3CO + Fe_2O_3 \rightarrow 2Fe + 3CO_2$	1
	limestone (decomposes to) form lime / CaO / calcium oxide (and carbon dioxide) **OR** $CaCO_3 \rightarrow CaO + CO_2$	1
	$CaO + SiO_2 \rightarrow CaSiO_3$	1

13.9 ESSENTIAL Classroom Active Learning Tasks 4 Uses of Metals

Topic Chem 10.4 **Q# 61/** iGCSE Chemistry/2007/s/Paper 3/Q6

(d) Give an explanation for each of the following.

(i) Aluminium is used extensively in the manufacture of aircraft.

..... [1]

(ii) Aluminium is used to make food containers.

..... [2]

(iii) Aluminium electricity cables have a steel core.

..... [1]

Topic Chem 10.4 **Q# 62/** iGCSE Chemistry/2006/w/Paper 3/ Q6

(b) Impure copper is extracted from the ore. This copper is refined by electrolysis.

(iii) One use of this pure copper is electrical conductors, another is to make alloys. Name the metal that is alloyed with copper to make brass.

..... [1]

Topic Chem 10.4 **Q# 63/** iGCSE Chemistry/2006/s/Paper 3/ Q1

(e) Most of the iron is converted into mild steel or stainless steel. Give **one** use for each.

mild steel .....

stainless steel ..... [2]

Topic Chem 10.4 **Q# 64/** iGCSE Chemistry/2003/w/Paper 3/Q3

(b) A major use of zinc is to make diecasting alloys. These contain about 4% of aluminium and they are stronger and less malleable than pure zinc.

(i) Give one other large scale use of zinc.

.....[1]

Topic Chem 10.4 **Q# 65/** iGCSE Chemistry/2003/s/Paper 3/

1 No one knows where iron was first isolated. It appeared in China, the Middle East and in Africa. It was obtained by reducing iron ore with charcoal.

(d) Stainless steel is an alloy of iron. It contains iron, other metals and about 0.5% of carbon.

(i) State a use of stainless steel.

.....

(ii) Name a metal, other than iron, in stainless steel.

..... {2}

Topic Chem 10.4 **Q# 66/** iGCSE Chemistry/2002/w/Paper 3/

4 For over 5000 years copper has been obtained by the reduction of its ores. More recently the metal has been purified by electrolysis.

(a) Copper is used to make alloys.

(i) Give **two** other uses of copper.

.....[2]

Topic Chem 10.4 **Q# 67/** iGCSE Chemistry/2002/s/Paper 3/Q1

(c) One property of aluminium is that it resists corrosion because it is covered with a layer of its oxide.

(i) Give **one** use of the metal that depends on this property.

.....[1]

(ii) Give another use of the metal that depends on a different property.

use .....

property.....[2]

Topic Chem 10.4 **Q# 68/** iGCSE Chemistry/2001/w/Paper 3/Q4

(c) Zinc is used to make alloys.

(i) Name an alloy that contains zinc.

.....[1]

(ii) What is the other metal in this alloy?

.....[1]

Mark Scheme for T10 Uses of Metals

Q# 61/ iGCSE Chemistry/2008/s/Paper 31/Q6

(d) (i) low density **or** light or resistant to corrosion
accept strength/weight ratio **or** alloys are strong
strong on its own is neutral [1]

(ii) not attacked **or** corroded **or** unreactive
oxide layer
easily shaped **or** malleable **or** ductile
any **TWO** [2]

(iii) for strength **or** so it does not break **or** does not sag **or** can have pylons further apart [1]

NOT steel is a better conductor
NOT aluminium protects steel from rusting

Q# 62/ iGCSE Chemistry/2006/w/Paper 3/ Q6 (b)

(iii) Zinc [1]

Q# 63/ iGCSE Chemistry/2006/s/Paper 3/ Q1

(e) mild steel cars **or** machinery **or** fridges etc. **[1]**
stainless steel cutlery **or** chemical plants etc. **[1]**

Q# 64/ iGCSE Chemistry/2003/w/Paper 3/

(b) (i) making brass **or** any zinc containing alloy **or** galvanising [1]
or sacrificial protection **or** batteries **or** roofs

Q# 65/ iGCSE Chemistry/2003/s/Paper 3/ Q1

(d) (i) Cutlery **or** chemical plant **or** watches **or** utensils **or** surgical instruments **or** cars **or** sinks **or** aircraft **or** garden tools [1]
(ii) nickel **or** chromium **or** molybdenum **or** niobium **or** titanium [1]

Q# 66/ iGCSE Chemistry/2002/w/Paper 3/Q4a

4 (a) (i) wiring **NOT** good conductor
pipes
utensils
roofs
electroplating
lightning conductor
bi-metallic strips
NOT coinage metal or any other use than involves an alloy
TWO from above [2]

Q# 67/ iGCSE Chemistry/2002/s/Paper 3/Q1

(c) (i) packaging of food or window frames or roofs [1]
accept "cans"
NOT aircraft cars etc
(ii) low density [1]
light alloys for aircraft [1]
or electrical cables
good conductor
or foil
malleable
good conductor of heat
If use repeated with different properties then 2/3

Q# 68/ iGCSE Chemistry/2001/w/Paper 3/Q4

(c) (i)	brass	bronze (2% zinc)	diecast alloy	[1]
(ii)	copper	copper	aluminium	[1]

13.10 ESSENTIAL EXAM QUESTIONS Topic 10 Paper 2 50marks

Q# 1/ iGCSE Chemistry/2018/w/Paper 23/

24 Heating copper(II) carbonate produces copper(II) oxide and carbon dioxide.

Heating the copper(II) oxide formed with carbon produces copper.

Which colour changes are observed during these reactions?

A green → black → brown

B green → white → brown

C blue → black → silver

D blue → white → brown

25 Calcium reacts with cold water to produce hydrogen.

Lead reacts slowly when heated in air to form an oxide but has almost no reaction with steam.

Silver does not react with either air or water.

Zinc reacts when heated with steam to produce hydrogen.

What is the order of reactivity starting with the least reactive?

	least reactive →			most reactive
A	calcium	lead	zinc	silver
B	calcium	zinc	lead	silver
C	silver	lead	zinc	calcium
D	silver	zinc	lead	calcium

26 Which row describes the use of a metal and the property upon which the use depends?

	metal	use	property
A	aluminium	aircraft bodies	aluminium is a heat conductor
B	aluminium	cooking utensils	aluminium has a low density
C	copper	cooking utensils	copper has a high density
D	copper	electrical wiring	copper is a good conductor of electricity

27 Which statement about the manufacture of aluminium by electrolysis is correct?

A Aluminium ions are oxidised to aluminium by gaining electrons.

B Aluminium is extracted from its ore hematite.

C Molten cryolite is used to dissolve the aluminium oxide.

D Oxygen is formed at the negative electrode.

Q# 2/ iGCSE Chemistry/2018/w/Paper 22/

24 Heating copper(II) carbonate produces copper(II) oxide and carbon dioxide.

Heating the copper(II) oxide formed with carbon produces copper.

Which processes are involved in this conversion of copper(II) carbonate to copper?

A sublimation followed by oxidation

B sublimation followed by reduction

C thermal decomposition followed by oxidation

D thermal decomposition followed by reduction

25 Four metals, W, X, Y and Z, are separately reacted with water and dilute hydrochloric acid.

The results are shown.

	metal			
	W	X	Y	Z
reaction with water	fizzes	no reaction	fizzes vigorously	no reaction
reaction with dilute hydrochloric acid	fizzes	no reaction	fizzes violently	fizzes

What is the order of reactivity of the four metals starting with the least reactive?

	least reactive →			most reactive
A	X	W	Z	Y
B	X	Z	W	Y
C	Y	W	Z	X
D	Y	Z	W	X

26 Which statement about the uses of metals is **not** correct?

A Aluminium is used in aircraft because of its strength and good electrical conductivity.

B Copper is used in electrical wiring because of its good electrical conductivity.

C Stainless steel resists corrosion and is used to make cutlery.

D Transition elements are often used as catalysts.

27 Bauxite contains aluminium oxide.

Aluminium is extracted from aluminium oxide by electrolysis.

Why is cryolite added to the electrolytic cell used to extract aluminium?

A Cryolite prevents the carbon anodes being burned away.

B Cryolite removes impurities from the bauxite.

C Cryolite increases the rate at which aluminium ions are discharged.

D Molten cryolite dissolves the aluminium oxide.

Q# 3/ iGCSE Chemistry/2018/w/Paper 21/

24 A student heated copper(II) carbonate and copper(II) nitrate in separate test-tubes.

Both compounds decomposed.

Which row shows the gases produced from each reaction?

	copper(II) carbonate	copper(II) nitrate
A	carbon dioxide	nitrogen dioxide only
B	carbon dioxide	oxygen only
C	carbon dioxide	oxygen and nitrogen dioxide
D	oxygen	oxygen and nitrogen dioxide

25 Metal X reacts with steam but not with cold water.

What is X?

A calcium

B copper

C sodium

D zinc

26 Which row shows uses of the metals listed?

	aluminium	copper	mild steel
A	aircraft manufacture	food containers	cutlery
B	cutlery	electrical wiring	chemical plant
C	electrical wiring	aircraft manufacture	cooking utensils
D	food containers	cooking utensils	car bodies

27 Aluminium objects do not need protection from corrosion.

Iron objects must be protected from corrosion.

Why does aluminium resist corrosion?

A Aluminium does not form ions easily.

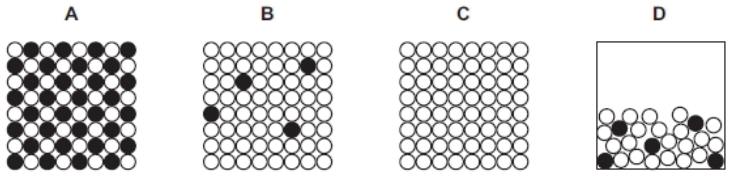
B Aluminium does not react with water or air.

C Aluminium has a protective oxide layer.

D Aluminium is below iron in the reactivity series.

Q# 4/ iGCSE Chemistry/2018/s/Paper 23/

24 Which diagram represents a solid alloy?



25 The ionic equations for four reactions are shown.

$$Z + X^{2+} \rightarrow Z^{2+} + X$$

$$Z + 2W^{+} \rightarrow Z^{2+} + 2W$$

$$X + 2W^{+} \rightarrow X^{2+} + 2W$$

$$Y + Z^{2+} \rightarrow Y^{2+} + Z$$

What is the order of reactivity of the four metals, W, X, Y and Z?

	most reactive	→		least reactive
A	W	X	Z	Y
B	X	W	Y	Z
C	Y	Z	X	W
D	Z	W	X	Y

26 Which equation represents the first stage in the extraction of zinc from zinc blende?

A $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$

B $ZnS + H_2O \rightarrow ZnO + H_2S$

C $ZnO + CO \rightarrow Zn + CO_2$

D $ZnO + H_2SO_4 \rightarrow ZnSO_4 + H_2O$

27 Which statement explains why aluminium is used to manufacture aircraft?

A It has a low density.

B It is a good conductor of electricity.

C It is a good conductor of heat.

D It is ductile.

Q# 5/ iGCSE Chemistry/2018/s/Paper 22/

24 Stainless steel is an alloy of iron, carbon and other metals.

Which row is correct?

	stainless steel is harder than pure iron	stainless steel resists corrosion better than pure iron
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

25 Metal X is more reactive than metal Y. Metal Y is more reactive than metal Z.

Which statement is correct?

A When metal X is placed in a solution of Y sulfate, there is no reaction.

B When metal X is placed in a solution of Z sulfate, a reaction occurs.

C When metal Y is placed in a solution of Z sulfate, there is no reaction.

D When metal Z is placed in a solution of X sulfate, a reaction occurs.

26 Which statement about the industrial extraction of zinc is correct?

A Cryolite is added to lower the melting point.

B Molten zinc oxide is electrolysed.

C Zinc oxide is heated with coke.

D Zinc sulfide is heated with coke.

27 Which row describes the use of an alloy and the property upon which the use depends?

	alloy	use	property
A	mild steel	cutlery	resistant to corrosion
B	mild steel	machinery	strong
C	stainless steel	cutlery	low density
D	stainless steel	machinery	good conductor of electricity

Q# 6/ iGCSE Chemistry/2018/s/Paper 21/

24 The following statements are made about the metals copper, iron, magnesium and zinc.

1 Their oxides are acidic.

2 They all conduct electricity in the solid state.

3 They all have high melting points.

4 They all react with dilute acids to form hydrogen.

Which statements are correct?

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

25 Silver is a less reactive metal than cadmium.

Cadmium is a less reactive metal than barium.

Which statement is correct?

A Barium does not react when heated with silver oxide.

B Cadmium displaces barium from a solution of barium chloride.

C Cadmium displaces silver from a solution of silver nitrate.

D Cadmium reacts when heated with barium oxide.

26 Aluminium metal is extracted from aluminium oxide using electrolysis.

Which statement about the extraction process is **not** correct?

A A large amount of electricity is required.

B Molten cryolite is used to dissolve the aluminium oxide.

C Oxygen gas is released which reacts to form carbon dioxide.

D The negative electrodes burn away and have to be replaced.

27 Which statement explains why aluminium is used in the manufacture of aircraft?

A It conducts heat well.

B It has a low density.

C It is a good conductor of electricity.

D It is easy to recycle.

Q# 7/ iGCSE Chemistry/2018/m/Paper 22/

27 In which reaction does Fe(s) form ions when the mixture is heated?

A Fe(s) + CaO(s)

B Fe(s) + MgO(s)

C Fe(s) + ZnO(s)

D Fe(s) + CuO(s)

28 The list gives the order of some metals and hydrogen in the reactivity series.

Metal X is also included.

most reactive	K
	Mg
	Zn
	H
	X
least reactive	Cu

Which row correctly shows the properties of metal X?

	reacts with dilute acids	oxide reduced by carbon
A	no	no
B	no	yes
C	yes	no
D	yes	yes

29 Which metal carbonate does **not** produce carbon dioxide when it is heated?

A copper(II) carbonate

B iron(II) carbonate

C potassium carbonate

D zinc carbonate

30 Which statement about the extraction of metals is correct?

A Aluminium is extracted by the electrolysis of hematite.

B Cryolite acts as a reducing agent in the extraction of aluminium.

C Zinc is extracted by the electrolysis of zinc blende.

D Zinc is obtained by heating zinc oxide with coke.

Q# 8/ iGCSE Chemistry/2017/w/Paper 23/

26 Aluminium is obtained by the electrolysis of a mixture of aluminium oxide and cryolite.

Why is cryolite used?

A as a catalyst to speed up the process

B as a coolant to prevent the process getting too hot

C as a solvent for aluminium oxide

D as the main source of aluminium ions

27 Metal M is mixed with copper to produce brass.

What is M?

A chromium

B nickel

C vanadium

D zinc

28 Some metal nitrates and carbonates decompose when heated strongly.

Metal Q has a nitrate that decomposes to give a salt and a colourless gas only.

The carbonate of metal Q does not decompose when heated with a Bunsen burner.

What is metal Q?

A calcium

B copper

C sodium

D zinc

Q# 9/ iGCSE Chemistry/2017/w/Paper 22/

26 Aluminium is extracted from bauxite by electrolysis.

Which row shows the anode material and the anode reaction?

	anode material	anode reaction
A	carbon	$Al^{3+} + 3e^- \rightarrow Al$
B	carbon	$2O^{2-} \rightarrow O_2 + 4e^-$
C	steel	$Al^{3+} + 3e^- \rightarrow Al$
D	steel	$2O^{2-} \rightarrow O_2 + 4e^-$

27 Which statement about the metal zinc is **not** correct?

A It forms an oxide more readily than iron.

B It is manufactured by the electrolysis of zinc blende.

C It is used to make brass.

D It is used to prevent iron from rusting.

28 Calcium nitrate decomposes when it is heated.

What is the equation for the thermal decomposition of calcium nitrate?

A $2Ca(NO_3)_2 \rightarrow 2CaO + O_2 + 4NO_2$

B $Ca(NO_3)_2 \rightarrow Ca(NO_2)_2 + O_2$

C $Ca(NO_3)_2 \rightarrow Ca + O_2 + 2NO_2$

D $Ca(NO_3)_2 \rightarrow Ca + 3O_2 + N_2$

Q# 10/ iGCSE Chemistry/2017/w/Paper 21/

25 What is a property of **all** metals?

A conduct electricity

B hard

C low melting points

D react with water

26 Aluminium is extracted by the electrolysis of aluminium oxide.

Which statement is **not** correct?

A Aluminium ions are oxidised at the cathode.

B Carbon dioxide is made at the anode.

C Cryolite is added to lower the melting point of the aluminium oxide.

D The electrodes are made from graphite.

27 Which row describes how the metals are used?

	mixed with zinc to form brass	used to galvanise iron
A	aluminium	tin
B	aluminium	zinc
C	copper	tin
D	copper	zinc

28 Information about the nitrates and carbonates of two metals, Q and R, is shown.

	appearance	solubility in water	effect of heat
nitrate of Q	white solid	soluble	colourless gas evolved which relights a glowing splint
carbonate of Q	white solid	soluble	no reaction
nitrate of R	white solid	soluble	brown gas evolved
carbonate of R	white solid	insoluble	colourless gas evolved which turns limewater milky

Which statement is correct?

A Q is calcium and R is magnesium.

B Q is magnesium and R is sodium.

C Q is potassium and R is copper.

D Q is sodium and R is calcium.

Q# 11/ iGCSE Chemistry/2017/s/Paper 23/

25 Which equation from the zinc extraction process shows the metal being produced by reduction?

A $ZnO + C \rightarrow Zn + CO$

B $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$

C $Zn(g) \rightarrow Zn(l)$

D $Zn(l) \rightarrow Zn(s)$

27 The section of the reactivity series shown includes a newly discovered element, symbol X.

The only oxide of X has the formula XO.

Ca
Mg
Fe
X
H
Cu

Which equation shows a reaction which occurs?

A $Cu(s) + X^{2+}(aq) \rightarrow Cu^{2+}(aq) + X(s)$

B $2X(s) + Cu^{2+}(aq) \rightarrow 2X^{+}(aq) + Cu(s)$

C $X(s) + Fe_2O_3(s) \rightarrow 2Fe(s) + 3XO(s)$

D $X(s) + 2HCl(aq) \rightarrow XCl_2(aq) + H_2(g)$

Q# 12/ iGCSE Chemistry/2017/s/Paper 22/

25 Which process is involved in the extraction of zinc from zinc blende?

A Cryolite is added to lower the melting point of zinc blende.

B Molten zinc blende is electrolysed.

C Zinc blende is heated with carbon.

D Zinc blende is roasted in air.

26 Element E:

- forms an alloy
- has a basic oxide
- is below hydrogen in the reactivity series.

What is E?

A carbon

B copper

C sulfur

D zinc

27 A list of metals is shown.

aluminium
copper
iron
magnesium
silver
zinc

Which metal will displace all of the other metals from aqueous solutions of their salts?

A aluminium

B iron

C magnesium

D zinc

Q# 13/ iGCSE Chemistry/2017/s/Paper 21/

25 Metal X is added to a colourless aqueous solution of the sulfate of metal Y.

A coloured solution is formed and metal Y is deposited at the bottom of the beaker.

Which row describes elements X and Y and their relative reactivity?

	type of element	relative reactivity
A	X is a transition element	X is more reactive than Y
B	X is a transition element	Y is more reactive than X
C	Y is a transition element	X is more reactive than Y
D	Y is a transition element	Y is more reactive than X

26 Element E:

- forms an alloy
- has a basic oxide
- is below hydrogen in the reactivity series.

What is E?

A carbon

B copper

C sulfur

D zinc

27 Zinc metal is extracted from its ore zinc blende in a similar method to that used to extract iron from hematite.

In which way is zinc extraction different from iron extraction?

A Carbon and carbon monoxide are the main reducing agents.

B Hot air at the base of the furnace reacts with coke to keep the furnace hot.

C The metal is removed as a vapour at the top of the furnace.

D The metal oxide is added into the top of the furnace.

28 Stainless steel is an alloy of iron and other metals. It is strong and does not rust but it costs much more than normal steel.

What is **not** made from stainless steel?

A cutlery

B pipes in a chemical factory

C railway lines

D saucepans

13.10.1 ESSENTIAL EXAM QUESTIONS Topic 10 Paper 2 50marks Mark Scheme

Q# 1/ iGCSE Chemistry/2018/w/Paper 23/

24	A
25	C
26	D
27	C

Q# 2/ iGCSE Chemistry/2018/w/Paper 22/

24	D
25	B
26	A
27	D

Q# 3/ iGCSE Chemistry/2018/w/Paper 21/

24	C
25	D
26	D
27	C

Q# 4/ iGCSE Chemistry/2018/s/Paper 23/

24	B
25	C
26	A
27	A

Q# 5/ iGCSE Chemistry/2018/s/Paper 22/

24	A
25	B
26	C
27	B

Q# 6/ iGCSE Chemistry/2018/s/Paper 21/

24	C
25	C
26	D
27	B

Q# 7/ iGCSE Chemistry/2018/m/Paper 22/

27	D
28	B
29	C
30	D

Q# 8/ iGCSE Chemistry/2017/w/Paper 23/

25	A
26	C
27	D
28	C

Q# 9/ iGCSE Chemistry/2017/w/Paper 22/

25	A
26	B
27	B
28	A

Q# 10/ iGCSE Chemistry/2017/w/Paper 21/

25	A
26	A
27	D
28	D

Q# 11/ iGCSE Chemistry/2017/s/Paper 23/

25	A
27	D

Q# 12/ iGCSE Chemistry/2017/s/Paper 22/

25	D
26	B
27	C
28	C

Q# 13/ iGCSE Chemistry/2017/s/Paper 21/

25	A
26	B
27	C
28	C

13.11 ESSENTIAL EXAM QUESTIONS Paper 3/4 268marks Topic 10

These questions are organised by sub-topic order, so if you are not going to solve all of them, make sure that you solve questions from both

Topic Chem 10.1 **Q# 1/** iGCSE Chemistry/2003/w/Paper 3/ Q2 (b)

(iii) Suggest why the introduction of a different metallic atom into the structure makes the alloy stronger than the pure metal.

.....

.....[2]

Topic Chem 10.1 **Q# 2/** iGCSE Chemistry/2002/w/Paper 3/

4 For over 5000 years copper has been obtained by the reduction of its ores. More recently the metal has been purified by electrolysis.

(ii) Alloys have similar structures to pure metals. Give a labelled diagram that shows the structure of a typical alloy, such as brass.

[3]

Topic Chem 10.2 **Q# 3/** iGCSE Chemistry/2015/w/Paper 31/

2 Describe how to separate the following. In each example, give a description of the procedure used and explain why this method works.

(a) Copper powder from a mixture containing copper and zinc powders.

procedure .....

.....

explanation .....

.....

[3]

Topic Chem 10.2 **Q# 4/** iGCSE Chemistry/2013/w/Paper 31/Q2

(b) The following metals are in order of reactivity.

potassium
zinc
copper

For those metals which react with water or steam, name the products of the reaction, otherwise write 'no reaction'.

potassium .....

.....

zinc .....

.....

copper .....

..... [5]

Topic Chem 10.2 **Q# 5/** iGCSE Chemistry/2013/s/Paper 31/

5 The reactivity series shows the metals in order of reactivity.

(a) The reactivity series can be established using displacement reactions. A piece of zinc is added to aqueous lead nitrate. The zinc becomes coated with a black deposit of lead.

$$Zn + Pb^{2+} \rightarrow Zn^{2+} + Pb$$

Zinc is more reactive than lead.

The reactivity series can be written as a list of ionic equations.

..... → ..... + ... most reactive metal : the best reductant (reducing agent)

$Zn \rightarrow Zn^{2+} + 2e^-$

$Fe \rightarrow Fe^{2+} + 2e^-$

$Pb \rightarrow Pb^{2+} + 2e^-$

$Cu \rightarrow Cu^{2+} + 2e^-$

$Ag \rightarrow Ag^+ + e^-$

(i) In the space at the top of the list, write an ionic equation for a metal which is more reactive than zinc. [1]

(ii) Write an ionic equation for the reaction between aqueous silver(I) nitrate and zinc.

..... [2]

(iii) Explain why the positive ions are likely to be oxidants (oxidising agents).

..... [1]

(iv) Deduce which ion is the best oxidant (oxidising agent).

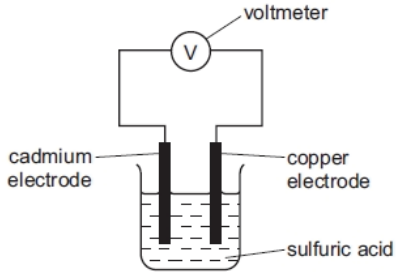
..... [1]

(v) Which ion(s) in the list can oxidise lead metal?

..... [1]

Topic Chem 10.2 **Q# 6/** iGCSE Chemistry/2013/s/Paper 31/

(b) A reactivity series can also be established by measuring the voltage of simple cells. The diagram shows a simple cell.



Results from cells using the metals tin, cadmium, zinc and copper are given in the table below.

cell	electrode 1 positive electrode	electrode 2 negative electrode	voltage / volts
1	copper	cadmium	0.74
2	copper	tin	0.48
3	copper	zinc	1.10

Write the four metals in order of increasing reactivity and explain how you used the data in the table to determine this order.

.....

.....

..... [3]

Topic Chem 10.2 **Q# 7/** iGCSE Chemistry/2012/s/Paper 31/ Q5

(b) All nitrates decompose when heated.

(i) The equation for the thermal decomposition of silver(I) nitrate is given below.

$$2AgNO_3 \rightarrow 2Ag + 2NO_2 + O_2$$

What are the products formed when copper(II) nitrate is heated?

..... [1]

(ii) Complete the equation for the action of heat on sodium nitrate.

.....$NaNO_3$ → ..... + ...

[2]

Topic Chem 10.2 **Q# 8/** iGCSE Chemistry/2012/s/Paper 31/

5 Reactive metals tend to have unreactive compounds. The following is part of the reactivity series.

sodium	most reactive
calcium	↓
zinc	
copper	
silver	least reactive

The table above is the one mentioned in question 5(c) and 5(d)

(c) Which of the metals in the list on page 5 have oxides which are not reduced by carbon?

..... [1]

(d) Choose from the list on page 5, metals whose ions would react with zinc.

..... [2]

Topic Chem 10.2 **Q# 9/** iGCSE Chemistry/2011/w/Paper 31/

7 Some hydroxides, nitrates and carbonates decompose when heated.

(a) (i) Name a metal hydroxide which does not decompose when heated.

..... [1]

(ii) Write the equation for the thermal decomposition of copper(II) hydroxide.

..... [2]

(iii) Suggest why these two hydroxides behave differently.

..... [1]

(b) (i) Metal nitrates, except those of the Group 1 metals, form three products when heated. Name the products formed when zinc nitrate is heated.

.....

..... [2]

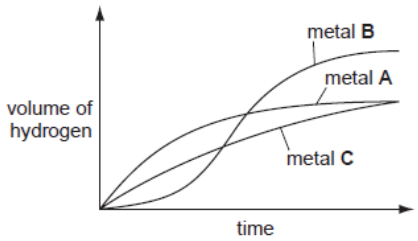
(ii) Write the equation for the thermal decomposition of potassium nitrate.

..... [2]

Topic Chem 10.2 **Q# 10/** iGCSE Chemistry/2011/s/Paper 31/

7 Excess hydrochloric acid was added to powdered zinc. The hydrogen evolved was collected and its volume measured every 20 seconds.

The experiments were repeated at the same temperature using the same number of moles of powdered magnesium and aluminium.



(a) Identify metals **A**, **B** and **C** by choosing from zinc, magnesium and aluminium. Give a reason for each choice.

metal **A** .....

.....

metal **B** .....

.....

metal **C** .....

..... [5]

(b) Using 'moles', explain why two of the metals form the same volume of hydrogen but the third metal forms a larger volume.

.....

.....

..... [3]

Topic Chem 10.2 **Q# 11/** iGCSE Chemistry/2010/w/Paper 31/ Q2

(c) The common ore of tin is tin(IV) oxide and an ore of copper is malachite, $CuCO_3.Cu(OH)_2$.

(ii) Malachite is heated to form copper oxide and two other chemicals.
Name these chemicals.

..... and ..... [2]

Topic Chem 10.2 **Q# 12/** iGCSE Chemistry/2010/s/Paper 31/b

8 Methanoic acid is the first member of the homologous series of carboxylic acids.

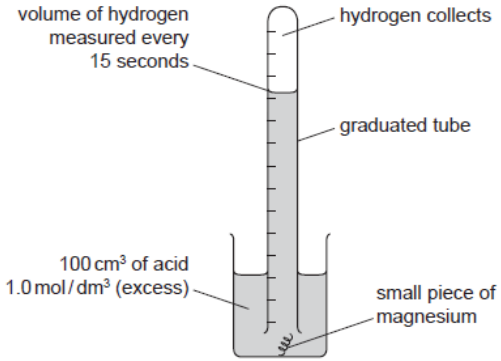
(iii) Aluminium is also above hydrogen in the reactivity series.
Why does methanoic acid not react with an aluminium kettle?

.....

..... [1]

Topic Chem 10.2 **Q# 13/** iGCSE Chemistry/2010/s/Paper 31/

3 A diagram of the apparatus which could be used to investigate the rate of reaction between magnesium and an excess of an acid is drawn below.



(a) The magnesium kept rising to the surface. In one experiment, this was prevented by twisting the magnesium around a piece of copper. In a second experiment, the magnesium was held down by a plastic net fastened to the beaker.

(i) Suggest a reason why magnesium, which is denser than water, floated to the surface.

.....

..... [1]

(ii) Iron, zinc and copper have similar densities. Why was copper a better choice than iron or zinc to weigh down the magnesium?

.....

..... [1]

Topic Chem 10.2 **Q# 14/** iGCSE Chemistry/2009/s/Paper 31/

4 The reactivity series of metals given below contains both familiar and unfamiliar elements. For most of the unfamiliar elements, which are marked *, their common oxidation states are given.

* barium	Ba
* lanthanum	La (+3)
magnesium	
zinc	
* chromium	Cr (+2), (+3), (+6)
iron	
copper	
* palladium	(+2)

Choose metal(s) from the above list to answer the following questions.

(i) Which **two** metals would not react with dilute hydrochloric acid?

..... [2]

(ii) Which **two** unfamiliar metals (*) would react with cold water?

..... [2]

(iii) What is the oxidation state of barium?

..... [1]

(iv) Name an unfamiliar metal (*) whose oxide cannot be reduced by carbon.

..... [1]

(v) Why should you be able to predict that metals such as iron and chromium have more than one oxidation state?

.....

..... [1]

Topic Chem 10.2 **Q# 15/** iGCSE Chemistry/2008/w/Paper 31/ Q6 (b)

(ii) Their hydroxides are heated.
If the compound decomposes, complete the word equation.
If it does not decompose, write "no reaction".

Potassium hydroxide → .....

Calcium hydroxide → ..... [2]

(iii) Complete the equations for the decomposition of their nitrates.

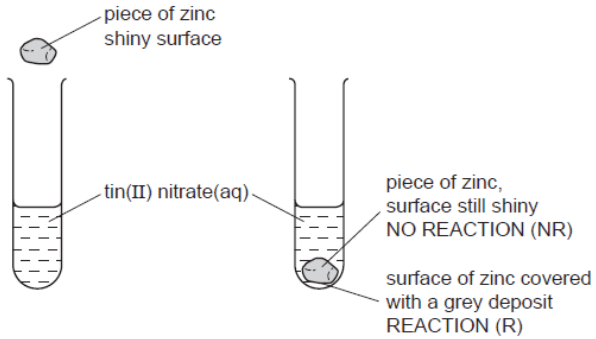
$2KNO_3$ → ..... + ...

$2Ca(NO_3)_2$ → ..... + ... + ... [4]

Topic Chem 10.2 **Q# 16/** iGCSE Chemistry/2008/w/Paper 31/

6 The reactivity series lists metals in order of reactivity.

(a) To find out which is the more reactive metal, zinc or tin, the following experiment could be carried out.



This experiment could be carried out with other metals and the results recorded in a table. Then the order of reactivity can be deduced.

(i) The order was found to be:

manganese	most reactive
zinc	
tin	
silver	least reactive

Complete the table of results from which this order was determined.

aqueous solution	tin Sn	manganese Mn	silver Ag	zinc Zn
tin(II) nitrate		R	NR	R
manganese(II) nitrate				
silver(I) nitrate				
zinc nitrate				

[3]

(ii) Write the ionic equation for the reaction between tin atoms and silver(I) ions.

..... [2]

(iii) The following is a redox reaction.

$$Mn + Sn^{2+} \longrightarrow Mn^{2+} + Sn$$

Indicate on the equation the change which is oxidation.
Give a reason for your choice.

..... [2]

(iv) Explain why experiments of this type cannot be used to find the position of aluminium in the reactivity series.

.....

..... [2]

Topic Chem 10.2 **Q# 17/** iGCSE Chemistry/2007/s/Paper 3/

5 **(a)** Titanium is produced by the reduction of its chloride. This is heated with magnesium in an inert atmosphere of argon.

$$TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2$$

(i) Explain why it is necessary to use argon rather than air.

..... [1]

(ii) Name another metal that would reduce titanium chloride to titanium.

..... [1]

Topic Chem 10.2 **Q# 18/** iGCSE Chemistry/2006/s/Paper 3/

2 Some reactions of metals **W**, **X**, **Y** and **Z** are given below.

metal	reaction with water	reaction with dilute hydrochloric acid
W	A few bubbles form slowly in cold water.	Vigorous reaction. Gas given off.
X	Vigorous reaction. Metal melts. Gas given off.	Explosive reaction. Should not be attempted.
Y	No reaction.	No reaction.
Z	Does not react with cold water. Hot metal reacts with steam.	Steady fizzing.

(a) Arrange these metals in order of reactivity.

most reactive .....

.....

.....

least reactive ..... [2]

(b) Which of these metals could be

(i) magnesium,

..... [1]

(ii) copper?

..... [1]

Topic Chem 10.2 **Q# 19/** iGCSE Chemistry/2005/w/Paper 3/Q5

The major ore of strontium is its carbonate, $SrCO_3$. Strontium is extracted by the electrolysis of its molten chloride.

(d) Both metals react with water.

(i) Write a word equation for the reaction of zinc and water and state the reaction conditions.

word equation ..... [1]

conditions ..... [2]

(ii) Write an equation for the reaction of strontium with water and give the reaction condition.

equation ..... [2]

condition ..... [1]

Topic Chem 10.2 **Q# 20/** iGCSE Chemistry/2005/s/Paper 3/ Q6

(d) Predict the equations for the decomposition of the following aluminium compounds.

(i) ..... $Al(OH)_3$ ⟶ ..... + ... [2]

(ii) aluminium nitrate ⟶ ..... + ... + ...

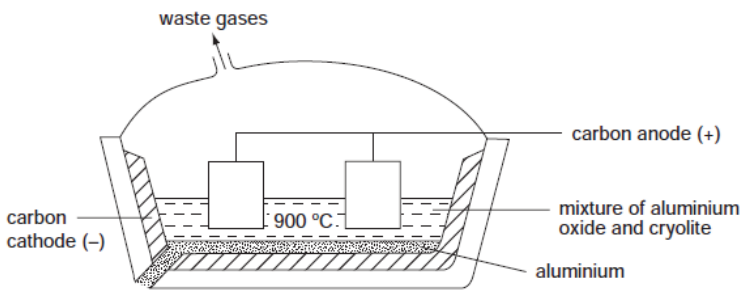
.... [2]

Topic Chem 10.2 **Q# 21/** iGCSE Chemistry/2005/s/Paper 3/

6 The position of aluminium in the reactivity series of metals is shown below.

magnesium
aluminium
zinc
copper

(a) Aluminium is extracted by the electrolysis of its molten oxide.



(b) Aluminium reacts very slowly with aqueous copper(II) sulphate.

$$2Al(s) + 3CuSO_4(aq) \longrightarrow Al_2(SO_4)_3(aq) + 3Cu(s)$$

(i) Which of the two metals has the greater tendency to form ions?

..... [1]

(ii) Describe what you would see when this reaction occurs.

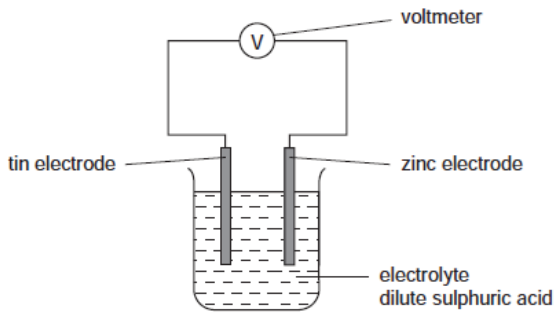
..... [1]

(iii) Explain why aluminium reacts so slowly.

..... [1]

Topic Chem 10.2 **Q# 22/** iGCSE Chemistry/2004/w/Paper 3/ Q4

(b) The following diagram shows a simple cell.



(i) Predict how the voltage of the cell would change if the tin electrode was replaced with a silver one.

[1]

(ii) Which electrode would go into the solution as positive ions? Give a reason for your choice.

[1]

(iii) State how you can predict the direction of the electron flow in cells of this type.

[1]

Topic Chem 10.2 **Q# 23/** iGCSE Chemistry/2004/w/Paper 3/

7 **(a)** **(i)** Write a symbol equation for the action of heat on zinc hydroxide.

[2]

(ii) Describe what happens when solid **sodium** hydroxide is heated strongly.

[1]

(b) What would be **observed** when copper(II) nitrate is heated?

.....

[3]

Topic Chem 10.2 **Q# 24/** iGCSE Chemistry/2004/w/Paper 3/

4 In the following list of ionic equations, the metals are in order of reactivity.

$\square \rightarrow \square + \square$

$Zn \rightarrow Zn^{2+} + 2e^-$

$Sn \rightarrow Sn^{2+} + 2e^-$

$Hg \rightarrow Hg^{2+} + 2e^-$

$Ag \rightarrow Ag^+ + e^-$

↑ reactivity of metals increases

(a) **(i)** In the space at the top of the series, write an ionic equation that includes a more reactive metal. [1]

(ii) Define *oxidation* in terms of electron transfer.

.....

[1]

(iii) Explain why the positive ions are likely to be oxidising agents.

[1]

(iv) Which positive ion(s) can oxidise mercury metal (Hg)?

[1]

Topic Chem 10.2 **Q# 25/** iGCSE Chemistry/2003/s/Paper 3/

4 Nitrogen dioxide, NO_2, is a dark brown gas.

(a) Most metal nitrates decompose when heated to form the metal oxide, nitrogen dioxide and oxygen.

(i) Write a symbol equation for the decomposition of lead(II) nitrate.

$Pb(NO_3)_2 \rightarrow$ ..... + ... + ... [2]

(ii) Potassium nitrate does not form nitrogen dioxide on heating. Write the word equation for its decomposition.

.....[1]

Topic Chem 10.2 **Q# 26/** iGCSE Chemistry/2003/s/Paper 3/

5 The first three elements in Period 6 of the Periodic Table of the Elements are caesium, barium and lanthanum.

(c) All three metals react with cold water. Complete the word equation for these reactions.

metal + water → ..... + ... [2]

Topic Chem 10.2 **Q# 27/** iGCSE Chemistry/2002/w/Paper 3/ Q4

(d) Copper is an unreactive metal. Its compounds are easily reduced to the metal or decomposed to simpler compounds. Complete the following equations.

(i) ...CuO + ... → ...Cu + ...

(ii) Copper(II) hydroxide $\xrightarrow[\text{(heat)}]{}$ ..... + ...

.....

(iii) $Cu(NO_3)_2 \xrightarrow[\text{(heat)}]{}$ ..... + ... + ...

[4]

Topic Chem 10.2 **Q# 28/** iGCSE Chemistry/2002/w/Paper 3/ Q1

(c) The results of an investigation into the action of heat on copper(II) sulphate-5-water, a blue crystalline solid, are given below.

The formula is $CuSO_4.5H_2O$ and the mass of one mole is 250 g

A 5.0 g sample of the blue crystals is heated to form 3.2 g of a white powder. With further heating this decomposes into a black powder and sulphur trioxide.

(i) Name the white powder.

.....[1]

(ii) What is observed when water is added to the white powder?

.....[1]

(iii) Name the black powder.

.....[1]

(iv) Calculate the mass of the black powder. Show your working.

.....

.....

.....[3]

Topic Chem 10.2 **Q# 29/** iGCSE Chemistry/2002/s/Paper 3/

1 In 1886, the modern electrolytic process for the extraction of aluminium was discovered in the USA by C. Hall.

(a) Before this discovery, the only method of extracting the metal was by displacement.

(i) Name a metal that can displace aluminium from aluminium chloride.

.....[1]

(ii) Write a word equation for this displacement reaction.

.....[1]

(iii) Complete the equation for the reaction.

$AlCl_3$ + ... ⟶ ..... + ...[2]

Topic Chem 10.3 **Q# 30/** iGCSE Chemistry/2015/s/Paper 31/

2 Iron from the Blast Furnace is impure. It contains about 5% of impurities, mainly carbon, sulfur, silicon and phosphorus, which have to be removed when this iron is converted into steel.

(a) Explain how the addition of oxygen and calcium oxide removes these impurities. Include an equation for a reaction of oxygen and a word equation for a reaction of calcium oxide in this process.

.....

.....

.....

.....

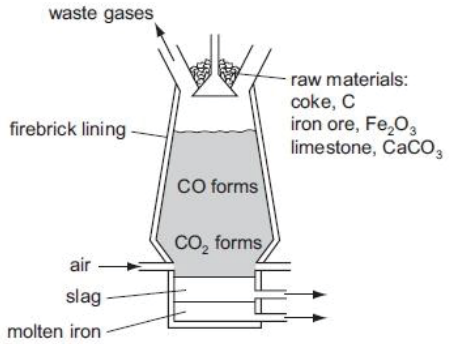
.....

.....

[5]

Topic Chem 10.3 **Q# 31/** iGCSE Chemistry/2014/w/Paper 31/

4 Iron is extracted from the ore hematite in the Blast Furnace.



(a) The coke reacts with the oxygen in the air to form carbon dioxide.

$$C + O_2 \rightarrow CO_2$$

(i) Explain why carbon monoxide is formed higher in the Blast Furnace.

.....

..... [2]

(ii) Write an equation for the reduction of hematite, Fe_2O_3, by carbon monoxide.

..... [2]

(b) (i) Limestone decomposes to form two products, one of which is calcium oxide.
Name the other product.

..... [1]

(ii) Calcium oxide reacts with silicon(IV) oxide, an acidic impurity in the iron ore, to form slag.
Write an equation for this reaction.

..... [2]

(iii) Explain why the molten iron and the molten slag form two layers and why molten iron is the lower layer.

.....

..... [2]

(iv) Suggest why the molten iron does **not** react with the air.

..... [1]

Topic Chem 10.3 **Q# 32/** iGCSE Chemistry/2014/s/Paper 31/

5 Zinc is obtained from the ore, zinc blende, ZnS.

(a) Describe the extraction of zinc from its ore, zinc blende. Include at least one balanced equation in your description.

.....

.....

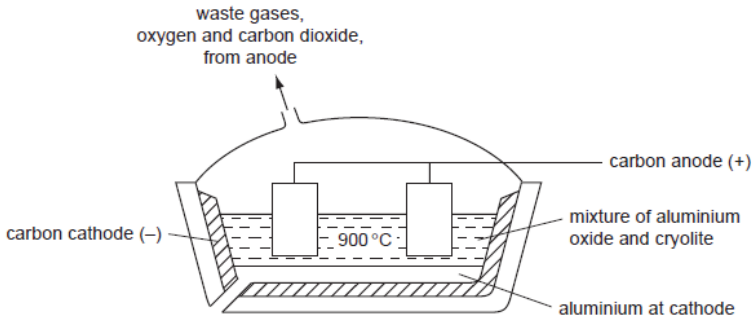
.....

.....

..... [5]

Topic Chem 10.3 **Q# 33/** iGCSE Chemistry/2011/w/Paper 31/

3 Aluminium is extracted by the electrolysis of a molten mixture of alumina, which is aluminium oxide, and cryolite.



(a) (i) Alumina is obtained from the main ore of aluminium.
Name this ore.

..... [1]

(ii) Explain why it is necessary to use a mixture, alumina and cryolite, rather than just alumina.

.....

..... [2]

(iii) Copper can be extracted by the electrolysis of an aqueous solution.
Suggest why the electrolysis of an aqueous solution cannot be used to extract aluminium.

.....

.....

..... [2]

(b) The ions which are involved in the electrolysis are Al^{3+} and O^{2-}. The products of this electrolysis are given on the diagram.
Explain how they are formed. Use equations where appropriate.

.....

.....

.....

..... [4]

Topic Chem 10.3 **Q# 34/** iGCSE Chemistry/2011/s/Paper 31/

3 Iron from the blast furnace is impure. It contains about 4 % carbon and 0.5 % silicon. Most of this impure iron is used to make mild steel, an alloy of iron containing less then 0.25 % carbon.

(a) A jet of oxygen is blown through the molten iron in the presence of a base, usually calcium oxide. Explain how the percentage of carbon is reduced and how the silicon is removed.

.....

.....

.....

..... [4]

Topic Chem 10.3 **Q# 35/** iGCSE Chemistry/2011/s/Paper 31/

4 A major ore of zinc is zinc blende, ZnS. A by-product of the extraction of zinc from this ore is sulfur dioxide which is used to make sulfuric acid.

(a) (i) Zinc blende is heated in air. Zinc oxide and sulfur dioxide are formed. Write the balanced equation for this reaction.

..... [2]

(ii) Zinc oxide is reduced to zinc by heating with carbon. Name **two** other reagents which could reduce zinc oxide.

..... [2]

(iii) The zinc obtained is impure. It is a mixture of metals. Explain **how** fractional distillation could separate this mixture.
zinc bp = 908 °C, cadmium bp = 765 °C, lead bp = 1751 °C

.....

..... [2]

Topic Chem 10.3 **Q# 36/** iGCSE Chemistry/2010/w/Paper 31/ Q2

(c) The common ore of tin is tin(IV) oxide and an ore of copper is malachite, $CuCO_3.Cu(OH)_2$.

(i) Write a word equation for the reduction of tin(IV) oxide by carbon.

..... [1]

Topic Chem 10.3 **Q# 37/** iGCSE Chemistry/2010/s/Paper 31/

7 Titanium is a transition element. It is isolated by the following reactions.

titanium ore → titanium(IV) oxide → titanium(IV) chloride → titanium

TiO_2 $TiCl_4$ Ti

(a) Why is it usually necessary to include a number in the name of the compounds of transition elements?

..... [1]

(b) Titanium(IV) chloride is made by heating the oxide with coke and chlorine.

$$TiO_2 + 2Cl_2 \rightleftharpoons TiCl_4 + O_2$$

$$2C + O_2 \rightleftharpoons 2CO$$

Explain why the presence of coke ensures the maximum yield of the metal chloride.

.....

.....

..... [2]

(c) Explain why the change, titanium(IV) chloride to titanium, is reduction.

.....

..... [1]

Topic Chem 10.3 **Q# 38/** iGCSE Chemistry/2009/w/Paper 3/

3 (a) An important ore of zinc is zinc blende, ZnS.

(i) How is zinc blende changed into zinc oxide?

..... [1]

(ii) Write a balanced equation for the reduction of zinc oxide to zinc by carbon.

..... [2]

Topic Chem 10.3 **Q# 39/** iGCSE Chemistry/2008/w/Paper 31/ Q3

(b) (i) Name a reagent that can reduce iron(III) oxide to iron.

..... [1]

(ii) Write a symbol equation for the reduction of iron(III) oxide, Fe_2O_3, to iron.

..... [2]

Topic Chem 10.3 **Q# 40/** iGCSE Chemistry/2008/w/Paper 31/ Q3

(d) Iron from the blast furnace is impure. Two of the impurities are carbon and silicon. These are removed by blowing oxygen through the molten iron and adding calcium oxide.

(i) Explain how the addition of oxygen removes carbon.

.....

..... [1]

(ii) Explain how the addition of oxygen and calcium oxide removes silicon.

.....

..... [2]

Topic Chem 10.3 **Q# 41/** iGCSE Chemistry/2007/w/Paper 3/ Q4

(b) Some of the zinc oxide was mixed with an excess of carbon and heated to 1000 °C Zinc distils out of the furnace.

$$2ZnO + C \rightleftharpoons 2Zn + CO_2$$
$$C + CO_2 \rightarrow 2CO$$

(ii) Why is it necessary to use an excess of carbon?

.....

..... [2]

Topic Chem 10.3 **Q# 42/** iGCSE Chemistry/2007/s/Paper 3/

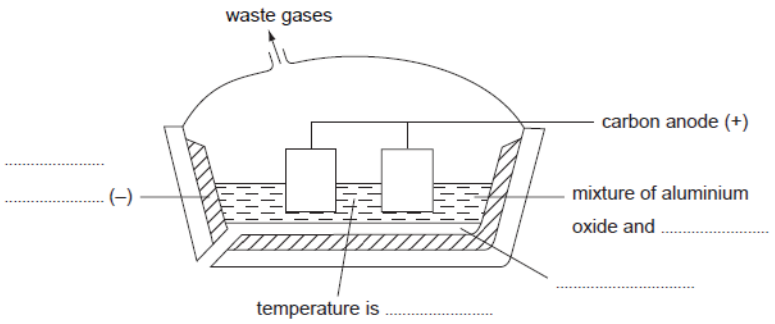
6 Aluminium is extracted by the electrolysis of a molten mixture that contains alumina, which is aluminium oxide, Al_2O_3.

(a) The ore of aluminium is bauxite. This contains alumina, which is amphoteric, and iron(III) oxide, which is basic. The ore is heated with aqueous sodium hydroxide. Complete the following sentences.

The ..... dissolves to give a solution of .....

The ..... does not dissolve and can be removed by ..... [4]

(b) Complete the labelling of the diagram.



[4]

(c) The ions that are involved in the electrolysis are Al^{3+} and O^{2-}.

(i) Write an equation for the reaction at the cathode.

..... [2]

(ii) Explain how carbon dioxide is formed at the anode.

.....

..... [2]

Topic Chem 10.3 **Q# 43/** iGCSE Chemistry/2006/s/Paper 3/ Q1

(c) Iron is extracted in a blast furnace. The list below gives some of the substances used or formed in the extraction.

carbon monoxide **coke** **iron ore** **limestone** **slag**

(i) Which substance is a mineral containing largely calcium carbonate?

..... [1]

(ii) Which substance is formed when impurities in the ore react with calcium oxide?

..... [1]

(iii) Which substance is also called hematite?

..... [1]

Topic Chem 10.3 **Q# 44/** iGCSE Chemistry/2006/s/Paper 3/ Q1

(d) State **two** functions of the coke used in the blast furnace.

.....

..... [2]

Topic Chem 10.3 **Q# 45/** iGCSE Chemistry/2005/w/Paper 3/ Q5

(b) The major ore of zinc is zinc blende, ZnS.

(i) Describe how zinc is extracted from zinc blende.

.....

.....

..... [2]

(ii) Give a use of zinc.

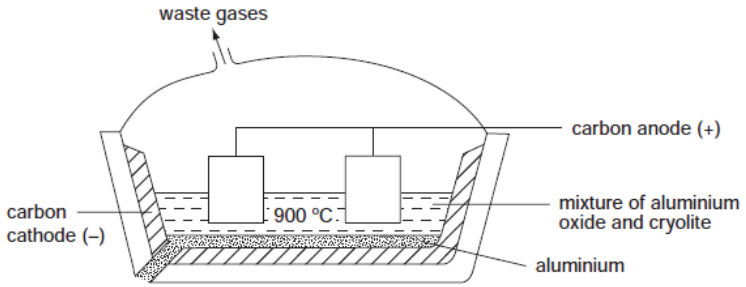
..... [1]

Topic Chem 10.3 **Q# 46/** iGCSE Chemistry/2005/s/Paper 3/

6 The position of aluminium in the reactivity series of metals is shown below.

magnesium
aluminium
zinc
copper

(a) Aluminium is extracted by the electrolysis of its molten oxide.



(i) Name the main ore of aluminium.

..... [1]

(ii) Why does the molten electrolyte contain cryolite?

..... [1]

(iii) Oxygen is produced at the positive electrode (anode). Name another gas which is given off at this electrode.

..... [1]

Topic Chem 10.3 **Q# 47/** iGCSE Chemistry/2003/w/Paper 3/

3 Zinc blende is the common ore of zinc. It is usually found mixed with an ore of lead and traces of silver.

(a) **(i)** Describe how zinc blende is changed into zinc oxide.

.....

.....[2]

(ii) Write an equation for the reduction of zinc oxide by carbon.

.....[2]

(iii) The boiling point of lead is 1740 °C and that of zinc is 907 °C. Explain why, when both oxides are reduced by heating with carbon at 1400 °C, only lead remains in the furnace.

.....

.....[2]

Topic Chem 10.3 **Q# 48/** iGCSE Chemistry/2003/s/Paper 3/

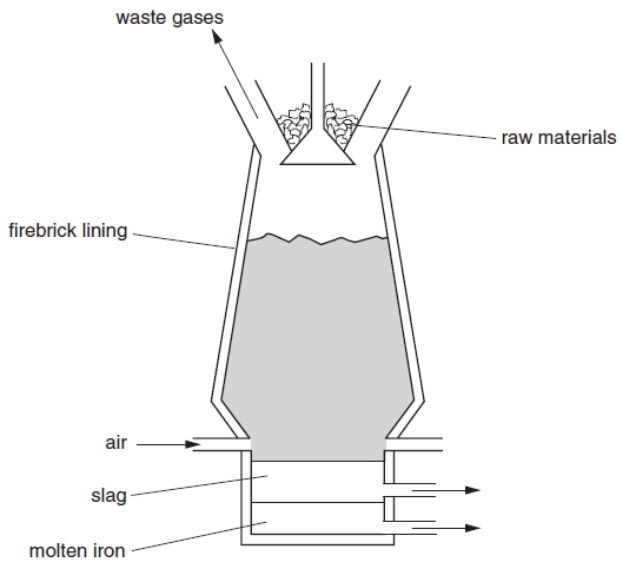
1 No one knows where iron was first isolated. It appeared in China, the Middle East and in Africa. It was obtained by reducing iron ore with charcoal.

(a) Complete the following equation.

Fe_2O_3 (iron ore) + C (charcoal) → ..... + ...

[2]

(b) In 1705 Abraham Darby showed that iron ore could be reduced using coke in a blast furnace.



(i) The temperature in the furnace rises to 2000 °C. Write an equation for the exothermic reaction that causes this high temperature.

.....

(ii) In the furnace, the ore is reduced by carbon monoxide. Explain how this is formed.

.....

.....[3]

(c) The formation of slag removes an impurity in the ore. Write a word equation for the formation of the slag.

.....[2]

Topic Chem 10.3 **Q# 49/** iGCSE Chemistry/2003/s/Paper 3/

1 No one knows where iron was first isolated. It appeared in China, the Middle East and in Africa. It was obtained by reducing iron ore with charcoal.

(iii) The iron from the blast furnace is impure. It contains about 5% of carbon and other impurities, such as silicon and phosphorus. Describe how the percentage of carbon is reduced and the other impurities are removed.

.....

.....

..... [4]

Topic Chem 10.3 **Q# 50/** iGCSE Chemistry/2002/s/Paper 3/ QiGCSE Chemistry/Q1

(b) Aluminium is produced by the electrolysis of an electrolyte that contains aluminium oxide.

(i) Write an ionic equation for the reduction of the aluminium ion at the cathode.

.....[2]

(ii) Name the main ore of aluminium.

.....[1]

(iii) Complete the following description of the electrolyte by filling the spaces.

The electrolyte is a ..... mixture of aluminium oxide and ..... which is maintained at 900 °C. [2]

(iv) Explain why the gas given off at the anode is a mixture of oxygen and carbon dioxide.

.....

.....[2]

Topic Chem 10.3 **Q# 51/** iGCSE Chemistry/2001/w/Paper 3/Q4 (a)

(ii) Describe how zinc is extracted from zinc blende.

.....

.....

.....[3]

Topic Chem 10.3 **Q# 52/** iGCSE Chemistry/2001/w/Paper 3/

4 (a) Zinc is made by reducing zinc oxide. In 1695 Homberg obtained zinc from calamine, zinc carbonate. At present zinc is extracted from the ore, zinc blende.

(i) Suggest a way of changing calamine into zinc oxide.

.....[1]

Topic Chem 10.4 **Q# 53/** iGCSE Chemistry/2015/s/Paper 31/

2 Iron from the Blast Furnace is impure. It contains about 5% of impurities, mainly carbon, sulfur, silicon and phosphorus, which have to be removed when this iron is converted into steel.

(b) Mild steel is the most common form of steel. Mild steel contains a maximum of 0.3% of carbon.

High carbon steel contains 2% of carbon. It is less malleable and much harder than mild steel.

(i) Give a use of mild steel.

..... [1]

(ii) Suggest a use of high carbon steel.

..... [1]

(iii) Explain why metals are malleable.

.....

.....

.....

..... [3]

(iv) Suggest an explanation why high carbon steel is less malleable and harder than mild steel.

.....

.....

..... [2]

Topic Chem 10.4 **Q# 54/** iGCSE Chemistry/2014/s/Paper 31/Q5

(b) State **two** major uses of zinc.

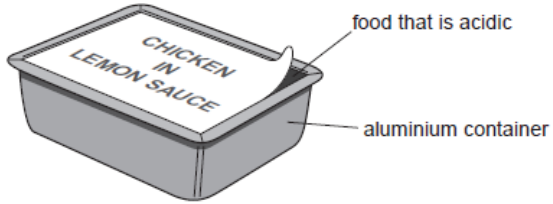
.....

..... [2]

Topic Chem 10.4 **Q# 55/** iGCSE Chemistry/2011/w/Paper 31/ Q3

(c) The uses of a metal are determined by its properties.

(i) Foods which are acidic can be supplied in aluminium containers.



Explain why the acid in the food does not react with the aluminium.

.....

..... [1]

Topic Chem 10.4 **Q# 56/** iGCSE Chemistry/2011/s/Paper 31/Q3

(b) (i) Why are steel alloys used in preference to iron?

..... [1]

(ii) State a use of the following alloys.

mild steel .....

stainless steel ..... [2]

Topic Chem 10.4 **Q# 57/** iGCSE Chemistry/2010/w/Paper 31/ Q2c

(iv) Give **one** use of copper, other than making alloys.

..... [1]

Topic Chem 10.4 **Q# 58/** iGCSE Chemistry/2010/s/Paper 31/

7 Titanium is a transition element. It is isolated by the following reactions.

titanium ore → titanium(IV) oxide → titanium(IV) chloride → titanium

TiO_2 $TiCl_4$ Ti

(d) Complete the table which shows some of the properties of titanium and its uses. The first line has been completed as an example.

property	related use
soluble in molten steel	making steel titanium alloys
.....	making aircraft and space vehicles
resistant to corrosion, especially in sea water	.....

[2]

Topic Chem 10.4 **Q# 59/** iGCSE Chemistry/2008/s/Paper 31/ Q3

(c) (i) Give **two** reasons why copper is used,

in electric wiring, ...

..... [2]

in cooking utensils. .....

..... [2]

(ii) Give another use of copper.

..... [1]

Topic Chem 10.4 **Q# 60/** iGCSE Chemistry/2007/w/Paper 3/ Q4

(d) Give two uses of zinc.

1. .....

2. ..... [2]

13.11.1 ESSENTIAL EXAM QUESTIONS Paper 3/4 268marks T10

Q# 1/ iGCSE Chemistry/2003/w/Paper 3/ Q3 (b)

(iii) different size atom **NOT** shape [1]
prevents layers from moving [1]

Q# 2/ iGCSE Chemistry/2002/w/Paper 3/Q4a

(ii) regular array [1]
different sizes [1]
delocalised or mobile or free electrons [1]

Q# 3/ iGCSE Chemistry/2015/w/Paper 31/

Question	Answer	Marks
2(a)	add a (dilute) acid; filter; copper does not react or dissolve / zinc reacts or dissolves or forms a salt;	1 1 1

Q# 4/ iGCSE Chemistry/2013/w/Paper 31/

(b) potassium hydrogen (1) and potassium hydroxide (1)
zinc hydrogen (1) and zinc oxide (1)
copper no reaction (1) [5]

Q# 5/ iGCSE Chemistry/2013/s/Paper 31/

5 (a) (i) any metal above zinc
$Mg \rightarrow Mg^{2+} + 2e^-$ [1]

(ii) $Zn + 2Ag^+ \rightarrow Zn^{2+} + 2Ag$ [2]
Note: not balanced only [1]

(iii) because they can accept or gain electrons / change into atoms or can be reduced [1]

(iv) Ag^+ or silver [1]
charge not essential but if given must be correct

(v) Ag^+ and Cu^{2+} **or** silver and copper [1]
charge not essential but if given must be correct

Q# 6/ iGCSE Chemistry/2013/s/Paper 31/

(b) Cu Sn Cd Zn *(i.e. all **4** in correct order)* [1]
relates order to voltage [1]

one relevant comment from: [1]

higher reactivity metals are the negative electrode / copper is least reactive because it is the positive electrode because copper would have the lowest voltage / copper cell V = 0 / the bigger the difference in reactivity, the bigger the voltage / zinc has highest voltage because it is most reactive / more reactive metals have higher voltage

Q# 7/ iGCSE Chemistry/2012/s/Paper 31/

(b) (i) CuO **and** NO_2 **and** O_2; [1]
accept: names or correct formulae

(ii) $2NaNO_3 \rightarrow 2NaNO_2 + O_2$ [2]
accept: $NaNO_3 \rightarrow NaNO_2 + 1/2\ O_2$
not balanced = [1]

Q# 8/ iGCSE Chemistry/2012/s/Paper 31/ Q5

(c) Na / Ca; [1]

(d) Cu; Ag; [2]
accept: *ions Cu^{2+} and Ag^{+}*

Q# 9/ iGCSE Chemistry/2011/w/Paper 31/

7 (a) (i) any Group 1 metal [1]
accept: LiOH

(ii) $Cu(OH)_2 \rightarrow CuO + H_2O$ [2]
note: products only = 1

(iii) reactivity of metals / metals have different reactivities [1]

(b) (i) zinc oxide, nitrogen dioxide, oxygen [2]
note: two correct = 1

(ii) $2KNO_3 \rightarrow 2KNO_2 + O_2$ [2]
note: unbalanced = 1, correct word equation = 1

Q# 10/ iGCSE Chemistry/2011/s/Paper 31/

7 (a) metal A is magnesium [1]
cond most reactive or fastest reaction [1]

metal B is aluminium [1]
cond faster reaction after removal of oxide layer / it would give more hydrogen / aluminium more reactive than zinc [1]

metal C is zinc [1]
zinc least reactive [1]
NOTE MAX [5]
If you encounter different reasoning which is correct, please award the appropriate marks.

(b) for magnesium and zinc same volume of hydrogen [1]

because both have valency of 2 / 1 mole of metal gives 1 mole of hydrogen / 1 mole of metal reacts with 2 moles of acid [1]

bigger volume for aluminium because its valency is 3 / 1 mole of metal gives 1.5 moles of hydrogen / 1 mole of metal reacts with 3 moles of acid [1]

If you encounter different reasoning which is correct, please award the appropriate marks.

accept balanced equations
accept ionic charges as alternative to valency

Q# 11/ iGCSE Chemistry/2010/w/Paper 31/ Q2

(ii) water [1]
carbon dioxide [1]

Q# 12/ iGCSE Chemistry/2010/s/Paper 31/Q8b

(iii) protected by oxide layer [1]

Q# 13/ iGCSE Chemistry/2010/s/Paper 31/

3 (a) (i) bubbles / effervescence / hydrogen / gas pushes up / lifts metal [1]

(ii) does not react with acid / zinc and iron react with acid [1]
not just unreactive

Q# 14/ iGCSE Chemistry/2009/s/Paper 31/

4 (i) Cu and Pd [2]

(ii) Ba and La [2]

(iii) +2 **or** 2+ **or** Ba^{2+} [1]

(iv) Ba **or** La [1]

(v) it is a transition metal **or** a d block element [1]

[Total: 7]

Q# 15/ iGCSE Chemistry/2008/w/Paper 31/ 6 (b)

(ii) potassium hydroxide → no reaction [1]
calcium hydroxide → calcium oxide and water [1]
ACCEPT metal oxide

(iii) $2KNO_3 \rightarrow 2KNO_2 + O_2$ [2]
[1] for **formula** of either product

$2Ca(NO_3)_2 \rightarrow 2CaO + 4NO_2 + O_2$ [2]
[1] for **formulae** of any **TWO** products

Q# 16/ iGCSE Chemistry/2008/w/Paper 31/

6 (a) (i)

aqueous solution	tin Sn	manganese Mn	silver Ag	zinc Zn
tin(II) nitrate		R	NR	R
manganese(II) nitrate	NR		NR	NR
silver(I) nitrate	R	R		R
zinc nitrate	NR	R	NR	

[1] for each row [3]
ignore anything written in blank space

(ii) $Sn + 2Ag^{+} \rightarrow Sn^{2+} + 2Ag$ [2]
all species correct [1]
accept equation with Sn^{4+}

(iii) Mn to Mn^{2+} need both species [1]
electron loss **or** oxidation number increases [1]

(iv) covered with oxide layer [1]
makes it unreactive **or** protects **or** aluminium oxide unreactive [1]

Q# 17/ iGCSE Chemistry/2008/s/Paper 31/

5 (a) (i) air would react (with the magnesium **or** titanium)
OR argon would not react (with the metals) [1]
NOT argon is inert

(ii) any metal higher than magnesium in reactivity series [1]

Q# 18/ iGCSE Chemistry/2006/s/Paper 3/

2 (a) X
W
Z
Y **[2]**
For most reactive X and least Y [1] **ONLY**
All other responses [0]

(b) magnesium W **[1]**
copper Y **[1]**

Q# 19/ iGCSE Chemistry/2005/w/Paper 3/Q5

(d)(i) zinc + water = zinc oxide + hydrogen **[1]**
heat **[1]** steam **[1]** **[2]**

(ii) $Sr + 2H_2O = Sr(OH)_2 + H_2$ **[2]**
Not balanced **[1]**
cold water **[1]**

Q# 20/ iGCSE Chemistry/2005/s/Paper 3/ Q6

(d) (i) $2Al(OH)_3 = Al_2O_3 + 3H_2O$ **[2]**
Not balanced [1]

(ii) Aluminium nitrate = aluminium oxide + nitrogen dioxide + oxygen **[2]**
only TWO correct products [1]

Q# 21/ iGCSE Chemistry/2005/s/Paper 3/ Q6

(b) (i) aluminium **[1]**

(ii) solution goes colourless **or** copper formed **[1]**
or a brown solid forms **or** blue colour disappears
or bubbles
NOT goes clear **or** copper formed

(iii) covered with an oxide layer **[1]**

Q# 22/ iGCSE Chemistry/2004/w/Paper 3/ Q4

(b) (i) increase **[1]**

(ii) zinc
COND and a correct reason - such as it loses electrons more easily **or**
it is more reactive **[1]**
Need both zinc and reason for the mark.

(iii) from the more reactive to the less reactive **NOT** just from zinc to lead **[1]**

Q# 23/ iGCSE Chemistry/2004/w/Paper 3/

7 (a) (i) $Zn(OH)_2 = ZnO + H_2O$ **[2]**
reactant [1] products [1]

(ii) it would melt **or** it does not decompose **or** it does not react **[1]**
NOT no change

(iii) blue (solid) **[1]**
to black (solid) **[1]**
brown gas **[1]**

Q# 24/ iGCSE Chemistry/2004/w/Paper 3/

4 (a) (i) Correct equation with a more reactive metal **[1]**

(ii) Electron loss **[1]**

(iii) Because they can accept electrons or take electrons away from..... **[1]**

(iv) Silver or silver(I) **[1]**

Q# 25/ iGCSE Chemistry/2003/s/Paper 3/

4 (a) (i) Correct equation [2]
not balanced [1] ONLY
$2Pb(NO_3)_2 = 2PbO + 4NO_2 + O_2$
$Pb(NO_3)_2 = PO + 2\ NO_2 + \frac{1}{2}\ O_2$

(ii) potassium nitrate → potassium nitrite + oxygen [1]

Q# 26/ iGCSE Chemistry/2003/s/Paper 3/Q5

(c) metal hydroxide or hydroxide ions [1]
hydrogen [1]

Q# 27/ iGCSE Chemistry/2002/w/Paper 3/ Q4

(d) (i) $CuO + C \Longrightarrow Cu + CO$
or $2CuO + C \Longrightarrow 2\ Cu + CO_2$
or any other correct reductant – hydrogen or metal [1]

(ii) Copper(II) hydroxide = copper oxide + water [1]
accept symbols

(iii) $2Cu(NO_3)_2 \Longrightarrow 2CuO + 4NO_2 + O_2$ [2]
unbalanced ONLY [1]
NOT word equation

Q# 28/ iGCSE Chemistry/2002/w/Paper 3/ Q1

(c) (i) copper sulphate **or** anhydrous copper sulphate [1]
accept "unhydrated"
NOT formula

(ii) goes blue **or** becomes hot **or** steam [1]

(iii) copper oxide [1]

(iv) 5/250 = 0.02 moles [1]
Mr = 80 [1]
80 x 0.02 = 1.6 g [1]
NB (iv) to be marked **conseq** to (iii)
Correct answer no working **ONLY** [1]

Q# 29/ iGCSE Chemistry/2002/s/Paper 3/Q1

1 (a) (i) Any metal above aluminium Na, K, Ca, Mg etc [1]

(ii) If (i) is correct then word equation [1]

(iii) **conseq** to (i) symbol equation [2]
If not balanced **ONLY** [1]

Q# 30/ iGCSE Chemistry/2015/s/Paper 31/

Question	Answer	Marks	Guidance
2(a)	M1 *Forming an oxide* (all) elements or (all) impurities become oxides;		(All) elements or (all) impurities react with oxygen **A** M1 for any one element becoming an oxide
	M2 *Gaseous oxides* carbon dioxide or sulfur (di)oxide escape / are removed as gases;		**A** formulae / carbon monoxide **A** oxides of sulfur / carbon **I** sulfur trioxide
	M3 *Acidic oxides* silicon(IV) oxide or phosphorus(III / V) oxide react / are neutralised by calcium oxide / lime;		**A** silicon (di)oxide for silicon(IV) oxide **A** phosphorus (tri/pent)oxide for phosphorus(III / V) oxide
	M4 *Equation mark* any one of the following equations $S + O_2 \rightarrow SO_2$; $C + O_2 \rightarrow CO_2$ or $2C + O_2 \rightarrow 2CO$; $Si + O_2 \rightarrow SiO_2$; $4P + 5O_2 \rightarrow 2P_2O_5$ or $P_4 + 5O_2 \rightarrow 2P_2O_5$; $4P + 3O_2 \rightarrow 2P_2O_3$ or $P_4 + 3O_2 \rightarrow 2P_2O_3$;		**A** multiples **I** state symbols **I** unbalanced equations **R** other combustion equations with incorrect species
	M5 *Word equation mark* any one of the following word equations calcium oxide + silicon(IV) oxide → calcium silicate; calcium oxide + phosphorus(III / V) oxide → calcium phosphate;	5	**A** calcium oxide + silicon(IV) oxide → slag **A** correct symbol equation for M5 but **R** other equations with incorrect species used as M5

Q# 31/ iGCSE Chemistry/2014/w/Paper 31/

4 (a) (i) insufficient/limited oxygen [1]
or $2C + O_2 \rightarrow 2CO$

coke/carbon reacts with carbon dioxide [1]
or $C + CO_2 \rightarrow 2CO$

(ii) $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$
species (1) balancing (1) [2]

(b) (i) carbon dioxide [1]

(ii) $CaO + SiO_2 \rightarrow CaSiO_3$ [2]
[1] each side correct

(iii) (molten) iron higher density (than slag) [2]

(iv) No oxygen in contact with iron **or** layer of slag prevents hot iron reacting with oxygen/air **or** (all) oxygen reacts with carbon (so no oxygen left to react with iron) [1]

Q# 32/ iGCSE Chemistry/2014/s/Paper 31/

5 (a) M1: (zinc sulfide) heated / roasted / burnt in **air** (1)

M2: zinc oxide formed (1)

M3: zinc oxide **reduced** (1)

M4: (by adding) coke or carbon (1)

M5: Balanced equation (any one of) (1) [5]

$2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$
$2ZnO + C \rightarrow 2Zn + CO_2$
$ZnO + C \rightarrow Zn + CO$
$ZnO + CO \rightarrow Zn + CO_2$

Q# 33/ iGCSE Chemistry/2011/w/Paper 31/

3 (a) (i) bauxite [1]

(ii) lowers melting point [1]
better conductor / reduces amount of energy needed / reduces cost / more economic / makes process viable / conserves energy [1]

(iii) aluminium more reactive than copper / aluminium higher in reactivity series [1]
hydrogen not aluminium formed at cathode [1]

(b) $Al^{3+} + 3e \rightarrow Al$ [1]
$2O^{2-} \rightarrow O_2 + 4e$ [2]
note: not balanced = 1
oxygen reacts with carbon (anode) to form carbon dioxide / $C + O_2 \rightarrow CO_2$ [1]
note: if mark(s) for an electrode reaction are not awarded then allow aluminium ions accept electrons / are reduced [1]
oxide ion loses electrons / is oxidised [1]
max 4

Q# 34/ iGCSE Chemistry/2011/s/Paper 31/

3 (a) any four max 4
carbon forms carbon dioxide / carbon monoxide [1]
this is a gas it escapes / blown out / diffuses [1]
silicon forms silicon(IV) oxide / silica [1]
/ silicon(IV) oxide present in impure iron
silicon(IV) oxide reacts with calcium oxide to form slag **or** calcium silicate [1]
slag removed from surface [1]
accept skimmed, syphoned, poured off
not tapped max [4]
accept correct formula or equations
not calcium oxide reacts with silicon

Q# 35/ iGCSE Chemistry/2011/s/Paper 31/

4 (a) (i) $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$ [2]
not balanced only [1]

(ii) **two** reagents from named metal(s) more reactive than zinc/carbon monoxide [2]
not hydrogen

(iii) they have different boiling points [1]
cadmium will distil first then zinc leaving lead/lead distilled last [1]

Q# 36/ iGCSE Chemistry/2010/w/Paper 31/ Q2

(c) (i) tin(IV) oxide + carbon → tin + carbon dioxide [1]
not carbon monoxide as a reductant
accept carbon monoxide as a product
not tin(IV)
accept correct symbol equation

Q# 37/ iGCSE Chemistry/2010/s/Paper 31/

7 (a) a transition element has more than one oxidation state or valency [1]
accept different oxidation states

(b) by removing oxygen concentration of O_2 decreases [1]
prevents the back reaction / equilibrium shifts to right [1]

(c) oxidation number reduced (from (+) 4 to 0) [1]
accept accepts electrons **or** accepts four electrons
if number given must be 4

Q# 38/ iGCSE Chemistry/2009/w/Paper 3/

3 (a) (i) heat **or** roast **or** burn <u>in air</u> [1]
need both points for mark

(ii) $ZnO + C \rightarrow Zn + CO$ [2]
or $2ZnO + C \rightarrow 2Zn + CO_2$
unbalanced **ONLY** [1]

Q# 39/ iGCSE Chemistry/2008/w/Paper 31/ Q3

(b) (i) hydrogen **or** carbon **or** carbon monoxide **or** methane
or more reactive metal **NOT** Group I [1]

(ii) any correct equation [2]
only error not balanced [1]

Q# 40/ iGCSE Chemistry/2008/w/Paper 31/ Q3

(d) (i) forms carbon dioxide/carbon monoxide (which escapes) [1]

(ii) forms silicon(IV) oxide **or** silicon oxide **or** silica [1]
OR CaO reacts with SiO_2
to form slag **or** calcium silicate [1]
ignore an incorrect formula if a correct name "slag" given
NOT $Si + O_2 + CaO$ form slag, this gains mark for slag only

Q# 41/ iGCSE Chemistry/2007/w/Paper 3/ Q4 (b)

(ii) to get maximum yield of zinc **or** reduce all zinc oxide [1]
NOTE the above mark is awarded for why add excess carbon moves equilibrium to right **or** to favours the products **or** removes CO_2 from equilibrium [1]
NOTE this mark is awarded for how does the addition of excess carbon give max yield of zinc
NOTE Allow any coherent explanation <u>flexibly</u> based on the above ideas
EXAMPLES:
moves equilibrium to right [1] because carbon dioxide removed [1]
to get maximum yield of zinc [1] as equilibrium moves to right [1]
NOT just to make CO from CO_2

Q# 42/ iGCSE Chemistry/2008/s/Paper 31/

6 (a) alumina **or** aluminium oxide [1]
sodium aluminate [1]
iron(III) oxide [1]
filtration **or** centrifuge NOT conditional [1]

(b) from left to right:
<u>carbon</u> cathode **or** <u>carbon</u> negative electrode [1]
900 to 1000°C [1]
aluminium [1]
cryolite [1]

(c) (i) $Al^{3+} + 3e = Al$ [2]
not balanced [1]
$Al^{3+}(aq) = 0$

(ii) oxygen is formed **NOT** oxide [1]
reacts with carbon anode [1]

Q# 43/ iGCSE Chemistry/2006/s/Paper 3/ Q1

(c) (i) limestone **[1]**

(ii) slag **[1]**

(iii) iron ore **[1]**

Q# 44/ iGCSE Chemistry/2006/s/Paper 3/ Q1

(d) to burn **or** provide heat **[1]**
to make carbon monoxide **[1]**

Q# 45/ iGCSE Chemistry/2005/w/Paper 3/ Q5

(b)(i) heat zinc blende in air to form oxide **[1]**
reduce oxide with carbon **[1]**

(ii) galvanising
sacrificial protection
alloys
batteries
roofing
Any **ONE** **[1]**

Q# 46/ iGCSE Chemistry/2005/s/Paper 3/

6 (a) (i) bauxite **[1]**

(ii) to reduce melting point **or** improve conductivity **[1]**
or as a solvent **or** reduce the working temperature

(iii) carbon dioxide **or** monoxide **or** fluorine **[1]**

Q# 47/ iGCSE Chemistry/2003/w/Paper 3/

3 (a) (i) heat **or** roast [1]
in air [1]

(ii) Either correct equation [2]
$ZnO + C = Zn + CO$
$2ZnO + C = 2Zn + CO_2$
Not balanced **ONLY** [1]
NOT carbon monoxide as a reductant

(iii) bp of lead above 1400 ^{0}C it remains
bp of zinc below 1400 ^{0}C
boils away **or** forms vapour
Any TWO [2]

OR lead does not boil [1]
zinc boils [1]

Q# 48/ iGCSE Chemistry/2003/s/Paper 3/

1 (a) A correct equation either CO or CO_2 as product
If not balanced but otherwise correct [1] ONLY [2]

(b) (i) $C + O_2 \rightarrow CO_2$ NOT word equation [1]

(ii) (higher in furnace) no oxygen left [1]
carbon dioxide reacts with carbon (to give carbon monoxide) [1]

OR incomplete combustion of carbon [2]

OR either equation gains both marks
$CO_2 + C = 2CO$ or $2C + O_2 = 2CO$

OR carbon dioxide reacts [1]
with carbon [1]

(c) limestone + sand → slag [2]
OR calcium carbonate + silicon (IV) oxide → calcium silicate (+ carbon dioxide)

For knowing that impurity is sand [1] ONLY

Accept calcium oxide and silicon oxide
Accept lime

Q# 49/ iGCSE Chemistry/2003/s/Paper 3/ Q1

(iii) blow air/oxygen through
carbon becomes carbon dioxide
carbon dioxide escapes as gas
silicon and phosphorus become oxides
calcium oxide or calcium carbonate
forms slag
Any FOUR NOT blast furnace [4]

Q# 50/ iGCSE Chemistry/2002/s/Paper 3/ QiGCSE Chemistry/Q1

(b) (i) $Al^{3+} + 3e \Longrightarrow Al$ [2]
For Al^{3+} ONLY [1] anywhere in equation

(ii) bauxite [1]

(iii) **molten or liquid or fused or homogeneous** [1]
cryolite [1]

(iv) **oxygen from oxide or formed at anode or**
implied it is formed [1]
carbon (anode) to form carbon dioxide [1]

Q# 51/ iGCSE Chemistry/2001/w/Paper 3/Q4 (a)

(ii) zinc sulphide or roast or burn or sulphur dioxide formed [1]
zinc oxide [1]
reduce with carbon or dissolve zinc oxide in sulphuric acid and electrolyse [1]
NOT electrolysis of blende or oxide

Q# 52/ iGCSE Chemistry/2001/w/Paper 3/

4 (a) (i) heat (ignore air) **or** roast **NOT** burn [1]

Q# 53/ iGCSE Chemistry/2015/s/Paper 31/

2(b)(i)	*Any **one** from:* (making) car (bodies); machinery; chains; pylons; white goods; nails; screws; as a building material; sheds / roofs; reinforcing concrete;	1	**A** bridges **A** tools **I** cutlery
2(b)(ii)	*Any **one** from:* knives; drills; railway tracks; machine/ cutting tools / hammers; razor blades; chisels;	1	**I** cutlery items **I** bridges
2(b)(iii)	M1 atoms or cations or (positive) ions or metal ions; M2 arranged in a lattice or in layers or in rows or in a regular structure; M3 rows or layers slide over one another;	3	**I** (sea of) electrons **R** protons or nuclei for M1 **A** M2 non-directional forces **A** ECF on particle named in M1 for M3 **I** 'atoms' slide over one another
2(b)(iv)	M1 carbon **atoms** or **particles** in structure different size (to cations); M2 so reduce moving or interrupt movement;	2	**R** ions and molecules for M1 **A** M2 for prevents sliding **A** M2 for 'stops' sliding

Q# 54/ iGCSE Chemistry/2014/s/Paper 31/

(b) Any **two** from: [2]

- (making) brass **or** alloys (1)
- galvanising (1)
- sacrificial protection (1)
- batteries (1)

Q# 55/ iGCSE Chemistry/2011/w/Paper 31/ Q3

(c) (i) protective oxide layer [1]

Q# 56/ iGCSE Chemistry/2011/s/Paper 31/Q3

(b) (i) any sensible suggestion – harder/stronger/can be tailored for a specific use/more resistant to corrosion [1]
not steel does not rust

(ii) mild steel – cars or any vehicle/bicycles/white goods/screws or nails/roof/bridges/tools/ buildings/ships/pipes/machinery etc. [1]

stainless steel – chemical plants/cooking utensils/jewellery/cutlery/surgical equipment/ kitchen sinks/pipes/etc. [1]

Q# 57/ iGCSE Chemistry/2010/w/Paper 31/ Q2

(iv) wires / pipes / jewellery / nails / roofing / ammunition / coins / cookware / catalyst / sculpture [1]

Q# 58/ iGCSE Chemistry/2010/s/Paper 31/

(d) low density / lightweight / light [1]
propellers / fittings on ships / inert anodes in electrolysis / hip replacements / ship building / chemical plants / cathodic protection / diving equipment [1]

Q# 59/ iGCSE Chemistry/2008/s/Paper 31/ Q3

(c) (i) good conductor [1]
malleable **or** ductile [1]

good conductor of heat
high melting point (and high boiling point)
unreactive **or** resists corrosion
appearance
any **TWO** [2]
do not accept malleable **or** ductile if either is given for wiring

(ii) alloys **or** named alloy **or** pipes **or** ornaments **or** jewellery **or** integrated circuit boards **or** electroplating **or** roofs, etc. [1]

Q# 60/ iGCSE Chemistry/2007/w/Paper 3/ Q4

(d) prevent iron from rusting **NOT** with galvanising **or** sacrificial protection
making brass **or** making alloys **NOT** bronze
electroplating **or** as an electrode in electrolysis
cells
roofing
sacrificial protection
coinage
TWO uses [2]

13.12 FUNDAMENTAL Assessed Activity 1 Keyword Test

Topic #	English	Meaning
2124	**blast furnace**	
3786	**alloy steels**)	
3955	**ore**	
7323	**alloys**	
8980	**galvanising**	
8993	**reactivity series of metals**	
9278	**carbon steel**	
9448	**basic oxygen process**	

13.13 ESSENTIAL Assessed Activity 2Topic 10 Paper 2 16marks

Q# 14/ iGCSE Chemistry/2017/m/Paper 22/

26 Which statement about **all** metals is correct?

A They are attracted to a magnet.

B They are weak and brittle.

C They may be used to form alloys.

D They react with water.

27 Which substance produces sulfur dioxide when roasted in air?

A bauxite

B cryolite

C hematite

D zinc blende

28 Which metal carbonate does **not** produce carbon dioxide when it is heated with a Bunsen burner?

A copper(II) carbonate

B magnesium carbonate

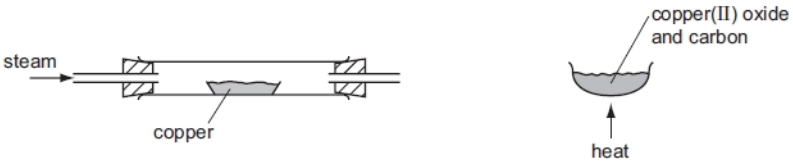
C sodium carbonate

D zinc carbonate

29 Two experiments are carried out.

In experiment 1, copper is heated with steam.

In experiment 2, copper(II) oxide is heated with carbon.



experiment 1 experiment 2

Which row describes what happens in experiments 1 and 2?

	experiment 1	experiment 2
A	no reaction	no reaction
B	no reaction	reaction
C	reaction	no reaction
D	reaction	reaction

Q# 15/ iGCSE Chemistry/2016/w/Paper 23/

25 Basic oxides and oxygen are used to convert iron into steel.

Which statement is **not** correct?

A Carbon is converted into carbon dioxide.

B Silicon is converted into silicon(IV) oxide.

C The basic oxides react with acidic impurities to form slag.

D The oxygen reacts with the iron to produce hematite.

26 The results of two experiments are given.

1 Cobalt displaces manganese from an aqueous solution of a manganese salt.

2 Manganese displaces silver from an aqueous solution of a silver salt.

Three more experiments are carried out.

3 Cobalt is added to an aqueous solution of a silver salt.

4 Manganese is added to an aqueous solution of a cobalt salt.

5 Silver is added to an aqueous solution of a cobalt salt.

In which experiments does a reaction take place?

A 3 only **B** 3 and 4 **C** 4 and 5 **D** 5 only

27 Cryolite, Na_3AlF_6, is added to aluminium oxide in the electrolytic extraction of aluminium.

What is the reason for this?

A to decrease the melting point of the electrolyte

B to protect the anodes

C to produce more aluminium

D to stop the aluminium reacting with air

28 Different forms of steel contain different proportions of carbon.

Steel P contains a high proportion of carbon.

Steel Q contains a low proportion of carbon.

Which statement is correct?

A P is stronger and more brittle than Q.

B P is stronger and less brittle than Q.

C P is less strong and more brittle than Q.

D P is less strong and less brittle than Q.

Q# 16/ iGCSE Chemistry/2016/w/Paper 22/

25 Impurities in iron obtained from the blast furnace include carbon, phosphorus and silicon.

Which impurities are removed from the molten iron as gases when it is made into steel?

A carbon and phosphorus

B carbon and silicon

C carbon only

D phosphorus and silicon

26 Y displaces X from its aqueous sulfate.

X does not displace W from its aqueous sulfate.

X displaces Z from its aqueous sulfate.

What is the order of reactivity of elements W, X, Y and Z?

	most reactive	→		least reactive
A	W	X	Y	Z
B	W	Y	X	Z
C	Z	X	Y	W
D	Z	W	Y	X

27 Which statement about the industrial extraction of aluminium from aluminium oxide is correct?

A Aluminium is extracted by heating its oxide with carbon.

B Aluminium is extracted using electrolysis and is collected at the anode.

C Aluminium is extracted using platinum electrodes and direct current.

D Molten cryolite is used as a solvent for aluminium oxide.

28 The alloy brass is a mixture of copper and another metal.

Brass is used to make the pins of electrical plugs.

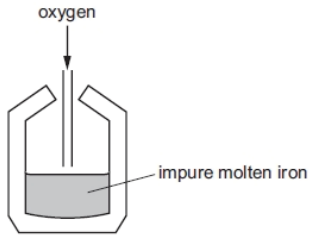
Copper is used to make electrical wiring.

Which row about brass is correct?

	hardness	electrical conductivity	other metal
A	harder than copper	better than copper	tin
B	harder than copper	worse than copper	zinc
C	softer than copper	better than copper	tin
D	softer than copper	worse than copper	zinc

Q# 17/ iGCSE Chemistry/2016/w/Paper 21/

25 Impure iron from the blast furnace is converted to steel as shown.



Which statement about the process is correct?

A Acidic oxides are added to remove alkaline impurities.

B Coke is added as a reducing agent.

C Oxygen is blown in to oxidise the impure iron.

D The steel produced contains less carbon than the impure iron.

26 The ionic equations represent the reactions between four metals, P, Q, R and S, and solutions of the salts of the same metals.

$$P + Q^{2+} \rightarrow \text{no reaction}$$

$$R + P^{2+} \rightarrow R^{2+} + P$$

$$Q + S^{2+} \rightarrow Q^{2+} + S$$

$$S + P^{2+} \rightarrow S^{2+} + P$$

$$S + R^{2+} \rightarrow S^{2+} + R$$

$$S + Q^{2+} \rightarrow \text{no reaction}$$

What is the correct order of reactivity of the metals?

	most →			least
A	P	R	S	Q
B	Q	R	S	P
C	Q	S	R	P
D	S	Q	P	R

27 Aluminium is extracted by electrolysis.

From which ore is aluminium extracted and at which electrode is aluminium deposited during electrolysis?

	ore	electrode
A	bauxite	negative
B	bauxite	positive
C	cryolite	negative
D	cryolite	positive

28 Zinc oxide can be reacted with carbon to produce zinc metal.

Which equation for this reaction is correct?

A $2ZnO + C \rightarrow 2Zn + CO$

B $2ZnO + 2C \rightarrow 2Zn + 2CO_2$

C $ZnO + C \rightarrow Zn + CO$

D $ZnO + 2C \rightarrow Zn + 2CO_2$

13.14 ESSENTIAL Assessed Activity 3 28 marks Topic 10 Paper 3/4

Topic Chem 10.2 **Q# 1/**

7 One way of establishing a reactivity series is by displacement reactions.

(a) A series of experiments was carried out using the metals lead, magnesium, zinc and silver. Each metal was added in turn to aqueous solutions of the metal nitrates.

The order of reactivity was found to be:

magnesium — most reactive
zinc ↓
lead
silver — least reactive

(i) Complete the table.

✓ = reacts
✗ = does not react

	metal			
aqueous solution	lead Pb	magnesium Mg	zinc Zn	silver Ag
lead(II) nitrate		✓	✓	✗
magnesium nitrate				
zinc nitrate				
silver nitrate				

[3]

(ii) Displacement reactions are redox reactions.
On the following equation, draw a **ring** around the reducing agent and an **arrow** to show the change which is oxidation.

$$Zn + Pb^{2+} \rightarrow Zn^{2+} + Pb$$

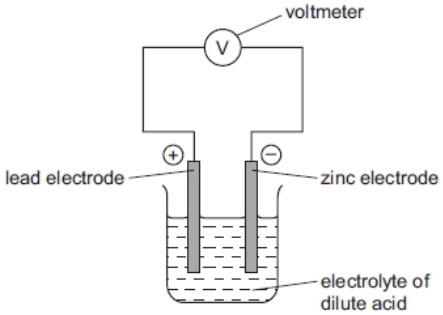
[2]

(iii) Complete the following ionic equation.

$$Zn + 2Ag^{+} \rightarrow \text{.....} + \text{.....}$$

[1]

(b) Another way of determining the order of reactivity of metals is by measuring the voltage and polarity of simple cells. The polarity of a cell is shown by which metal is the positive electrode and which metal is the negative electrode. An example of a simple cell is shown below.



(i) Mark on the above diagram the direction of the electron flow. [1]

(ii) Explain, in terms of electron transfer, why the more reactive metal is always the negative electrode.

.....

.....

..... [2]

(iii) The following table gives the polarity of cells using the metals zinc, lead, copper and manganese.

cell	electrode 1	polarity	electrode 2	polarity
A	zinc	–	lead	+
B	manganese	–	lead	+
C	copper	+	lead	–

What information about the order of reactivity of these four metals can be deduced from the table?

.....

.....

..... [2]

(iv) What additional information is needed to establish the order of reactivity of these four metals using cells?

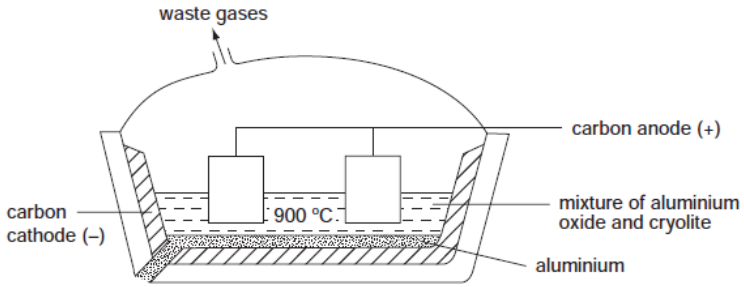
..... [1]

Topic Chem 10.3 **Q# 2/**

6 The position of aluminium in the reactivity series of metals is shown below.

magnesium
aluminium
zinc
copper

(a) Aluminium is extracted by the electrolysis of its molten oxide.



(i) Name the main ore of aluminium.

..... [1]

(ii) Why does the molten electrolyte contain cryolite?

..... [1]

(iii) Oxygen is produced at the positive electrode (anode). Name another gas which is given off at this electrode.

..... [1]

Topic Chem 10.3 **Q# 3/**

3 Zinc blende is the common ore of zinc. It is usually found mixed with an ore of lead and traces of silver.

(a) **(i)** Describe how zinc blende is changed into zinc oxide.

.....

.....[2]

(ii) Write an equation for the reduction of zinc oxide by carbon.

.....[2]

(iii) The boiling point of lead is 1740 °C and that of zinc is 907 °C. Explain why, when both oxides are reduced by heating with carbon at 1400 °C, only lead remains in the furnace.

.....

.....[2]

Topic Chem 10.3 **Q# 4/**

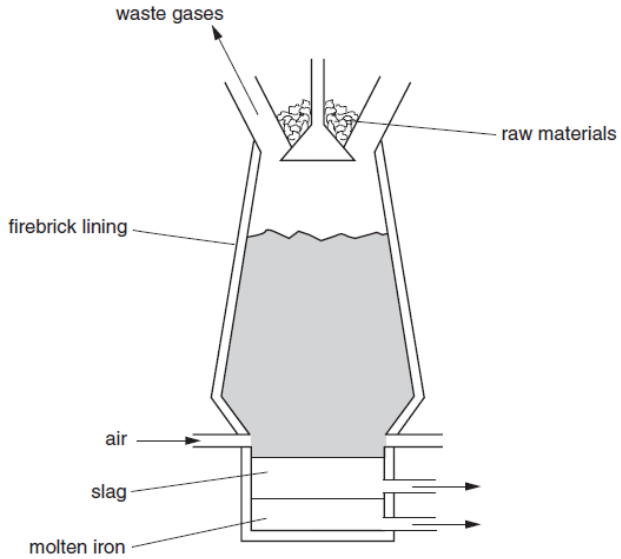
1 No one knows where iron was first isolated. It appeared in China, the Middle East and in Africa. It was obtained by reducing iron ore with charcoal.

(a) Complete the following equation.

Fe_2O_3 (iron ore) + C (charcoal) → ..... + ...

[2]

(b) In 1705 Abraham Darby showed that iron ore could be reduced using coke in a blast furnace.



(i) The temperature in the furnace rises to 2000 °C. Write an equation for the exothermic reaction that causes this high temperature.

.....

(ii) In the furnace, the ore is reduced by carbon monoxide. Explain how this is formed.

.....

.....[3]

(c) The formation of slag removes an impurity in the ore. Write a word equation for the formation of the slag.

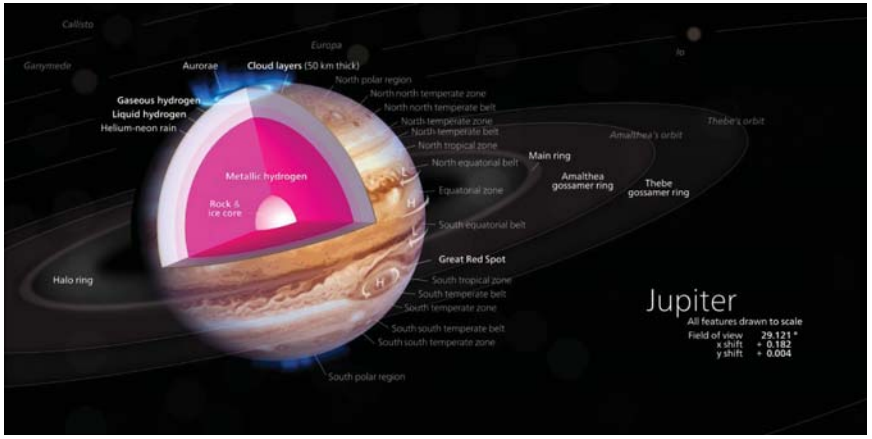
.....[2]

13.15 Exceptional Additional Activities, Further Reading and Exploring Beyond the Syllabus

Is hydrogen a metal or a non-metal?

For articles and information that explores this idea go to this webpage:

https://www.smashingsciencecn.org/igcse-chem-additional-resources



A diagram of Jupiter showing a model of the planet's interior, with a rocky core overlaid by a deep layer of liquid metallic hydrogen (shown as magenta) and an outer layer predominantly of molecular hydrogen. Jupiter's true interior composition is uncertain. For instance, the core may have shrunk as convection currents of hot liquid metallic hydrogen mixed with the molten core and carried its contents to higher levels in the planetary interior. Furthermore, there is no clear physical boundary between the hydrogen layers—with increasing depth the gas increases smoothly in temperature and density, ultimately becoming liquid. Features are shown to scale except for the aurorae and the orbits of the Galilean moons.

Are neutron stars metals or non metals? Why have all of the non-metals been discovered? Could there be a third type of element other than metals and non-metals yet to be discovered?

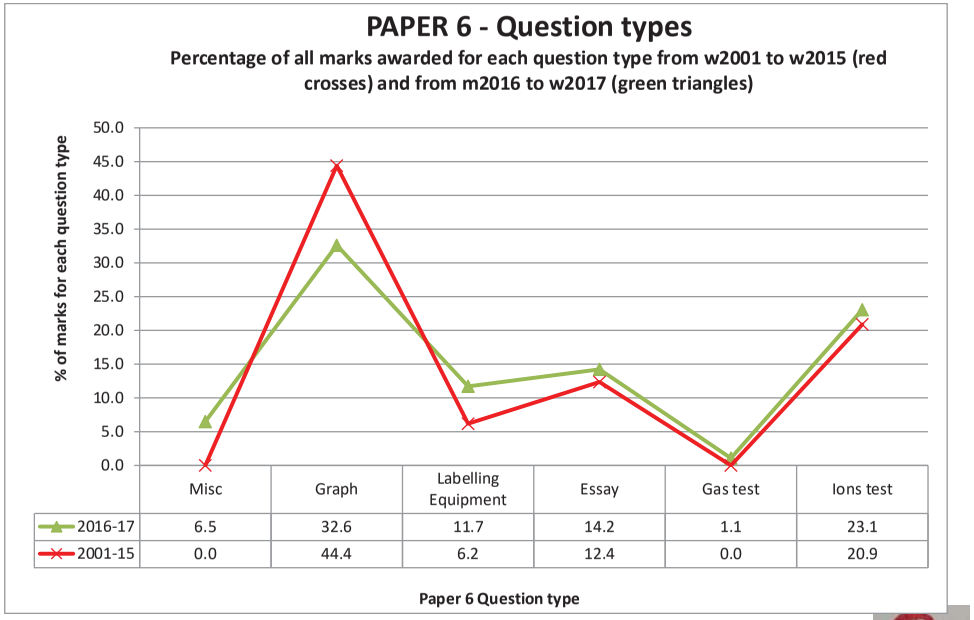
14 Paper 6 Alternative to Practical Unit

14.1 End of Paper 6 Alternative to Practical Unit Goals Checklist

Aspect	What you should have done	Yes/No	Level
Interacted with your teacher	Ask your teacher 1 question, about anything, once a week		FUNDAMENTAL
	Try to answer one question asked by your teacher at least once a week		ESSENTIAL
	Ask your teacher one question about something you do not understand in science once a week		ESSENTIAL
	Ask your teacher one question about something to do with science every lesson		EXTENSION
Notes and follow up notes	Complete set of class note		FUNDAMENTAL
	Cornell Notetaking Attempted		ESSENTIAL
	Cornell Notetaking Completed		EXTENSION
	Cornell Notetaking Completed to an exemplary standard		EXCEPTIONAL
	Attempted the Mind Map for this topic		ESSENTIAL
	Completed the Mind Map for this topic		EXTENSION
Textbook	Read ahead before the topic has been started		EXTESNION
	Highlighted key ideas and translate new words		FUNDAMENTAL
	Completed the questions at the end of each 2 page spread in your exercise book		EXTENSION
	Added to your class notes ideas and important information from the textbook that you learnt		EXTENSION
Past Exam Questions	Worked on at least 25% of the exam questions in this workbook		FUNDAMENTAL
	Attempted more than 25% of the questions and those questions you have completed you have marked in a different colour pen		ESSENTIAL
	Completed and marked all questions here		EXTENSION
	Completed, marked and additional key ideas where you have located the most difficult marks added to your notebook		EXCEPTIONAL
	Used the resources available online to answer additional questions not found in this workbook on the current topic.		EXCEPTIONAL
	Ask your teacher about an exam question that they cannot answer		EXCEPTIONALLY SMASHING!!!
Assessed Activities	Complete the word list activity using the word list at the front of each topic as little as possible		FUNDAMENTAL
	Complete 2 assessed activities, either in class or as homework		ESSENTIAL
	Complete 2 assessed activities and scored over 70% on average		ESSENTIAL
	Complete 2 assessed activities and scored over 80% on average		EXTENSION
	Complete 2 assessed activities and scored over 90% on average		EXCEPTIONAL
End of Topic Test	Revised sufficiently well to improve upon your score from the previous test (except if you are scoring over 90%, then just write Y for this goal)		ESSENTIAL
	Scored 10% higher than your current average		EXTENSION
	Scored 15% or more than your previous end of topic average		EXCEPTIONAL
	Scored over 90%		EXTESNION
	Scored over 95%		SMASHING!!!

Aspect	What you should have done	Yes/No	Level
Reading	Spend more than 1 hour a week reading a book **you enjoy** (in any language) about anything.		ESSENTIAL
	Spend more than 3 hours a week reading a book **you enjoy** (in any language) about anything.		EXTENSION
	Spend more than 5 hours a week reading a book **you enjoy** (in any language) about anything.		EXCEPTIONAL
	Spend at least one hour a week reading a book **you enjoy** in English about anything.		EXTENSION
	Spend more than 3 hours a week reading a book **you enjoy** in English about anything.		EXCEPTIONAL
Reflection	You completed this goal setting table		FUNDAMENTAL
	You have looked at the goals you have achieved and the ones you have not and added them up and entered them into the table in the Review and Reflection section		ESSENTIAL
	You have given an answer for every question in the Review and Reflection section at the end of this topic		EXTENSION
	You have Given good and thoughtful answers for every question in the Review and Reflection section at the end of this topic		EXCEPTIONAL

14.2 ESSENTIAL EXAM QUESTIONS Paper 6 Essay type questions by topic 124marks



	Misc	Graph	Labelling Equipment	Essay	Gas test	Ions test
2016-17	6.5	32.6	11.7	14.2	1.1	23.1
2001-15	0.0	44.4	6.2	12.4	0.0	20.9

Topic 1

04w6

7 Forged Banknote

A fake banknote can be investigated by dissolving the ink off the paper.

You are provided with four different inks from four different criminals. Describe an experiment to show which one of these inks is the same as the ink from the banknote.

You can use a labelled diagram to help you answer the question.

.....

.....

.....

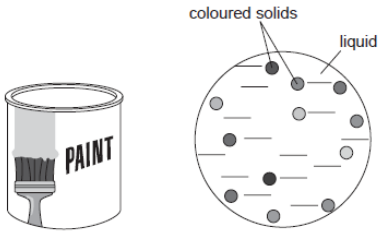
.....

.....

..... [6]

06w6

6 You are provided with a pot of paint as shown below.



magnified view of paint

The paint is a mixture of a liquid and a solid.
The liquid can be dissolved in water. The solids are insoluble in water but soluble in organic solvents.

(a) How can a sample of the solid be separated from the rest of the paint?

.....

.....

..... [2]

(b) How would you determine the number of coloured substances contained in the solid you separated in **(a)**?

.....

.....

.....

..... [4]

(c) The label on the paint tin states

"Touch-dry in three hours"

(i) How could you check this value?

.....

..... [2]

(ii) Suggest how you could speed up this drying process.

..... [1]

09w6

7 Leaves from trees contain a mixture of coloured pigments which are not soluble in water. A student was given these two instructions to investigate the pigments in the leaves.

1. Crush some leaves to extract the coloured pigments.
2. Use the liquid extract to find the number of coloured pigments in the leaves.

(a) What would the student need in order to effectively carry out instruction 1?

.....

.....

.....

..... [3]

(b) Describe an experiment to carry out instruction 2.
A space has been left below if you want to draw a diagram to help answer the question.

.....

.....

.....

.....

..... [4]

7 Leaves from trees contain a mixture of coloured pigments which are not soluble in water. A student was given these two instructions to investigate the pigments in the leaves.

1. Crush some leaves to extract the coloured pigments.
2. Use the liquid extract to find the number of coloured pigments in the leaves.

(a) What would the student need in order to effectively carry out instruction 1?

.....

.....

.....

..... [3]

(b) Describe an experiment to carry out instruction 2.
A space has been left below if you want to draw a diagram to help answer the question.

.....

.....

.....

.....

..... [4]

[Total: 7]

11w6

6 Seawater contains sodium chloride and other salts.
Plan an experiment to find the mass of salts in 1 dm^3 of seawater.
You will be provided with a small bottle of seawater.
You should include details of the method and any apparatus used.
(1 dm^3 = 1000 cm^3)

.....

.....

.....

.....

.....

.....

.....

..... [6]

Topic 5

02s6

8 **ELECTROPLATING A COPPER KEY**

Electroplating is when a metal is coated with another metal using electricity.

To electroplate a metal a very clean surface is needed.

Describe an experiment to nickel plate a copper key. You are provided with the following items.

6 V bulb and holder

6 V battery and connecting wires

250 cm^3 beaker

steel wool/sandpaper

copper key

distilled water

nickel rod

solid nickel(II) sulphate, $NiSO_4$

You can use a labelled diagram to help you answer the question.

.....

.....

.....

.....

.....

.....[5]

Topic 6

07s6

7 When cement powder is added to water a reaction takes place.

(a) Describe an experiment to show that this reaction is exothermic.

.....

.....

.....

.....

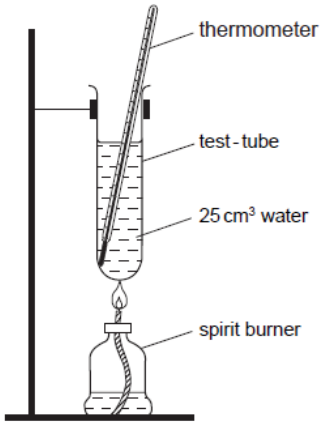
.....

..... [4]

07w6

7 Diesel is a liquid fuel obtained from crude oil. Biodiesel is a fuel made from oil obtained from the seeds of plants such as sunflowers.

Using the apparatus below plan an experiment to investigate which of these two fuels produces more energy.



.....

.....

.....

.....

.....

.....

.....

..... [6]

Topic 7

04s6

8 Is manganese(IV) oxide a catalyst?

A catalyst is a substance that speeds up a chemical reaction and remains unchanged.

Hydrogen peroxide, H_2O_2 breaks down to form oxygen. This reaction is very slow without a catalyst. Describe an experiment to show that manganese(IV) oxide is a catalyst for this reaction.

You are provided with the following items.

Hydrogen peroxide solution

Manganese(IV) oxide

Measuring cylinder

Balance

Beaker

Filtration apparatus

Splints/Bunsen burner

Distilled water

.....

.....

.....

.....

.....

..... [6]

05s6

8 An aqueous solution of hydrogen peroxide decomposes very slowly to form oxygen. The speed of decomposition can be increased by using a catalyst. Two possible catalysts are the solids copper(II) oxide and chromium(III) oxide.

Plan an investigation to find out which of these two oxides is the better catalyst for this decomposition.

The space below can be used for a diagram.

.....

.....

.....

.....

.....

..... [6]

Topic 8

03s6

6 Beach sand is a mixture of sand and broken shells (calcium carbonate). Calcium carbonate reacts with dilute hydrochloric acid to form a solution of calcium chloride.

Plan an investigation to find out the percentage of shell material in a given sample of beach sand.

.....

.....

.....

.....

.....

.....

.....

.....[6]

05s6

6 The label below is from a bottle of concentrated lemon drink.

Concentrated lemon drink
Ingredients: Water, sugar, citric acid, preservatives, potassium sorbate (artificial sweetener). Yellow colourings E102 and E104.

(a) What is meant by the term *concentrated*?

..... [1]

(b) Predict the pH of the lemon drink.

..... [1]

(c) Describe an experiment to show that two different yellow colourings are present in the drink.

[4]

05w6

7 Some plants do not grow well in acidic soil.
A farmer gives you a small sample of soil from a corner of one of his fields.

(a) Plan an investigation to find out the pH of the soil sample.

You are provided with Universal Indicator solution and common laboratory apparatus.

.....

.....

.....

.....

.....

..... [5]

(b) Why would further experiments be necessary to inform the farmer which plants should be grown in each of his fields?

.....

..... [2]

06s6

6 The diagram shows two bottles of liquid oven cleaner.

The oven cleaners contain sodium hydroxide solution. Plan an investigation to show which oven cleaner contains the highest concentration of sodium hydroxide.

The oven cleaners contain sodium hydroxide solution. Plan an investigation to show which oven cleaner contains the highest concentration of sodium hydroxide.

.....

.....

.....

.....

.....

.....

.....

..... [6]

08w6

7 A solution of magnesium sulphate can be made by reacting magnesium oxide with warm sulphuric acid.

(a) Describe how you could make a solution of magnesium sulphate starting with magnesium oxide powder and dilute sulphuric acid.

.....

.....

.....

.....

.....

..... [3]

(b) Describe how you would obtain pure dry crystals of hydrated magnesium sulphate, $MgSO_4.7H_2O$, from the solution of magnesium sulphate in **(a)**.

.....

.....

.....

.....

.....

..... [3]

09s6

6 Acid base indicators

Indicators are used to identify acids and bases.
Indicators can be obtained from berries and other fruits.

(a) Plan an experiment to obtain an aqueous solution of an indicator from some berries.

.....

.....

.....

.....

.....

.....

..... [3]

(b) Plan an experiment to use the indicator solution to show that it is an effective indicator.

.....

.....

.....

.....

.....

.....

..... [3]

Topic 10

10s6

7 Malachite is a naturally occurring form of copper carbonate. Outline how a sample of copper metal could be obtained from large lumps of malachite in the laboratory.
Copper is one of the least reactive metals.
Your answer should include any chemicals used and conditions.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

Topic 11

02w6

7 **FASTGROW FERTILISER**

Fertilisers are used to increase the growth of plants. Fertilisers have to dissolve in water if they are to be used by plants.

Plan an experiment to find the solubility, in g/100 cm^3, of FASTGROW fertiliser at 30 °C.

.....

.....

.....

.....

.....

.....[6]

12s6

6

STOP RUST!

Solutions of chemicals known as corrosion inhibitors are added to the water in steel radiators to reduce rust.
You are provided with three different bottles of liquid corrosion inhibitors, **R**, **S** and **T**, and some steel nails.
Plan an experiment to test if these inhibitors prevent the corrosion of steel and which of these inhibitors is the most effective.

.....

.....

.....

.....

.....

.....

..... [7]

Topic 12

03w6

6 Sulphur dioxide gas is a common pollutant formed when fossil fuels burn in air. Sulphur dioxide can be detected by using an acidic solution of potassium dichromate(VI). The dichromate solution changes colour from orange to green when a certain amount of sulphur dioxide has reacted with it.

Plan an experiment to investigate which of three different samples of coal produces most sulphur dioxide.

.....

.....

.....

.....

.....

.....

.....

.....[6]

Topic 13

12w6

Which is the more pure - limestone or marble?

Calcium carbonate is found in limestone and in marble. All carbonates react with hydrochloric acid to form chlorides. Calcium carbonate is insoluble in water but calcium chloride is water soluble.
Most impurities in limestone and marble are insoluble.
Plan an experiment to find out which of limestone and marble contain most insoluble impurities.
You are provided with common laboratory apparatus.

.....

.....

.....

.....

.....

.....

.....

..... [7]

14.3 MARK SCHEMES ESSENTIAL EXAM QUESTIONS Paper 6 Essay type questions by topic 124marks

Topic 1 Mark Scheme

04w6

7 chromatography (1) apply inks/spots to paper (1)

organic solvent/water (1) rises up paper (1)

check heights/positions of spots (1) compare to find ink from banknote (1) **(6)**

N.B. all marks can be obtained from a diagram

06w6

6 (a) paint sample + water(1) filter(1) solid residue(1) max 2 **[2]**

(b) solid + organic solvent(1) add to paper(1)
chromatography(1) use of solvent(1) description of spots(1)
max 4 NB use of water = max 1 for chromatography **[4]**

(c) (i) apply paint, start timer(1) method of checking dry, note time(1)
no painting = 0 **[2]**

(ii) correct method(1) e.g. hair drier/wind/fan/increase temperature.
NOT catalyst. **[1]**

09w6

7 **(a)** pestle/mortar/solvent/sand (any three)
ignore water and/or heat [3]

(b) NB marks can be obtained from a diagram
chromatography or chromatogram (1)
paper (1)
apply spot/extract to paper (1)
description or name of solvent used (1)
and separation e.g. spots on paper (1) (max 4) [4]

If water used as solvent (max 3)
If paper dipped into extract (max 3)
If method would not work (max 2)

11w6

6 measured volume of seawater (1)
using measuring cylinder (1)
into evaporating dish/beaker (1)
pre-weighed (1)
evaporate/heat (1)
to dryness/constant mass (1)
re-weigh (1)
indication of calculation method (1) max [6]

would not work = max 0

Topic 5 Mark Scheme

02s6

8

circuit set up (1) bulb (1)

copper key cleaned with sandpaper/steel wool (1)

copper key is ~~anode~~ cathode (+) (1)
nickel rod is ~~cathode~~ anode (-) (1)
} wrong way round = (1)

solution of nickel sulphate in beaker (1)

All marks could be obtained from a diagram. Max 5

6/5

Topic 6

Mark Scheme

07s6

7 **(a)** initial temperature of cold water or cement (1)
add cement (1)
using thermometer / in beaker etc. (1)
measure temperature (1)
temperature rise (2) max 4 [4]

NB
no water = 0
no cement = 0
use of heat = 0
wrong chemicals = 0
would not work = 0

(b) sodium hydroxide (1) white precipitate (1) [2]
or flame test (1) red (1)

[Total: 6]

07w6

7 same volume/mass of fuel/idea of fair test (1)
initial temperature of water (1)
burn/ignite fuel (1)
record temperature of water (1)
repeat (1)
compare e.g. greatest temperature rise in specified time shows better fuel (1) [6]

Topic 7 Mark Scheme

04s6

8	Add known mass of manganese oxide	**1**	
	To (measured volume of) hydrogen peroxide	**1**	
	Bubbles	**1**	
	Test gas with glowing splint	**1**	
	Result	**1**	
	Filter	**1**	
	Dry solid	**1**	
	Reweigh and compare	**1**	
	(max 6)		**[6]**

05s6

8 same amount/measured volume of peroxide (1)

add known mass of metal oxide (1)

time (1) measure volume of oxygen (1)

repeat with other oxide (1) compare/conclusion (1) **[6]**

method will not work = 0

Topic 8 Mark Scheme

03s6

6 Known mass of beach sand (1)
add excess (1) dilute hydrochloric acid (1)
filter (1) wash (1) dry (1) residue
and weigh sand (1) working out result (1)
max 6 of 8 [6]

05s6

6 **(a)** no/little water present/little water implied (1) **[1]**

(b) any value less than 7 (1) **[1]**

(c) chromatography (1) apply to paper (1) use of solvent (1)

description of two yellow spots (1) **[4]**

paper in drink = max 2

05w6

7 **(a)** soil sample + water (1)

stir/heat (1)

filter (1)

add Universal Indicator (1)

chart (1) **[5]**

(b) more samples (1)

different parts of field (1) **[2]**

06s6

6 Measured volume of oven cleaner (1)
Add indicator/named indicator (1)
Add named acid (1), from a burette/pipette (1)
Until colour change/end point (1), measure/record volume of acid (1)
Repeat with other cleaner (1), compare (1)

Max 6 **[6]**

07s6

7 **(a)** initial temperature of cold water or cement (1)
add cement (1)
using thermometer / in beaker etc. (1)
measure temperature (1)
temperature rise (2) max 4 [4]

NB
no water = 0
no cement = 0
use of heat = 0
wrong chemicals = 0
would not work = 0

(b) sodium hydroxide (1) white precipitate (1) [2]
or flame test (1) red (1)

[Total: 6]

08w6

7 **(a)** heat/warm the acid (1)
add excess oxide or description of no more solid reacting (1)
filter/decant (1) [3]

(b) heat qualified e.g. to crystallising point or description of e.g. using glass rod/leave it to evaporate (1)
cool to form crystals (1)
filter off crystals (1)
method of drying crystals e.g. pressed filter papers/oven at low temperature (1) [max 3]

[Total: 6]

09s6

6 **(a)** add water (1)
crush/mix/warm (1)
filter/decant or pipette off liquid/sieve (1) [3]

(b) add indicator solution to acid (and note colour) (1)
add indicator solution to alkali or named alkali (and note colour) (1) not base
conclusion e.g. colours should be different owtte (1) [3]

Topic 10 Mark Scheme

10s6

7	crush malachite (1)	using pestle/mortar (1)	add named acid (1)	
	solution formed (1)	add magnesium/zinc/iron (1)	displacement (1)	
	obtain copper/filter (1) max [6]			[6]

or first two steps (2)	add carbon/reactive metal/hydrogen (1)	heat (1)
displace/redox (1)	until goes pink (1)	obtain copper (1)
or first four steps (4)	electrolyse solution (1)	copper deposited at cathode (1)
obtain copper (1)	NB If malachite anode used allow max 3 even if it would not work.	

Topic 11 Mark Scheme

02w6

7	Known mass of fertiliser (1) Add known volume of water (1) Warm to 30°C (1) Stir (1) Filter (1) / Evaporate to dryness Dry and weigh residue (1) Work out solubility (1) max 6 / conclusion	6

12s6

6	steel nail(s) in test-tube/suitable glass container (1) x cm^3 (1) water (1) no water = max 3 known volume of inhibitor added (1) observe effect after suitable time (1) note: minimum time = 1 day repeat using other inhibitors (1) observe/comparison of results (1) [7]

[Total: 7]

Topic 12 Mark Scheme

03w6

6	Weigh coal sample (1) same amount Burn coal (1) Pass gas or diagram to show (1) Through acid/dichromate (1) Use of timer (1) Record time for colour change (1) Repeat/compare with other samples (1) Max 6	6

Topic 13 Mark Scheme

12w6

6 any seven from:
equal weight/mass of limestone and marble (1) [7]

crush (1)

add excess owtte (1) hydrochloric acid (1)

stir (1)

filter mixture (1)

dry (1)

reweigh (1)

conclusion (1)

14.4 ESSENTIAL Assessed Activity 3

14.5 Essential End of Topic Review and Reflection

Looking at the goals you could have achieved and the goals you actually achieved try to reflect on your progress.

Try to be as honest and as detailed as possible. Sometimes you may think you have thought about an idea well, but when you talk with someone else, or write it out, it helps you better understand and allows you think more completely and more clearly.

Did you achieve more goals this topic than last topic?

Fill in this table

Level	Number of goals achieved at each level	Success rate, %
FUNDAMENTAL	/5	
ESSENTIAL	/10	
EXTENSION	/13	
EXCEPTIONAL	/10	

Do you feel you tired harder? If yes, what helped you to do so? If not, why not?

What could you do differently next time, in addition to what you are already doing to improve, not only your score in the end of topic tests and other assessed activities, but also in how you learn. How could you become a more effective student to get more learning out of the time you are investing in your studies?

What did you enjoy most about this topic?

What did you find most difficult?

What did you find easiest?

On a scale of 1 being hardest and 5 being most difficult, circle how challenging you found this topic

1 2 3 4 5

What could be done to make this topic easier to understand?

Do you have any questions about this topic?

14.6 Exceptional Additional Activities, Further Reading and Exploring Beyond the Syllabus

Empiricism. What is it and what are the alternatives? Will we ever discover a better way to understand the universe than through science? Is empiricism a good idea?

This touches on very deep but fundamental philosophical ideas about what it means to know, and why it might matter that you know things in different ways. For instance, it is important that you know who your family members are, but it is more important that you think about them in a different way than how you think about your clothes, or a tree or seeing a sunset. Another way of exploring how we understand things is to look at neurobiology and what the mind is.

For a variety of different opinions about this larger topic go here: https://www.smashingsciencecn.org/igcse-chem-additional-resources

Above are two very different views on thought and reason, both extremely famous. Click on them to find out more!

15 APPENDIX – Glossery of the Complete iGCSE Syllabus

15.1 ESSENTIAL Glossary for Keywords for this topic

Many words used in science have a meaning that is slightly different to their common everyday English meaning, for instance a salt is the product of an acid and base reacting together in chemistry, but normally thought of as table salt (NaCl) in common use.

The keywords have been auto translated into Chinese, so the translations will not be perfect but they should hopefully make sense. If there is a better translation you can simply write it out yourself on a Post-it note and stick it over the printed one.

Topic #	English	Chinese
1	**boiling** a condition under which gas bubbles are able to form within a liquid – gas molecules escape from the body of a liquid, not just from its surface	沸腾在液体中能够形成气泡的条件下–**气体分子从液体体内逸出，而不**仅仅是从其表面逸出
1	**boiling point** the temperature at which a liquid boils, when the pressure of the gas created above the liquid equals atmospheric pressure	**沸点，当在液体上方**产生的气体压力等于大气压时，液体沸腾的温**度**
1	**condensation** the change of a vapour or a gas into a liquid; during this process heat is given out to the surroundings	**将蒸气或气体的**变化冷凝成液体；在此过程中，热量散发到周围环境**中**
1	**diffusion** the process by which different fluids mix as a result of the random motions of their particles	扩散由于粒子的随机运动而导致不同流体混合的过**程**
1	**evaporation** a process occurring at the surface of a liquid, involving the change of state from a liquid into a vapour at a temperature below the boiling point	蒸发一种在液体表面发生的过程，包括在低于沸点的温度下从液体状态转变为蒸气状态
1	**fluid** a gas or a liquid, they are able to flow	**流体是气体或液体，它**们能够流动
1	**melting point** the temperature at which a solid turns into a liquid – it has the same value as the freezing point; a pure substance has a sharp melting point	**熔点固体**变成液体的温度，它与凝固点的值相同；纯物质具有尖锐的熔**点**
1	**physical change** a change in the physical state of a substance or the physical nature of a situation that does not involve a change in the chemical substance(s) present	**物理**变化不涉及所存**在化学物**质变化的物质的物理状态变化或情况的物理性质变**化**
1	**states of matter** solid, liquid and gas are the three states of matter in which any substance can exist, depending on the conditions of temperature and pressure	**固体，液体和气体的物**质状态是可以存在任何物质的三种物质状态，具体取决于温度和压力的条**件**
1	**sublimation** the direct change of state from solid to gas or gas to solid: the liquid phase is bypassed	**升**华状态从固体到气体或从气体到固体的直接变化：绕过液**相**
3	**atom** the smallest particle of an element that can take part in a chemical reaction	**原子可以参与化学反**应的元素的最小颗**粒**

Topic #	English	Chinese
3	**atomic number (*Z*)** the number of protons in the nucleus of an atom; it is also the number of electrons present in an atom and the position of the element in the Periodic Table	**原子序数**（Z）**原子核中的**质子数；它也是原子中存在的电子数和元素在周期表中的位置
3	**chemical bonding** the strong forces that hold atoms (or ions) together in the various structures that chemical substances can form – metallic bonding, covalent bonding and ionic (electrovalent bonding)	**化学**键将化学物质可形成的各种结构中的原子（或离子）保持在一起的强大力-**金属**键，共价键和离子（电价键）
3	**compound** a substance formed by the chemical combination of two or more elements in fixed proportions	**由两种或多种元素按固定比例化学**结合形成的物质
3	**covalent bond** a chemical bond formed by the sharing of one or more pairs of electrons between two atoms	**共价**键由两个原子之间共享一对或多对电子形成的化学键
3	**density** expresses the relationship between the mass of a substance and the volume it occupies: density = mass / volume	**密度表示物**质的质量与它所占据的体积之间的关系：密度=质量/**体**积
3	**diatomic molecule** a molecule containing two atoms, for example hydrogen, H2	**双原子分子一种包含两个原子的分子，例如**氢，H2
3	**electrical conductor** a substance that conducts electricity but is not chemically changed in the process	电导体导电但在过程中不会发生化学变化的物质
3	**electron (arrangement) configuration** a shorthand method of describing how electrons are organised by energy levels of an atom.	电子（排列）构型是描述电子如何通过原子能级组织的简写方法。
3	**electron** a subatomic particle with negligible mass and a charge of –1; electrons are present in all atoms, located in energy levels outside the nucleus	电子是质量可忽略且电荷为-1**的**亚原子粒子；电子存在于所有原子中，位于原子核之外的能级
3	**electrostatic force of attraction** a strong pulling force between particles with opposite charges – such forces are involved in	**静**电吸引力在带相反电荷的粒子之间产生强大的拉力-这种力**与**
3	**element** a substance which cannot be further divided into simpler substances by chemical methods; all the atoms of an element contain the same number of protons	**指不能通**过化学方法进一步分为简单物质的物质；元素的所有原子都包含相同数量的质**子**
3	**energy levels (of electrons)** the allowed energies of electrons in atoms – electrons fill these levels (or **shells**) starting with the one closest to the nucleus	（电子的）能级原子中电子的允许能量–电子从最靠近原子核的那一层开始填充这些能级（或壳）
3	**giant ionic structure** a lattice held together by the electrostatic forces of attraction between positive and negative ions	**巨大的离子**结构通过正负离子之间的静电吸引力将晶格保持在一起的结**构**
3	**giant metallic lattice** a regular arrangement of positive metal ions held together by the mobile 'sea' of electrons moving between the ions	**巨大的金属晶格，正离子的**规则排列通过在离子之间移动的电子"**移**动"**海洋而保持在一起**

Topic #	English	Chinese
3	**giant molecular structure** substance where large numbers of atoms are joined by covalent bonds forming a strong lattice structure	**巨大的分子**结构物质，其中大量原子通过共价键连接而形成坚固的晶格结**构**
3	**insulator** substance that does not conduct electricity	**不**导电的绝缘体物质
3	**intermolecular forces** the weak attractive forces which act between molecules	**分子**间作用力作用于分子之间的弱吸引**力**
3	**ionic (electrovalent) bond** a strong electrostatic force of attraction between oppositely charged ions	**离子**（电价）键在带相反电荷的离子之间形成强大的静电吸引**力**
3	**ions** charged particles made from an atom, or groups of atoms (polyatomic ions), by the loss or gain of electrons	**离子通**过电子的丢失或获得而使由一个原子或一组原子（多原子离子）制成的粒子带电
3	**isotopes** atoms of the same element which have different numbers of neutrons in their nuclei: they differ in their mass (nucleon) numbers; some isotopes are radioactive because their nuclei are unstable (**radio-isotopes**)	**同一元素的原子核中子数不同的同位素原子**：**它**们的质量（核子）数不同；一些同位素具有放射性，因为它们的原子核不稳定（放射性同位素）
3	**lattice** a regular three-dimensional arrangement of atoms, molecules or ions in a crystalline solid	**将晶体**，**固体中原子**，**分子或离子的**规则三维排列成晶**格**
3	**malleable** a word used to describe the property that metals can be bent and beaten into sheets	**可塑性的**单词，用来描述金属可以弯曲并打成薄片的特**性**
3	**mass number (*A*)** the total number of protons and neutrons present in the nucleus of an atom	质量数（A）**原子核中存在的**质子和中子总**数**
3	**matter** anything which occupies space and has mass	**占据空**间并具有质量的任何事物都无所谓
3	**metallic bond** an electrostatic force of attraction between the mobile 'sea' of electrons and the regular array of positive metal ions within a solid metal	**金属**键是电子的移动"**海洋**"**与固体金属中**规则的正金属离子阵列之间的静电吸引**力**
3	**molecule** a group of atoms held together by covalent bonds	**分子通**过共价键结合在一起的一组**原子**
3	**neutron** an uncharged subatomic particle present in the nuclei of atoms – a neutron has a mass of 1 relative to a proton	**中子原子核中存在的不**带电荷的亚原子粒子–**中子相**对于质子的质量为1
3	**non-metals** a class of chemical elements that are typically poor conductors of heat and electricity	**非金属一**类化学元素，通常是热和电的不良导**体**
3	**nucleon number (*A*)** the total number of protons and neutrons present in the nucleus of an atom	**核子数**（A）**原子核中存在的**质子和中子总**数**
3	**nucleus (of an atom)** the central region of an atom that is made up of the protons and neutrons of the atom; the electrons orbit	**原子核**（**原子的**）**原子的中心区域**，**由原子的**质子和中子组成；电子围绕原子核以不同的"**壳**"**或**"**能**级"**运行**

Topic #	English	Chinese
	around the nucleus in different 'shells' or 'energy levels'	
3	**proton** a subatomic particle with a relative mass of 1 and a charge +1 found in the nucleus of all atoms	质子是在所有原子的原子核中都具有相对质量**1且**电荷**+1的**亚原子粒**子**
3	**proton number** another name for atomic number	质子数原子数的别**称**
3	**radioactivity** the spontaneous decay of unstable radio-isotopes	**放射性不**稳定同位素的自发衰**减**
3	**salts** ionic compounds made by the neutralisation of an acid with a base (or alkali); for example, copper(II) sulfate and potassium nitrate	**通**过酸与碱（或碱）中和而制得的盐离子化合物；例如，硫酸铜（II）**和硝酸**钾
3	**simple molecular substances** are made up of individual molecules held together by covalent bonds: there are only weak forces between the molecules	简单的分子物质由通过共价键结合在一起的单个分子组成：分子之间只有弱**力**
3	**subatomic particles** very small particles – **protons**, **neutrons** and **electrons** – from which all atoms are built	亚原子粒子非常小的粒子-质子，中子和电子-**构成所有原子**
3	**valency** the combining power of an atom or group of atoms: in ionic compounds the valency of each ion is equal to its charge; in a covalent molecule the valency of an atom is the number of bonds that atom makes	**化合价一个原子或一**组原子的结合能：在离子化合物中，每个离子的化合价等于其电荷；在共价分子中，原子的化合价是原子形成的键的数**量**
4	**balanced chemical (symbol) equation** a summary of a chemical reaction using chemical formulae – the total number of any of the atoms involved is the same on both the reactant and product sides of the equation	**平衡化学**（**符号**）**方程式-使用化学式**进行化学反应的摘要–**涉及的任何原子**总数在方程式的反应物和产物侧均相**同**
4	**chemical reaction** a change in which a new substance is formed	**化学反**应形成新物质的变**化**
4	**concentration** a measure of how much solute is dissolved in a solvent. Solutions can be **dilute** (with a high proportion of the solvent), or **concentrated** (with a high proportion of the solute)	浓度衡量溶质溶解在溶剂中的量度。溶液可以是稀溶液（高比例的溶剂），也可以是浓缩液（高比例的溶质）
4	**empirical formula** a formula for a compound which shows the simplest ratio of atoms present	经验公式化合物的公式，显示存在的最简单的原子**比**
4	**formula (chemical)** a shorthand method of representing chemical elements and compounds using the symbols of the elements	**公式**（**化学**）：**使用元素符号表示化学元素和化合物的**简写方**法**
4	**hydrated salts** ionic compounds that contain water of crystallisation between the ions within the solid	**在固体中离子之**间含有结晶水的水合盐离子化合**物**

Topic #	English	Chinese
4	**ionic equation** the simplified equation for a reaction involving ionic substances: only those ions which take part in the reaction are shown	**离子方程式涉及离子物**质的反应的简化方程式：仅显示那些参与反应的离**子**
4	**law of conservation of mass** matter cannot be lost or gained in a chemical reaction – the total mass of the reactants equals the total mass of the products	**物**质守恒定律在化学反应中不会丢失或获得**–反**应物的总质量等于产物的总质量
4	**molar concentration** the measure of the concentration of a solution in terms of the number of moles of the solute dissolved per cubic decimetre of solution (mol/dm3)	**摩**尔浓度溶液浓度的量度，以每立方米溶液中溶解的溶质的摩尔数表示（mol / dm3）
4	**molar mass** the mass, in grams, of one mole of a substance	**摩**尔质量一摩尔物质的质量，以克为单**位**
4	**molar volume of a gas** one mole of any gas has the same volume under the same conditions of temperature and pressure (24 dm3 at one atmosphere and room temperature)	**气体的摩**尔体积一摩尔的任何气体在相同的温度和压力条件下（在一个大气压和室温下为24 dm3）**具有相同的体**积
4	**mole** the measure of amount of substance in chemistry; one mole of a substance has a mass equal to its relative formula mass in grams – that amount of substance contains 6.02×10^{23} (the **Avogadro constant**) atoms, molecules or formula units depending on the substance considered	**摩**尔化**学中物**质含量的量度；一摩尔物质的质量等于其相对分子式的质量（以克为单位）–该物质的数量包含6.02×1023（Avogadro**常数**）**原子**，**分子或分子式**，**具体取决于所考**虑的物质
4	**molecular formula** a formula which shows the actual number of atoms of each element present in a molecule of the compound	**分子式**，**表示化合物分子中存在的每种元素的**实际原子数**的分子式**
4	**molecular mass** another, less precise, name for relative molecular mass	**分子量相**对不太精确的另一个称呼是相对分子量
4	**percentage purity** a measure of the purity of the product from a reaction carried out experimentally: percentage purity = mass of pure product mass of impure product ×100	纯度百分比衡量通过实验进行的反应的产物纯度的度量：纯度百分比=纯产物的质量不纯产物的质量×100
4	**percentage yield** a measure of the actual yield of a reaction when carried out experimentally compared to the theoretical yield calculated from the equation: percentage yield = actual yield predicted yield ×100	产率百分比相对于根据等式计算出的理论产率，通过实验进行的反应实际产率的量度：产率百分比=实际产率，预测产率×100
4	**products** (in a chemical reaction) the substance(s) produced by a chemical reaction	产品（在化学反应中）由化学反应产生的物质
4	**reactants** (in a chemical reaction) the chemical substances that react together in a chemical reaction	**反**应物（在化学反应中）在化学反应中一起反应的化学物质
4	**relative formula mass (*Mr*)** the sum of all the relative atomic masses of the atoms present in a 'formula unit' of a substance	**相**对公式质量（Mr）**物**质"**公式**单位"**中存在的所有原子的相**对原子质量的总**和**

Topic #	English	Chinese
4	**relative molecular mass (*Mr*)** the sum of all the relative atomic masses of the atoms present in a molecule	**相**对分子质量（Mr）**分子中所有原子的所有相**对原子质量的总**和**
4	**spectator ions** these are present in a chemical reaction but take no part in it. They are not included in ionic equations	这些离子存在于化学反应中，但不参与其中。它们不包含在离子方程式**中**
4	**standard atom** the atom against which the relative atomic masses of all other atoms are measured using the mass spectrometer; one atom of the carbon-12 isotope is given a mass of exactly 12	标准原子使用质谱仪测量所有其他原子的相对原子质量的原子；碳12**同位素的一个原子的**质量刚好为12
4	**standard solution** a solution whose concentration is known precisely – this solution is then used to find the concentration of another solution by titration	标准溶液一种浓度精确已知的溶液**–然后将**该溶液用于通过滴定找到另一种溶液的浓**度**
4	**state symbols** these are used to show the physical state of the reactants and products in a chemical reaction: they are (s) solid, (l) liquid, (g) gas and (aq) dissolved in solution in water	**状**态符号，用于显示化学反应中反应物和产物的物理状态：它们是（s）**固体**，（l）**液体**，（g）**气体和**（aq）**溶解在水中的溶液**
4	**structural formula** the structural formula of an organic molecule shows how the atoms and bonds in a molecule are arranged in space: all the atoms and covalent bonds must be shown	结构分子式：有机分子的结构式表明分子中的原子和键如何在空间中排列：必须显示所有原子和共价键
4	**symbol (chemical)** a simple letter, or group of letters, that represents an element in a chemical formula	**符号**（**化学**）**一个**简单的字母或一组字母，代表化学式中的元**素**
4	**titration** a method of quantitative analysis using solutions: one solution is slowly added to a known volume of another solution using a burette until an end-point is reached	**使用溶液**进行滴定的定量分析方法：使用滴定管将一种溶液缓慢添加到已知体积的另一种溶液中，直至达到终**点**
4	**water of crystallisation** water included in the structure of certain salts as they crystallise; for example, copper(II) sulfate pentahydrate (CuSO4.5H2O) contains five molecules of water of crystallisation per molecule of copper(II) sulfate	结晶水某些盐的结晶过程中所含的水；例如，五水合硫酸铜（II）（CuSO4.5H2O）**每分子硫酸**铜（II）**包含五分子**结晶**水**
4	**word equation** a summary of a chemical reaction using the chemical names of the reactants and products	词方程式，是使用反应物和产物的化学名称进行的化学反应的摘**要**
9	**alkali metals** elements in Group I of the Periodic Table; they are the most reactive group of metals	**元素周期表第I族中的碱金属元素**；**它**们是最活泼的金**属**
9	**displacement reaction** a reaction in which a more reactive element displaces a less reactive element from a solution of its salt	置换反应一种反应，其中反应性较高的元素从其盐溶液中置换反应性较低的元**素**

Topic #	English	Chinese
9	**group** a vertical column of the Periodic Table containing elements with similar properties; atoms of elements in the same group have the same number of electrons in their outer energy levels	将元素周期表中包含相似属性的元素的垂直列分组；同一组元素的原子在其外部能级中具有相同数量的电子
9	**halides** compounds formed between an element and a halogen; for example, sodium iodide	在元素和卤素之间形成的卤化物；例如碘化钠
9	**halogens** elements in Group VII of the Periodic Table – generally the most reactive group of non-metals	元素周期表第VII组中的卤素元素–通常是反应性最高的非金属基团
9	**main-group elements** the elements in the outer groups of the Periodic Table (Groups I to VII and 0)	主族元素周期表中外族的元素（I至VII族和0族）
9	**metalloid (semi-metal)** element which shows some of the properties of metals and some of non-metals; for example, boron and silicon	准金属（半金属）元素，具有某些金属和一些非金属的特性；例如硼和硅
9	**metals** a class of chemical elements (and alloys) which have a characteristic shiny appearance and are good conductors of heat and electricity	金属是一类化学元素（和合金），具有独特的光泽外观，并且是良好的热和电导体
9	**noble gases** elements in Group 0 – a group of stable, very unreactive gases	第0组中的稀有气体元素–一组稳定的，非常不活泼的气体
9	**period** a horizontal row of the Periodic Table	周期表的水平行
9	**Periodic Table** a table of elements arranged in order of increasing proton number (atomic number) to show the similarities of the chemical elements with related electron configurations	周期表按质子数（原子数）递增顺序排列的元素表，以显示化学元素与相关电子构型的相似性
9	**transition metals** elements from the central region of the Periodic Table – they are hard, strong, dense metals that form compounds which are often coloured	元素周期表中部的过渡金属元素，它们是硬，强，致密的金属，通常形成有色化合物
13	**decomposition** (see also **thermal decomposition**) a type of chemical reaction where a compound breaks down into simpler substances	分解（另见热分解），一种化学反应，其中化合物分解成更简单的物质
13	**dehydration** a chemical reaction in which water is removed from a compound	脱水一种化学反应，其中从化合物中除去水
13	**drying agent** a chemical substance that absorbs water; anhydrous calcium chloride and concentrated sulfuric acid are two examples	干燥剂一种吸收水分的化学物质；无水氯化钙和浓硫酸是两个例子
13	**flue-gas desulfuriser** or 'scrubber' a tower in which the waste gases from a coal- or oil-fi red power station are treated to remove acidic gases such as sulfur dioxide	烟气脱硫器或"洗涤塔"塔，在该塔中处理来自煤或油红色发电厂的废气，以除去酸性气体，例如二氧化硫

Topic #	English	Chinese
13	**lime** a white solid known chemically as calcium oxide (CaO), produced by heating limestone; it can be used to counteract soil acidity, to manufacture calcium hydroxide (slaked lime) and is also used as a drying agent	石灰一种白色固体，化学上称为氧化钙（CaO），是通过加热石灰石产生的；它可以用来抵消土壤酸度，制造氢氧化钙（熟石灰），也可以用作干燥剂
13	**limestone** a form of calcium carbonate (CaCO3)	石灰石是一种碳酸钙（CaCO3）
13	**limewater** a solution of calcium hydroxide in water; it is an alkali and is used in the test for carbon dioxide gas	石灰水氢氧化钙在水中的溶液；它是一种碱，用于测试二氧化碳气体
13	**thermal decomposition** the breakdown of a compound due to heating	热分解加热导致化合物分解
14	**addition polymer** a polymer formed by an addition reaction – the monomer molecules must contain a C=C double bond	加成聚合物由加成反应形成的聚合物–单体分子必须包含C=C双键
14	**addition reaction** a reaction in which a simple molecule adds across the carbon–carbon double bond of an alkene	加成反应一个简单分子跨烯烃的碳-碳双键加成的反应
14	**alcohols (alkanols)** a series of organic compounds containing the functional group –OH and the general formula C*n*H2*n*+1OH	醇（烷醇）一系列含有官能团–OH和通式CnH2n + 1OH的有机化合物
14	**alkanes** a series of hydrocarbons with the general formula C*n*H2*n*+2; they are saturated compounds as they have only single bonds between carbon atoms in their structure	烷烃一系列通式为CnH2n + 2的烃;它们是饱和化合物，因为它们的结构中碳原子之间只有一个单键
14	**alkenes** a series of hydrocarbons with the general formula CnH2n; they are unsaturated molecules as they have a C=C double bond somewhere in the chain	烯烃一系列通式为CnH2n的烃;它们是不饱和分子，因为它们在链中某处具有C = C双键
14	**amide link** (or peptide link) the link between monomers in a protein or nylon, formed by a condensation reaction between a carboxylic acid group on one monomer and an amine group on the next monomer	酰胺键（或肽键）蛋白质或尼龙中的单体之间的连接，是通过一个单体上的羧酸基团与下一个单体上的胺基之间的缩合反应形成的
14	**amino acids** naturally occurring organic compounds which possess both an amino (-NH2) group and an acid (-COOH) group in the molecule; there are 20 naturally occurring amino acids and they are polymerised in cells to make proteins	氨基酸天然存在的有机化合物，在分子中同时具有氨基（-NH2）和酸（-COOH）；有20种天然氨基酸，它们在细胞中聚合成蛋白质
14	**biodegradable plastics** these are designed to be degraded (decomposed) by bacteria	可生物降解的塑料，旨在被细菌降解（分解）
14	**carbohydrates** a group of naturally occurring organic compounds containing carbon, hydrogen and oxygen; the ratio of hydrogen to oxygen atoms in the molecules is always 2 : 1 and they have the general formula C*x*(H2O)*y*	碳水化合物，一组天然存在的有机化合物，含有碳，氢和氧；分子中氢与氧原子的比率始终为2：1，它们的通式为Cx（H2O）y

Topic #	English	Chinese
14	**carboxylic acids** a family of organic compounds containing the functional group -COOH (-CO2H), with the general formula C*n* H2*n*+1COOH, they can also be called alkanoic acids	羧酸一族含有官能团-COOH（-CO2H）的有机化合物，通式为Cn H2n + 1COOH，也可以称为链烷酸
14	**catalytic cracking** the decomposition of long-chain alkanes into alkenes and alkanes of lower relative molecular mass; involves passing the larger alkane molecules over a catalyst heated to 500 °C	催化裂化长链烷烃分解为相对分子质量较低的烯烃和烷烃；涉及将较大的烷烃分子通过加热至500°C的催化剂
14	**coal** a black, solid fossil fuel formed underground over geological periods of time by conditions of high pressure and temperature acting on decayed vegetation	煤是一种黑色的固体化石燃料，在高压的条件下作用于腐烂的植被，可在地质时期内在地下形成
14	**condensation polymer** a polymer formed by a **condensation reaction**; for example, nylon is produced by the condensation reaction between 1,6-diaminohexane and hexanedioic acid – this is the type of polymerisation used in biological systems to produce proteins, nucleic acids and polysaccharides	缩合聚合物通过缩合反应形成的聚合物；例如，尼龙是通过1,6-二氨基己烷和己二酸之间的缩合反应生成的-这是生物系统中用于生产蛋白质，核酸和多糖的聚合类型
14	**crude oil** the common name for petroleum	原油石油的俗称
14	**ester link** the link produced when an ester is formed from a carboxylic acid and an alcohol; also found in polyesters and in the esters present in fats and vegetable oils	酯连接由羧酸和醇形成酯时产生的连接；也存在于脂肪和植物油中的聚酯和酯中
14	**esterification** the chemical reaction between an alcohol and a carboxylic acid that produces an ester; the other product is water	酯化醇与羧酸之间产生酯的化学反应；其他产品是水
14	**esters** a family of organic compounds formed by esterification, characterised by strong and pleasant tastes and smells	酯通过酯化反应形成的一系列有机化合物，其特征是强烈而令人愉悦的味道和气味
14	**fossil fuels** include coal, oil and natural gas, formed underground over geological periods of time from the remains of plants and animals	化石燃料包括煤炭，石油和天然气，它们是在地质时期内从动植物残骸中地下形成的
14	**fractionating column** the vertical column which is used to bring about the separation of liquids in **fractional distillation fractions (from distillation)** the different mixtures that distil over at different temperatures during fractional distillation	分馏塔立式塔，用于实现分馏馏分（来自蒸馏）中液体的分离，分馏期间在不同温度下蒸馏的不同混合物
14	**functional group** the atom or group of atoms responsible for the characteristic reactions of a compound	官能团负责化合物特征反应的原子或原子团
14	**homologous series** a 'family' of organic compounds with the same functional group and similar properties	同源系列是具有相同官能团和相似特性的有机化合物的"家族"

Topic #	English	Chinese
14	**hydrocarbons** compounds which contain carbon and hydrogen only	仅包含碳和氢的碳氢化合物
14	**hydrogenation** an addition reaction in which hydrogen is added across the double bond in an alkene	氢化加成反应，其中氢通过烯烃中的双键加成
14	**hydrolysis** a chemical reaction between a covalent compound and water; covalent bonds are broken during the reaction and the elements of water added to the fragments; can be carried out with acids or alkalis, or by using enzymes	水解共价化合物与水之间的化学反应；反应期间共价键断裂，水元素添加到片段中；可以用酸或碱或使用酶进行
14	**isomerism** the property shown by molecules which have the same molecular formula but different structures	异构现象具有相同分子式但结构不同的分子显示的性质
14	**isomers** compounds which have the same molecular formula but different structural arrangements of the atoms – they have different structural formulae	具有相同分子式但原子结构不同的异构体化合物–它们具有不同的结构式
14	**monomer** a small molecule, such as ethene, which can be polymerised to make a **polymer**	单体，例如乙烯的小分子，可以聚合成聚合物
14	**monomers polymerisation** the chemical reaction in which molecules (monomers) join together to form a long-chain polymer	单体聚合化学反应，分子（单体）结合在一起形成长链聚合物
14	**natural gas** a fossil fuel formed underground over geological periods of time by conditions of high pressure and temperature acting on the remains of dead sea creatures; natural gas is more than 90% methane	天然气是一种在高压地质条件下作用于死海生物遗体在地下地质时期形成的化石燃料；天然气中甲烷含量超过90%
14	**oil refining** the industrial plant where the processes of converting petroleum (crude oil) into useful fractions and products are carried out	对工厂进行炼油，将石油（原油）转化为有用的馏分和产品
14	**organic chemistry** the branch of chemistry concerned with compounds of carbon found originally in living organisms	有机化学涉及最初在活生物体中发现的碳化合物的化学分支
14	**petroleum** a fossil fuel formed underground over geological periods of time by conditions of high pressure and temperature acting on the remains of dead sea creatures	石油在地质时期内，高压和高温条件作用于死海生物的遗骸而在地下形成的化石燃料
14	**polyamide** a polymer where the monomer units are joined together by amide (peptide) links; for example, nylon and proteins	聚酰胺是一种聚合物，其中的单体单元通过酰胺（肽）键连接在一起；例如，尼龙和蛋白质
14	**polyester** a polymer where the monomer units are joined together by ester links; for example, Terylene	聚酯，其中单体单元通过酯键连接在一起的聚合物；例如，Terylene
14	**polymer** a substance consisting of very large molecules made by polymerising a large number of repeating units or	聚合物一种由非常大的分子组成的物质，这些分子是通过聚合大量重复单元或

Topic #	English	Chinese
14	**proteins** polymers of amino acids formed by a condensation reaction; they have a wide variety of biological functions	通过缩合反应形成的氨基酸蛋白质聚合物；它们具有多种生物学功能
14	**substitution reaction** a reaction in which an atom (or atoms) of a molecule is (are) replaced by different atom(s), without changing the molecule's general structure	取代反应指一个分子中的一个或多个原子被不同的原子取代而无需改变分子的一般结构的反应

15.2 EXTENSION Keywords

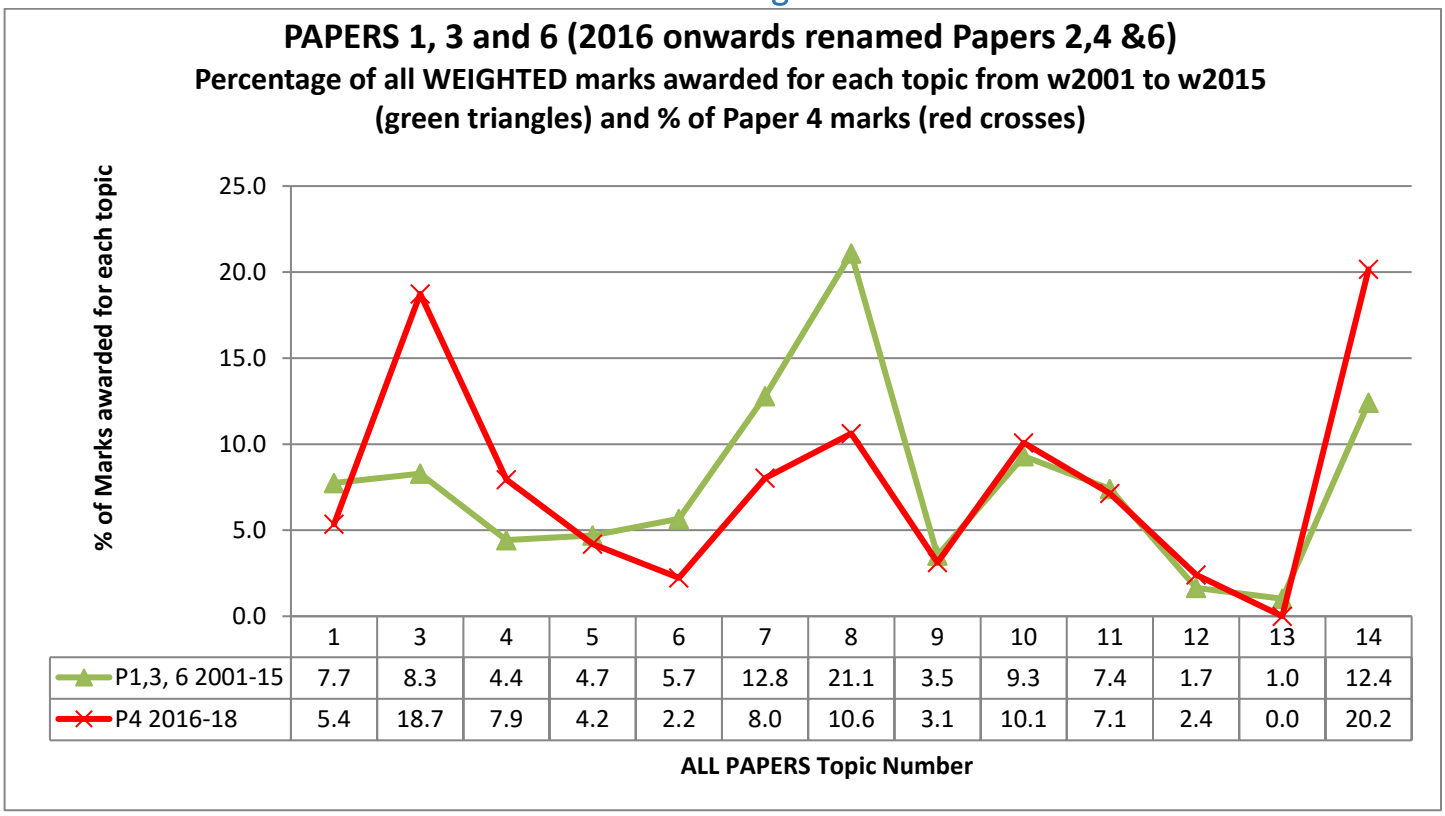
You do not need to understand these words to score a good A, or even a low A* but if you are aiming for a good or high A* then understanding words like these here will be helpful.

Topic #	English	Chinese
x1	**absolute temperature** a temperature measured with respect to absolute zero on the Kelvin scale – absolute zero is the lowest possible temperature that can be achieved	绝对温度相对于开氏温标上的绝对零测量的温度–绝对零是可以达到的最低温度
x1	**atmospheric pressure** the pressure exerted by the atmosphere on the surface of the Earth due to the weight of the atmosphere	大气压力由于大气层的重量，大气层在地球表面施加的压力
x1	**centrifugation** the separation of an insoluble solid from a liquid by rapid spinning during which the solid collects at the bottom of the sample tubes – the liquid can then be decanted off carefully	离心通过快速旋转从液体中分离出不溶性固体，在此期间固体收集在样品管的底部，然后可以小心地倾析出液体
x1	**distillate** the liquid distilling over during distillation	蒸馏过程中蒸馏出的液体
x1	**immiscible** if two liquids form two layers when they are mixed together, they are said to be immiscible	如果两种液体混合在一起时形成两层，则称它们是不溶混的
x1	**miscible** if two liquids form a completely uniform mixture when added together, they are said to be this.	如果将两种液体加在一起形成完全均匀的混合物，则可以混溶。
x1	**solubility curve** a graph showing how the solubility of a substance in a solvent changes with temperature	溶解度曲线表示物质在溶剂中的溶解度如何随温度变化的曲线图
x3	**ceramics** materials such as pottery made from inorganic chemicals, like clay, by high-temperature processing	陶瓷材料，例如由粘土等无机化学物质通过高温加工制成的陶器
x3	**ductile** a word used to describe the property that metals can be drawn out and stretched into wires	延性这个词用来描述金属可以被拉出并拉成金属丝的特性
x3	**half-life** the time taken for half of the radioactive atoms in a sample of a radio isotope to decay	半衰期放射性同位素样品中一半放射性原子衰变所需的时间
x3	**mass spectrometer** an instrument in which atoms or molecules are ionised and then accelerated; the ions are then separated according to their mass	质谱仪一种将原子或分子离子化然后加速的仪器；然后根据它们的质量分离离子

Topic #	English	Chinese
x3	**volatile** term that describes a liquid that which evaporates easily; it is a liquid with a low boiling point having only weak intermolecular forces between the molecules in the liquid	挥发性术语，描述易于蒸发的液体；它是一种低沸点的液体，液体中分子之间的分子间力很弱
x3	**volatility** the property of how easily a liquid can become a gas	挥发性液体容易变成气体的特性
x4	**Avogadro constant** another name for a mole	Avogadro常数痣的另一个名字
x4	**mass concentration** the measure of the concentration of a solution in terms of the mass of the solute, in grams, dissolved per cubic decimetre of solution (g/dm3)	质量浓度，以每立方分米溶液中溶解的溶质质量（克）为单位的溶液浓度的量度（g / dm3）
x4	**relative atomic mass (*A*r)** the average mass of an atom of an element, taking account of the isotopes of the element, on a scale where a carbon-12 atom has a mass of exactly 12	相对原子质量（Ar）元素的原子平均质量，考虑到元素的同位素，碳12原子的质量恰好为12
x5	**non-electrolytes** liquids or solutions that do not take part in electrolysis: they do not contain ions	不参与电解的非电解质液体或溶液：它们不含离子
x6	**heat of neutralisation** the heat change which takes place when one mole of hydrogen ions is completely neutralised	中和热当一摩尔氢离子完全被中和时发生的热变化
x7	**spontaneous (reaction)** a reaction that can take place simply by mixing the reactants	通过混合反应物即可发生的自发反应
x8	**antacid** compound used medically to treat indigestion by neutralising excess stomach acid	用于中和过量胃酸的消化不良的抗酸药
x8	**dibasic acid (diprotic acid)** an acid which contains two replaceable hydrogen atoms per molecule of the acid; for example, sulfuric acid, H2SO4	二元酸（二质子酸）一种酸，每个酸分子包含两个可取代的氢原子；例如硫酸，硫酸
x9	**alkaline earth metals** elements in Group II of the Periodic Table	元素周期表第II族中的碱土金属元素
x10	**core (of Earth) the central, densest part of the Earth, composed mainly of iron and nickel; the outer core is molten and surrounds the solid, inner core which exists at very high temperature and pressure**	（地球的）核心，是地球中央最密集的部分，主要由铁和镍组成；外芯是熔融的，并围绕存在于很高温度和压力下的固态内芯
x10	**crust (of Earth) the solid, outermost, layer of the Earth; it is not continuous, but subdivided into plates of continental or oceanic crust**	地壳（地球的），是地球最坚固的最外层；它不是连续的，而是细分为大陆或洋壳板块
x10	**geological time very long, extended periods of time (over millions of years) during which the Earth was shaped**	地质时间很长，很长一段时间（数百万年）
x10	**grain boundaries the boundaries between the grains in a metal, along which a piece of metal may fracture**	晶粒边界金属中的晶粒之间的边界，金属可能会沿着该边界破裂
x10	**grains the small crystal areas in a metal: controlling the grain size affects the properties of a piece of metal**	使金属中的小晶体区域晶粒化：控制晶粒尺寸会影响金属的性能
x10	**rock cycle the natural cycle by which rocks are pushed upwards, then eroded, transported, deposited, and possibly changed into another type of rock by conditions of temperature and pressure – these rocks may then be uplift ed to enter a new cycle**	岩石循环一种自然循环，岩石被向上推动，然后被侵蚀，运输，沉积，并可能在温度和压力条件下变成另一种类型的岩石，然后这些岩石可能被抬升进入新的循环

Topic #	English	Chinese
x11	**nitrogen fixation the direct use of atmospheric nitrogen in the formation of important compounds of nitrogen; most plants cannot fi x nitrogen directly, but bacteria present in the root nodules of certain plants are able to take nitrogen from the atmosphere to form essential protein molecules**	固氮直接利用大气中的氮来形成重要的氮化合物；大多数植物不能直接固定氮，但是某些植物根瘤中存在的细菌能够从大气中吸收氮以形成必需的蛋白质分子
x11	**photodegradable plastics polymers designed to degrade under the influence of sunlight**	可光降解的塑料聚合物，旨在在日光的影响下降解
x12	**Frasch process the process of obtaining sulfur from sulfur beds below the Earth's surface; superheated water is pumped down a shaft to liquefy the sulfur, which is then brought to the surface**	Frasch处理从地球表面以下的硫层中获取硫的过程；过热水沿井下泵抽，以使硫液化，然后将硫带到地面
x14	**anaerobic decay breakdown of organic matter which takes place in the absence of air by living things**	生物在没有空气的情况下发生有机物的厌氧衰减分解
x14	**detergent a soap-like substance, which is used with water to remove dirt and grease from clothes, dishes and other objects**	洗涤剂，类似于肥皂的物质，可与水一起使用，以去除衣服，餐具和其他物品上的污垢和油脂
x14	**drug any substance, natural or synthetic, that alters the way in which the body works**	服用任何会改变人体工作方式的天然或合成物质
x14	**rancid a term used to describe oxidised organic material (food) – usually involving a bad smell**	腐烂的术语，用于描述氧化的有机物质（食物）–通常涉及难闻的气味
x14	**saponification the name given to the hydrolysis of fats or vegetable oils by hot, concentrated sodium hydroxide solution to produce soap**	皂化：通过加热的浓氢氧化钠溶液水解脂肪或植物油以产生肥皂的名称
x14	**soaps substances formed by saponification**	皂化皂化物质
x14	**synthesis (see also photosynthesis) a chemical reaction in which a compound is made from its elements**	合成（另见光合作用）一种化学反应，其中由其元素制成化合物

15.3 APPENDIX EXCEPTIONAL Statistics Relating to the Course



	1	3	4	5	6	7	8	9	10	11	12	13	14
P1,3, 6 2001-15	7.7	8.3	4.4	4.7	5.7	12.8	21.1	3.5	9.3	7.4	1.7	1.0	12.4
P4 2016-18	5.4	18.7	7.9	4.2	2.2	8.0	10.6	3.1	10.1	7.1	2.4	0.0	20.2

	Paper 2	Paper 4	Paper 6	Totals	Average
Relative value %	30	50	20	100	
Number of marks	40	80	40	160	
Value of each mark/% of iGCSE	0.75	0.63	0.50		0.63
Time/min	45	75	60	180	60
Time per mark/sec	68	56	60		61
Portion of syllabus examined	C & S	C & S	Core		
	C = Core	S = Supplement			

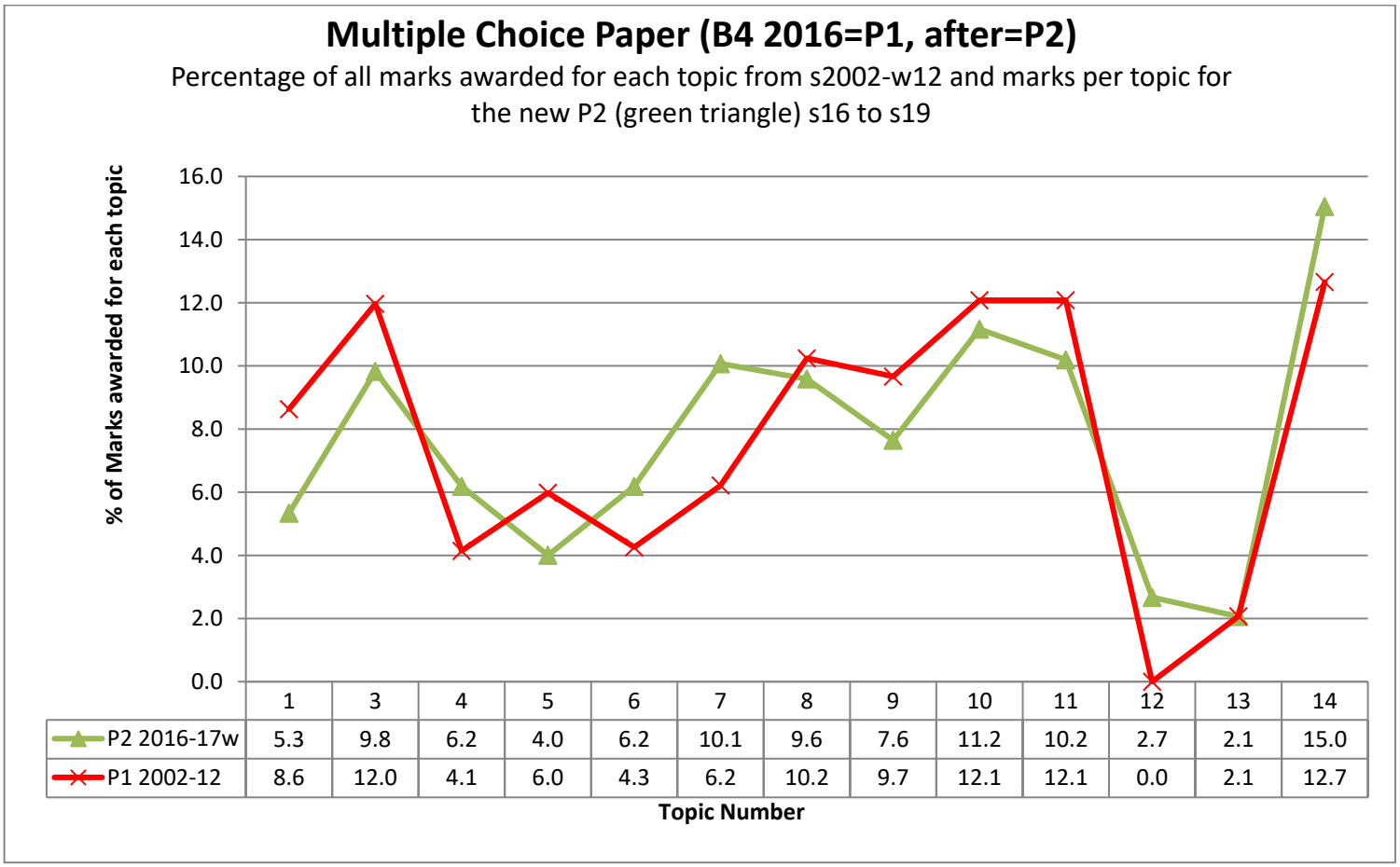
15.4 Topics in Rank Order

Topic	14	3	10	7	8	11	4	5	9	1	12	6	13
Rank ALL Papers	2	4	5	3	1	6	9	8	11	7	12	10	13
Rank P3: A* Focus	1	2	3	4	5	6	7	8	9	10	10	12	13
All Syllabus Word Count RANK	1	2	5	3	6	4	9	7	10	8	12	11	13

Greener = Better; "Words per %..." refers to the words in the syllabus versus weighted marks awarded since w2001

15.5 Key Points about these graphs and data

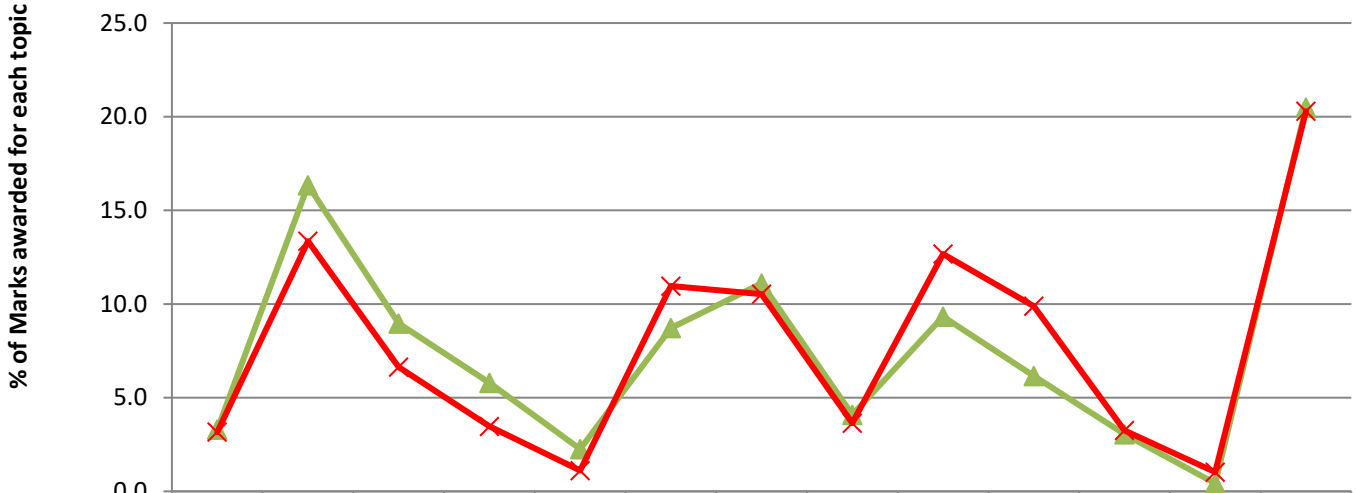
- **To do well, you must learn T8 (40 and 10.5% of P6 & P3) but to get an A* T14 is essential (20.2% of P3).**
- Paper 3 (after 2016renamed Paper 4) is easily the most important paper, it has gotten more challenging over the last 5 years with the same questions being asked, but with less help with the answer that is required (so more 5 or 6 marks questions), also the same questions are being asked but have fewer marks attached meaning that you not only need to know the answer, but you need to better understand the priority (e.g. many sources of sulfur, but the main source, from petroleum, is the only acceptable answer).
- ***However, these changes only make it harder for the less well prepared student, if you have not only answered these questions before, and checked your answers, but also looked at how some questions change with time (ANALYSIED the trends) then it is in fact easier than ever before. There are fewer new questions than ever before!***
- These are just averages, so for instance T13 is not often examined, so appears less relevant, but when it is in a paper (P3) it will be on average 5 marks, and because it is all supplement material, these will be a lot of the higher marks. This data should hopefully allow you to prioritise topics in your revision.
- T4 is the most efficient topic to learn (least to learn per mark awarded), provided you are good at maths (predicted to get at least a B grade), otherwise it is by far the least worthwhile topic (which these numbers don't show but has been my experience in teaching) if you struggle with maths. You can still get an A* withoutthis topic, but you'll not be able to drop many marks in any other topic.
- If there was a fire and you had to leave one topic behind, T5 would be the one taking a hit for the team.
- Most important topics to your grades are 14, 8, 3, 10, 7 and 11, in that order.



	1	3	4	5	6	7	8	9	10	11	12	13	14
P2 2016-17w	5.3	9.8	6.2	4.0	6.2	10.1	9.6	7.6	11.2	10.2	2.7	2.1	15.0
P1 2002-12	8.6	12.0	4.1	6.0	4.3	6.2	10.2	9.7	12.1	12.1	0.0	2.1	12.7

0620 PAPER 4 (pre2016 called Paper 3)

Percentage of all marks awarded for each topic from s2013 to w2015 (red cross) and for 2016m to 2018w (green triangle)

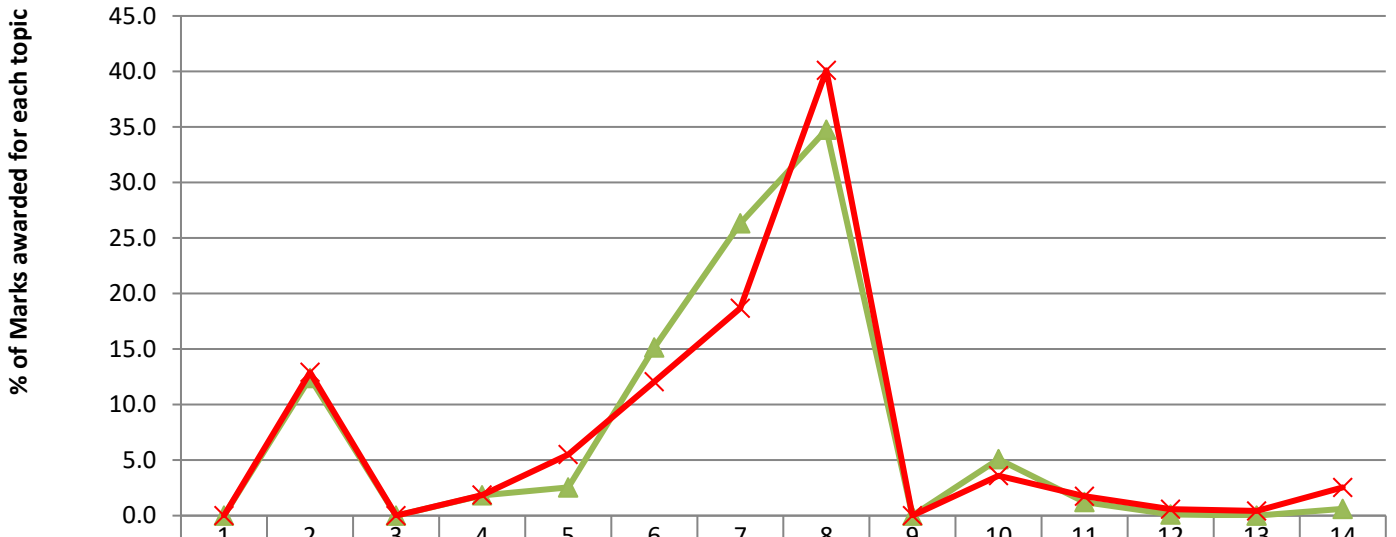


	1	3	4	5	6	7	8	9	10	11	12	13	14
P4 2016m-18w	3.3	16.3	9.0	5.8	2.3	8.7	11.1	4.1	9.3	6.2	3.0	0.4	20.5
P3 2001-15	3.2	13.4	6.6	3.5	1.1	11.0	10.5	3.6	12.7	9.9	3.3	1.0	20.3

Topic Number

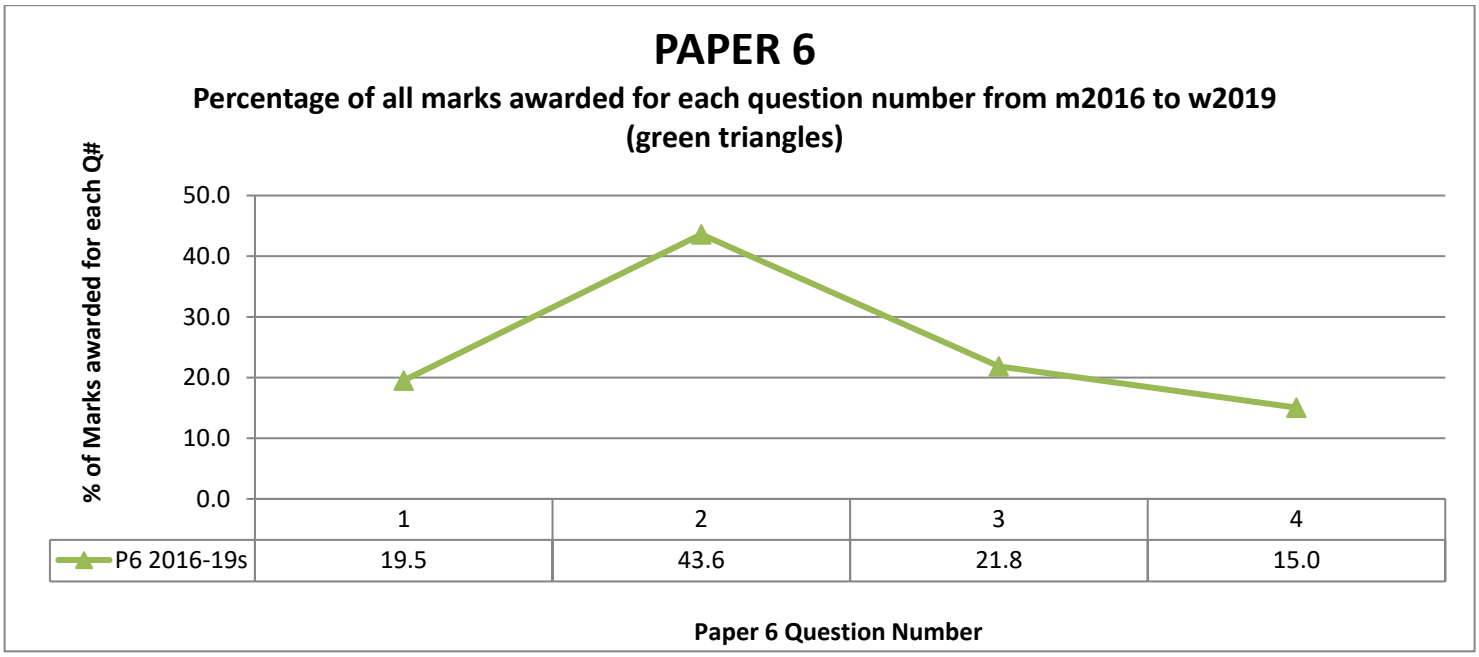
PAPER 6

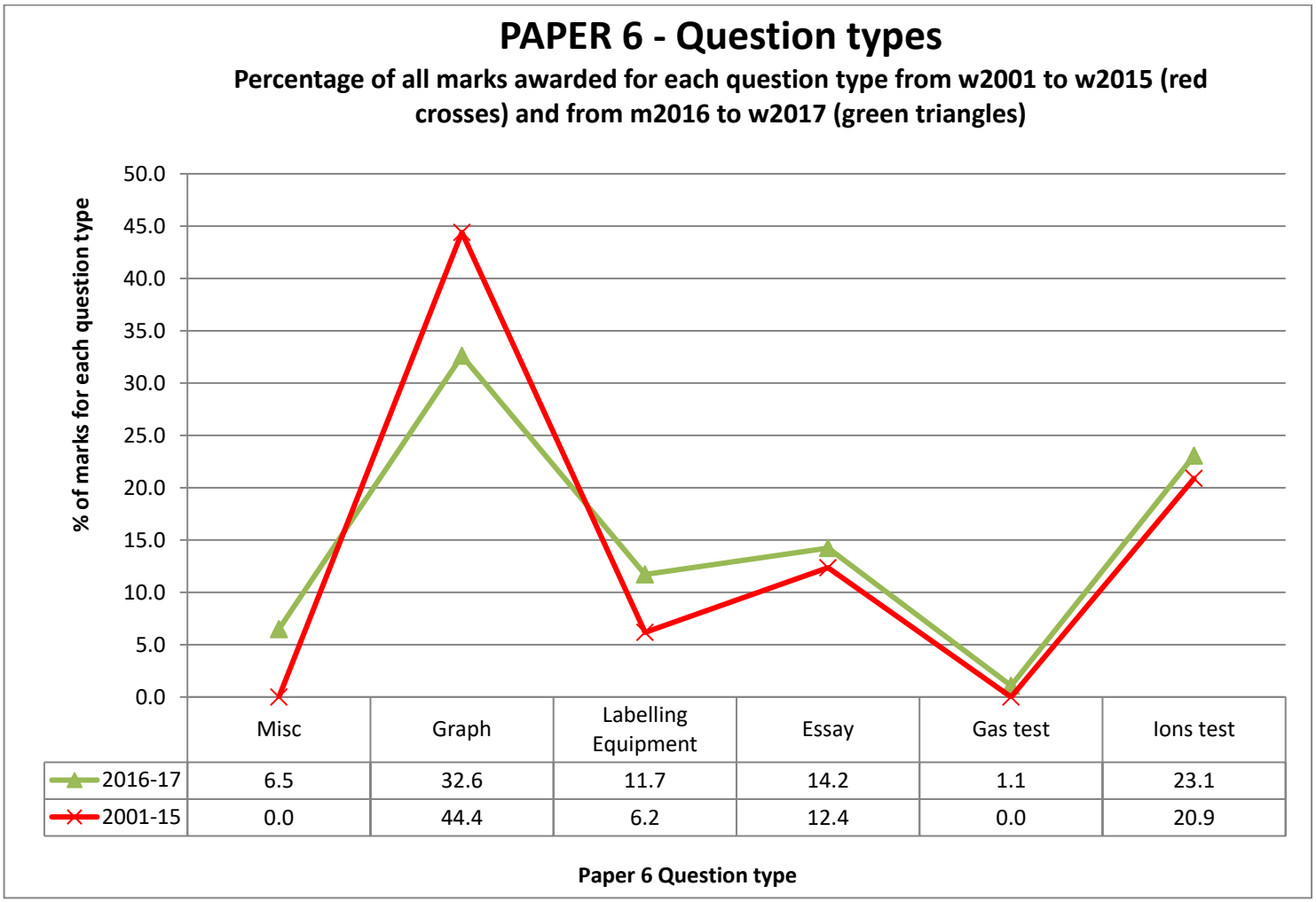
Percentage of all marks awarded for each topic from w2001 to w2015 (red crosses) and from m2016 to s2019 (green triangles)



	1	2	3	4	5	6	7	8	9	10	11	12	13	14
P6 2016-19s	0.0	12.4	0.0	1.8	2.5	15.1	26.3	34.8	0.0	5.1	1.2	0.1	0.0	0.6
P6 2001-15	0.0	12.9	0.0	1.9	5.5	12.1	18.7	40.1	0.0	3.6	1.7	0.6	0.4	2.5

Paper 6 Topic Number





Above are the main experiments and the main question types in Paper 6. Word files broken down by these categories are available on my website (e.g.

s

15.5.1 Raw Data Info Used to Make the Graphs

		Topic													Averages
		1	3	4	5	6	7	8	9	10	11	12	13	14	
P1	% of Marks	8.6	12.0	4.1	6.0	4.3	6.2	10.2	9.7	12.1	12.1	0.0	2.1	12.7	7.7
P1	# of Questions	27.0	44.0	25.0	28.0	27.0	32.0	45.0	36.0	41.0	39.0	0.0	16.0	39.0	30.7
P1	Average marks per Q	2.8	2.4	1.4	1.9	1.4	1.7	2.0	2.3	2.6	2.7	0.0	1.1	2.8	1.9
P3	% of Marks	3.3	13.2	6.6	5.6	1.1	10.8	10.5	3.6	11.2	9.6	3.3	1.0	20.2	7.7
P3	# of Questions	20.0	58.0	39.0	25.0	6.0	46.0	53.0	19.0	54.0	46.0	14.0	5.0	79.0	35.7
P3	Average marks per Q	3.8	5.3	4.0	5.2	4.3	5.5	4.6	4.5	4.8	4.9	5.4	4.8	6.0	4.9
P6	% of Marks	12.9	0.0	1.9	5.5	12.1	18.7	40.1	0.0	3.6	1.7	0.6	0.4	2.5	7.7
P6	# of Questions	40.0	0.0	4.0	17.0	17.0	32.0	93.0	0.0	7.0	6.0	2.0	2.0	10.0	17.7
P6	Average marks per Q	6.1	0.0	8.8	6.1	13.4	11.0	8.2	0.0	9.7	5.5	5.5	4.0	4.8	6.4
ALL	% of Marks (Weighted)	6.8	9.9	4.9	5.7	4.4	11.5	17.2	4.2	9.6	8.4	1.9	1.1	14.4	7.7
ALL	# of Questions	87.0	102.0	68.0	70.0	50.0	110.0	191.0	55.0	102.0	91.0	16.0	23.0	128.0	84.1
ALL	Average marks per Q	2.1	2.7	2.0	2.2	2.4	2.9	2.5	2.1	2.6	2.5	3.2	1.4	3.1	2.4
Rank Order		**7**	**4**	**9**	**8**	**10**	**3**	**1**	**11**	**5**	**6**	**12**	**13**	**2**	

Comments

Yellow indicates the paper range for P1 is not the same as for the other papers, this is because P1 is changing, and taking apart that paper is particularly soul destroying, I can't justify the hours of mind-numbing tedium if the information is going to be increasingly irrelevant.

Blue indicates the substantial difference in the total number of marks I should be able to account for (Total Marks All Papers) and the ones that have gone into the topic calculations. This is hopefully the result of a RANDOM error where some questions have had parts duplicated and I have not filtered these duplications out. Realistically, though it isn't. When I started to break this paper down by topic I was not systematic in my process; my intentions were disorganised and I wasn't thinking about being able to account for every mark, just for every question. So some topics were duplicated

15.6 Words per topic statistics from the syllabus

Core Syllabus Word Count	218	344	131	130	58	183	273	209	241	287	44	56	363	2537	
Suppliment Syllabus Word Count	82	141	122	191	73	245	68	41	134	124	29	2	352	1604	
All Syllbus Word Count	300	485	253	321	131	428	341	250	375	411	73	58	715	4141	
Core Syllabus Word Count %	5.3	8.3	3.2	3.1	1.4	4.4	6.6	5.0	5.8	6.9	1.1	1.4	8.8		
Suppliment Syllabus Word Count %	2.0	3.4	2.9	4.6	1.8	5.9	1.6	1.0	3.2	3.0	0.7	0.0	8.5		
All Syllbus Word Count %	7.2	11.7	6.1	7.8	3.2	10.3	8.2	6.0	9.1	9.9	1.8	1.4	17.3		
All Syllabus Word Count RANK	8	2	9	7	11	3	6	10	5	4	12	13	1		
% Total ALL Papers	6.8	9.9	4.9	5.7	4.4	11.5	17.2	4.2	9.6	8.4	1.9	1.1	14.4		
% Total P3: A* Focus	3.3	13.2	6.6	5.6	1.1	10.8	10.5	3.6	11.2	9.6	3.3	1.0	20.2		
Words per % ALL Papers	44	49	51	57	30	37	20	59	39	49	39	51	49.8		
Words per % P3	25	11	18	34	66	23	6.5	11	12	13	9	2	17.4		

Although this is only one course so there is very little data at present to go on, a possible generalisation which might be of value when studying for other CIE subjects is that the more words there are in the syllabus, the more important that topic is to the exam. So to get an idea, count the words (can be done electronically: 1. Mark for redaction all of the section of the syllabus for supplement 2. Redact 3. Copy and past all of it to word 4. Do the same for supplement 5. Highlight the topic and word will give you the number of words). The actual results of this will not probably be too surprising, but outcome of this exercise and why it will help is it will force you to think objectively about the syllabus. Instead of thinking about the things that you didn't like or you didn't think you were good at, you will have the opportunity to get a different perspective on the subject. And hopefully, instead of thinking of the subject as a whole, you will start to break it down into more manageable chunks and begin the process of prioritisation, which when done well, is perhaps the most important principle in thought.

[Looking back on this project to count the words in the syllabus, which I did about 5 years ago, I cannot say it produced anything really interesting or useful. But it was super boring to do! Would not recommend doing it]

15.7 Papers Used to create the revision resources I use

Red is still to do					For paper 1, at 2011s none are identical but all have the same questions										Method for checking: Open all 3 timezone papers, display dise by side, compare first question, last page and scan through all, two or three pages at a time, and look for keywords and the same diagram, as well as how each question starts.										
Green is Done					Blue is not checked					Gray is when TZ2 and 3 are identical															
Session	m	m	m		s	s	s	s	s	s	s	s	s		w	w	w	w	w	w	w	w	w		
Paper	1	3	6		1	1	1	3	3	3	6	6	6		1	1	1	3	3	3	6	6	6		
Timezone	2	2	2		1	2	3	1	2	3	1	2	3		1	2	3	1	2	3	1	2	3		
Year																									
1997																									
1998																									
1999																									
2000																									
2001				1			2001s P3.1										2001w P3.1			2001w P6.1					
2002				2	2002s P1.1		2002s P3.1				2002s P6.1				2002w P1.1		2002w P3.1			2002w P6.1					
2003				3	2003s P1.1		2003s P3.1				2003s P6.1				2003w P1.1		2003w P3.1			2003w P6.1					
2004				4	2004s P1.1		2004s P3.1				2004s P6.1				2004w P1.1		2004w P3.1			2004w P6.1					
2005				5	2005s P1.1		2005s P3.1				2005s P6.1				2005w P1.1		2005w P3.1			2005w P6.1					
2006				6	2006s P1.1		2006s P3.1				2006s P6.1				2006w P1.1		2006w P3.1			2006w P6.1					
2007				7	2007s P1.1		2007s P3.1				2007s P6.1				2007w P1.1		2007w P3.1			2007w P6.1					
2008				8	2008s P1.1		2008s P3.1				2008s P6.1				2008w P1.1		2008w P3.1			2008w P6.1					
2009				9	2009s P1.1		2009s P3.1				2009s P6.1				2009w P1.1		2009w P3.1			2009w P6.1					
2010				10	2010s P1.1	2010s P1.2	2010s P1.3	2010s P3.1	2010s P3.2	2010s P3.3	2010s P6.1	2010s P6.2	2010s P6.3		2010w P1.1	2010w P1.2	2010w P1.3	2010w P3.1	2010w P3.2	2010w P3.3	2010w P6.1	2010w P6.2	2010w P6.3		
2011				11	2011s P1.1	2011s P1.2	2011s P1.3	2011s P3.1	2011s P3.2	2011s P3.3	2011s P6.1	2011s P6.2	2011s P6.3		2011w P1.1	2011w P1.2	2011w P1.3	2011w P3.1	2011w P3.2	2011w P3.3	2011w P6.1	2011w P6.2	2011w P6.3		
2012				12	2012s P1.1	2012s P1.2	2012s P1.3	2012s P3.1	2012s P3.2	2012s P3.3	2012s P6.1	2012s P6.2	2012s P6.3		2012w P1.1	2012w P1.2	2012w P1.3	2012w P3.1	2012w P3.2	2012w P3.3	2012w P6.1	2012w P6.2	2012w P6.3		
				13																					
2013				14	2013s P1.1	2013s P1.2	2013s P1.3	2013s P3.1	2013s P3.2	2013s P3.3	2013s P6.1	2013s P6.2	2013s P6.3		2013w P1.1	2013w P1.2	2013w P1.3	2013w P3.1	2013w P3.2	2013w P3.3	2013w P6.1	2013w P6.2	2013w P6.3		
2014				15	2014s P1.1	2014s P1.2	2014s P1.3	2014s P3.1	2014s P3.2	2014s P3.3	2014s P6.1	2014s P6.2	2014s P6.3		2014w P1.1	2014w P1.2	2014w P1.3	2014w P3.1	2014w P3.2	2014w P3.3	2014w P6.1	2014w P6.2	2014w P6.3		
2015	2015m P1.2	2015m P3.2	2015m P6.2	16	2015s P1.1	2015s P1.2	2015s P1.3	2015s P3.1	2015s P3.2	2015s P3.3	2015s P6.1	2015s P6.2	2015s P6.3		2015w P1.1	2015w P1.2	2015w P1.3	2015w P3.1	2015w P3.2	2015w P3.3	2015w P6.1	2015w P6.2	2015w P6.3		
New Syllabus	*Paper 1 was replaced with paper Paper 2 (including Supplement material in the syllabus, so harder). Paper 3 was renamed Paper 4, not other structurual changes. Paper 6 went from 60marks to 40marks, no other structural change*																								
	m	m	m		s	s	s	s	s	s	s	s	s		w	w	w	w	w	w	w	w	w		
	1	3	6		2	2	2	4	4	4	6	6	6		2	2	2	4	4	4	6	6	6		
	2	2	2		1	2	3	1	2	3	1	2	3		1	2	3	1	2	3	1	2	3		
2016	2016m P1.2	2016m P3.2	2016m P6.2	17	2016s P2.1	2016s P2.2	2016s P2.3	2016s P4.1	2016s P4.2	2016s P4.3	2016s P6.1	2016s P6.2	2016s P6.3		2016w P2.1	2016w P2.2	2016w P2.3	2016w P4.1	2016w P4.2	2016w P4.3	2016w P6.1	2016w P6.2	2016w P6.3		
2017	2017m P1.2	2017m P3.2	2017m P6.2	18	2017s P2.1	2017s P2.2	2017s P2.3	2017s P4.1	2017s P4.2	2017s P4.3	2017s P6.1	2017s P6.2	2017s P6.3		2017w P2.1	2017w P2.2	2017w P2.3	2017w P4.1	2017w P4.2	2017w P4.3	2017w P6.1	2017w P6.2	2017w P6.3		
2018	2018m P1.2	2018m P3.2	2018m P6.2	19	2018s P2.1	2018s P2.2	2018s P2.3	2018s P4.1	2018s P4.2	2018s P4.3	2018s P6.1	2018s P6.2	2018s P6.3		2018w P2.1	2018w P2.2	2018w P2.3	2018w P4.1	2018w P4.2	2018w P4.3	2018w P6.1	2018w P6.2	2018w P6.3		
2019	2019m P1.2	2019m P3.2	2019m P6.2	20	2019s P2.1	2019s P2.2	2019s P2.3	2019s P4.1	2019s P4.2	2019s P4.3	2019s P6.1	2019s P6.2	2019s P6.3		2019w P2.1	2019w P2.2	2019w P2.3	2019w P4.1	2019w P4.2	2019w P4.3	2019w P6.1	2019w P6.2	2019w P6.3		
2020																									
2021																									
2022																									
2023																									
Total papers	5	5	5		19	4	4	20	9	7	19	8	8		19	4	4	20	9	9	20	9	9	216	
Papers done	4	4	4		18	3	3	19	5	5	3	3	3		18	3	3	19	5	5	3	3	3	136	167
P done OldP6											15	0	0								16	0	0	31	
Mark per Paper	40	80	40		40	40	40	80	80	80	40	40	40		40	40	40	80	80	80	40	40	40	1120	
MarksPerP Old P6			60								60	60	60								60	60	60	360	1260
Total marks	200	400	200		760	160	160	1600	720	560	760	320	320		760	160	160	1600	720	720	800	360	360	11800	
Total marks I have	160	320	160		720	120	120	1520	400	400	120	120	120		720	120	120	1520	400	400	120	120	120	7920	
															Proportion of marks represented in my revision resources						67	%			

This is an example of an Open Source resource, indicating exactly which exam papers I have used. Students are unlikely to learn anything about chemistry from it, but hopefully it is an introduction to the Open Source community (to find out more look here: https://opensource.org/history) It could be of use for teachers and also, if printed in colour or seen through the electronic version of this book, looks super sciency, very colourful and splendidly pretty

DATA SHEET
The Periodic Table of the Elements

Group

I	II											III	IV	V	VI	VII	0
							1 H Hydrogen 1										4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98				No Nobelium 102	Lr Lawrencium 103

*58-71 Lanthanoid series
†90-103 Actinoid series

Key: a X b — a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

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The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).