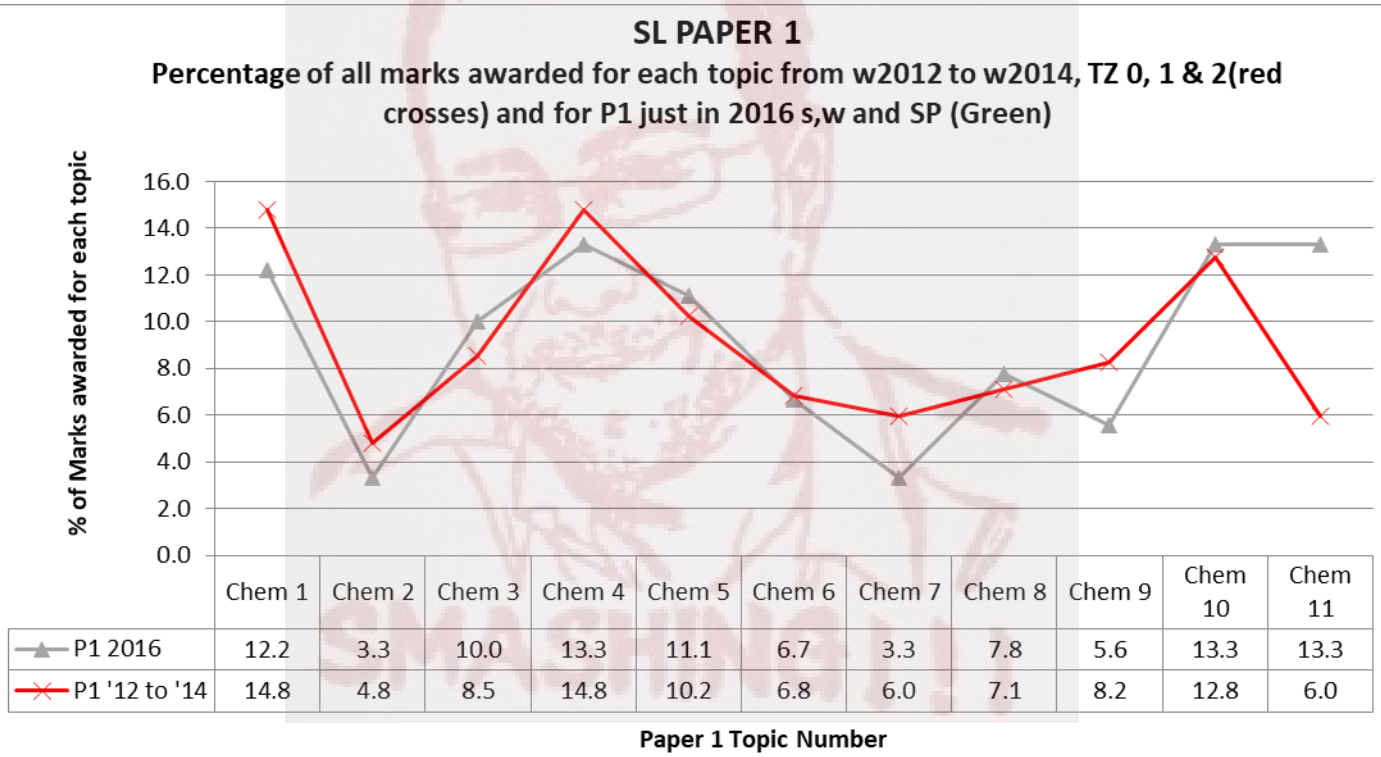
Name

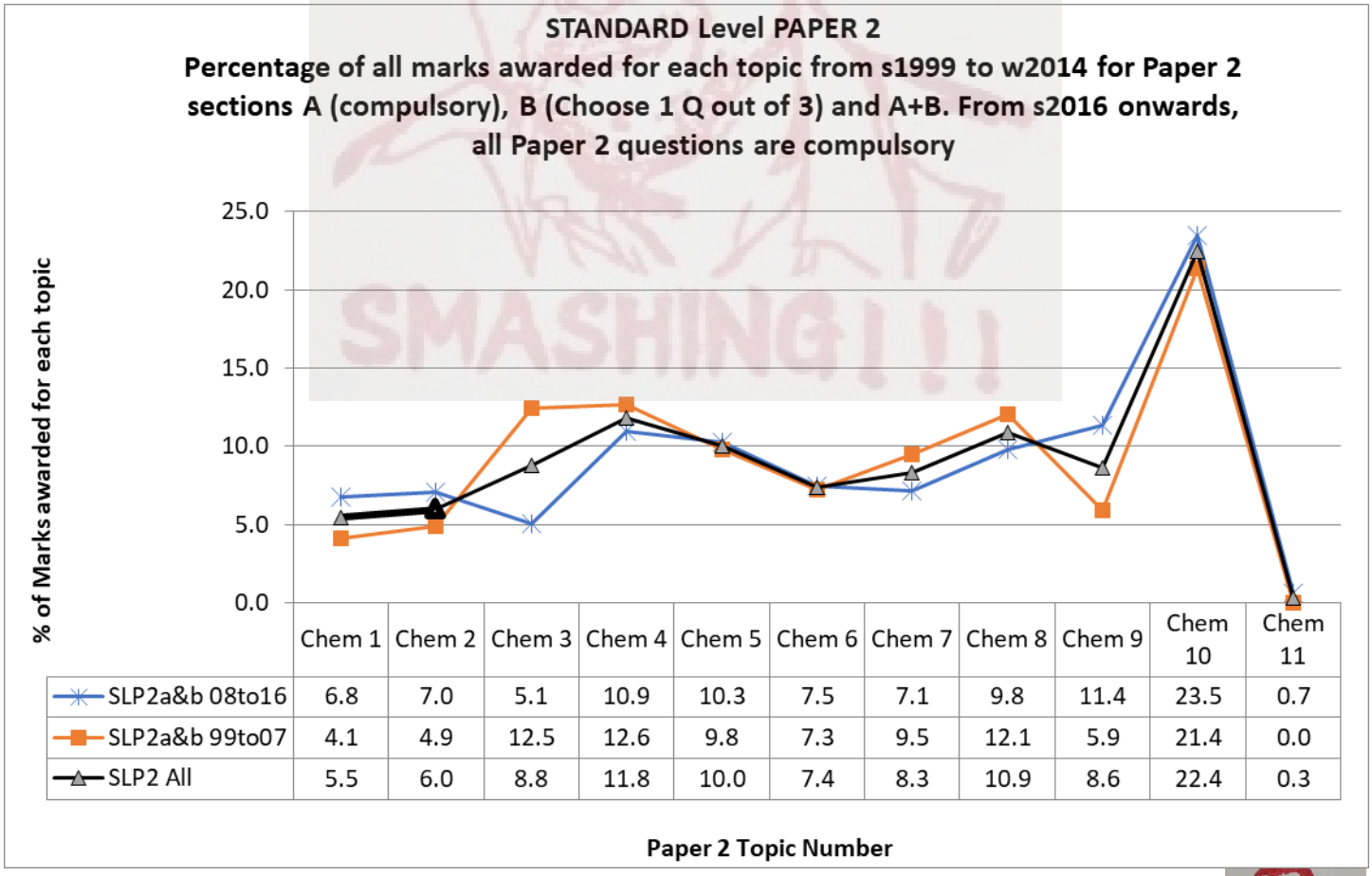
IB ALL SL 1 P1 REVISION BOOK STANDARD LEVEL 364marks Paper 1 2019 to 2015 inclusive (DRAFT)

Before 2016 paper 2 was included 4 section B questions, of which you had to chose 2. After 2016 all questions became compulsory on Paper 2



	Chem 1	Chem 2	Chem 3	Chem 4	Chem 5	Chem 6	Chem 7	Chem 8	Chem 9	Chem 10	Chem 11
P1 2016	12.2	3.3	10.0	13.3	11.1	6.7	3.3	7.8	5.6	13.3	13.3
P1 '12 to '14	14.8	4.8	8.5	14.8	10.2	6.8	6.0	7.1	8.2	12.8	6.0

Contents

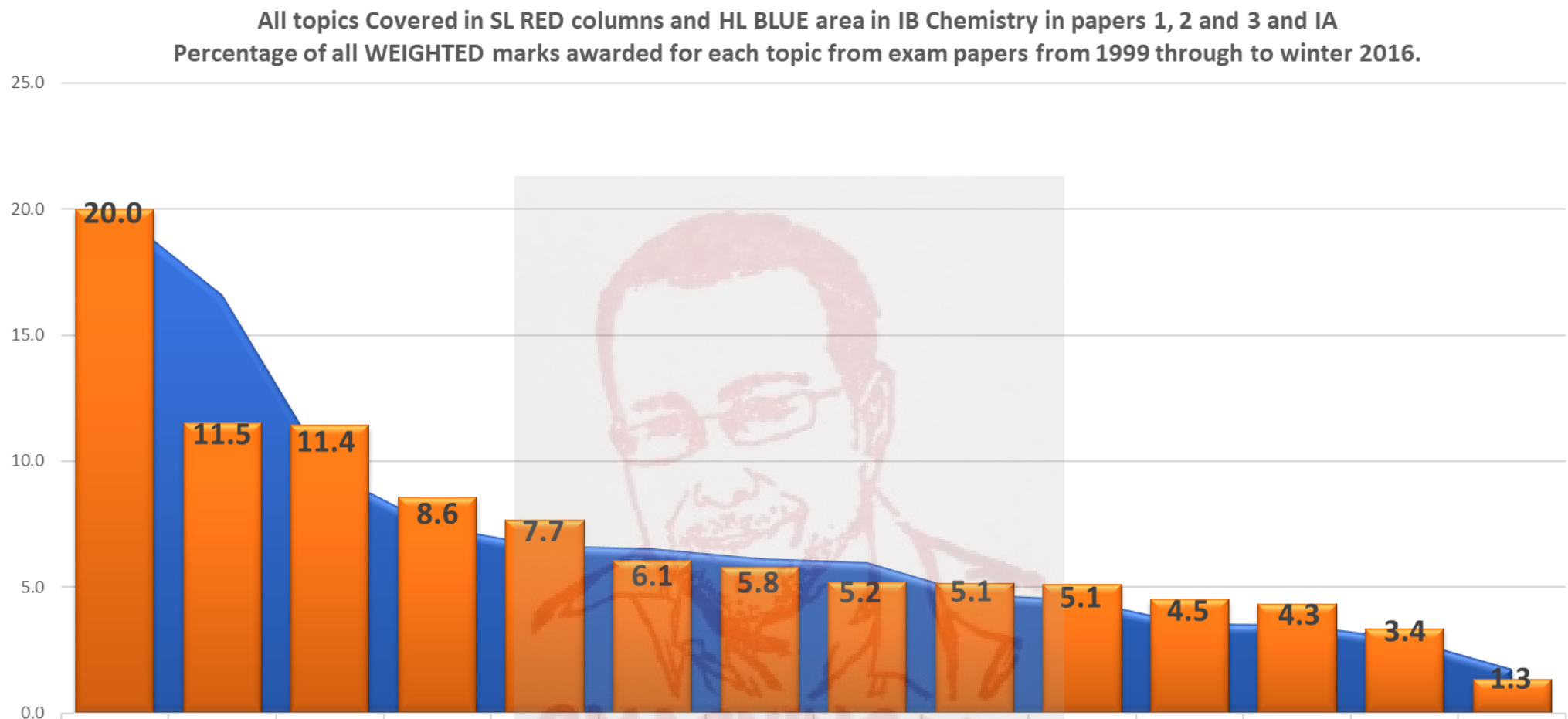


	Chem 1	Chem 2	Chem 3	Chem 4	Chem 5	Chem 6	Chem 7	Chem 8	Chem 9	Chem 10	Chem 11
SLP2a&b 08to16	6.8	7.0	5.1	10.9	10.3	7.5	7.1	9.8	11.4	23.5	0.7
SLP2a&b 99to07	4.1	4.9	12.5	12.6	9.8	7.3	9.5	12.1	5.9	21.4	0.0
SLP2 All	5.5	6.0	8.8	11.8	10.0	7.4	8.3	10.9	8.6	22.4	0.3

All topics ranked according to their impact on your final grade using exam papers from 1999 to 2016

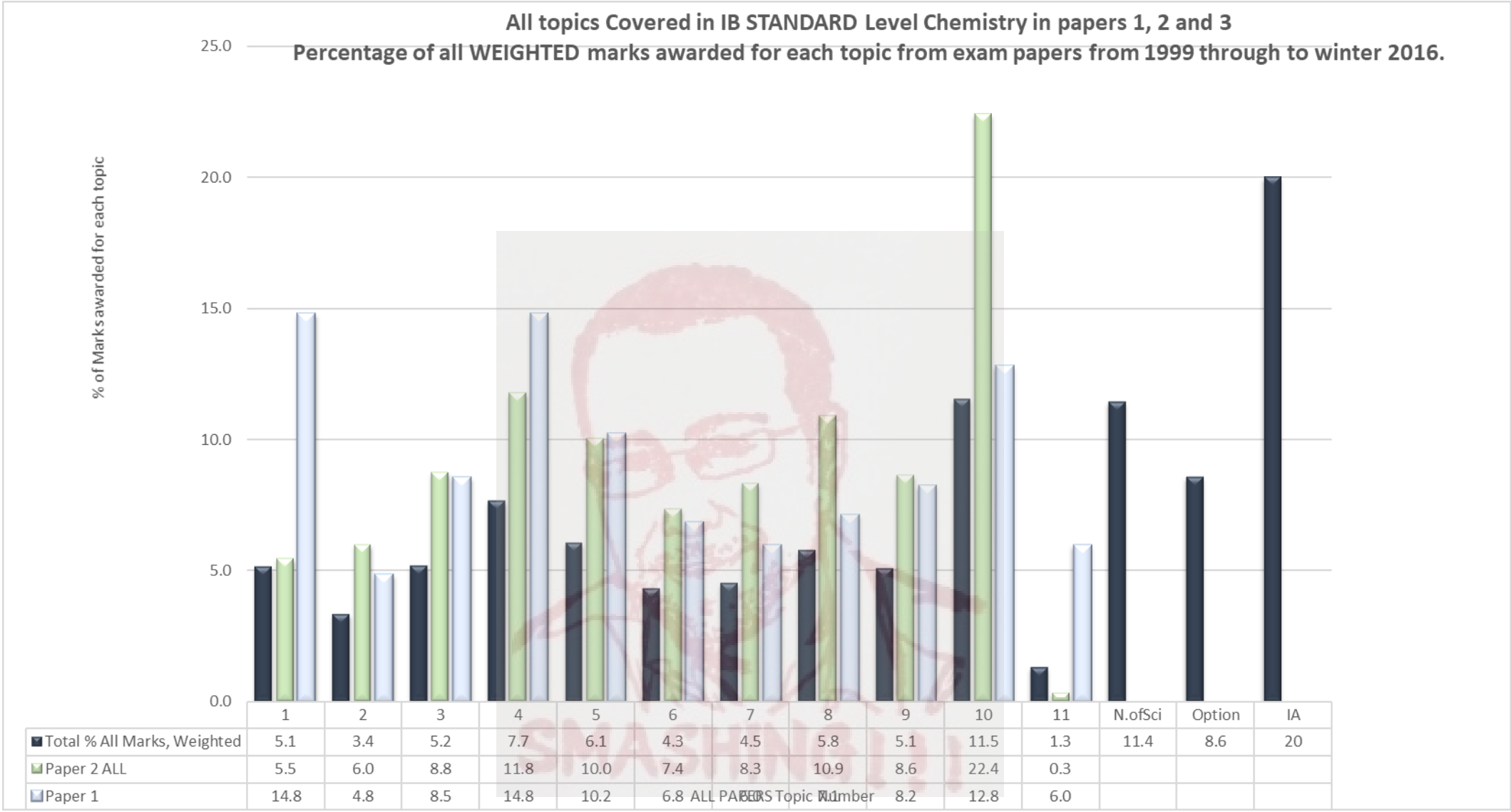
	TOPICS and IA													
	IA	**10**	**Option**	**N.ofSci**	**4**	**5**	**8**	**3**	**1**	**9**	**7**	**6**	**2**	**11**
Paper 1		12.8			14.8	10.2	7.1	8.5	14.8	8.2	6.0	6.8	4.8	6.0
Paper 2 16 to 08		23.5			10.9	10.3	9.8	5.1	6.8	11.4	7.1	7.5	7.0	0.7
Paper 2 07 to 99		21.4			12.6	9.8	12.1	12.5	4.1	5.9	9.5	7.3	4.9	0.0
Paper 2 ALL		22.4			11.8	10.0	10.9	8.8	5.5	8.6	8.3	7.4	6.0	0.3
Paper 3		0.0	57.1	42.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total % All Marks, Weighted	20	11.5	11.4	8.6	7.7	6.1	5.8	5.2	5.1	5.1	4.5	4.3	3.4	1.3
Rank Order	1	2	3	4	5	6	7	8	9	10	11	12	13	14

Standard and Higher Level components compared



	IA	Option	10	N.ofSci	8	4	5	9	6	3	7	1	2	11
HL	20.0	16.6	9.6	7.4	6.7	6.6	6.2	6.0	4.7	4.5	3.6	3.5	3.0	1.8
SL	20.0	11.5	11.4	8.6	7.7	6.1	5.8	5.2	5.1	5.1	4.5	4.3	3.4	1.3

Essentially, IA has the exact same weight, the Option in HL is almost 50% more important than in SL but Topic 10 is more important in SL than HL. All other topics contribute almost equally to a SL and HL grade.



	1	2	3	4	5	6	7	8	9	10	11	N.ofSci	Option	IA
Total % All Marks, Weighted	5.1	3.4	5.2	7.7	6.1	4.3	4.5	5.8	5.1	11.5	1.3	11.4	8.6	20
Paper 2 ALL	5.5	6.0	8.8	11.8	10.0	7.4	8.3	10.9	8.6	22.4	0.3			
Paper 1	14.8	4.8	8.5	14.8	10.2	6.8	6.1	7.1	8.2	12.8	6.0			

The dark blue bars are where your final IB grade will be from:

1. Your IA is the single most important part of your IB SL, more important than even the Option. Imagine how much time in class, at home and in revision you have or will give to topics 9, 10 and 11. **Your IA, on average, will be worth more to your final grade than all those combined.**
2. The Option is the most important topic for your IB grade compared to the everything else

Topic 10, Organic Chemistry, is by far the most important topic for papers 1 and 2.

Topic Chem 1 **Q# 1/** IB Chem/2019/w/TZ0/Paper1/Standard Level/ www.SmashingScience.org :o)

1. 0.10 mol of hydrochloric acid is mixed with 0.10 mol of calcium carbonate.

$$2HCl(aq) + CaCO_3(s) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

Which is correct?

	Limiting reagent	Maximum yield of CO_2 / mol
A.	$HCl(aq)$	0.10
B.	$CaCO_3(s)$	0.05
C.	$HCl(aq)$	0.05
D.	$CaCO_3(s)$	0.10

2. What is the sum of the coefficients when the equation is balanced with whole numbers?

$$\_\_MnO_2(s) + \_\_HCl(aq) \rightarrow \_\_MnCl_2(aq) + \_\_H_2O(l) + \_\_Cl_2(g)$$

A. 6

B. 7

C. 8

D. 9

3. Which is correct?

A. Mixtures are either homogeneous or heterogeneous and their chemical properties are an average of the individual component properties.

B. Mixtures are never heterogeneous and their chemical properties are an average of the individual component properties.

C. Mixtures are either homogeneous or heterogeneous and the components retain their individual chemical properties.

D. Mixtures are never homogeneous and the components retain their individual chemical properties.

4. Which contains the greatest number of moles of oxygen atoms?

A. 0.05 mol $Mg(NO_3)_2$

B. 0.05 mol $C_6H_4(NO_2)_2$

C. 0.1 mol H_2O

D. 0.1 mol NO_2

1. How many moles of magnesium hydroxide are produced with 0.50 mol of ammonia?

$$Mg_3N_2(s) + 6H_2O(l) \rightarrow 3Mg(OH)_2(aq) + 2NH_3(aq)$$

A. 0.25

B. 0.33

C. 0.75

D. 1.5

2. What is the sum of the integer coefficients when propene undergoes complete combustion?

$$\_\_C_3H_6(g) + \_\_O_2(g) \rightarrow \_\_CO_2(g) + \_\_H_2O(l)$$

A. 11

B. 17

C. 21

D. 23

3. What is the volume of gas when the pressure on 100 cm^3 of gas is changed from 400 kPa to 200 kPa at constant temperature?

A. 50.0 cm^3

B. 100 cm^3

C. 200 cm^3

D. 800 cm^3

4. What is the concentration, in mol dm^{-3}, of 20.0 g of NaOH (M_r = 40.0) in 500.0 cm^3?

A. 0.250

B. 0.500

C. 1.00

D. 4.00

4. Which graph would **not** show a linear relationship for a fixed mass of an ideal gas with all other variables constant?

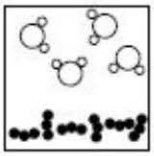
A. P against V

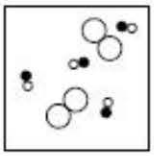
B. P against $\frac{1}{V}$

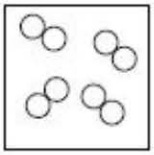
C. P against T

D. V against T

1. Which diagram represents a heterogeneous mixture?

A. 

B. 

C. 

D. 

2. What is the sum of the coefficients when the equation is balanced with the smallest whole numbers?

$$\_\_BaCl_2(aq) + \_\_Fe_2(SO_4)_3(aq) \rightarrow \_\_FeCl_3(aq) + \_\_BaSO_4(s)$$

A. 4

B. 6

C. 8

D. 9

3. What is the empirical formula of a hydrocarbon with 75 % carbon and 25 % hydrogen by mass?

A. C_3H

B. CH_2

C. C_2H_6

D. CH_4

1. How many moles of FeS_2 are required to produce 32 g of SO_2? (A_r: S = 32, O = 16)

$$4FeS_2(s) + 11O_2(g) \rightarrow 2Fe_2O_3(s) + 8SO_2(g)$$

A. 0.25

B. 0.50

C. 1.0

D. 2.0

2. The volume of a sample of gas measured at 27 °C is 10.0 dm^3. What is the temperature when the volume is reduced to 9.0 dm^3 at the same pressure?

A. −3.0 °C

B. 24.3 °C

C. 29.7 °C

D. 57.0 °C

3. 16 g of bromine react with 5.2 g of metal, M, to form MBr_2. What is the relative atomic mass of the metal M? (A_r: Br = 80)

A. 13

B. 26

C. 52

D. 104

4. An antacid tablet containing 0.50 g of $NaHCO_3$ (M_r = 84) is dissolved in water to give a volume of 250 cm^3. What is the concentration, in mol dm^{-3}, of HCO_3^- in this solution?

A. $\frac{0.250 \times 84}{0.50}$

B. $\frac{0.50}{84 \times 0.250}$

C. $\frac{250 \times 84}{0.50}$

D. $\frac{0.50}{84 \times 250}$

4. What is the percentage yield when 2.0 g of ethene, C_2H_4, is formed from 5.0 g of ethanol, C_2H_5OH?
M_r (ethene) = 28; M_r (ethanol) = 46

A. $\frac{2.0}{28} \times \frac{5.0}{46} \times 100$

B. $\frac{\frac{2.0}{28}}{\frac{5.0}{46}} \times 100$

C. $\frac{28}{2.0} \times \frac{5.0}{46} \times 100$

D. $\frac{\frac{28}{2.0}}{\frac{5.0}{46}} \times 100$

1. What is the sum of the coefficients when the equation is balanced with the lowest whole number ratio?

$$\_\_Na_2S_2O_3\ (aq) + \_\_HCl\ (aq) \rightarrow \_\_S\ (s) + \_\_SO_2\ (g) + \_\_NaCl\ (aq) + \_\_H_2O\ (l)$$

A. 6

B. 7

C. 8

D. 9

2. What is the number of atoms of oxygen in 2.0 mol of hydrated sodium carbonate, $Na_2CO_3 \cdot 10H_2O$? Avogadro's constant, L or N_A : $6.02 \times 10^{23}\ mol^{-1}$

A. 6

B. 26

C. 3.6×10^{24}

D. 1.6×10^{25}

3. What is the volume, in cm^3, of the final solution if 100 cm^3 of a solution containing 1.42 g of sodium sulfate, Na_2SO_4, is diluted to the concentration of 0.020 mol dm^{-3}?
M_r (Na_2SO_4) = 142

A. 50

B. 400

C. 500

D. 600

4. What is the percentage yield when 7 g of ethene produces 6 g of ethanol?

M_r (ethene) = 28 and M_r (ethanol) = 46

$$C_2H_4\,(g) + H_2O\,(g) \rightarrow C_2H_5OH\,(g)$$

A. $\frac{6 \times 7 \times 100}{28 \times 46}$

B. $\frac{6 \times 46 \times 100}{7 \times 28}$

C. $\frac{6 \times 28}{7 \times 46 \times 100}$

D. $\frac{6 \times 28 \times 100}{7 \times 46}$

1. Which is a homogeneous mixture?

A. Oil and water

B. Sand and water

C. Ethanol and water

D. Chalk and sand

2. What is the molecular formula of a hydrocarbon containing 84.6 % carbon by mass with a molar mass of 142.3 g mol^{-1}?

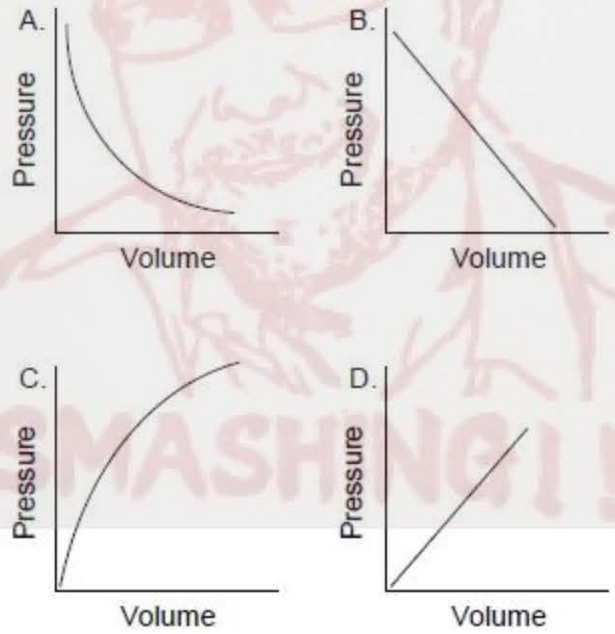
A. $C_{20}H_{44}$

B. $C_{11}H_{10}$

C. $C_{10}H_{22}$

D. C_5H_{11}

3. Which graph shows the relationship between the volume and pressure of a fixed mass of an ideal gas?



1. How many atoms of nitrogen are there in 0.50 mol of $(NH_4)_2CO_3$?

A. 1

B. 2

C. 3.01×10^{23}

D. 6.02×10^{23}

2. What is the value of **x** when 32.2 g of $Na_2SO_4 \cdot xH_2O$ are heated leaving 14.2 g of anhydrous Na_2SO_4? $M_r(H_2O) = 18$; $M_r(Na_2SO_4) = 142$.

$$Na_2SO_4 \cdot xH_2O(s) \rightarrow Na_2SO_4(s) + xH_2O(g)$$

A. 0.1

B. 1

C. 5

D. 10

3. How many grams of sodium azide, NaN_3, are needed to produce 68.1 dm^3 of $N_2(g)$ at STP? Molar volume at STP = 22.7 $dm^3 mol^{-1}$; $M_r(NaN_3) = 65.0$

$$2NaN_3(s) \rightarrow 3N_2(g) + 2Na(s)$$

A. 32.5

B. 65.0

C. 130.0

D. 195.0

4. What is the sum of the coefficients when the following equation is balanced using the smallest whole numbers?

$$\_\_C_6H_{12}O_6(aq) \rightarrow \_\_C_2H_5OH(aq) + \_\_CO_2(g)$$

A. 4

B. 5

C. 9

D. 10

4. Which factors affect the molar volume of an ideal gas?

I. Pressure
II. Temperature
III. Empirical formula

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

1. What is the sum of the coefficients when the equation is balanced with whole numbers?

$$\_\_C_8H_{18}(g) + \_\_O_2(g) \rightarrow \_\_CO(g) + \_\_H_2O(l)$$

A. 26.5

B. 30

C. 53

D. 61

2. How many moles of oxygen atoms are there in 0.500 mol of hydrated iron(II) ammonium sulfate, $(NH_4)_2Fe(SO_4)_2{\cdot}6H_2O(s)$?

A. 4.00

B. 7.00

C. 8.00

D. 14.00

3. What is the maximum volume, in dm^3, of $CO_2(g)$ produced when 1.00 g of $CaCO_3(s)$ reacts with 20.0 cm^3 of 2.00 mol dm^{-3} HCl(aq)?

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

Molar volume of gas = 22.7 $dm^3 mol^{-1}$; $M_r(CaCO_3) = 100.00$

A. $\frac{1}{2} \times \frac{20.0 \times 2.00}{1000} \times 22.7$

B. $\frac{20.0 \times 2.00}{1000} \times 22.7$

C. $\frac{1.00}{100.00} \times 22.7$

D. $\frac{1.00}{100.00} \times 2 \times 22.7$

Topic Chem 1 **Q# 13/** IB Chem/2017/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

4. What is the expression for the volume of hydrogen gas, in dm^3, produced at STP when 0.30 g of magnesium reacts with excess hydrochloric acid solution?

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

Molar volume of an ideal gas at STP = $22.7\,dm^3\,mol^{-1}$

A. $\frac{0.30 \times 2 \times 22.7}{24.31}$

B. $\frac{0.30 \times 22.7}{24.31}$

C. $\frac{0.30 \times 24.31}{22.7}$

D. $\frac{0.30 \times 22.7}{24.31 \times 2}$

Topic Chem 1 **Q# 14/** IB Chem/2017/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

1. Which compound has the greatest percentage by mass of nitrogen atoms?

A. N_2H_4

B. NH_3

C. N_2O_4

D. $NaNO_3$

2. Which statements about mixtures are correct?

I. The components may be elements or compounds.
II. All components must be in the same phase.
III. The components retain their individual properties.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

3. 5.0 cm^3 of 2.00 mol dm^{-3} sodium carbonate solution, $Na_2CO_3(aq)$, was added to a volumetric flask and the volume was made up to 500 cm^3 with water. What is the concentration, in mol dm^{-3}, of the solution?

A. 0.0050

B. 0.0040

C. 0.020

D. 0.010

1. Which change of state is exothermic?

A. $CO_2(s) \rightarrow CO_2(g)$

B. $H_2O(l) \rightarrow H_2O(g)$

C. $NH_3(g) \rightarrow NH_3(l)$

D. $Fe(s) \rightarrow Fe(l)$

2. Which volume, in cm^3, of $0.20\,mol\,dm^{-3}$ NaOH (aq) is needed to neutralize 0.050 mol of $H_2S(g)$?

$$H_2S(g) + 2NaOH(aq) \rightarrow Na_2S(aq) + 2H_2O(l)$$

A. 0.25

B. 0.50

C. 250

D. 500

3. The complete combustion of $15.0\,cm^3$ of a gaseous hydrocarbon **X** produces $60.0\,cm^3$ of carbon dioxide gas and $75.0\,cm^3$ of water vapour. What is the molecular formula of **X**? (All volumes are measured at the same temperature and pressure.)

A. C_4H_6

B. C_4H_8

C. C_4H_{10}

D. C_6H_{10}

4. 5.0 mol of $Fe_2O_3(s)$ and 6.0 mol of CO (g) react according to the equation below. What is the limiting reactant and how many moles of the excess reactant remain unreacted?

$$Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$$

	Limiting reactant	Moles of excess reactant remaining
A.	CO	2.0
B.	CO	3.0
C.	Fe_2O_3	1.0
D.	Fe_2O_3	2.0

1. What is the total number of atoms in 0.50 mol of 1,4-diaminobenzene, $H_2NC_6H_4NH_2$? (Avogadro's constant (L or N_A) = 6.0×10^{23} mol^{-1}.)

A. 16.0×10^{23}

B. 48.0×10^{23}

C. 96.0×10^{23}

D. 192.0×10^{23}

2. What is the sum of the coefficients when the equation for the combustion of ammonia is balanced using the smallest possible whole numbers?

$$\_\_\_\ NH_3(g) + \_\_\_\ O_2(g) \rightarrow \_\_\_\ N_2(g) + \_\_\_\ H_2O(g)$$

A. 6

B. 12

C. 14

D. 15

4. 5.00 g of calcium carbonate, when heated, produced 2.40 g of calcium oxide. Which is the correct expression for the percentage yield of calcium oxide? ($M_r(CaCO_3) = 100$; $M_r(CaO) = 56$.)

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

A. $\frac{56 \times 5.00 \times 100}{2.40}$

B. $\frac{2.40 \times 100 \times 100}{56 \times 5.00}$

C. $\frac{56 \times 5.00 \times 100}{2.40 \times 100}$

D. $\frac{2.40 \times 100}{56 \times 5.00}$

1. Which equation represents sublimation?

A. $2Al(s) + 3I_2(g) \rightarrow 2AlI_3(s)$

B. $HgCl_2(s) \rightarrow HgCl_2(g)$

C. $I_2(g) \rightarrow I_2(s)$

D. $CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$

2. For which compound is the empirical formula the same as the molecular formula?

$A_r(H) = 1$; $A_r(C) = 12$; $A_r(O) = 16$

	Empirical formula	Molar mass / g mol^{-1}
A.	CO_2H	90
B.	CH_3O	62
C.	C_2H_4O	88
D.	C_4H_8O	72

3. In which mixture is NaOH the limiting reagent?

A. 0.20 mol NaOH + 0.10 mol H_2SO_4

B. 0.10 mol NaOH + 0.10 mol H_2SO_4

C. 0.20 mol NaOH + 0.10 mol HNO_3

D. 0.10 mol NaOH + 0.10 mol HNO_3

4. Why do gases deviate from the ideal gas law at high pressures?

A. Molecules have finite volume.

B. Cohesive forces increase the volume from the ideal.

C. Increasing pressure increases the temperature of the gas.

D. Collisions between molecules occur more frequently as pressure increases.

5. What is represented by A in $^{A}_{Z}X^{2-}$?

A. Number of electrons

B. Number of neutrons

C. Number of nucleons

D. Number of protons

6. Which represents the shape of an s atomic orbital?

A. 

B. 

C. 

D. 

7. Which property shows a general increase from left to right across period 2, Li to F?

A. Melting point

B. Electronegativity

C. Ionic radius

D. Electrical conductivity

5. Which is correct for $^{34}_{16}S^{2-}$?

	Protons	Neutrons	Electrons
A.	16	18	14
B.	18	16	18
C.	16	18	16
D.	16	18	18

6. Which transition in the hydrogen atom emits visible light?

A. n = 1 to n = 2

B. n = 2 to n = 3

C. n = 2 to n = 1

D. n = 3 to n = 2

5. Bromine consists of two stable isotopes that exist in approximately a 1 : 1 ratio. The relative atomic mass, A_r, of bromine is 79.90. Which are the stable isotopes of bromine?

A. ^{79}Br and ^{81}Br

B. ^{80}Br and ^{81}Br

C. ^{78}Br and ^{80}Br

D. ^{79}Br and ^{80}Br

6. What is the ground state electron configuration of an atom of chromium, Cr (Z = 24)?

A. $[Ar]3d^5$

B. $[Ar]4s^2 3d^4$

C. $[Ar]4s^1 3d^5$

D. $[Ar]4s^2 4p^4$

7. Which describes an atom of bismuth, Bi (Z = 83)?

	Principal energy level number	Number of valence electrons
A.	5	3
B.	5	5
C.	6	5
D.	6	15

Topic Chem 2 **Q# 21/** IB Chem/2018/w/TZ0/Paper1/Standard Level/ www.SmashingScience.org :o)

5. Which statements are correct for the emission spectrum of hydrogen?

I. The lines converge at higher frequencies.

II. Electron transitions to n = 2 are responsible for lines in the visible region.

III. Lines are produced when electrons move from lower to higher energy levels.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

6. Which statement about $^{56}Fe^{3+}$ and $^{54}Fe^{2+}$ is correct?

A. Both have the same numbers of protons and electrons.

B. Both have the same number of protons.

C. Both have the same number of neutrons.

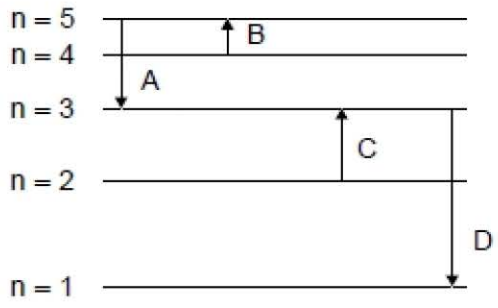
D. Both have the same numbers of protons and neutrons.

Topic Chem 2 **Q# 22/** IB Chem/2018/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

5. What is the composition of the nucleus of ^{26}Mg?

	Protons	Neutrons	Electrons
A.	12	14	12
B.	14	12	0
C.	14	12	14
D.	12	14	0

6. Which electron transition emits energy of the longest wavelength?



Topic Chem 2 **Q# 23/** IB Chem/2018/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

5. Which shows the number of subatomic particles in $^{31}P^{3-}$?

	Protons	Neutrons	Electrons
A.	15	16	18
B.	15	16	12
C.	16	31	15
D.	31	31	15

6. Which are correct statements about the emission spectrum of hydrogen in the visible region?

I. The red line has a lower energy than the blue line.

II. The lines converge at longer wavelength.

III. The frequency of the blue line is greater than the frequency of the red line.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

Topic Chem 2 **Q# 24/** IB Chem/2017/w/TZ0/Paper1/Standard Level/ www.SmashingScience.org :o)

5. What is the number of protons and the number of neutrons in ^{131}I?

	Protons	Neutrons
A.	53	78
B.	53	131
C.	78	53
D.	131	53

6. Which is the electron configuration of a chromium atom in the ground state?

A. $[Ne]3s^2 3p^6 4s^1 3d^4$

B. $[Ar]3d^3$

C. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^4$

D. $[Ar]4s^1 3d^5$

Topic Chem 2 **Q# 25/** IB Chem/2017/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

5. What does $^{24}_{12}Mg^{2+}$ represent?

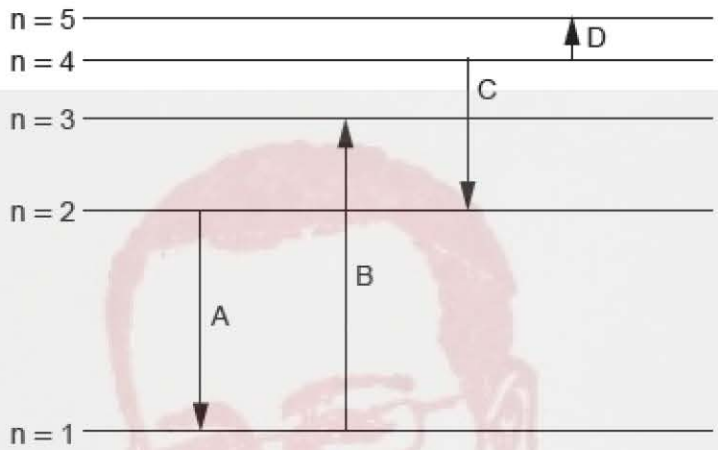
A. An ion with 12 protons and 24 neutrons

B. An ion with 14 protons and 24 neutrons

C. An ion with 12 protons and 12 neutrons

D. An ion with 12 protons and 22 neutrons

6. Which electron transition emits radiation of the longest wavelength?



Topic Chem 2 **Q# 26/** IB Chem/2017/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

5. In which set do all the species contain more electrons than neutrons?

A. ^{14}N, ^{16}O, ^{11}C

B. ^{14}N, ^{16}O, $^{11}C^{4-}$

C. $^{14}N^{3-}$, $^{16}O^{2-}$, ^{11}C

D. $^{14}N^{3-}$, $^{16}O^{2-}$, $^{11}C^{4+}$

6. Which electron transition in the hydrogen atom emission spectrum emits radiation with the longest wavelength?

A. $n = 2 \rightarrow n = 1$

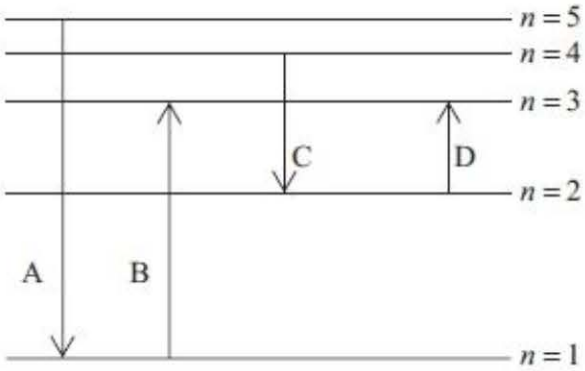
B. $n = 1 \rightarrow n = 2$

C. $n = 4 \rightarrow n = 1$

D. $n = 3 \rightarrow n = 2$

Topic Chem 2 **Q# 27/** IB CHEM/2016/Specimen Paper/TZ0/Paper 1/Standard Level/ www.SmashingScience.org :o)

5. Which electronic transition would absorb the radiation of the shortest wavelength?



Topic Chem 2 **Q# 28/** IB CHEM/2016/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

5. Which is correct for the chromium isotope $^{53}_{24}Cr$?

A. 24 neutrons and 53 nucleons

B. 24 protons and 29 nucleons

C. 24 protons and 29 neutrons

D. 24 electrons and 53 neutrons

6. Which electron configuration is correct for the selenide ion, Se^{2-}?

A. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 4d^{10}\ 4p^4$

B. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 4d^{10}\ 4p^6$

C. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^4$

D. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6$

Topic Chem 3 **Q# 29/** IB Chem/2019/w/TZ0/Paper1/Standard Level/ www.SmashingScience.org :o)

7. Which property shows a general increase from left to right across period 2, Li to F?

A. Melting point

B. Electronegativity

C. Ionic radius

D. Electrical conductivity

8. Which is an f-block element?

A. Sc

B. Sm

C. Sn

D. Sr

Topic Chem 3 **Q# 30/** IB Chem/2019/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

9. How does a lithium atom form the most stable ion?

A. The atom gains a proton to form a positive ion.

B. The atom loses a proton to form a negative ion.

C. The atom loses an electron to form a positive ion.

D. The atom gains an electron to form a negative ion.

Topic Chem 3 **Q# 31/** IB Chem/2019/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

7. Which of the following would have the same numerical value for all elements in the same period?

A. Highest energy levels occupied

B. Energy sub-levels occupied

C. Orbitals occupied

D. Valence electrons

8. How do the following properties change down Group 17 of the periodic table?

	Ionization energy	**Ionic radius**
A.	increases	decreases
B.	increases	increases
C.	decreases	increases
D.	decreases	decreases

Topic Chem 3 **Q# 32/** IB Chem/2018/w/TZ0/Paper1/Standard Level/ www.SmashingScience.org :o)

7. Which oxides produce an acidic solution when added to water?

I. Al_2O_3 and SiO_2

II. P_4O_6 and P_4O_{10}

III. NO_2 and SO_2

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

8. Which species will require the least energy for the removal of one electron?

A. Na^+

B. Mg^+

C. Al^{2+}

D. C^{3+}

Topic Chem 3 **Q# 33/** IB Chem/2018/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

7. Which increase across a period from left to right?

A.	ionic radius	electronegativity
B.	atomic radius	ionic radius
C.	1st ionization energy	atomic radius
D.	1st ionization energy	electronegativity

8. Which element is in the p-block?

A. Pb

B. Pm

C. Pt

D. Pu

Topic Chem 3 **Q# 34/** IB Chem/2018/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

7. Which describes the oxide of sodium, Na_2O?

	Bonding	Conduction of electricity (pure substance)	pH of aqueous solution
A.	covalent	as a solid and liquid	low
B.	covalent	as a solid only	high
C.	ionic	as a solid and liquid	low
D.	ionic	as a liquid only	high

8. Which statement is correct?

A. Atomic radius decreases down group 17.

B. First ionization energy decreases down group 1.

C. Atomic radius increases across period 3 from Na to Cl.

D. First ionization energy decreases across period 3 from Na to Cl.

Topic Chem 3 **Q# 35/** IB Chem/2017/w/TZ0/Paper1/Standard Level/ www.SmashingScience.org :o)

7. Which trends are correct across period 3 (from Na to Cl)?

I. Atomic radius decreases
II. Melting point increases
III. First ionization energy increases

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

8. Which oxide dissolves in water to give a solution with a pH below 7?

A. MgO

B. Li_2O

C. CaO

D. P_4O_{10}

Topic Chem 3 **Q# 36/** IB Chem/2017/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

8. Which element is a lanthanide?

A. Hf

B. Tb

C. U

D. Y

Topic Chem 3 **Q# 37/** IB Chem/2017/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

7. Which property increases down Group 1, the alkali metals?

A. Atomic radius

B. Electronegativity

C. First ionization energy

D. Melting point

Topic Chem 3 **Q# 38/** IB Chem/2017/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

7. The full electron configuration of an element is:

$$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$$

To which group and period does the element belong?

	Group	Period
A.	2	3
B.	3	2
C.	3	4
D.	14	3

8. Which oxide, when added to water, produces the solution with the highest pH?

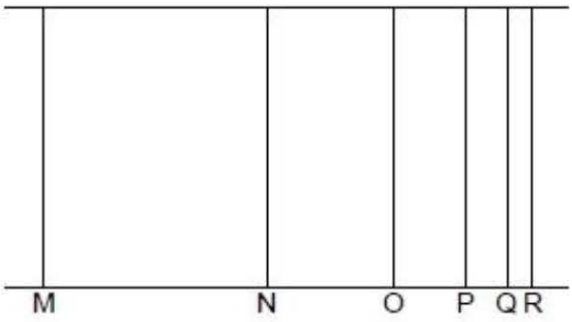
A. Na_2O

B. SO_3

C. MgO

D. CO_2

5. Which is correct for the line emission spectrum for hydrogen?



A. Line M has a higher energy than line N.

B. Line N has a lower frequency than line M.

C. Line M has a longer wavelength than line N.

D. Lines converge at lower energy.

6. What is the condensed electron configuration of the Fe^{2+} ion?

A. $[Ar]3d^6$

B. $[Ar]3d^4 4s^2$

C. $[Ar]3d^5 4s^1$

D. $[Ar]3d^6 4s^2$

7. Which equation represents the first electron affinity of chlorine?

A. $Cl(g) + e^- \rightarrow Cl^-(g)$

B. $\frac{1}{2}Cl_2(g) + e^- \rightarrow Cl^-(g)$

C. $Cl^+(g) + e^- \rightarrow Cl(g)$

D. $Cl(g) \rightarrow Cl^+(g) + e^-$

8. Which solution forms when phosphorus(V) oxide, P_4O_{10}, reacts with water?

	Product	**pH of solution**
A.	H_3PO_3	< 7
B.	H_3PO_3	> 7
C.	H_3PO_4	< 7
D.	H_3PO_4	> 7

Topic Chem 3 **Q# 40/** IB CHEM/2016/Specimen Paper/TZ0/Paper 1/Standard Level/ www.SmashingScience.org :o)

6. What are the numbers of protons, neutrons and electrons in the ion $^{238}_{92}X^{2+}$?

	Protons	Neutrons	Electrons
A.	146	92	144
B.	92	146	90
C.	92	146	94
D.	92	238	90

7. Which element is in the f-block of the periodic table?

A. Be

B. Ce

C. Ge

D. Re

8. Which property increases down group 1 of the periodic table?

A. Melting point

B. First ionization energy

C. Atomic radius

D. Electronegativity

Topic Chem 3 **Q# 41/** IB CHEM/2016/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

7. Which element is a metalloid?

A. Co

B. As

C. Cs

D. Es

8. Which periodic trend is described correctly?

	Trend in	Down the group (top to bottom)	Across the period (left to right)
A.	atomic radius	increases	increases
B.	ionic radius	decreases	increases
C.	first ionization energy	decreases	decreases
D.	electronegativity	decreases	increases

9. Which is correct for all solid ionic compounds?

A. High volatility

B. Poor electrical conductivity

C. Low melting point

D. Good solubility in water

10. Which compound has the shortest C to O bond?

A. CH_3CHO

B. CO

C. CO_2

D. $C_2H_5OC_2H_5$

11. Which describes a resonance structure?

A. Double bond can be drawn in alternative positions.

B. Bonds vibrate by absorbing IR radiation.

C. A double and a single bond in the molecule

D. A Lewis structure

12. What is the structure and bonding in $SiO_2(s)$?

	Structure	Bonding
A.	giant	covalent
B.	giant	ionic
C.	bent molecule	covalent
D.	linear molecule	covalent

Topic Chem 4 **Q# 43/** IB Chem/2019/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

10. Which combination causes the strength of metallic bonding to increase?

	Charge on cations	Ionic radius
A.	smaller	smaller
B.	larger	larger
C.	smaller	larger
D.	larger	smaller

11. Which molecule contains an incomplete octet of electrons?

A. NF_3

B. BF_3

C. BrF

D. SF_2

12. Which compound has hydrogen bonds between its molecules?

A. CH_4

B. CH_4O

C. CH_3Cl

D. CH_2O

Topic Chem 4 **Q# 44/** IB Chem/2019/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

12. Which combination corresponds to a strong metallic bond?

	Charge on the metal ion	Radius of ion
A.	large	large
B.	large	small
C.	small	small
D.	small	large

8. What are typical characteristics of metals?

	Ionization energy	Electron affinity
A.	low	low
B.	high	high
C.	high	low
D.	low	high

9. What is the order of increasing boiling point?

A. $CH_3CH_2CH_2CH_3 < CH_3CH(OH)CH_3 < CH_3COCH_3 < CH_3CO_2H$

B. $CH_3CH_2CH_2CH_3 < CH_3COCH_3 < CH_3CH(OH)CH_3 < CH_3CO_2H$

C. $CH_3CO_2H < CH_3COCH_3 < CH_3CH(OH)CH_3 < CH_3CH_2CH_2CH_3$

D. $CH_3CH_2CH_2CH_3 < CH_3COCH_3 < CH_3CO_2H < CH_3CH(OH)CH_3$

10. Which species does **not** have resonance structures?

A. C_6H_6

B. NH_4^+

C. CO_3^{2-}

D. O_3

11. Which describes an ionic compound?

	Melting point	Electrical conductivity of solid
A.	high	high
B.	high	low
C.	low	high
D.	low	low

9. Which species has the same molecular geometry as SO_3^{2-}?

A. BF_3

B. SO_3

C. PF_3

D. CO_3^{2-}

10. How many lone pairs and bonding pairs of electrons surround the central chlorine atom in ClF_2^+?

	Lone pairs	Bonding pairs
A.	0	2
B.	0	4
C.	2	4
D.	2	2

12. Which molecule is polar?

A. $BeCl_2$

B. BCl_3

C. NCl_3

D. CCl_4

Topic Chem 4 **Q# 47/** IB Chem/2018/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

11. What are the predicted electron domain geometries around the carbon and both nitrogen atoms in urea, $(NH_2)_2CO$, applying VSEPR theory?

	Carbon atom	Nitrogen atoms
A.	trigonal planar	trigonal pyramidal
B.	trigonal planar	tetrahedral
C.	tetrahedral	tetrahedral
D.	trigonal pyramidal	trigonal planar

12. The compounds shown below have similar relative molecular masses. What is the correct order of increasing boiling point?

A. $CH_3COOH < (CH_3)_2CO < (CH_3)_2CHOH$

B. $CH_3COOH < (CH_3)_2CHOH < (CH_3)_2CO$

C. $(CH_3)_2CO < CH_3COOH < (CH_3)_2CHOH$

D. $(CH_3)_2CO < (CH_3)_2CHOH < CH_3COOH$

Topic Chem 4 **Q# 48/** IB Chem/2018/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

9. What is the formula of magnesium nitride?

A. MgN

B. Mg_2N_3

C. Mg_3N

D. Mg_3N_2

10. Which species has the longest carbon to oxygen bond length?

A. CO

B. CH_3OH

C. $CH_3CO_2^-$

D. H_2CO

Topic Chem 4 **Q# 49/** IB Chem/2018/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

11. What is the molecular geometry and bond angle in the molecular ion NO_3^-?

	Molecular geometry	Bond angle
A.	tetrahedral	109.5°
B.	trigonal planar	120°
C.	trigonal pyramidal	107°
D.	trigonal planar	109.5°

12. What are the strongest intermolecular forces between molecules of propanone, CH_3COCH_3, in the liquid phase?

A. London (dispersion) forces

B. Covalent bonding

C. Hydrogen bonding

D. Dipole–dipole forces

Topic Chem 4 **Q# 50/** IB Chem/2018/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

9. What is the formula of ammonium phosphate?

A. $(NH_3)_3PO_4$

B. $(NH_4)_3PO_4$

C. $(NH_4)_2PO_4$

D. $(NH_3)_2PO_3$

10. Which form of carbon is the poorest electrical conductor?

A. Graphite

B. Graphene

C. Diamond

D. Carbon nanotube

9. The electronegativity values of four elements are given.

C	N	O	F
2.6	3.0	3.4	4.0

What is the order of **increasing** polarity of the **bonds** in the following compounds?

A. $CO < OF_2 < NO < CF_4$

B. $CF_4 < CO < OF_2 < NO$

C. $NO < OF_2 < CO < CF_4$

D. $CF_4 < NO < OF_2 < CO$

10. Which compound has the shortest C–N bond?

A. CH_3NH_2

B. $(CH_3)_3CNH_2$

C. CH_3CN

D. CH_3CHNH

11. Which of the following series shows increasing hydrogen bonding with water?

A. Propane < propanal < propanol < propanoic acid

B. Propane < propanol < propanal < propanoic acid

C. Propanal < propane < propanoic acid < propanol

D. Propanoic acid < propanol < propanal < propane

12. Which statements are correct for metals?

I. They conduct electricity because they have free moving ions.
II. They consist of a close-packed lattice of positive ions with delocalized electrons.
III. They are malleable because the layers of positive ions can slide over each other.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

Topic Chem 4 **Q# 52/** IB Chem/2017/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

12. Which metal has the strongest metallic bond?

A. Li

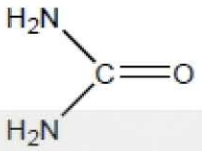
B. Na

C. K

D. Rb

Topic Chem 4 **Q# 53/** IB Chem/2017/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

9. How many bonding electrons are there in the urea molecule?



A. 8

B. 16

C. 20

D. 24

10. Which bonds cause the boiling point of water to be significantly greater than that of hydrogen sulfide?

A. London (dispersion)

B. Covalent

C. Ionic

D. Hydrogen

11. What are the approximate bond angles and structure of crystalline SiO_2?

	O–Si–O	**Structure**
A.	90°	giant molecule
B.	109°	giant molecule
C.	180°	small molecule
D.	180°	giant molecule

10. Which two atoms form the most polar bond?

A. C and F

B. C and Cl

C. Si and F

D. Si and Cl

11. Which combination describes the sulfate(IV) ion, SO_3^{2-} (also known as sulfite ion)?

	Number of electron domains around S	Electron domain geometry	Molecular geometry	O-S-O angle
A.	3	trigonal planar	trigonal planar	120°
B.	3	tetrahedral	trigonal pyramidal	109.5°
C.	4	trigonal pyramidal	trigonal pyramidal	107°
D.	4	tetrahedral	trigonal pyramidal	107°

12. Which correctly states the strongest intermolecular forces in the compounds below?

	CH_4	CH_3Cl	CH_3NH_2
A.	dipole-dipole	London forces	hydrogen bonding
B.	London forces	dipole-dipole	hydrogen bonding
C.	hydrogen bonding	London forces	dipole-dipole
D.	London forces	hydrogen bonding	dipole-dipole

9. A substance has the following properties:

Melting point / °C	Electrical conductivity	
	Molten	Solid
1414	poor	poor

What is the most probable structure of this substance?

A. Network covalent

B. Polar covalent molecule

C. Ionic lattice

D. Metallic lattice

9. Which pair of molecules has the same bond angles?

A. PCl_3 and BCl_3

B. SO_2 and CO_2

C. H_2O and NH_3

D. CCl_4 and SiH_4

10. The C=N bond has a bond length of 130 pm and an average bond enthalpy of 615 kJ mol^{-1}. Which values would be most likely for the C–N bond?

	Bond length / pm	Average bond enthalpy / kJ mol^{-1}
A.	147	286
B.	147	890
C.	116	286
D.	116	890

11. Between which pair of molecules can hydrogen bonding occur?

A. CH_4 and H_2O

B. CH_3OCH_3 and CF_4

C. CH_4 and HF

D. CH_3OH and H_2O

12. Which substance has a giant covalent structure?

	Melting point / °C	Solubility in water	Electrical conductivity in the molten state
A.	186	high	none
B.	801	high	good
C.	1083	low	good
D.	1710	low	none

9. Which is the best description of ionic bonding?

A. Electrostatic attraction between oppositely charged ions

B. Electrostatic attraction between positive ions and electrons

C. Electrostatic attraction of nuclei towards shared electrons in the bond between the nuclei

D. Electrostatic attraction between nuclei

10. Which has bonds with the greatest covalent character?

A. $SrCl_2$

B. $SiCl_4$

C. $SnCl_2$

D. Sn

11. Which bond is the least polar?

A. C=O in CO_2

B. C–H in CH_4

C. C–Cl in CCl_4

D. N–H in CH_3NH_2

12. Which substance has a high melting point and does not conduct electricity in any state?

A. $PbBr_2$

B. Fe

C. NaCl

D. SiO_2

Topic Chem 4 **Q# 58/** IB CHEM/2016/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

9. Which molecule is non-polar?

A. OF_2

B. NH_3

C. BF_3

D. SO_2

10. Which compound contains both ionic and covalent bonds?

A. SiH_4

B. $NaNO_3$

C. H_2CO

D. Na_2S

11. Which compound has resonance structures?

A. C_6H_{12}

B. CH_3CHO

C. NaBr

D. Na_2CO_3

12. Which of the following are van der Waals' forces?

I. Dipole-dipole forces
II. Hydrogen bonds
III. London (dispersion) forces

A. I and II only

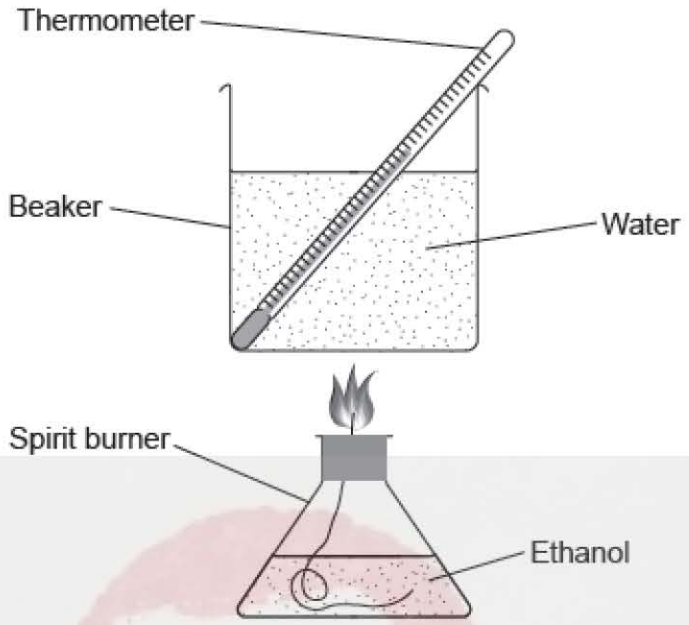
B. I and III only

C. II and III only

D. I, II and III

Topic Chem 5 **Q# 59/** IB Chem/2019/w/TZ0/Paper1/Standard Level/Page 4

Questions 13 and 14 are about an experiment to measure the enthalpy of combustion, ΔH_c, of ethanol, using the apparatus and setup shown.



13. What is the enthalpy of combustion, ΔH_c, of ethanol in $kJ\,mol^{-1}$?

Maximum temperature of water: 30.0 °C
Initial temperature of water: 20.0 °C
Mass of water in beaker: 100.0 g
Loss in mass of ethanol: 0.230 g
M_r (ethanol): 46.08
Specific heat capacity of water: $4.18\,J\,g^{-1}K^{-1}$
$q = mc\Delta T$

A. $-\dfrac{100.0 \times 4.18 \times (10.0 + 273)}{\dfrac{0.230}{46.08} \times 1000}$

B. $-\dfrac{0.230 \times 4.18 \times 10.0}{\dfrac{100.0}{46.08} \times 1000}$

C. $-\dfrac{100.0 \times 4.18 \times 10.0}{\dfrac{0.230}{46.08} \times 1000}$

D. $-\dfrac{100.0 \times 4.18 \times 10.0}{\dfrac{0.230}{46.08}}$

14. Which quantity is likely to be the most inaccurate due to the sources of error in this experiment?

A. Mass of ethanol burnt

B. Molecular mass of ethanol

C. Mass of water

D. Temperature change

15. What is the enthalpy change of the reaction?

$$C_6H_{14}(l) \rightarrow C_2H_4(g) + C_4H_{10}(g)$$

	Enthalpy of combustion / kJ mol^{-1}
$C_6H_{14}(l)$	–4163
$C_2H_4(g)$	–1411
$C_4H_{10}(g)$	–2878

A. + 1411 + 2878 + 4163

B. + 1411 – 2878 – 4163

C. + 1411 + 2878 – 4163

D. – 1411 – 2878 + 4163

16. Which equation represents the N–H bond enthalpy in NH_3?

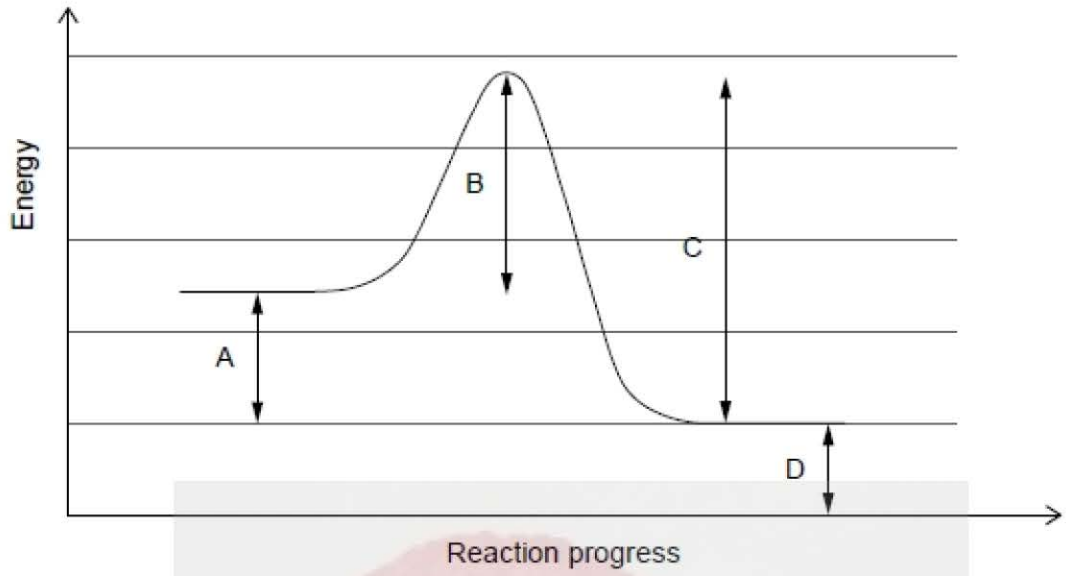
A. $NH_3(g) \rightarrow N(g) + 3H(g)$

B. $\frac{1}{3}NH_3(g) \rightarrow \frac{1}{3}N(g) + H(g)$

C. $NH_3(g) \rightarrow \frac{1}{2}N_2(g) + \frac{3}{2}H_2(g)$

D. $NH_3(g) \rightarrow \bullet NH_2(g) + \bullet H(g)$

15. Which is the activation energy of the forward reaction?



Topic Chem 5 **Q# 61/** IB Chem/2019/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

13. Consider the following equations.

$$2Al(s) + \frac{3}{2}O_2(g) \rightarrow Al_2O_3(s) \qquad \Delta H^\ominus = -1670\,kJ$$

$$Mn(s) + O_2(g) \rightarrow MnO_2(s) \qquad \Delta H^\ominus = -520\,kJ$$

What is the standard enthalpy change, in kJ, of the reaction below?

$$4Al(s) + 3MnO_2(s) \rightarrow 2Al_2O_3(s) + 3Mn(s)$$

A. $-1670 + 520$

B. $\frac{3}{2}(-1670) + 3(520)$

C. $2(-1670) + 3(-520)$

D. $2(-1670) + 3(520)$

14. Methane undergoes incomplete combustion.

$$2CH_4(g) + 3O_2(g) \rightarrow 2CO(g) + 4H_2O(g)$$

What is the enthalpy change, in kJ, using the bond enthalpy data given below?

Bond	Average bond enthalpy / kJ mol^{-1}
C–H	414
O–H	463
O=O	498
C≡O	1077

A. $[2(1077) + 4(463)] - [2(414) + 3(498)]$

B. $[2(414) + 3(498)] - [2(1077) + 4(463)]$

C. $[8(414) + 3(498)] - [2(1077) + 8(463)]$

D. $[2(1077) + 8(463)] - [8(414) + 3(498)]$

Topic Chem 5 **Q# 62/** IB Chem/2019/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

15. Which is correct for the reaction?

$$2Al(s) + 6HCl(aq) \rightarrow 2AlCl_3(aq) + 3H_2(g) \qquad \Delta H = -1049\,kJ$$

A. Reactants are less stable than products and the reaction is endothermic.

B. Reactants are more stable than products and the reaction is endothermic.

C. Reactants are more stable than products and the reaction is exothermic.

D. Reactants are less stable than products and the reaction is exothermic.

13. When equal masses of X and Y absorb the same amount of energy, their temperatures rise by 5 °C and 10 °C respectively. Which is correct?

A. The specific heat capacity of X is twice that of Y.

B. The specific heat capacity of X is half that of Y.

C. The specific heat capacity of X is one fifth that of Y.

D. The specific heat capacity of X is the same as Y.

14. What is the enthalpy change of reaction for the following equation?

$$C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$$

$$C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(l) \qquad \Delta H = x$$

$$C_2H_6(g) + \frac{7}{2}O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l) \qquad \Delta H = y$$

$$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l) \qquad \Delta H = z$$

A. $x + y + z$

B. $-x - y + z$

C. $x - y - z$

D. $x - y + z$

13. Consider the following reactions:

$$Fe_2O_3(s) + CO(g) \rightarrow 2FeO(s) + CO_2(g) \qquad \Delta H^{\ominus} = -3\,kJ$$

$$Fe(s) + CO_2(g) \rightarrow FeO(s) + CO(g) \qquad \Delta H^{\ominus} = +11\,kJ$$

What is the $\Delta H^{\ominus}$ value, in kJ, for the following reaction?

$$Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$$

A. −25

B. −14

C. +8

D. +19

14. Which is correct when $Ba(OH)_2$ reacts with NH_4Cl?

$$Ba(OH)_2(s) + 2NH_4Cl(s) \rightarrow BaCl_2(aq) + 2NH_3(g) + 2H_2O(l) \qquad \Delta H^{\ominus} = +164\,kJ\,mol^{-1}$$

	Temperature	Enthalpy	Stability
A.	increases	products have lower enthalpy than the reactants	products are less stable than the reactants
B.	decreases	products have lower enthalpy than the reactants	products are more stable than the reactants
C.	decreases	products have higher enthalpy than the reactants	products are less stable than the reactants
D.	increases	products have higher enthalpy than the reactants	products are more stable than the reactants

15. Consider the following reaction:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

	Bond enthalpies / kJ mol^{-1} (at 298 K)
H–H	x
N≡N	y
N–H	z

Which calculation gives $\Delta H^{\ominus}$, in kJ, for the forward reaction?

A. $2z - y - 3x$

B. $y + 3x - 2z$

C. $y + 3x - 6z$

D. $6z - y - 3x$

14. What is the enthalpy change of combustion of urea, $(NH_2)_2CO$, in kJ mol^{-1}?

$$2(NH_2)_2CO\ (s) + 3O_2\ (g) \rightarrow 2CO_2\ (g) + 2N_2\ (g) + 4H_2O\ (l)$$

	ΔH_f / kJ mol^{-1}
$(NH_2)_2CO$ (s)	–333
CO_2 (g)	–394
H_2O (l)	–286

A. $2 \times (-333) - 2 \times (-394) - 4 \times (-286)$

B. $\frac{1}{2}[2 \times (-394) + 4 \times (-286) - 2 \times (-333)]$

C. $2 \times (-394) + 4 \times (-286) - 2 \times (-333)$

D. $\frac{1}{2}[2 \times (-333) - 2 \times (-394) - 4 \times (-286)]$

15. Two 100 cm^3 aqueous solutions, one containing 0.010 mol NaOH and the other 0.010 mol HCl, are at the same temperature.

When the two solutions are mixed the temperature rises by y °C.

Assume the density of the final solution is 1.00 g cm^{-3}.
Specific heat capacity of water = 4.18 J g^{-1} K^{-1}

What is the enthalpy change of neutralization in kJ mol^{-1}?

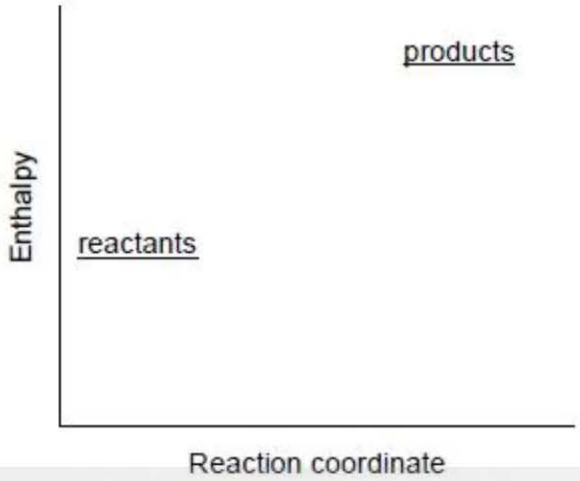
A. $\frac{200 \times 4.18 \times y}{1000 \times 0.020}$

B. $\frac{200 \times 4.18 \times y}{1000 \times 0.010}$

C. $\frac{100 \times 4.18 \times y}{1000 \times 0.010}$

D. $\frac{200 \times 4.18 \times (y + 273)}{1000 \times 0.010}$

13. Which describes the reaction shown in the potential energy profile?



A. The reaction is endothermic and the products have greater enthalpy than the reactants.

B. The reaction is endothermic and the reactants have greater enthalpy than the products.

C. The reaction is exothermic and the products have greater enthalpy than the reactants.

D. The reaction is exothermic and the reactants have greater enthalpy than the products.

Topic Chem 5 **Q# 67/** IB Chem/2018/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

14. What is the enthalpy of combustion of butane in **kJ mol^{-1}**?

$$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(l)$$

$$C(s) + O_2(g) \rightarrow CO_2(g) \qquad \Delta H = x \text{ kJ}$$

$$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l) \qquad \Delta H = y \text{ kJ}$$

$$4C(s) + 5H_2(g) \rightarrow C_4H_{10}(g) \qquad \Delta H = z \text{ kJ}$$

A. $4x + 5y - z$

B. $4x + 5y + z$

C. $8x + 10y - 2z$

D. $8x + 5y + 2z$

15. Which statement is correct?

A. In an exothermic reaction, the products have more energy than the reactants.

B. In an exothermic reversible reaction, the activation energy of the forward reaction is greater than that of the reverse reaction.

C. In an endothermic reaction, the products are more stable than the reactants.

D. In an endothermic reversible reaction, the activation energy of the forward reaction is greater than that of the reverse reaction.

Topic Chem 5 **Q# 68/** IB Chem/2018/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

13. The enthalpy of combustion of ethanol is determined by heating a known mass of tap water in a glass beaker with a flame of burning ethanol.

Which will lead to the greatest error in the final result?

A. Assuming the density of tap water is $1.0\,\text{g cm}^{-3}$

B. Assuming all the energy from the combustion will heat the water

C. Assuming the specific heat capacity of the tap water is $4.18\,\text{J g}^{-1}\,\text{K}^{-1}$

D. Assuming the specific heat capacity of the beaker is negligible

13. Which statement is correct for this reaction?

$$Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g) \qquad \Delta H = -26.6\,kJ$$

A. 13.3 kJ are released for every mole of Fe produced.

B. 26.6 kJ are absorbed for every mole of Fe produced.

C. 53.2 kJ are released for every mole of Fe produced.

D. 26.6 kJ are released for every mole of Fe produced.

14. The enthalpy changes for two reactions are given.

$$Br_2(l) + F_2(g) \rightarrow 2BrF(g) \qquad \Delta H = x\,kJ$$
$$Br_2(l) + 3F_2(g) \rightarrow 2BrF_3(g) \qquad \Delta H = y\,kJ$$

What is the enthalpy change for the following reaction?

$$BrF(g) + F_2(g) \rightarrow BrF_3(g)$$

A. $x - y$

B. $-x + y$

C. $\frac{1}{2}(-x + y)$

D. $\frac{1}{2}(x - y)$

15. What is the enthalpy change, in kJ, of the following reaction?

$$3H_2(g) + N_2(g) \rightleftharpoons 2NH_3(g)$$

Bond	Bond enthalpy / kJ mol^{-1}
N≡N	945
H–H	436
N–H	391

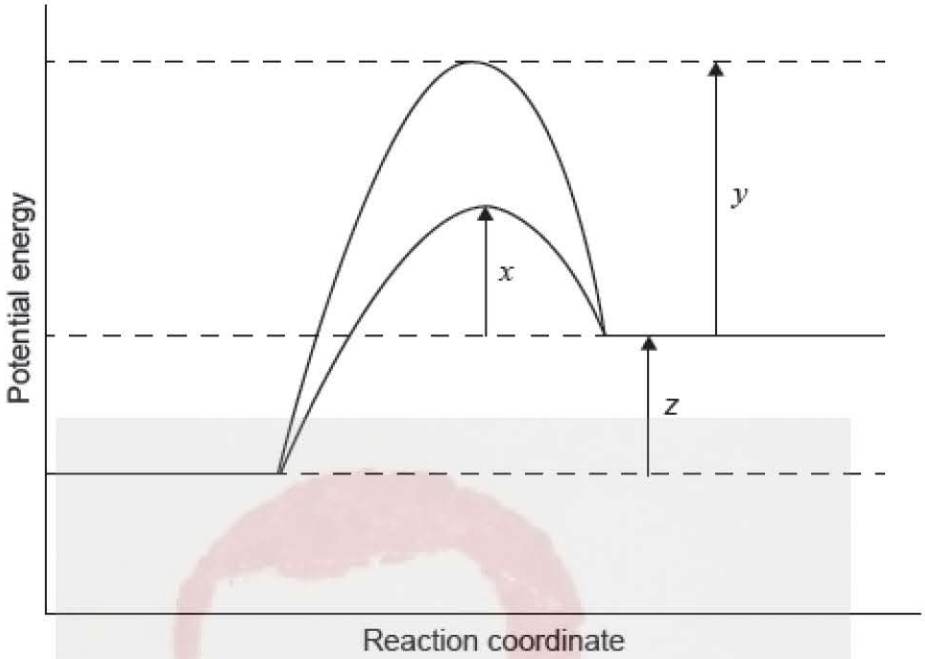
A. $(6 \times 391) - [(3 \times 436) + 945]$

B. $(3 \times 391) - (436 + 945)$

C. $-[(3 \times 436) + 945] + (3 \times 391)$

D. $-(6 \times 391) + [(3 \times 436) + 945]$

16. The diagram shows the energy profile for a catalysed and uncatalysed reaction.
Which represents the enthalpy change, ΔH, and the activation energy, E_a, for the **catalysed** reaction?



	ΔH	E_a (catalysed reaction)
A.	z	$x + z$
B.	z	$z + y$
C.	$-z$	x
D.	$z + x$	x

Topic Chem 5 **Q# 70/** IB Chem/2017/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

15. What can be deduced from the facts that ozone absorbs UV radiation in the region of 340 nm and molecular oxygen in the region of 242 nm?

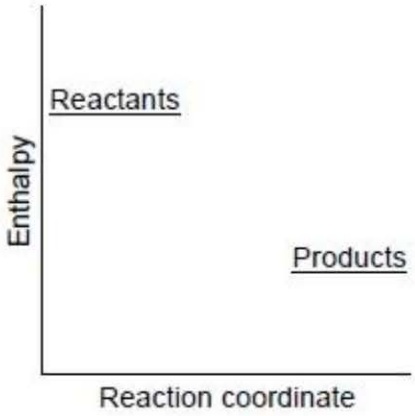
A. The bond between atoms in molecular oxygen is a double bond.

B. The bonds in ozone are delocalized.

C. The bonds between atoms in ozone are stronger than those in molecular oxygen.

D. The bonds between atoms in molecular oxygen need more energy to break.

13. What can be deduced from this reaction profile?



A. The reactants are less stable than the products and the reaction is exothermic.

B. The reactants are less stable than the products and the reaction is endothermic.

C. The reactants are more stable than the products and the reaction is exothermic.

D. The reactants are more stable than the products and the reaction is endothermic.

14. Why is the value of the enthalpy change of this reaction calculated from bond enthalpy data less accurate than that calculated from standard enthalpies of formation?

$$2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(g)$$

A. All the reactants and products are gases.

B. Bond enthalpy data are average values for many compounds.

C. Elements do not have standard enthalpy of formation.

D. Standard enthalpies of formation are per mole.

13. Which expression gives the mass, in g, of ethanol required to produce 683.5 kJ of heat upon complete combustion?

(M_r for ethanol = 46.0, $\Delta H_c^{\ominus} = -1367\ \text{kJ mol}^{-1}$)

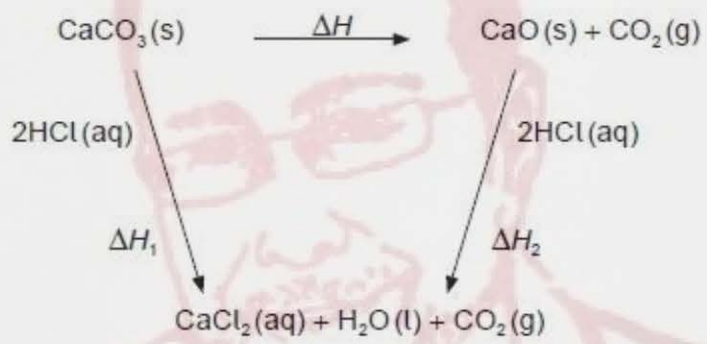
A. $\dfrac{683.5}{1367 \times 46.0}$

B. $\dfrac{1367}{683.5 \times 46.0}$

C. $\dfrac{683.5 \times 46.0}{1367}$

D. $\dfrac{1367 \times 46.0}{683.5}$

14. Which expression gives the enthalpy change, ΔH, for the thermal decomposition of calcium carbonate?



A. $\Delta H = \Delta H_1 - \Delta H_2$

B. $\Delta H = 2\Delta H_1 - \Delta H_2$

C. $\Delta H = \Delta H_1 - 2\Delta H_2$

D. $\Delta H = \Delta H_1 + \Delta H_2$

15. In which order does the oxygen–oxygen bond enthalpy increase?

A. $H_2O_2 < O_2 < O_3$

B. $H_2O_2 < O_3 < O_2$

C. $O_2 < O_3 < H_2O_2$

D. $O_3 < H_2O_2 < O_2$

13. Hydrazine reacts with oxygen.

$$N_2H_4(l) + O_2(g) \rightarrow N_2(g) + 2H_2O(l) \qquad \Delta H^{\ominus} = -623\,kJ$$

What is the standard enthalpy of formation of $N_2H_4(l)$ in kJ? The standard enthalpy of formation of $H_2O(l)$ is $-286\,kJ$.

A. $-623 - 286$

B. $-623 + 572$

C. $-572 + 623$

D. $-286 + 623$

14. In which reaction do the reactants have a lower potential energy than the products?

A. $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$

B. $HBr(g) \rightarrow H(g) + Br(g)$

C. $Na^+(g) + Cl^-(g) \rightarrow NaCl(s)$

D. $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$

15. 5.35 g of solid ammonium chloride, $NH_4Cl(s)$, was added to water to form 25.0 g of solution. The maximum decrease in temperature was 14 K. What is the enthalpy change, in $kJ\,mol^{-1}$, for this reaction? (Molar mass of $NH_4Cl = 53.5\,g\,mol^{-1}$; the specific heat capacity of the solution is $4.18\,J\,g^{-1}\,K^{-1}$)

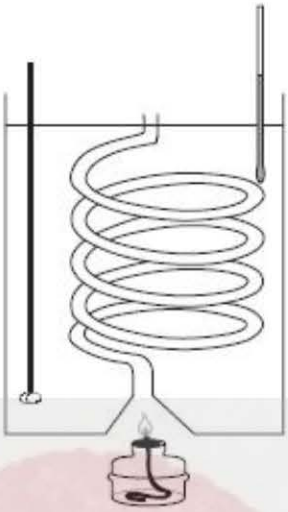
A. $\Delta H = +\dfrac{25.0 \times 4.18 \times (14 + 273)}{0.1 \times 1000}$

B. $\Delta H = -\dfrac{25.0 \times 4.18 \times 14}{0.1 \times 1000}$

C. $\Delta H = +\dfrac{25.0 \times 4.18 \times 14}{0.1 \times 1000}$

D. $\Delta H = +\dfrac{25.0 \times 4.18 \times 14}{1000}$

13. When 0.46 g of ethanol is burned under a water-filled calorimeter, the temperature of 500 g of water is raised by 3.0 K. (Molar mass of ethanol = 46 g mol^{-1}; specific heat capacity of water = 4.18 J g^{-1} K^{-1}; $q = mc\Delta T$.)



What is the expression for the enthalpy of combustion, ΔH_c, in kJ mol^{-1}?

A. $-\dfrac{500\times4.18\times3.0\times46}{0.46}$

B. $-\dfrac{500\times4.18\times(273+3.0)\times46}{0.46\times1000}$

C. $-\dfrac{500\times4.18\times3.0\times46}{0.46\times1000}$

D. $-\dfrac{0.46\times1000}{500\times4.18\times3.0\times46}$

14. Which reaction represents the average bond enthalpy of the C–H bond?

A. $\frac{1}{4}CH_4(g) \rightarrow \frac{1}{4}C(g) + \frac{1}{2}H_2(g)$

B. $\frac{1}{4}CH_4(g) \rightarrow \frac{1}{4}CH_2(g) + \frac{1}{4}H_2(g)$

C. $\frac{1}{4}CH_4(g) \rightarrow \frac{1}{4}C(g) + H(g)$

D. $\frac{1}{4}CH_4(g) \rightarrow \frac{1}{4}C(s) + H(g)$

15. Given the following information, what is the standard enthalpy of formation, $\Delta H^{\ominus}_f$, of methane?

$$C(s) + O_2(g) \rightarrow CO_2(g) \qquad \Delta H = E \text{ kJ}$$
$$H_2(g) + \tfrac{1}{2}O_2(g) \rightarrow H_2O(l) \qquad \Delta H = F \text{ kJ}$$
$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l) \qquad \Delta H = G \text{ kJ}$$

A. E + F + G

B. E + F – G

C. E + 2F + G

D. E + 2F – G

Topic Chem 5 **Q# 75/** IB CHEM/2016/Specimen Paper/TZ0/Paper 1/Standard Level/ www.SmashingScience.org :o)

3. Which changes of state are endothermic processes?

I. Condensing

II. Melting

III. Subliming

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

13. When 25.0 cm^3 0.100 mol dm^{-3} NaOH (aq) is mixed with 25.0 cm^3 0.100 mol dm^{-3} HCl (aq) at the same temperature, a temperature rise, ΔT, is recorded. What is the expression, in kJ mol^{-1}, for the enthalpy of neutralisation? (Assume the density of the mixture = 1.00 g cm^{-3} and its specific heat capacity = 4.18 kJ kg^{-1} K^{-1} = 4.18 J g^{-1} K^{-1})

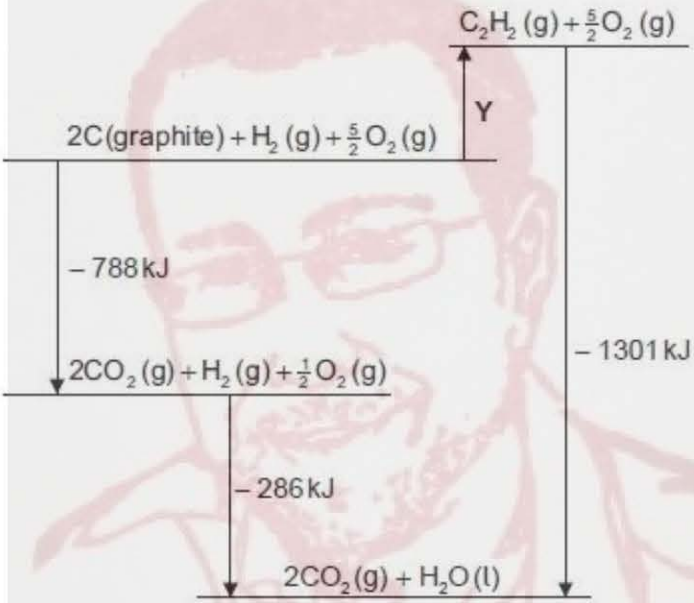
A. $-\dfrac{25.0 \times 4.18 \times \Delta T}{50.0 \times 0.100}$

B. $-\dfrac{25.0 \times 4.18 \times \Delta T}{25.0 \times 0.100}$

C. $-\dfrac{50.0 \times 4.18 \times \Delta T}{50.0 \times 0.100}$

D. $-\dfrac{50.0 \times 4.18 \times \Delta T}{25.0 \times 0.100}$

14. What is the enthalpy of formation of ethyne, in kJ mol^{-1}, represented by the arrow **Y** on the diagram?



A. – 788 – 286 + 1301

B. – 788 – 286 – 1301

C. + 788 + 286 – 1301

D. + 788 + 286 + 1301

15. Which equation represents the average bond enthalpy of the Si–H bond in SiH_4?

A. $SiH_4(g) \rightarrow SiH_3(g) + H(g)$

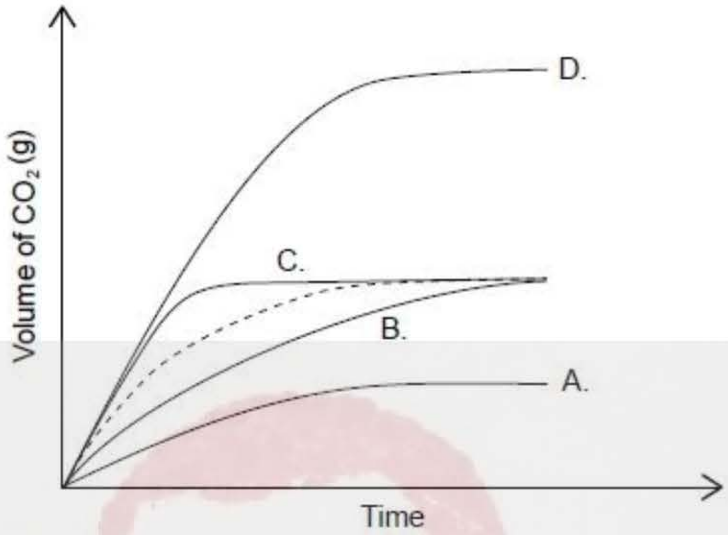
B. $\frac{1}{4}SiH_4(g) \rightarrow \frac{1}{4}Si(g) + H(g)$

C. $SiH_4(g) \rightarrow SiH_3(g) + \frac{1}{2}H_2(g)$

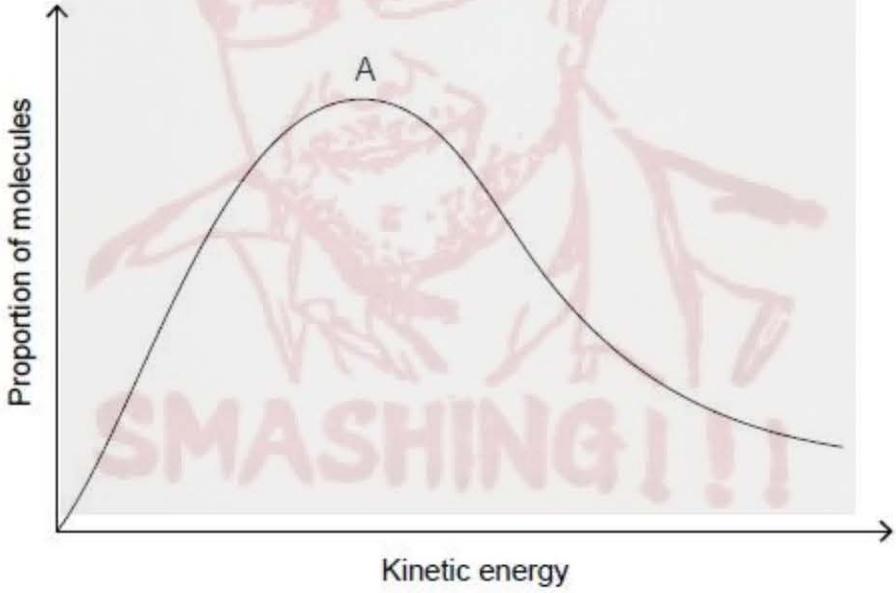
D. $SiH_4(g) \rightarrow Si(g) + 4H(g)$

17. The dotted line represents the volume of carbon dioxide evolved when excess calcium carbonate is added to hydrochloric acid.

Which graph represents the production of carbon dioxide when excess calcium carbonate is added to the same volume of hydrochloric acid of double concentration?



18. The graph shows the Maxwell–Boltzmann energy distribution curve for a given gas at a certain temperature.



How will the curve change if the temperature of the gas is increased, while other conditions remain constant?

A. The maximum is higher and to the left of A.

B. The maximum is higher and to the right of A.

C. The maximum is lower and to the right of A.

D. The maximum is lower and to the left of A.

Topic Chem 6 **Q# 78/** IB Chem/2019/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

17. Several reactions of calcium carbonate with dilute hydrochloric acid are carried out at the same temperature.

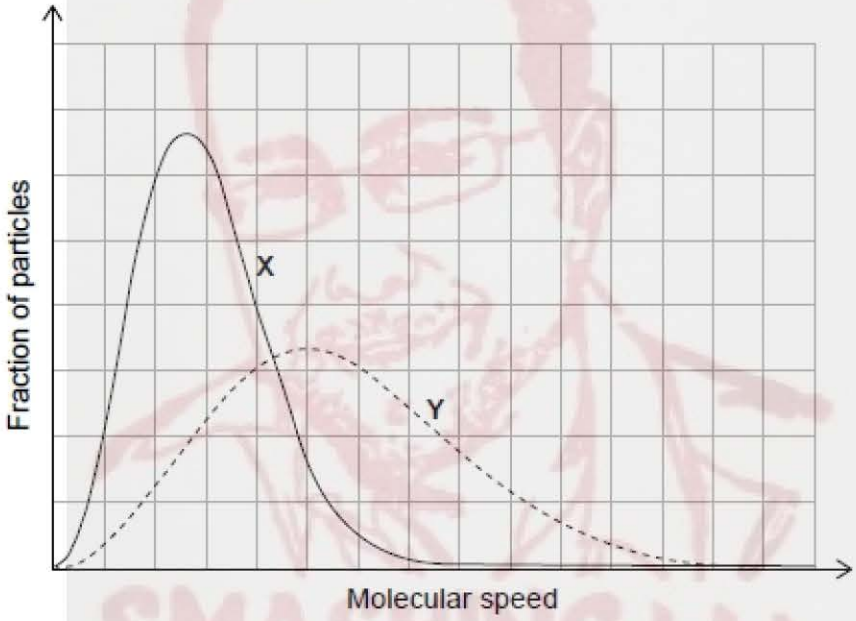
$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

Which reaction has the greatest rate?

	Concentration of HCl(aq)	Surface area of same mass of $CaCO_3(s)$
A.	higher	larger
B.	lower	smaller
C.	lower	larger
D.	higher	smaller

Topic Chem 6 **Q# 79/** IB Chem/2019/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

16. The same amount of two gases, **X** and **Y**, are in two identical containers at the same temperature. What is the difference between the gases?



A. **X** has the higher molar mass.

B. **Y** has the higher molar mass.

C. **X** has the higher average kinetic energy.

D. **Y** has the higher average kinetic energy.

Topic Chem 6 **Q# 80/** IB Chem/2019/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

16. Which properties can be monitored to determine the rate of the reaction?

$$Fe(s) + CuSO_4(aq) \rightarrow Cu(s) + FeSO_4(aq)$$

I. change in volume
II. change in temperature
III. change in colour

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

17. Which will increase the rate of reaction between calcium carbonate and hydrochloric acid?

I. an increase in temperature
II. an increase in concentration of hydrochloric acid
III. an increase in particle size of calcium carbonate

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

Topic Chem 6 **Q# 81/** IB Chem/2018/w/TZ0/Paper1/Standard Level/ www.SmashingScience.org :o)

16. Samples of sodium carbonate powder were reacted with separate samples of excess hydrochloric acid.

$$Na_2CO_3(s) + 2HCl(aq) \rightarrow CO_2(g) + 2NaCl(aq) + H_2O(l)$$

Reaction I: 1.0 g $Na_2CO_3(s)$ added to 0.50 mol dm^{-3} HCl(aq)
Reaction II: 1.0 g $Na_2CO_3(s)$ added to 2.0 mol dm^{-3} HCl(aq)

What is the same for reactions I and II?

A. Initial rate of reaction

B. Total mass of CO_2 produced

C. Total reaction time

D. Average rate of production of CO_2

17. What decreases the activation energy of a reaction?

A. Increasing the temperature

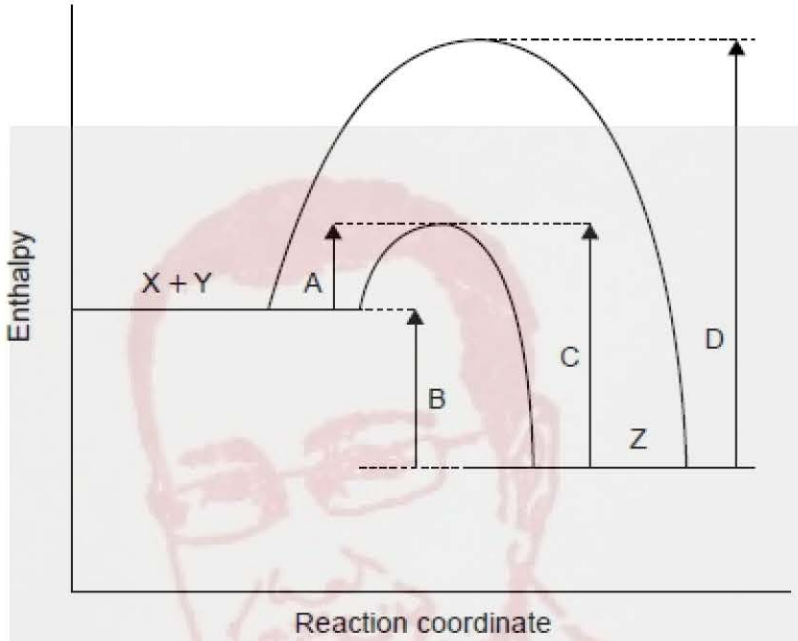
B. Adding a catalyst

C. Adding more reactants

D. Increasing collision frequency of reactants

Topic Chem 6 **Q# 82/** IB Chem/2018/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

16. The potential energy profile for the reversible reaction, $X + Y \rightleftharpoons Z$ is shown.



Which arrow represents the activation energy for the reverse reaction, $Z \rightarrow X + Y$, with a catalyst?

17. Which factors can affect the rate of reaction?

I. Particle size of solid reactant
II. Concentration of reacting solution
III. Pressure of reacting gas

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

Topic Chem 6 **Q# 83/** IB Chem/2018/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

17. Which statements are correct?

I. The activation energy of a reaction is not affected by temperature.

II. A catalyst reduces the enthalpy change of a reaction.

III. Catalysts provide alternative reaction pathways.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

Topic Chem 6 **Q# 84/** IB Chem/2018/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

16. Which change increases the rate of formation of hydrogen when zinc reacts with excess hydrochloric acid, assuming all other conditions remain the same?

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

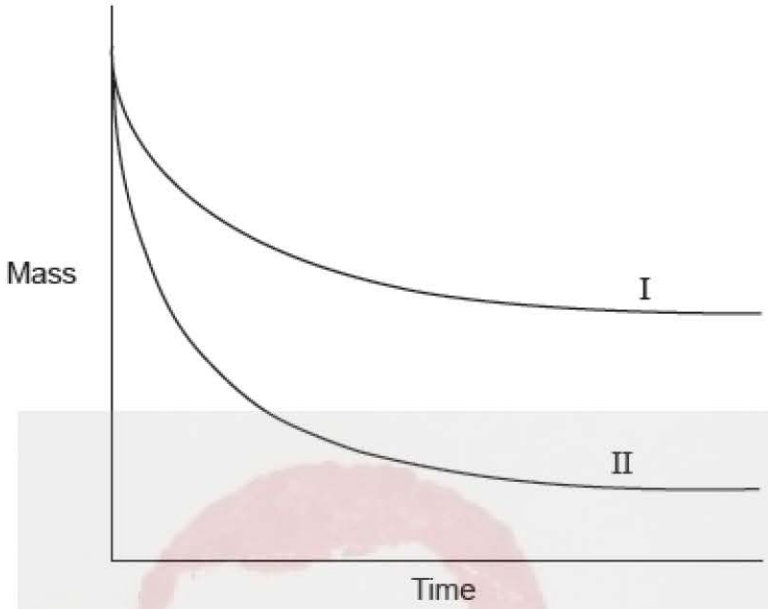
A. Adding water to the hydrochloric acid

B. Decreasing the temperature

C. Increasing the volume of hydrochloric acid

D. Decreasing the size of the zinc particles while keeping the total mass of zinc the same

17. Excess magnesium powder was added to a beaker containing hydrochloric acid, HCl (aq). The mass of the beaker and its contents was recorded and plotted against time (line I).



Which change could give line II?

A. Doubling the mass of powdered Mg

B. Using the same mass of Mg ribbon

C. Increasing the temperature

D. Using the same volume of more concentrated HCl

Questions 16 and 17 refer to the following reaction.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

16. Which change does **not** increase the initial rate of reaction when $CaCO_3(s)$ is added to excess $HCl(aq)$?

A. Decrease in the size of the $CaCO_3(s)$ particles

B. Increase in the temperature of the reaction mixture

C. Increase in the concentration of $HCl(aq)$, keeping the same volume

D. Increase in the volume of $HCl(aq)$, keeping the same concentration

17. Which methods can be used to monitor the progress of this reaction?

I. Change in colour of this reaction mixture
II. Change in mass of this reaction mixture
III. Change in volume of gas evolved

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

16. Copper catalyses the reaction between zinc and dilute sulfuric acid.

$$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$$

Why does copper affect the reaction?

A. Decreases the activation energy

B. Increases the activation energy

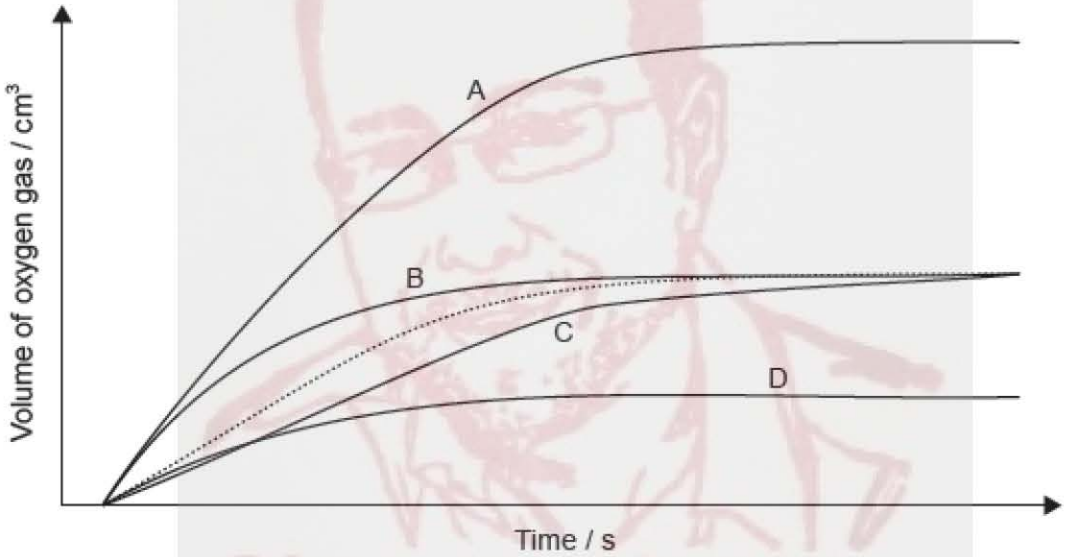
C. Increases the enthalpy change

D. Decreases the enthalpy change

17. 100 cm^3 of 10 % hydrogen peroxide solution decomposes at 298 K to form water and oxygen.

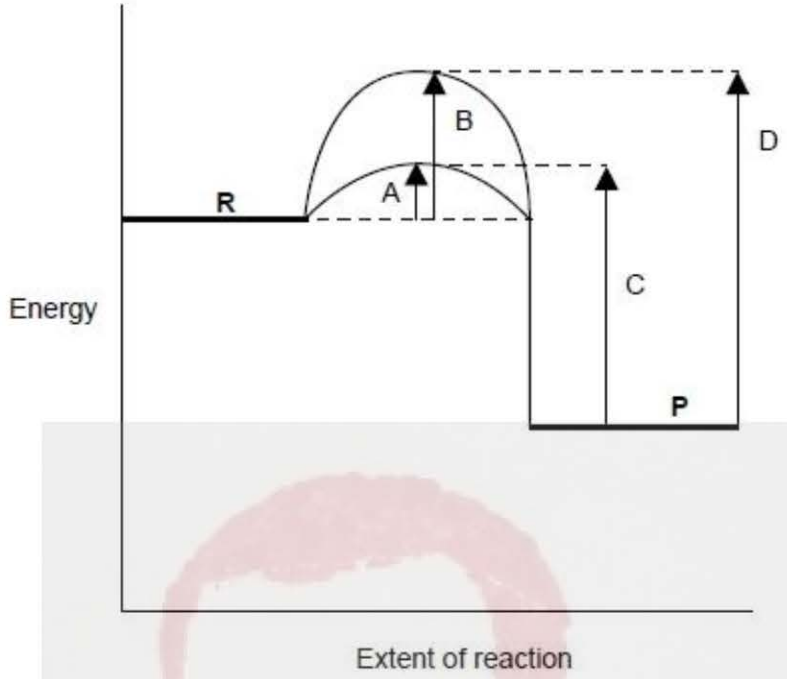
$$H_2O_2(aq) \rightarrow H_2O(l) + \frac{1}{2}O_2(g)$$

The dotted line graph represents the volume of oxygen produced.



Which graph represents the decomposition of an equal volume of a 20 % solution under the same conditions?

16. For the reaction **R** → **P**, which letter represents the activation energy for the catalysed **reverse** reaction?



17. Which experimental methods could be used to observe the progress of the following reaction?

$$Cr_2O_7^{2-}(aq) + 6I^-(aq) + 14H^+(aq) \rightarrow 2Cr^{3+}(aq) + 3I_2(aq) + 7H_2O(l)$$

I. Change in colour
II. Change in mass
III. Change in electrical conductivity

A. I and II only

B. I and III only

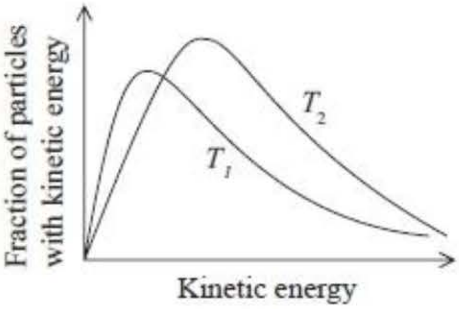
C. II and III only

D. I, II and III

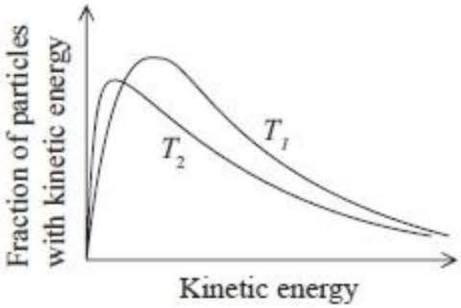
Topic Chem 6 **Q# 89/** IB CHEM/2016/Specimen Paper/TZ0/Paper 1/Standard Level/ www.SmashingScience.org :o)

16. Which graph shows the Maxwell-Boltzmann energy distribution of a same amount of a gas at two temperatures, where T_2 is greater than T_1?

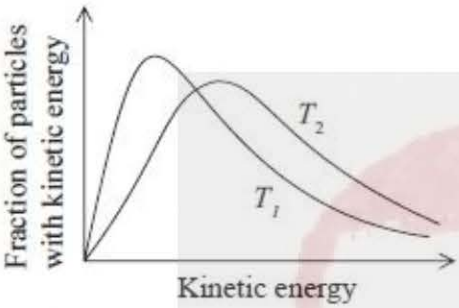
A.



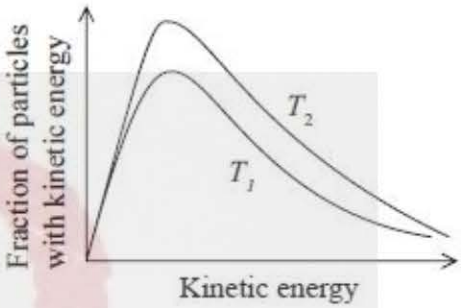
B.



C.



D.



17. Which changes increase the rate of this reaction, other conditions remaining constant?

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

I. Using larger lumps of calcium carbonate

II. Increasing the temperature of the reaction mixture

III. Increasing the concentration of hydrochloric acid

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

Topic Chem 6 **Q# 90/** IB CHEM/2016/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

16. Which conditions must be met for a reaction to take place?

I. Reactants collide with sufficient energy.
II. Reactants collide with correct orientation.
III. Reactants must be in the same state.

A. I and II only

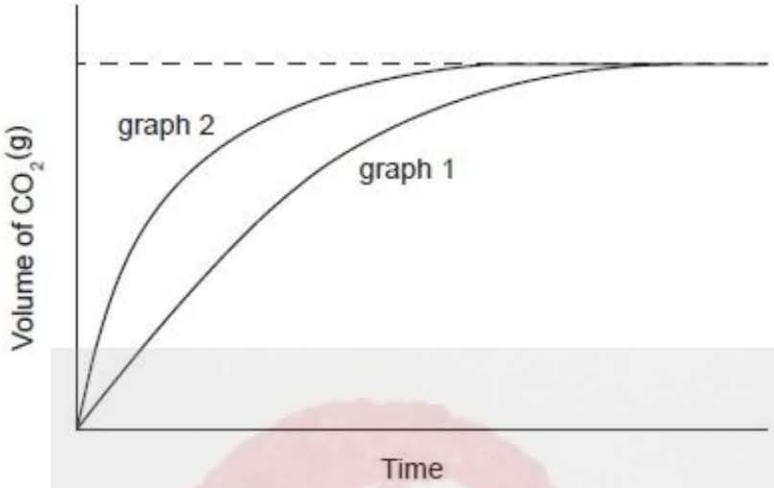
B. I and III only

C. II and III only

D. I, II and III

17. Graph 1 shows a plot of volume of $CO_2(g)$ against time for the reaction of $CaCO_3(s)$ with $1.00\,mol\,dm^{-3}$ $HCl(aq)$. The acid is the limiting reagent and entirely covers the lumps of $CaCO_3(s)$.

Which set of conditions is most likely to give the data plotted in graph 2 when the same mass of $CaCO_3(s)$ is reacted with the same volume of $HCl(aq)$ at the same temperature?



	Size of lumps	Concentration of acid / mol dm^{-3}
A.	larger	1.00
B.	smaller	0.05
C.	smaller	1.00
D.	larger	0.05

Topic Chem 7 **Q# 91/** IB Chem/2019/w/TZ0/Paper1/Standard Level/ www.SmashingScience.org :o)

19. What effect does increasing both pressure and temperature have on the equilibrium constant, K_c?

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -45.9\,kJ$$

A. Decreases

B. Increases

C. Remains constant

D. Cannot be predicted as effects are opposite

Topic Chem 7 **Q# 92/** IB Chem/2019/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

18. What is the equilibrium constant expression for the following equation?

$$2NO_2(g) + F_2(g) \rightleftharpoons 2NO_2F(g)$$

A. $\frac{2[NO_2F]}{2[NO_2] + [F_2]}$

B. $\frac{2[NO_2F]}{2[NO_2][F_2]}$

C. $\frac{[NO_2]^2[F_2]}{[NO_2F]^2}$

D. $\frac{[NO_2F]^2}{[NO_2]^2[F_2]}$

Topic Chem 7 **Q# 93/** IB Chem/2019/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

18. K_c for $2N_2O(g) \rightleftharpoons 2N_2(g) + O_2(g)$ is 7.3×10^{34}.

What is K_c for the following reaction, at the same temperature?

$$N_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons N_2O(g)$$

A. 7.3×10^{34}

B. $\frac{1}{\sqrt{7.3 \times 10^{34}}}$

C. $\frac{2}{7.3 \times 10^{34}}$

D. $\frac{1}{2 \times 7.3 \times 10^{34}}$

Topic Chem 7 **Q# 94/** IB Chem/2018/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

18. Which factor does **not** affect the position of equilibrium in this reaction?

$$2NO_2(g) \rightleftharpoons N_2O_4(g) \qquad \Delta H = -58\,kJ\,mol^{-1}$$

A. Change in volume of the container

B. Change in temperature

C. Addition of a catalyst

D. Change in pressure

Topic Chem 7 **Q# 95/** IB Chem/2018/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

18. The equilibrium constant for $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ is *K*.

What is the equilibrium constant for this equation?

$$2N_2(g) + 6H_2(g) \rightleftharpoons 4NH_3(g)$$

A. *K*

B. *2K*

C. K^2

D. $2K^2$

Topic Chem 7 **Q# 96/** IB Chem/2017/w/TZ0/Paper1/Standard Level/ www.SmashingScience.org :o)

18. What will happen if the pressure is increased in the following reaction mixture at equilibrium?

$$CO_2(g) + H_2O(l) \rightleftharpoons H^+(aq) + HCO_3^-(aq)$$

A. The equilibrium will shift to the right and pH will decrease.

B. The equilibrium will shift to the right and pH will increase.

C. The equilibrium will shift to the left and pH will increase.

D. The equilibrium will shift to the left and pH will decrease.

Topic Chem 7 **Q# 97/** IB Chem/2017/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

18. What is the equilibrium constant expression, K_c, for the following reaction?

$$2NH_3(g) + 2O_2(g) \rightleftharpoons N_2O(g) + 3H_2O(g)$$

A. $\frac{3[H_2O][N_2O]}{2[NH_3]2[O_2]}$

B. $\frac{[NH_3]^2[O_2]^2}{[N_2O][H_2O]^3}$

C. $\frac{2[NH_3]2[O_2]}{3[H_2O][N_2O]}$

D. $\frac{[N_2O][H_2O]^3}{[NH_3]^2[O_2]^2}$

Topic Chem 7 **Q# 98/** IB Chem/2017/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

18. Consider the equilibrium between $N_2O_4(g)$ and $NO_2(g)$.

$$N_2O_4(g) \rightleftharpoons 2NO_2(g) \qquad \Delta H = +58\,kJ\,mol^{-1}$$

Which changes shift the position of equilibrium to the right?

I. Increasing the temperature
II. Decreasing the pressure
III. Adding a catalyst

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

Topic Chem 7 **Q# 99/** IB CHEM/2016/w/TZ0/Paper 1/Standard Level/ www.SmashingScience.org :o)

18. What happens when the temperature of the following equilibrium system is increased?

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g) \qquad \Delta H^{\ominus} = -91\,kJ$$

	Position of equilibrium	Reaction rates of forward and reverse reactions
A.	shifts to the left	increase
B.	shifts to the left	decrease
C.	shifts to the right	decrease
D.	shifts to the right	increase

Topic Chem 7 **Q# 100/** IB CHEM/2016/Specimen Paper/TZ0/Paper 1/Standard Level/ www.SmashingScience.org :o)

18. Which conditions give the greatest equilibrium yield of methanal, $H_2CO(g)$?

$$CO(g) + H_2(g) \rightleftharpoons H_2CO(g) \qquad \Delta H = -1.8\,kJ$$

	Pressure	Temperature
A.	high	low
B.	high	high
C.	low	high
D.	low	low

Topic Chem 7 **Q# 101/** IB CHEM/2016/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

18. What is the effect of increasing temperature on the equilibrium?

$$ClNO_2(g) + NO(g) \rightleftharpoons ClNO(g) + NO_2(g) \qquad \Delta H^{\ominus} = -18.4\,kJ$$

	Position of equilibrium	K_c
A.	moves to left	decreases
B.	moves to left	no change
C.	moves to right	no change
D.	moves to right	increases

Topic Chem 8 **Q# 102/** IB Chem/2019/w/TZ0/Paper1/Standard Level/ www.SmashingScience.org :o)

20. What is the difference between a conjugate Brønsted–Lowry acid-base pair?

A. Electron pair

B. Positive charge

C. Proton

D. Hydrogen atom

21. Which is an example of an amphiprotic species?

A. Al_2O_3

B. CO_3^{2-}

C. P_4O_{10}

D. HPO_4^{2-}

Topic Chem 8 **Q# 103/** IB Chem/2019/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

19. What is the pH of $0.001\,mol\,dm^{-3}$ NaOH(aq)?

A. 1

B. 3

C. 11

D. 13

20. What is the major reason why the pH of unpolluted rain is less than 7?

A. methane

B. carbon dioxide

C. nitrogen oxides

D. sulfur dioxide

Topic Chem 8 **Q# 104/** IB Chem/2019/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

19. Which solution is basic at 25 °C?

$$K_w = 1.0 \times 10^{-14}$$

A. $[H^+] = 1.0 \times 10^{-3}\,mol\,dm^{-3}$

B. $[OH^-] = 1.0 \times 10^{-13}\,mol\,dm^{-3}$

C. solution of pH = 4.00

D. $[H_3O^+] = 1.0 \times 10^{-13}\,mol\,dm^{-3}$

20. Which is **not** a source of oxides of sulfur and nitrogen?

A. burning coal

B. internal combustion engines

C. burning methane

D. volcanic eruptions

Topic Chem 8 **Q# 105/** IB Chem/2018/w/TZ0/Paper1/Standard Level/ www.SmashingScience.org :o)

18. Consider the reaction:

$$2N_2O(g) \rightleftharpoons 2N_2(g) + O_2(g)$$

The values of K_c at different temperatures are:

Temperature / K	K_c
838	1.10×10^{-3}
1001	3.80×10^{-1}
1030	8.71×10^{-1}
1053	1.67

Which statement is correct at higher temperature?

A. The forward reaction is favoured.

B. The reverse reaction is favoured.

C. The rate of the reverse reaction is greater than the rate of the forward reaction.

D. The concentration of both reactants and products increase.

Topic Chem 8 **Q# 106/** IB Chem/2018/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

19. Activity series of selected elements:

K, Ca, Al, Fe, H, Cu, Ag, Au

greatest activity ← least activity

Which react with dilute sulfuric acid?

I. Cu
II. CuO
III. $CuCO_3$

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

20. Which statement is correct?

A. A strong acid is a good proton donor and has a strong conjugate base.

B. A weak acid is a poor proton acceptor and has a strong conjugate base.

C. A strong acid is a good proton donor and has a weak conjugate base.

D. A strong base is a good proton donor and has a weak conjugate acid.

Topic Chem 8 **Q# 107/** IB Chem/2018/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

20. What are the products of the reaction between sulfuric acid and sodium hydrogen carbonate?

A. $NaSO_4 + H_2O + CO_2$

B. $Na_2SO_4 + CO_2$

C. $Na_2SO_4 + H_2O + CO_2$

D. $NaSO_4 + H_2CO_3$

Topic Chem 8 **Q# 108/** IB Chem/2018/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

19. Which classification is correct for the reaction?

$$H_2PO_4^-(aq) + H_2O(l) \rightarrow HPO_4^{2-}(aq) + H_3O^+(aq)$$

	Brønsted–Lowry Acid	Brønsted–Lowry Base
A.	H_2O	$H_2PO_4^-$
B.	HPO_4^{2-}	$H_2PO_4^-$
C.	$H_2PO_4^-$	H_3O^+
D.	$H_2PO_4^-$	H_2O

Topic Chem 8 **Q# 109/** IB Chem/2017/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

19. Which of the following does **not** react with dilute HCl (aq)?

Extract from activity series

Increasing activity ↑
Na
Zn
H
Cu

A. Na_2CO_3

B. Cu

C. Zn

D. CuO

20. Which of the following is correct?

A. A weak acid is a proton donor and its aqueous solution shows good conductivity.

B. A weak acid is a proton donor and its aqueous solution shows poor conductivity.

C. A weak acid is a proton acceptor and its aqueous solution shows good conductivity.

D. A weak acid is a proton acceptor and its aqueous solution shows poor conductivity.

Topic Chem 8 **Q# 110/** IB Chem/2017/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

19. Which is an acid-base conjugate pair?

A. H_3O^+ / OH^-

B. H_2SO_4 / SO_4^{2-}

C. CH_3COOH / H_3O^+

D. $CH_3NH_3^+$ / CH_3NH_2

20. Which 1.0 mol dm^{-3} solution has the highest pH?

A. Ammonium chloride

B. Sulfuric acid

C. Sodium chloride

D. Ammonia

Topic Chem 8 **Q# 111/** IB CHEM/2016/w/TZ0/Paper 1/Standard Level/ www.SmashingScience.org :o)

19. Which species behave as Brønsted–Lowry bases in the following reaction?

$$H_2SO_4 + HNO_3 \rightleftharpoons H_2NO_3^+ + HSO_4^-$$

A. HNO_3 and HSO_4^-

B. HNO_3 and $H_2NO_3^+$

C. H_2SO_4 and HSO_4^-

D. $H_2NO_3^+$ and HSO_4^-

20. What occurs when solid sodium hydrogen carbonate reacts with aqueous sulfuric acid?

A. Bubbles of sulfur dioxide form.

B. Bubbles of both hydrogen and carbon dioxide form.

C. Bubbles of hydrogen form.

D. Bubbles of carbon dioxide form.

21. Which is a correct statement for the reaction below?

$$2MnO_4^-(aq) + 6H^+(aq) + 5NO_2^-(aq) \rightarrow 2Mn^{2+}(aq) + 5NO_3^-(aq) + 3H_2O(l)$$

A. MnO_4^- is the reducing agent and the oxidation number of Mn increases.

B. MnO_4^- is the oxidizing agent and the oxidation number of Mn decreases.

C. NO_2^- is the reducing agent and the oxidation number of N decreases.

D. NO_2^- is the oxidizing agent and the oxidation number of N increases.

Topic Chem 8 **Q# 112/** IB CHEM/2016/Specimen Paper/TZ0/Paper 1/Standard Level/ www.SmashingScience.org :o)

19. Which of the following is **not** amphiprotic?

A. H_2O

B. HPO_4^{2-}

C. $H_2PO_4^-$

D. H_3O^+

20. Which compound will react with dilute hydrochloric acid, HCl(aq), to give off a gas?

A. $Cu_2O(s)$

B. $Cu(OH)_2(s)$

C. $CuCO_3(s)$

D. $CuO(s)$

Topic Chem 8 **Q# 113/** IB CHEM/2016/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

19. Which is a conjugate Brønsted–Lowry acid-base pair?

$$CH_3COOH(aq) + H_2O(l) \rightleftharpoons CH_3COO^-(aq) + H_3O^+(aq)$$

A. CH_3COO^- / H_3O^+

B. H_2O / CH_3COO^-

C. H_2O / H_3O^+

D. CH_3COOH / H_2O

20. Which of the following gases does **not** result in acid deposition?

A. CO_2

B. NO_2

C. NO

D. SO_2

Topic Chem 9 **Q# 114/** IB Chem/2019/w/TZ0/Paper1/Standard Level/ www.SmashingScience.org :o)

22. In which species does sulfur have the same oxidation state as in SO_3^{2-}?

A. $S_2O_3^{2-}$

B. SO_4^{2-}

C. H_2S

D. $SOCl_2$

23. The following occurs when metal **X** is added to **Y** sulfate solution and **Z** sulfate solution. (**X**, **Y** and **Z** represent metal elements but not their symbols.)

$$\mathbf{X}(s) + \mathbf{Y}SO_4(aq) \rightarrow \mathbf{X}SO_4(aq) + \mathbf{Y}(s)$$

$$\mathbf{X}(s) + \mathbf{Z}SO_4(aq)\text{: no reaction}$$

What is the order of increasing reactivity?

A. X < Y < Z

B. Y < X < Z

C. Z < Y < X

D. Z < X < Y

24. What is formed at the electrodes during the electrolysis of molten sodium bromide?

	Positive electrode	Negative electrode
A.	Na^+	Br^-
B.	Na	Br_2
C.	Br^-	Na^+
D.	Br_2	Na

21. Which species contains nitrogen with the highest oxidation state?

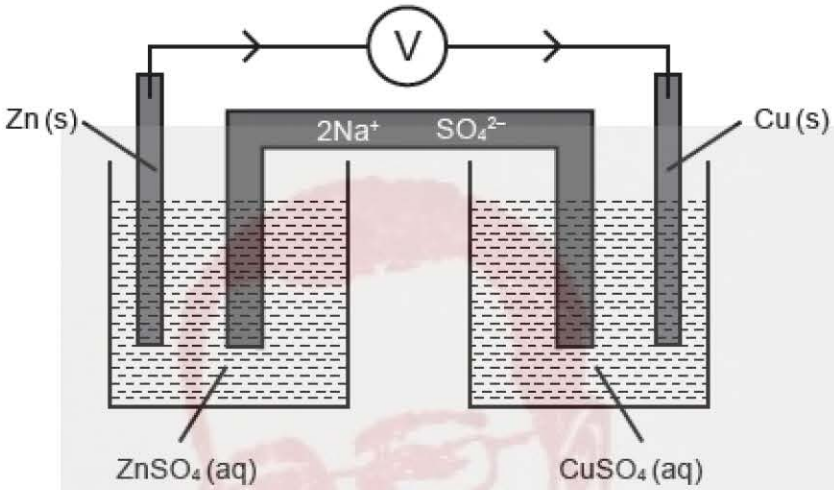
A. NO_3^-

B. NO_2^-

C. NO_2

D. N_2O

22. Consider the following electrochemical cell.



What happens to the ions in the salt bridge when a current flows?

A. Na^+ ions flow to the zinc half-cell and SO_4^{2-} ions flow to the copper half-cell.

B. Na^+ ions flow to the copper half-cell and SO_4^{2-} ions flow to the zinc half-cell.

C. Na^+ and SO_4^{2-} ions flow to the copper half-cell.

D. Na^+ and SO_4^{2-} ions flow to the zinc half-cell.

23. The following reaction occurs in a voltaic (galvanic) cell.

$$Mg(s) + 2Ag^+(aq) \rightarrow Mg^{2+}(aq) + 2Ag(s)$$

Which reaction takes place at each electrode?

	Anode (negative electrode)	**Cathode (positive electrode)**
A.	$Ag(s) \rightarrow Ag^+(aq) + e^-$	$Mg^{2+}(aq) + 2e^- \rightarrow Mg(s)$
B.	$Ag^+(aq) + e^- \rightarrow Ag(s)$	$Mg(s) \rightarrow Mg^{2+}(aq) + 2e^-$
C.	$Mg(s) \rightarrow Mg^{2+}(aq) + 2e^-$	$Ag^+(aq) + e^- \rightarrow Ag(s)$
D.	$Mg^{2+}(aq) + 2e^- \rightarrow Mg(s)$	$Ag(s) \rightarrow Ag^+(aq) + e^-$

Topic Chem 9 **Q# 116/** IB Chem/2019/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

22. Which is the species oxidized and the oxidizing agent in the reaction?

$$MnO_2(s) + 4HCl(aq) \rightarrow MnCl_2(aq) + Cl_2(g) + 2H_2O(l)$$

	Species oxidized	Oxidizing agent
A.	Cl^-	HCl
B.	MnO_2	MnO_2
C.	MnO_2	HCl
D.	Cl^-	MnO_2

23. Which product will be obtained at the anode (positive electrode) when molten NaCl is electrolysed?

A. Na (l)

B. Cl (g)

C. Cl_2 (g)

D. Na (s)

Topic Chem 9 **Q# 117/** IB Chem/2019/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

21. Where does oxidation occur in a voltaic cell?

A. positive electrode and anode

B. negative electrode and anode

C. positive electrode and cathode

D. negative electrode and cathode

Topic Chem 9 **Q# 118/** IB Chem/2018/w/TZ0/Paper1/Standard Level/ www.SmashingScience.org :o)

19. Which two species act as Brønsted–Lowry acids in the reaction?

$$H_2PO_4^-(aq) + OH^-(aq) \rightleftharpoons HPO_4^{2-}(aq) + H_2O(l)$$

A. HPO_4^{2-} (aq) and OH^- (aq)

B. $H_2PO_4^-$ (aq) and HPO_4^{2-} (aq)

C. HPO_4^{2-} (aq) and H_2O (l)

D. $H_2PO_4^-$ (aq) and H_2O (l)

20. What is the order of increasing pH for the following solutions of the same concentration?

A. $HCl(aq) < NH_3(aq) < NaOH(aq) < CH_3COOH(aq)$

B. $CH_3COOH(aq) < HCl(aq) < NH_3(aq) < NaOH(aq)$

C. $HCl(aq) < CH_3COOH(aq) < NH_3(aq) < NaOH(aq)$

D. $NaOH(aq) < NH_3(aq) < CH_3COOH(aq) < HCl(aq)$

Topic Chem 9 **Q# 119/** IB Chem/2018/w/TZ0/Paper1/Standard Level/ www.SmashingScience.org :o)

21. Which is correct for the reaction?

$$P_4(s) + 3H_2O(l) + 3OH^-(aq) \rightarrow PH_3(g) + 3H_2PO_2^-(aq)$$

	Oxidizing agent	Reducing agent
A.	H_2O	P_4
B.	P_4	OH^-
C.	OH^-	P_4
D.	P_4	P_4

22. Which describes the flow of electrons in a voltaic cell?

A. From the cathode (positive electrode) to the anode (negative electrode) through the external circuit

B. From the anode (negative electrode) to the cathode (positive electrode) through the external circuit

C. From the oxidizing agent to the reducing agent through the salt bridge

D. From the reducing agent to the oxidizing agent through the salt bridge

23. Which represents a reduction?

A. SO_3 to SO_4^{2-}

B. Mn_2O_3 to MnO_2

C. H_2O_2 to OH^-

D. CrO_4^{2-} to $Cr_2O_7^{2-}$

Topic Chem 9 **Q# 120/** IB Chem/2018/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

21. Which element has the same oxidation number in both species?

A. C in C_2H_4 and CO_2

B. H in H_2O and NaH

C. S in SO_4^{2-} and SO_3

D. O in H_2O_2 and H_2O

22. Which can describe oxidation?

A. Loss of hydrogen

B. Decrease in oxidation number

C. Gain of electrons

D. Loss of oxygen

Topic Chem 9 **Q# 121/** IB Chem/2018/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

23. What are the products of the electrolysis of molten zinc bromide?

	Negative electrode (cathode)	**Positive electrode (anode)**
A.	zinc	bromine
B.	hydrogen	bromine
C.	bromine	zinc
D.	bromine	hydrogen

21. Which equation shows oxygen undergoing reduction?

A. $2F_2 + O_2 \rightarrow 2F_2O$

B. $Na_2O + H_2O \rightarrow 2NaOH$

C. $H_2O_2 + 2HI \rightarrow 2H_2O + I_2$

D. $2CrO_4^{2-} + 2H^+ \rightleftharpoons Cr_2O_7^{2-} + H_2O$

22. What are the products of electrolysis when molten calcium bromide is electrolysed using graphite electrodes?

	Product at cathode (negative electrode)	**Product at anode (positive electrode)**
A.	calcium	bromine
B.	bromine	calcium
C.	calcium ions	bromide ions
D.	bromide ions	calcium ions

23. Which coefficients correctly balance this redox equation?

$$aFe^{2+}(aq) + MnO_4^-(aq) + bH^+(aq) \rightarrow cFe^{3+}(aq) + Mn^{2+}(aq) + dH_2O(l)$$

	a	**b**	**c**	**d**
A.	1	8	1	4
B.	5	4	5	2
C.	3	4	3	2
D.	5	8	5	4

23. What is the reaction type and major product at the **anode** (positive electrode) when molten sodium chloride is electrolysed using platinum electrodes?

	Reaction type	Product
A.	reduction	Cl_2
B.	oxidation	Cl_2
C.	reduction	Na
D.	oxidation	Na

24. What is the major product of the reaction between HCl and but-2-ene?

A. 1,2-dichlorobutane

B. 2,3-dichlorobutane

C. 1-chlorobutane

D. 2-chlorobutane

25. Which compound can be oxidized when heated with an acidified solution of potassium dichromate(VI)?

A. $CH_3C(O)CH_2CH_3$

B. $CH_3CH_2CH(OH)CH_3$

C. $(CH_3)_3COH$

D. $CH_3(CH_2)_2COOH$

21. What are the oxidation states of chromium in $(NH_4)_2Cr_2O_7(s)$ and $Cr_2O_3(s)$?

	$(NH_4)_2Cr_2O_7(s)$	$Cr_2O_3(s)$
A.	+7	+3
B.	+6	+3
C.	+6	+6
D.	+7	+6

22. Which of the following is a redox reaction?

A. $3Mg(s) + 2AlCl_3(aq) \rightarrow 2Al(s) + 3MgCl_2(aq)$

B. $SiO_2(s) + 2NaOH(aq) \rightarrow Na_2SiO_3(aq) + H_2O(l)$

C. $KCl(aq) + AgNO_3(aq) \rightarrow AgCl(s) + KNO_3(aq)$

D. $2NaHCO_3(aq) \rightarrow Na_2CO_3(aq) + CO_2(g) + H_2O(l)$

21. Which element is reduced in the following decomposition?

$$(NH_4)_2Cr_2O_7(s) \rightarrow N_2(g) + Cr_2O_3(s) + 4H_2O(g)$$

A. N

B. H

C. Cr

D. O

22. Which of the following is **not** a redox reaction?

A. $CH_4(g) + Cl_2(g) \rightarrow CH_3Cl(g) + HCl(g)$

B. $C(s) + O_2(g) \rightarrow CO_2(g)$

C. $2CO(g) \rightarrow CO_2(g) + C(s)$

D. $CH_3COOH(aq) + NaOH(aq) \rightarrow CH_3COONa(aq) + H_2O(l)$

23. What occurs at the anode (positive electrode) during the electrolysis of molten strontium bromide?

A. Formation of bromine and oxidation

B. Formation of bromine and reduction

C. Formation of strontium and oxidation

D. Formation of strontium and reduction

21. What is the order of decreasing reactivity of the metals (most reactive first)?

$$Zn(s) + Sn^{2+}(aq) \rightarrow Zn^{2+}(aq) + Sn(s)$$
$$Cu(s) + Zn^{2+}(aq) \rightarrow \text{No Reaction}$$
$$Sn(s) + Cu^{2+}(aq) \rightarrow Sn^{2+}(aq) + Cu(s)$$
$$Ag(s) + Cu^{2+}(aq) \rightarrow \text{No Reaction}$$

A. Zn > Cu > Sn > Ag

B. Sn > Zn > Ag > Cu

C. Ag > Cu > Zn > Sn

D. Zn > Sn > Cu > Ag

22. What is the oxidation half-equation in the redox reaction?

$$2S_2O_3^{2-}(aq) + I_2(aq) \rightarrow S_4O_6^{2-}(aq) + 2I^-(aq)$$

A. $I_2(aq) + 2e^- \rightarrow 2I^-(aq)$

B. $2I^-(aq) \rightarrow I_2(aq) + 2e^-$

C. $2S_2O_3^{2-}(aq) \rightarrow S_4O_6^{2-}(aq) + 2e^-$

D. $S_4O_6^{2-}(aq) + 2e^- \rightarrow 2S_2O_3^{2-}(aq)$

23. Which statements are correct for a voltaic cell?

I. A spontaneous redox chemical reaction produces electrical energy.
II. Oxidation occurs at the cathode (negative electrode).
III. Electrons flow from anode (negative electrode) to cathode (positive electrode).

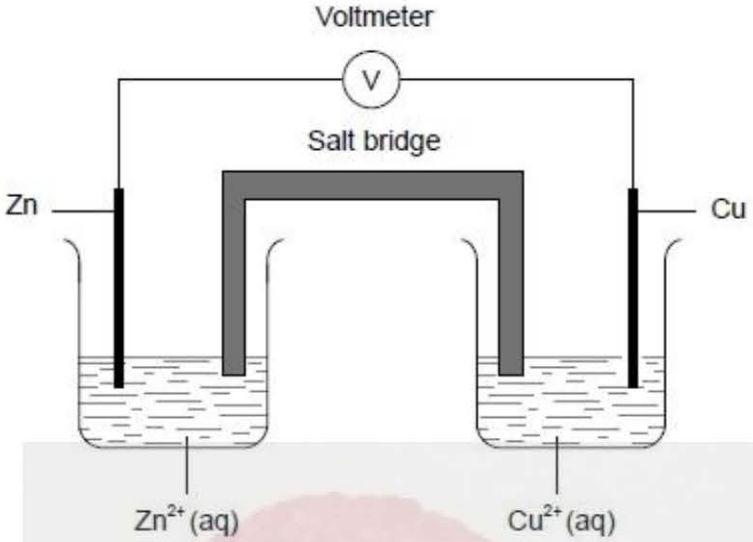
A. I and II only

B. I and III only

C. II and III only

D. I, II and III

22. A voltaic cell is constructed from zinc and copper half-cells. Zinc is more reactive than copper. Which statement is correct when this cell produces electricity?



A. Electrons flow from the copper half-cell to the zinc half-cell.

B. The concentration of Cu^{2+} (aq) increases.

C. Electrons flow through the salt bridge.

D. Negative ions flow through the salt bridge from the copper half-cell to the zinc half-cell.

Topic Chem 9 **Q# 128/** IB CHEM/2016/Specimen Paper/TZ0/Paper 1/Standard Level/ www.SmashingScience.org :o)

21. The equations below represent reactions involved in the Winkler method for determining the concentration of dissolved oxygen in water:

$$2Mn(OH)_2(s) + O_2(aq) \rightarrow 2MnO(OH)_2(s)$$
$$MnO(OH)_2(s) + 2H_2SO_4(aq) \rightarrow Mn(SO_4)_2(s) + 3H_2O(l)$$
$$Mn(SO_4)_2(s) + 2I^-(aq) \rightarrow Mn^{2+}(aq) + I_2(aq) + 2SO_4^{2-}(aq)$$
$$2S_2O_3^{2-}(aq) + I_2(aq) \rightarrow S_4O_6^{2-}(aq) + 2I^-(aq)$$

What is the amount, in mol, of thiosulfate ions, $S_2O_3^{2-}(aq)$, needed to react with the iodine, $I_2(aq)$, formed by 1.00 mol of dissolved oxygen?

A. 2.00

B. 3.00

C. 4.00

D. 6.00

22. What are the products when molten sodium chloride is electrolysed?

	Cathode	Anode
A.	hydrogen	chlorine
B.	sodium	chloride
C.	sodium	chlorine
D.	chlorine	sodium

Topic Chem 9 **Q# 129/** IB CHEM/2016/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

21. Applying IUPAC rules, what is the name of MnO_2?

A. Magnesium(II) oxide

B. Manganese(II) oxide

C. Magnesium(IV) oxide

D. Manganese(IV) oxide

22. Which statement is correct for a voltaic but **not** for an electrolytic cell?

A. An electrolyte is required.

B. The anode is where oxidation occurs.

C. Ions move in the electrolyte.

D. Electrons flow from the negative electrode to the positive electrode.

23. The following occurs when metal **X** is added to **Y** sulfate solution and **Z** sulfate solution. (**X**, **Y** and **Z** represent metal elements but not their symbols.)

$$\mathbf{X}(s) + \mathbf{Y}SO_4(aq) \rightarrow \mathbf{X}SO_4(aq) + \mathbf{Y}(s)$$

$$\mathbf{X}(s) + \mathbf{Z}SO_4(aq)\text{: no reaction}$$

What is the order of increasing reactivity?

A. X < Y < Z

B. Y < X < Z

C. Z < Y < X

D. Z < X < Y

24. What is formed at the electrodes during the electrolysis of molten sodium bromide?

	Positive electrode	Negative electrode
A.	Na^+	Br^-
B.	Na	Br_2
C.	Br^-	Na^+
D.	Br_2	Na

25. Which compound is **not** in the same homologous series as the others?

A. C_5H_{12}

B. C_6H_{12}

C. C_7H_{16}

D. C_8H_{18}

26. What type of reaction occurs when $C_6H_{13}Br$ becomes $C_6H_{13}OH$?

A. Nucleophilic substitution

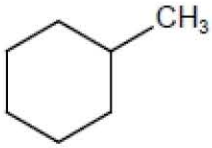
B. Electrophilic substitution

C. Radical substitution

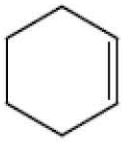
D. Addition

27. Which will react with a halogen by an electrophilic substitution mechanism?

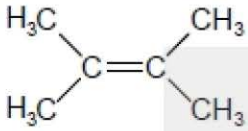
A. 

B. 

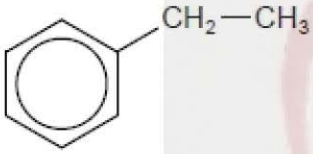
C. 

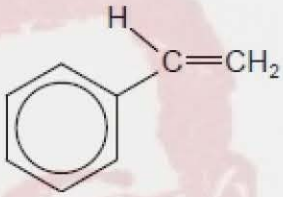
D. 

28. Which compound **cannot** undergo addition polymerization?

A. 

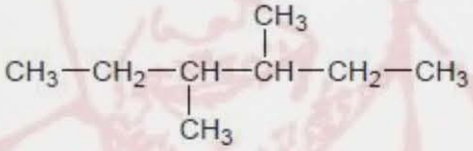
B. $H_2C{=}CH_2$

C. 

D. 

Topic Chem 10 **Q# 131/** IB Chem/2019/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

27. What is the name of this compound using IUPAC rules?



A. 2,3-diethylbutane

B. 2-ethyl-3-methylpentane

C. 3-methyl-4-ethylpentane

D. 3,4-dimethylhexane

24. Which compound has the lowest boiling point?

A. $CH_3CH_2CH_2CH_2CH_2CH_3$

B. $CH_3CH_2CH_2CH_2CH_3$

C. $CH_3CH(CH_3)CH_2CH_3$

D. $CH_3C(CH_3)_2CH_3$

25. Which of the following can be both formed from bromoethane and converted directly into ethanal?

$$CH_3CH_2Br \rightarrow \mathbf{X}$$

$$\mathbf{X} \rightarrow CH_3CHO$$

A. CH_3CH_2OH

B. CH_3OCH_3

C. CH_3COOH

D. $H_2C{=}CHBr$

26. Methane reacts with chlorine in sunlight.

$$CH_4(g) + Cl_2(g) \rightarrow CH_3Cl(g) + HCl(g)$$

Which type of reaction occurs?

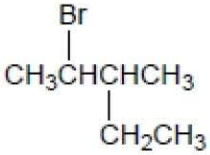
A. free-radical substitution

B. electrophilic substitution

C. nucleophilic substitution

D. electrophilic addition

25. What is the IUPAC name of the following molecule?



A. 2-bromo-3-ethylbutane

B. 3-methyl-4-bromopentane

C. 2-ethyl-3-bromobutane

D. 2-bromo-3-methylpentane

26. What is the mechanism of the reaction between alkenes and halogens in the absence of light?

A. radical substitution

B. electrophilic substitution

C. electrophilic addition

D. nucleophilic substitution

27. Which alcohol would produce a carboxylic acid when heated with acidified potassium dichromate(VI)?

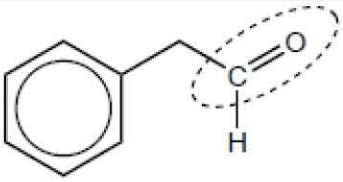
A. propan-2-ol

B. butan-1-ol

C. 2-methylpropan-2-ol

D. pentan-3-ol

24. Which functional group is surrounded in the molecule?



A. hydroxyl

B. carboxyl

C. carbonyl

D. ether

24. Which compounds cause the colour of acidified potassium manganate(VII) solution to change from purple to colourless?

I. $CH_3CH_2CH_2CH_2OH$

II. $(CH_3)_3CCH_2OH$

III. $CH_3CH_2CH(OH)CH_3$

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

25. What is the order of increasing boiling point for the isomers of C_5H_{12}?

A. $CH_3CH_2CH_2CH_2CH_3 < CH_3CH(CH_3)CH_2CH_3 < CH_3C(CH_3)_3$

B. $CH_3C(CH_3)_3 < CH_3CH(CH_3)CH_2CH_3 < CH_3CH_2CH_2CH_2CH_3$

C. $CH_3C(CH_3)_3 < CH_3CH_2CH_2CH_2CH_3 < CH_3CH(CH_3)CH_2CH_3$

D. $CH_3CH(CH_3)CH_2CH_3 < CH_3C(CH_3)_3 < CH_3CH_2CH_2CH_2CH_3$

27. Which compounds react to form $CH_3CH_2CH_2COOCH(CH_3)_2$?

A. propanoic acid and propan-2-ol

B. propanoic acid and butan-2-ol

C. butanoic acid and propan-1-ol

D. butanoic acid and propan-2-ol

11. Which compound has the highest boiling point?

A. CH_3CHO

B. CH_3CH_2F

C. CH_3OCH_3

D. $CH_3CH_2NH_2$

Topic Chem 10 **Q# 137/** IB Chem/2018/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

27. Which are structural isomers?

I. CH_3CH_2OH and CH_3OCH_3
II. $HOCH_2CH_3$ and CH_3CH_2OH
III. CH_3COOH and $HCOOCH_3$

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

Topic Chem 10 **Q# 138/** IB Chem/2018/s/TZ2/Paper 1/Standard Level/ www.SmashingScience.org :o)

24. Which compounds belong to the same homologous series?

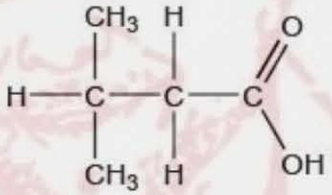
A. $CHCCH_2CH_3$, $CHCCH_2CH_2CH_3$

B. $CH_3CH_2CH_2CH_2OH$, $CH_3CH_2OCH_2CH_3$

C. CH_2CHCH_3, $CH_3CH_2CH_2CH_3$

D. CH_3COCH_3, $CH_3CH_2OCH_3$

25. What is the name of this compound, using IUPAC rules?



A. 1,1-dimethylpropanoic acid

B. 3,3-dimethylpropanoic acid

C. 2-methylbutanoic acid

D. 3-methylbutanoic acid

26. What is the mechanism for the reaction of propene with iodine in the dark?

A. electrophilic addition

B. electrophilic substitution

C. free radical substitution

D. nucleophilic substitution

24. What are possible names of a molecule with molecular formula $C_4H_{10}O$?

I. 1-Methoxypropane

II. 2-Methylpropan-2-ol

III. Butanal

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

25. What is the product of the reaction between hex-3-ene and steam?

A. Hexan-1-ol

B. Hexan-2-ol

C. Hexan-3-ol

D. Hexan-4-ol

26. Which of these reactions proceeds by a free radical mechanism in the presence of UV light?

A. $C_6H_6 + Cl_2 \rightarrow C_6H_5Cl + HCl$

B. $C_6H_6 + 3H_2 \rightarrow C_6H_{12}$

C. $CH_2CH_2 + HBr \rightarrow CH_3CH_2Br$

D. $CH_3CH_3 + Cl_2 \rightarrow CH_3CH_2Cl + HCl$

27. Which compound could be formed when $CH_3CH_2CH_2OH$ is heated with acidified potassium dichromate(VI)?

I. CH_3CH_2CHO

II. CH_3CH_2COOH

III. CH_3COCH_3

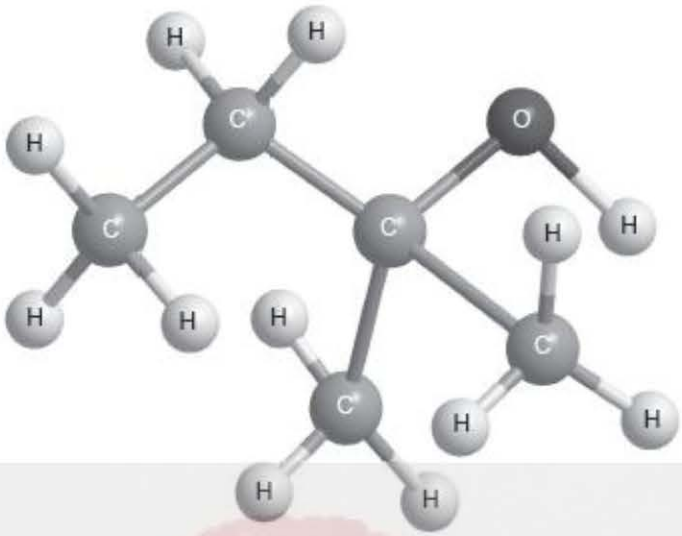
A. I and II only

B. I and III only

C. II and III only

D. I, II and III

26. What is the name of this compound, using IUPAC rules?



A. 3-methylbutan-3-ol

B. 2-ethylpropan-2-ol

C. 2-methylbutan-2-ol

D. 3-methylbutan-2-ol

27. Which type of reaction occurs between an alcohol and a carboxylic acid?

A. Addition

B. Oxidation

C. Esterification

D. Polymerization

28. How many structural isomers of C_6H_{14} exist?

A. 4

B. 5

C. 6

D. 7

27. Which compound contains a secondary carbon atom?

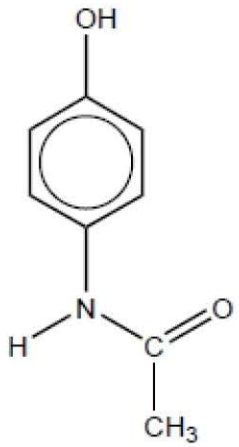
A. $CH_3CH(Cl)CH(CH_3)_2$

B. $(CH_3)_2CHCH_2Cl$

C. $(CH_3)_3CCl$

D. CH_3CH_2Cl

24. Which functional group is present in paracetamol?



A. Carboxyl

B. Amino

C. Nitrile

D. Hydroxyl

25. Which describes the reaction between a halogen and ethane?

	Mechanism	Bond fission in halogen
A.	free radical	homolytic
B.	free radical	heterolytic
C.	addition	homolytic
D.	addition	heterolytic

26. Which conditions are used to convert ethanol to ethanal?

A. Excess oxidizing agent and reflux

B. Excess oxidizing agent and distillation

C. Excess ethanol and reflux

D. Excess ethanol and distillation

27. Which molecule has a tertiary nitrogen?

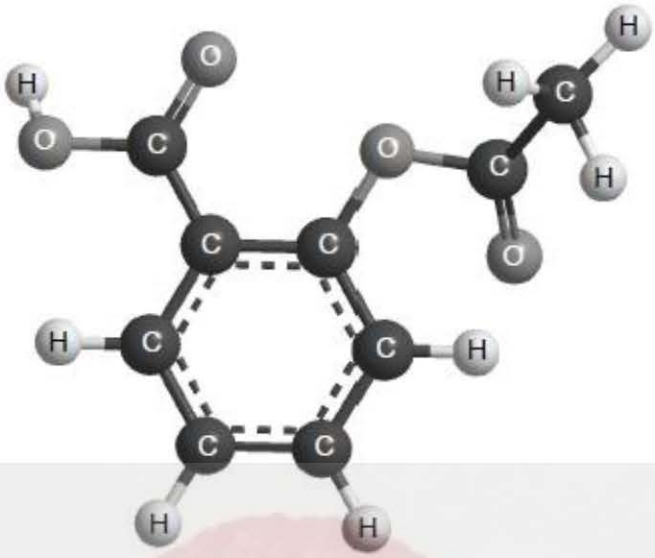
A. $(CH_3)_2NH$

B. $(C_2H_5)_4N^+I^-$

C. $C_3H_7N(CH_3)_2$

D. $C_6H_5NH_2$

25. What are the functional groups in the aspirin molecule?



I. Ether
II. Carboxyl
III. Ester

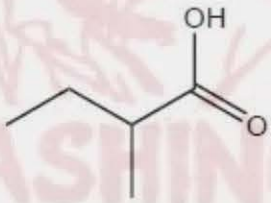
A. I and II only

B. I and III only

C. II and III only

D. I, II and III

26. What is the name of the compound with this molecular structure applying IUPAC rules?



A. 1-methylpropanoic acid

B. 2-methylpropanoic acid

C. 2-methylbutanoic acid

D. 3-methylbutanoic acid

Topic Chem 10 **Q# 145/** IB Chem/2017/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

24. What is the order of increasing boiling point?

A. $C_4H_{10} < CH_3COOH < CH_3CH_2CHO < CH_3CH_2CH_2OH$

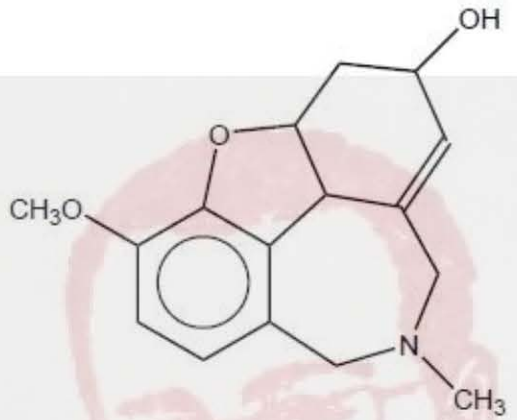
B. $C_4H_{10} < CH_3CH_2CHO < CH_3CH_2CH_2OH < CH_3COOH$

C. $CH_3COOH < CH_3CH_2CH_2OH < CH_3CH_2CHO < C_4H_{10}$

D. $C_4H_{10} < CH_3CH_2CH_2OH < CH_3CH_2CHO < CH_3COOH$

Topic Chem 10 **Q# 146/** IB CHEM/2016/w/TZ0/Paper 1/Standard Level/ www.SmashingScience.org :o)

23. The structure of a drug used to treat symptoms of Alzheimer's disease is shown below. Which functional groups are present in this molecule?



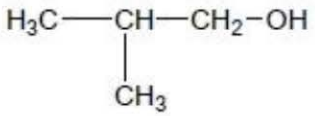
A. Hydroxyl and ester

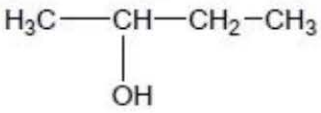
B. Hydroxide and ether

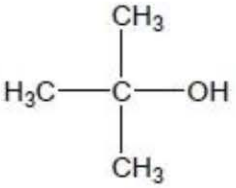
C. Hydroxyl and ether

D. Hydroxide and ester

24. Which alcohols are oxidized by acidified potassium dichromate(VI) solution when heated?

I. 

II. 

III. 

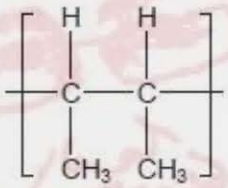
A. I and II only

B. I and III only

C. II and III only

D. I, II and III

25. Which monomer is used to form the polymer with the following repeating unit?



A. $CH_3CH{=}CHCH_3$

B. $CH_3CH_2CH{=}CH_2$

C. $CH_3CH_2CH_2CH_3$

D. $(CH_3)_2C{=}CH_2$

26. Which type of reaction occurs when methanol and propanoic acid react together in the presence of a catalyst?

A. Addition

B. Condensation

C. Redox

D. Neutralization

23. Which is propyl propanoate?

A. $CH_3CH_2CH_2OOCCH_2CH_3$

B. $CH_3CH_2CH_2COOCH_2CH_3$

C. $CH_3CH_2CH_2COCH_2CH_3$

D. $CH_3CH_2CH_2OCH_2CH_2CH_3$

24. Which are consecutive members of a homologous series?

A. CH_4, CH_3Cl, CH_2Cl_2

B. HCOOH, CH_3COOH, C_2H_5COOH

C. C_2H_2, C_2H_4, C_2H_6

D. HCOOH, HCHO, CH_3OH

25. Which could form an addition polymer?

A. $H_2NCH_2CHCHCH_2NH_2$

B. $H_2N(CH_2)_6CO_2H$

C. $HO(CH_2)_2CO_2H$

D. $H_2N(CH_2)_6NH_2$

26. A compound decolorizes bromine water in the dark. Which statement is correct?

A. It contains C=C and is an alkene.

B. It contains C–C and is an alkene.

C. It contains C=C and is an alkane.

D. It contains C–C and is an alkane.

23. How many alcohols have the general formula $C_4H_{10}O$?

A. 3

B. 4

C. 5

D. 6

24. What is the general formula of the alkyne series?

A. C_nH_n

B. C_nH_{2n-2}

C. C_nH_{2n}

D. C_nH_{2n+2}

25. Which compound can both be esterified and turn acidified potassium dichromate(VI) solution green?

A. $(CH_3)_3COH$

B. $CH_3CH_2CO_2H$

C. $(CH_3)_2CHOH$

D. $CH_3CH_2COCH_3$

26. What is the mechanism of the reaction between ethane and chlorine in sunlight?

A. Free radical substitution

B. Free radical addition

C. Electrophilic substitution

D. Electrophilic addition

29. What is the value of the temperature change?

Initial temperature: $2.0 \pm 0.1\,^{\circ}C$

Final temperature: $15.0 \pm 1.0\,^{\circ}C$

A. $13.0 \pm 0.1\,^{\circ}C$

B. $13.0 \pm 0.9\,^{\circ}C$

C. $13.0 \pm 1.0\,^{\circ}C$

D. $13.0 \pm 1.1\,^{\circ}C$

30. Which technique is used to detect the isotopes of an element?

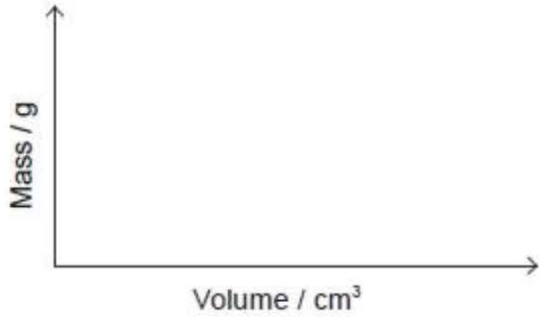
A. Mass spectrometry

B. Infrared spectroscopy

C. Titration

D. Recrystallization

29. Data collected from a larger number of silicon samples could also be plotted to determine the density using the following axes.



Which statements are correct?

I. The density is the slope of the graph.
II. The data will show that mass is proportional to volume.
III. The best-fit line should pass through the origin.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

30. What can be deduced from the infrared (IR) spectrum of a compound?

A. Number of hydrogens

B. Number of hydrogen environments

C. Bonds present

D. Molar mass

28. The following data were recorded for determining the density of three samples of silicon, Si.

Mass / g ±0.01 g	Volume / cm^3 ±0.1 cm^3
5.61	2.8
4.32	1.7
6.37	2.8

Which average density value, in $g\,cm^{-3}$, has been calculated to the correct number of significant figures?

A. 2

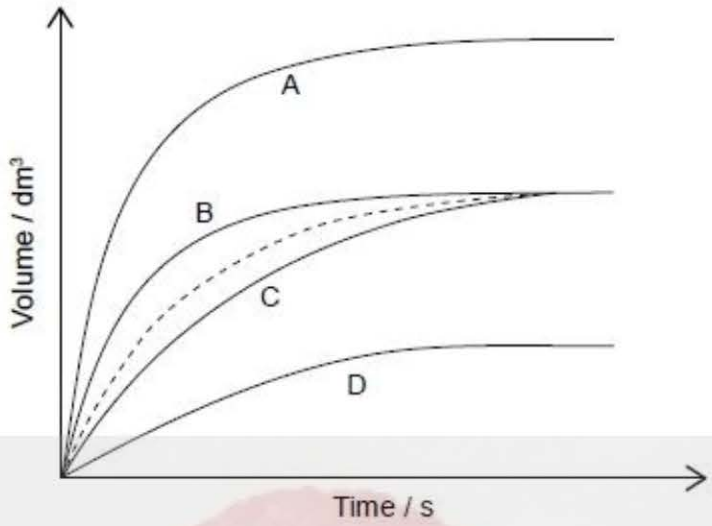
B. 2.3

C. 2.27

D. 2.273

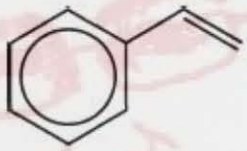
Topic Chem 11 **Q# 152/** IB Chem/2019/s/TZ1/Paper 1/Standard Level/ www.SmashingScience.org :o)

29. The dotted line represents the formation of oxygen, $O_2(g)$, from the uncatalysed complete decomposition of hydrogen peroxide, $H_2O_2(aq)$.



Which curve represents a catalysed reaction under the same conditions?

30. What is the degree of unsaturation (index of hydrogen deficiency) for the molecule?



A. 1

B. 2

C. 4

D. 5

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28. How should a measurement of 5.00 g from a balance be recorded?

A. $5.00 \pm 0.1\,g$

B. $5.00 \pm 0.01\,g$

C. $5.00 \pm 1\,g$

D. $5.00 \pm 0.001\,g$

26. Which is correct for benzene?

A. It readily undergoes addition reactions and decolourises bromine water.

B. It contains alternate single and double carbon–carbon bonds and is planar.

C. Its ^1H NMR spectrum shows six signals and it readily undergoes substitution reactions.

D. Its ^1H NMR spectrum shows one signal and it forms a single C_6H_5Br isomer.

28. Which is correct for the spectra of organic compounds?

A. Mass spectroscopy provides information about bond vibrations.

B. ^1H NMR spectroscopy provides the values of carbon–hydrogen bond lengths.

C. Infrared spectroscopy provides the number of hydrogen atoms.

D. Mass spectroscopy provides information about the structure.

29. What is the ratio of areas under each signal in the ^1H NMR spectrum of 2-methylbutane?

A. 6:1:2:3

B. 3:3:1:5

C. 6:1:5

D. 3:3:1:2:3

30. What are the absolute and percentage uncertainties for the change in mass?

Initial mass: 22.35 ±0.05 g
Final mass: 42.35 ±0.05 g

	Absolute uncertainty / g	Percentage uncertainty
A.	±0.05	0.1%
B.	±0.10	0.5%
C.	±0.05	0.5%
D.	±0.10	0.1%

28. Which feature of a molecule does infrared spectrometry detect?

A. molecular mass

B. bonds present

C. total number of protons

D. total number of proton environments

29. How are the uncertainties of two quantities combined when the quantities are multiplied together?

A. Uncertainties are added.

B. % uncertainties are multiplied.

C. Uncertainties are multiplied.

D. % uncertainties are added.

30. The rate of a reaction is studied at different temperatures.

Which is the best way to plot the data?

	x-axis	Type of variable on x-axis
A.	rate	dependent
B.	rate	independent
C.	temperature	independent
D.	temperature	dependent

28. Which value of q, in J, has the correct number of significant figures?

$$q = mc\Delta T$$

where $m = 2.500\,\text{g}$, $c = 4.18\,\text{J g}^{-1}\,\text{K}^{-1}$ and $\Delta T = 0.60\,\text{K}$.

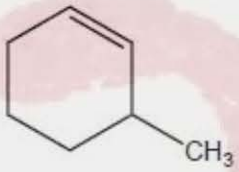
A. 6

B. 6.3

C. 6.27

D. 6.270

29. What is the index of hydrogen deficiency, IHD, of 3-methylcyclohexene?



A. 0

B. 1

C. 2

D. 3

30. What is the ratio of the areas of the signals in the ^{1}H NMR spectrum of pentan-3-ol?

A. 6:4:1:1

B. 6:2:2:2

C. 5:5:1:1

D. 3:3:2:2:1:1

29. What information is provided by ^{1}H NMR, MS and IR for an organic compound?

I. ^{1}H NMR: chemical environment(s) of protons
II. MS: fragmentation pattern
III. IR: types of functional group

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

30. A student performs an acid-base titration using a pH meter, but forgets to calibrate it. Which type of error will occur and how will it affect the quality of the measurements?

A. Random error and lower precision

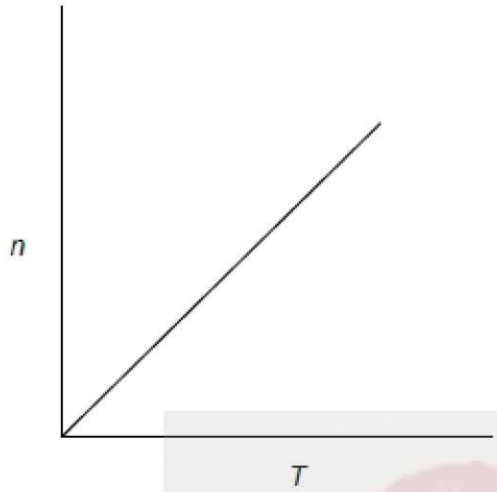
B. Systematic error and lower accuracy

C. Systematic error and lower precision

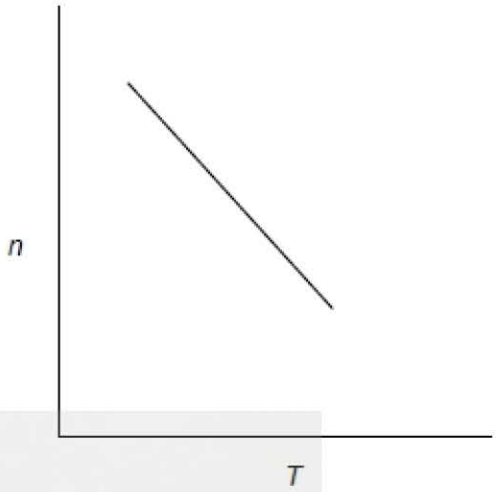
D. Random error and lower accuracy

30. What is the graphical relationship between n and T in the ideal gas equation, $pV = nRT$, all other variables remaining constant?

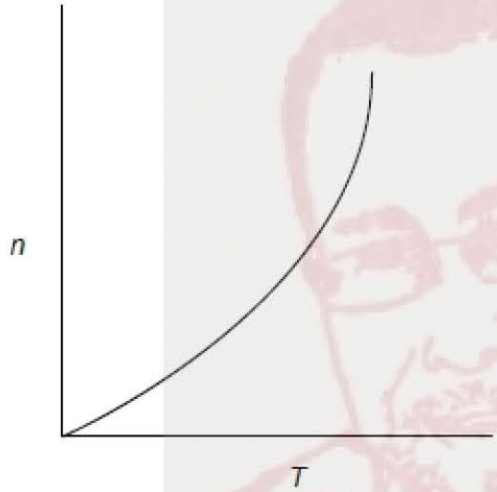
A.



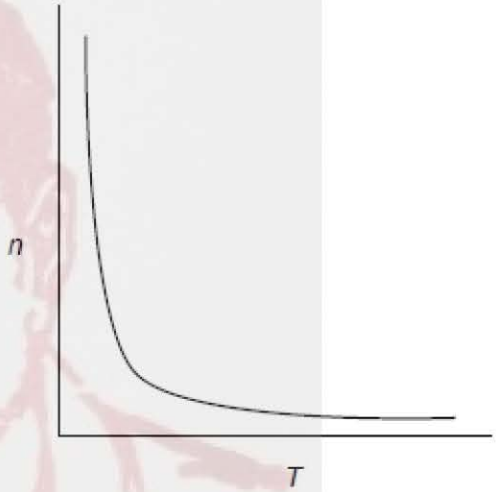
B.



C.



D.



28. Which information can be gained from an infrared (IR) spectrum?

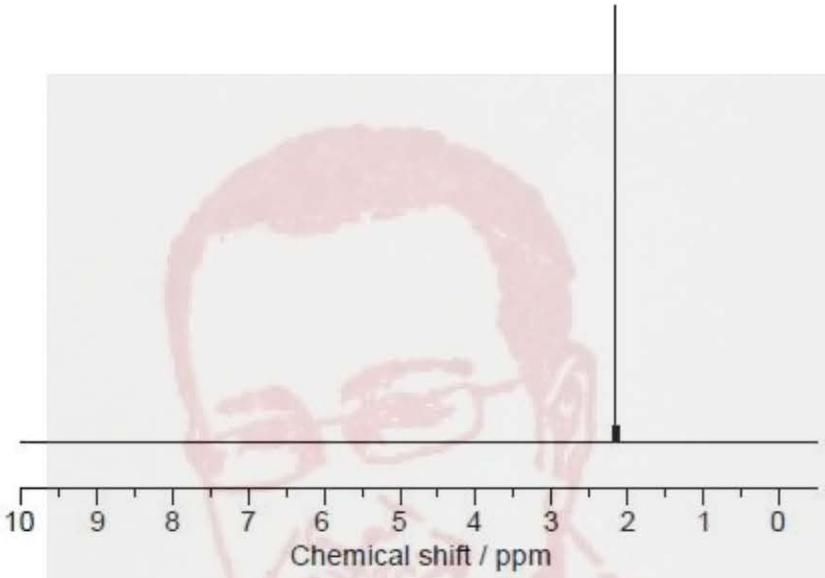
A. Ionization energy of the most abundant element

B. Number of different elements in the compound

C. Bonds present in a molecule

D. Molecular formula of the compound

29. What can be deduced from the following ^{1}H NMR spectrum?



A. There is only one hydrogen atom in the molecule.

B. There is only one hydrogen environment in the molecule.

C. The molecule is a hydrocarbon.

D. There is only one isotope in the element.

28. What can be determined about a molecule from the number of signals in its ^{1}H NMR spectrum?

A. Bonds present

B. Molecular formula

C. Molecular mass

D. Number of hydrogen environments

29. What is the density, in $g\,cm^{-3}$, of a 34.79 g sample with a volume of $12.5\,cm^{3}$?

A. 0.359

B. 0.36

C. 2.783

D. 2.78

30. What is the Index of Hydrogen Deficiency (IHD) for 1,3,5-hexatriene (C_6H_8)?

A. 1

B. 3

C. 5

D. 6

27. A student carried out a titration to determine the concentration of an acid and found that his value had good precision but poor accuracy. Which process explains this outcome?

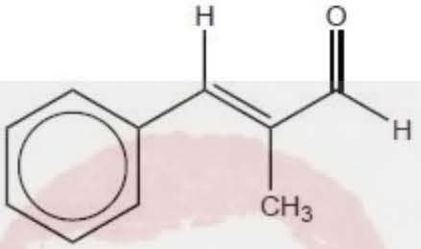
A. Consistently overshooting the volume of solution from the burette into the flask.

B. Collection of insufficient titration data.

C. Reading the meniscus in the burette at a different angle each time.

D. Forgetting to rinse the flask after one of the titrations.

28. What is the index of hydrogen deficiency (IHD) for this molecule?



A. 3

B. 4

C. 5

D. 6

29. What is always correct about the molecular ion, M^+, in a mass spectrum of a compound?

A. The M^+ ion peak has the smallest *m/z* ratio in the mass spectrum.

B. The *m/z* ratio of the M^+ ion peak gives the relative molecular mass of the molecule.

C. The M^+ ion is the most stable fragment formed during electron bombardment.

D. The M^+ ion peak has the greatest intensity in the mass spectrum.

30. A student measured the change in mass on heating a sample of calcium carbonate, $CaCO_3(s)$. What is the mass loss?

Mass before heating:	2.347 g ± 0.001
Mass after heating:	2.001 g ± 0.001

A. 0.346 g ± 0.001

B. 0.346 g ± 0.002

C. 0.35 g ± 0.002

D. 0.35 g ± 0.001

27. How can a systematic error be minimized?

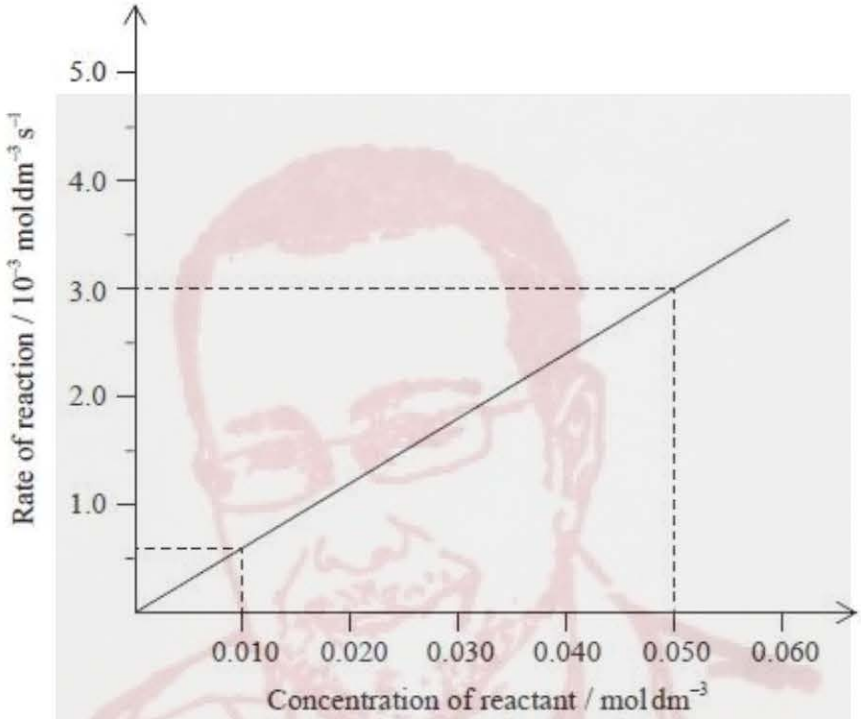
A. By taking the reading many times

B. By repeating the experiment many times

C. By using a more accurate measuring device

D. By evaluating and modifying the method

28. Which combination in the table correctly states the value and units of the gradient?



	Value	Units
A.	$\frac{3.0\times10^{-3}-0.6\times10^{-3}}{0.050-0.010}$	s^{-1}
B.	$\frac{3.0\times10^{-3}-0.6\times10^{-3}}{0.050-0.010}$	s
C.	$\frac{0.050-0.010}{3.0\times10^{-3}-0.6\times10^{-3}}$	s^{-1}
D.	$\frac{0.050-0.010}{3.0\times10^{-3}-0.6\times10^{-3}}$	s

29. Which part of the electromagnetic spectrum is used by ^{1}H NMR spectroscopy?

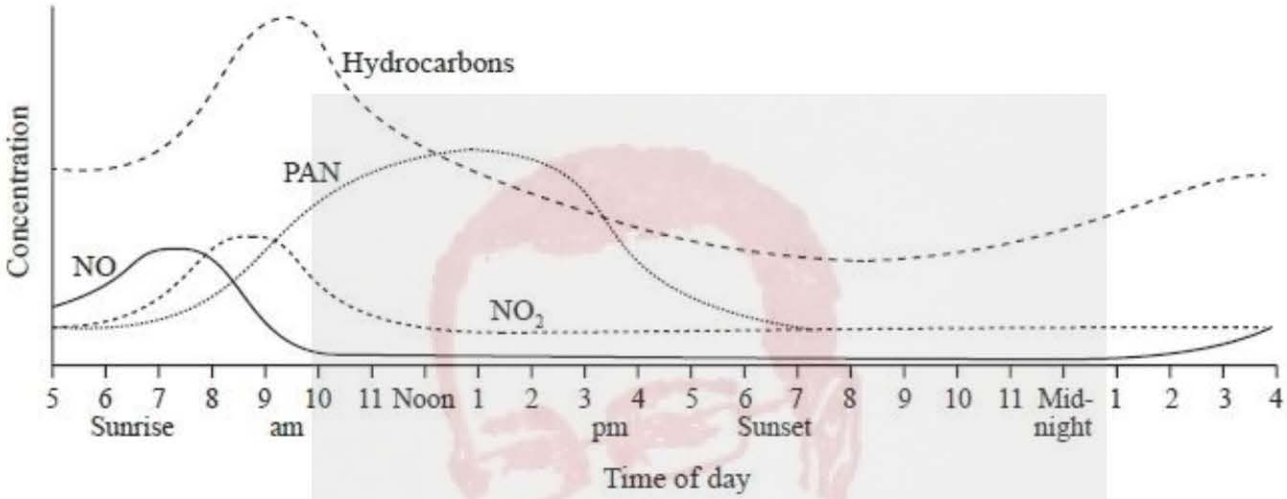
A. γ rays

B. X-rays

C. Microwaves

D. Radio waves

30. The graph shows the concentration of some pollutants in a city over a 24-hour period.



Which of the following could **not** be inferred from the graph?

A. Hydrocarbons cause less harm to health than PAN.

B. An increase in hydrocarbons is caused by the morning rush hour.

C. PAN concentration increases as the intensity of sunlight increases.

D. NO_2 production follows the production of NO.

27. A measuring cylinder was used to obtain a known volume of a liquid. The volume was read from the top of the meniscus and the liquid completely emptied into a flask. The exact same process was then repeated. Which statement is correct about the overall described procedure and the volumes measured?

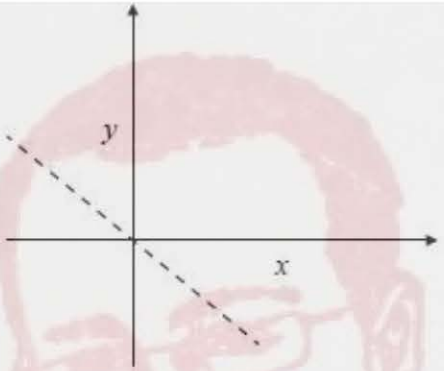
A. There is a systematic error and the volumes measured are accurate.

B. There is a random error and the volumes measured are accurate.

C. There is a random error and the volumes measured are inaccurate.

D. There is a systematic error and the volumes measured are inaccurate.

28. What is the relationship between the two variables sketched on the graph?



A. y is proportional to x

B. y is inversely proportional to x

C. y is proportional to $-x$

D. y decreases exponentially with an increase in x

29. Which feature of a molecule can be determined from its ^1H NMR spectrum?

A. Number of hydrogen environments

B. Total mass of hydrogen atoms present

C. Vibration frequency of C–H bonds

D. Ionization energy of a hydrogen atom

30. Which molecule has an index of hydrogen deficiency (IHD) = 1?

A. C_6H_6

B. C_2Cl_2

C. C_4H_9N

D. C_2H_6O

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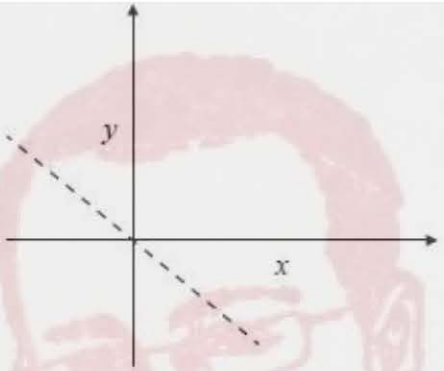

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Mark Scheme

Topic Chem 1 **Q# 1/** IB/P 1/2019/w/TZ0/SL/

1. C
2. D
3. C
4. A

Topic Chem 1 **Q# 2/** IB Chem/2019/s/TZ2/P1/SL/

1. C
2. D
3. C
4. C

Topic Chem 1 **Q# 3/** IB Chem/2019/s/TZ1/P1/SL/

4. A

Topic Chem 1 **Q# 4/** IB Chem/2019/s/TZ1/P1/SL/

1. A
2. D
3. D

Topic Chem 1 **Q# 5/** IB/P 1/2018/w/TZ0/SL/

1. A
2. A
3. C
4. B

Topic Chem 1 **Q# 6/** IB Chem/2018/s/TZ2/P1/SL/

4. B

Topic Chem 1 **Q# 7/** IB Chem/2018/s/TZ2/P1/SL/

1. C
2. D
3. C

Topic Chem 1 **Q# 8/** IB Chem/2018/s/TZ1/P1/SL/

4. D

Topic Chem 1 **Q# 9/** IB Chem/2018/s/TZ1/P1/SL/

1. C
2. C
3. A

Topic Chem 1 **Q# 10/** IB/P 1/2017/w/TZ0/SL/

1. D
2. D
3. C
4. B

Topic Chem 1 **Q# 11/** IB Chem/2017/s/TZ2/P1/SL/

4. A

Topic Chem 1 **Q# 12/** IB Chem/2017/s/TZ2/P1/SL/

1. C
2. B
3. C

Topic Chem 1 **Q# 13/** IB Chem/2017/s/TZ1/P1/SL/

4. B

Topic Chem 1 **Q# 14/** IB Chem/2017/s/TZ1/P1/SL/

1. A
2. B
3. C

Topic Chem 1 **Q# 15/** IB/P 1/2016/w/TZ0/SL/

1. C
2. D
3. C
4. B

Topic Chem 1 **Q# 16/** IB/P 1/2016/SP/TZ0/SL/

1. B
2. D
4. B

Topic Chem 1 **Q# 17/** IB/P 1/2016/s/TZ1/SL/

1. B
2. D
3. B
4. A

Topic Chem 2 **Q# 18/** IB/P 1/2019/w/TZ0/SL/

5. C
6. A
7. B

Topic Chem 2 **Q# 19/** IB Chem/2019/s/TZ2/P1/SL/

5. D

6. D

Topic Chem 2 **Q# 20/** IB Chem/2019/s/TZ1/P1/SL/

5. A

6. C

7. C

Topic Chem 2 **Q# 21/** IB/P 1/2018/w/TZ0/SL/

5. A

6. B

Topic Chem 2 **Q# 22/** IB Chem/2018/s/TZ2/P1/SL/

5. D

6. A

Topic Chem 2 **Q# 23/** IB Chem/2018/s/TZ1/P1/SL/

5. A

6. B

Topic Chem 2 **Q# 24/** IB/P 1/2017/w/TZ0/SL/

5. A

6. D

Topic Chem 2 **Q# 25/** IB Chem/2017/s/TZ2/P1/SL/

5. C

6. C

Topic Chem 2 **Q# 26/** IB Chem/2017/s/TZ1/P1/SL/

5. C

6. D

Topic Chem 2 **Q# 27/** IB/P 1/2016/SP/TZ0/SL/

5. B

Topic Chem 2 **Q# 28/** IB/P 1/2016/s/TZ1/SL/

5. C

6. D

Topic Chem 3 **Q# 29/** IB/P 1/2019/w/TZ0/SL/

7. B

8. B

Topic Chem 3 **Q# 30/** IB Chem/2019/s/TZ2/P1/SL/

9. C

Topic Chem 3 **Q# 31/** IB Chem/2019/s/TZ2/P1/SL/

7. A

8. C

Topic Chem 3 **Q# 32/** IB/P 1/2018/w/TZ0/SL/

5. A

6. B

Topic Chem 3 **Q# 33/** IB Chem/2018/s/TZ2/P1/SL/

7. D

8. A

Topic Chem 3 **Q# 34/** IB Chem/2018/s/TZ1/P1/SL/

7. D

8. B

Topic Chem 3 **Q# 35/** IB/P 1/2017/w/TZ0/SL/

7. B

8. D

Topic Chem 3 **Q# 36/** IB Chem/2017/s/TZ2/P1/SL/

8. B

Topic Chem 3 **Q# 37/** IB Chem/2017/s/TZ2/P1/SL/

7. A

Topic Chem 3 **Q# 38/** IB Chem/2017/s/TZ1/P1/SL/

7. D

8. A

Topic Chem 3 **Q# 39/** IB/P 1/2016/w/TZ0/SL/

5. C

6. A

7. A

8. C

Topic Chem 3 **Q# 40/** IB/P 1/2016/SP/TZ0/SL/

6. B

7. B

8. C

Topic Chem 3 **Q# 41/** IB/P 1/2016/s/TZ1/SL/

7. B

8. D

Topic Chem 4 **Q# 42/** IB/P 1/2019/w/TZ0/SL/

9. B

10. B

11. A

12. A

Topic Chem 4 **Q# 43/** IB Chem/2019/s/TZ2/P1/SL/

10. D

11. B

12. B

Topic Chem 4 **Q# 44/** IB Chem/2019/s/TZ1/P1/SL/

12. B

Topic Chem 4 **Q# 45/** IB Chem/2019/s/TZ1/P1/SL/

8. A

9. B

10. B

11. B

Topic Chem 4 **Q# 46/** IB/P 1/2018/w/TZ0/SL/

9. C

10. D

12. C

Topic Chem 4 **Q# 47/** IB Chem/2018/s/TZ2/P1/SL/

11. B

12. D

Topic Chem 4 **Q# 48/** IB Chem/2018/s/TZ2/P1/SL/

9. D

10. B

Topic Chem 4 **Q# 49/** IB Chem/2018/s/TZ1/P1/SL/

11. B

12. D

Topic Chem 4 **Q# 50/** IB Chem/2018/s/TZ1/P1/SL/

9. B

10. C

Topic Chem 4 **Q# 51/** IB/P 1/2017/w/TZ0/SL/

9. C

10. C

11. A

12. C

Topic Chem 4 **Q# 52/** IB Chem/2017/s/TZ2/P1/SL/

12. A

Topic Chem 4 **Q# 53/** IB Chem/2017/s/TZ2/P1/SL/

9. B

10. D

11. B

Topic Chem 4 **Q# 54/** IB Chem/2017/s/TZ1/P1/SL/

10. C

11. D

12. B

Topic Chem 4 **Q# 55/** IB Chem/2017/s/TZ1/P1/SL/

9. A

Topic Chem 4 **Q# 56/** IB/P 1/2016/w/TZ0/SL/

9. D

10. A

11. D

12. D

Topic Chem 4 **Q# 57/** IB/P 1/2016/SP/TZ0/SL/

9. A

10. B

11. B

12. D

Topic Chem 4 **Q# 58/** IB/P 1/2016/s/TZ1/SL/

9. C

10. B

11. D

12. B

Topic Chem 5 **Q# 59/** IB/P 1/2019/w/TZ0/SL/

13. C

14. D

15. C

16. B

Topic Chem 5 **Q# 60/** IB Chem/2019/s/TZ2/P1/SL/

15. B

Topic Chem 5 **Q# 61/** IB Chem/2019/s/TZ2/P1/SL/

13. D

14. C

Topic Chem 5 **Q# 62/** IB Chem/2019/s/TZ1/P1/SL/

15. D

Topic Chem 5 **Q# 63/** IB Chem/2019/s/TZ1/P1/SL/

12. B

13. A

14. D

Topic Chem 5 **Q# 64/** IB/P 1/2018/w/TZ0/SL/

13. A

14. C

15. C

Topic Chem 5 **Q# 65/** IB Chem/2018/s/TZ2/P1/SL/

14. B

15. B

Topic Chem 5 **Q# 66/** IB Chem/2018/s/TZ2/P1/SL/

13. A

Topic Chem 5 **Q# 67/** IB Chem/2018/s/TZ1/P1/SL/

14. A

15. D

Topic Chem 5 **Q# 68/** IB Chem/2018/s/TZ1/P1/SL/

13. B

Topic Chem 5 **Q# 69/** IB/P 1/2017/w/T Z0/SL/

13. A

14. C

15. D

16. A

Topic Chem 5 **Q# 70/** IB Chem/2017/s/TZ2/P1/SL/

15. D

Topic Chem 5 **Q# 71/** IB Chem/2017/s/TZ2/P1/SL/

13. A

14. B

Topic Chem 5 **Q# 72/** IB Chem/2017/s/TZ1/P1/SL/

13. C

14. A

15. B

Topic Chem 5 **Q# 73/** IB/P 1/2016/w/TZ0/SL/

13. C

14. B

15. C

Topic Chem 5 **Q# 74/** IB/P 1/2016/SP/TZ0/SL/

13. C

14. C

15. D

Topic Chem 5 **Q# 75/** IB/P 1/2016/SP/TZ0/SL/

3. C

Topic Chem 5 **Q# 76/** IB/P 1/2016/s/TZ1/SL/

13. D

14. A

15. B

Topic Chem 6 **Q# 77/** IB/P 1/2019/w/TZ0/SL/

17. D

18. C

Topic Chem 6 **Q# 78/** IB Chem/2019/s/TZ2/P1/SL/

17. A

Topic Chem 6 **Q# 79/** IB Chem/2019/s/TZ2/P1/SL/

16. A

Topic Chem 6 **Q# 80/** IB Chem/2019/s/TZ1/P1/SL/

16. C

17. A

Topic Chem 6 **Q# 81/** IB/P 1/2018/w/TZ0/SL/

16. B

17. B

Topic Chem 6 **Q# 82/** IB Chem/2018/s/TZ2/P1/SL/

16. C

17. D

Topic Chem 6 **Q# 83/** IB Chem/2018/s/TZ1/P1/SL/

17. B

Topic Chem 6 **Q# 84/** IB Chem/2018/s/TZ1/P1/SL/

16. D

Topic Chem 6 **Q# 85/** IB/P 1/2017/w/TZ0/SL/

17. D

Topic Chem 6 **Q# 86/** IB Chem/2017/s/TZ2/P1/SL/

16. D

17. C

Topic Chem 6 **Q# 87/** IB Chem/2017/s/TZ1/P1/SL/

16. A

17. A

Topic Chem 6 **Q# 88/** IB/P 1/2016/w/TZ0/SL/

16. C

17. B

Topic Chem 6 **Q# 89/** IB/P 1/2016/SP/TZ0/SL/

16. C

17. C

Topic Chem 6 **Q# 90/** IB/P 1/2016/s/TZ1/SL/

16. A

17. C

Topic Chem 7 **Q# 91/** IB/P 1/2019/w/TZ0/SL/

19. A

Topic Chem 7 **Q# 92/** IB Chem/2019/s/TZ2/P1/SL/

18. D

Topic Chem 7 **Q# 93/** IB Chem/2019/s/TZ1/P1/SL/

18. B

Topic Chem 7 **Q# 94/** IB Chem/2018/s/TZ2/P1/SL/

18. C

Topic Chem 7 **Q# 95/** IB Chem/2018/s/TZ1/P1/SL/

18. C

Topic Chem 7 **Q# 96/** IB/P 1/2017/w/TZ0/SL/

18. A

Topic Chem 7 **Q# 97/** IB Chem/2017/s/TZ2/P1/SL/

18. D

Topic Chem 7 **Q# 98/** IB Chem/2017/s/TZ1/P1/SL/

18. A

Topic Chem 7 **Q# 99/** IB/P 1/2016/w/TZ0/SL/

18. A

Topic Chem 7 **Q# 100/** IB/P 1/2016/SP/TZ0/SL/

18. A

19. D

Topic Chem 7 **Q# 101/** IB/P 1/2016/s/TZ1/SL/

18. A

Topic Chem 8 **Q# 102/** IB/P 1/2019/w/TZ0/SL/

20. C

21. D

Topic Chem 8 **Q# 103/** IB Chem/2019/s/TZ2/P1/SL/

19. C

20. B

Topic Chem 8 **Q# 104/** IB Chem/2019/s/TZ1/P1/SL/

20. C

21. B

Topic Chem 8 **Q# 105/** IB/P 1/2018/w/TZ0/SL/

18. A

Topic Chem 8 **Q# 106/** IB Chem/2018/s/TZ2/P1/SL/

19. C

20. C

Topic Chem 8 **Q# 107/** IB Chem/2018/s/TZ1/P1/SL/

20. C

Topic Chem 8 **Q# 108/** IB Chem/2018/s/TZ1/P1/SL/

19. D

Topic Chem 8 **Q# 109/** IB Chem/2017/s/TZ2/P1/SL/

19. B

20. B

Topic Chem 8 **Q# 110/** IB Chem/2017/s/TZ1/P1/SL/

19. D

20. D

Topic Chem 8 **Q# 111/** IB/P 1/2016/w/TZ0/SL/

19. A

20. D

21. B

Topic Chem 8 **Q# 112/** IB/P 1/2016/SP/TZ0/SL/

19. D

20. C

Topic Chem 8 **Q# 113/** IB/P 1/2016/s/TZ1/SL/

19. C

20. A

Topic Chem 9 **Q# 114/** IB/P 1/2019/w/TZ0/SL/

22. D

23. B

24. D

Topic Chem 9 **Q# 115/** IB Chem/2019/s/TZ2/P1/SL/

21. A

22. B

23. C

Topic Chem 9 **Q# 116/** IB Chem/2019/s/TZ1/P1/SL/

22. D

23. C

Topic Chem 9 **Q# 117/** IB Chem/2019/s/TZ1/P1/SL/

21. B

Topic Chem 9 **Q# 118/** IB/P 1/2018/w/TZ0/SL/

19. D

20. C

Topic Chem 9 **Q# 119/** IB/P 1/2018/w/TZ0/SL/

21. D

22. B

23. C

Topic Chem 9 **Q# 120/** IB Chem/2018/s/TZ2/P1/SL/

21. C

22. A

Topic Chem 9 **Q# 121/** IB Chem/2018/s/TZ2/P1/SL/

23. A

Topic Chem 9 **Q# 122/** IB Chem/2018/s/TZ1/P1/SL/

21. C

22. A

23. D

Topic Chem 9 **Q# 123/** IB/P 1/2017/w/TZ0/SL/

23. B

24. D

25. B

Topic Chem 9 **Q# 124/** IB/P 1/2017/w/TZ0/SL/

21. B

22. A

Topic Chem 9 **Q# 125/** IB Chem/2017/s/TZ2/P1/SL/

21. C

22. D

23. A

Topic Chem 9 **Q# 126/** IB Chem/2017/s/TZ1/P1/SL/

21. D

22. C

23. B

Topic Chem 9 **Q# 127/** IB/P 1/2016/w/TZ0/SL/

22. D

Topic Chem 9 **Q# 128/** IB/P 1/2016/SP/TZ0/SL/

21. C

22. C

Topic Chem 9 **Q# 129/** IB/P 1/2016/s/TZ1/SL/

21. D

22. D

Topic Chem 10 **Q# 130/** IB/P 1/2019/w/TZ0/SL/

23. B

24. D

25. B

26. A

27. A

28. C

Topic Chem 10 **Q# 131/** IB Chem/2019/s/TZ2/P1/SL/

27. D

Topic Chem 10 **Q# 132/** IB Chem/2019/s/TZ2/P1/SL/

24. D

25. A

26. A

Topic Chem 10 **Q# 133/** IB Chem/2019/s/TZ1/P1/SL/

25. D

26. C

27. B

Topic Chem 10 **Q# 134/** IB Chem/2019/s/TZ1/P1/SL/

24. C

Topic Chem 10 **Q# 135/** IB/P 1/2018/w/TZ0/SL/

24. D

25. B

27. D

Topic Chem 10 **Q# 136/** IB/P 1/2018/w/TZ0/SL/

11. D

Topic Chem 10 **Q# 137/** IB Chem/2018/s/TZ2/P1/SL/

27. B

Topic Chem 10 **Q# 138/** IB Chem/2018/s/TZ2/P1/SL/

24. A

25. D

26. A

Topic Chem 10 **Q# 139/** IB Chem/2018/s/TZ1/P1/SL/

24. A

25. C

26. D

27. A

Name

Topic Chem 10 **Q# 140/** IB/P 1/2017/w/TZ0/SL/

26. C

27. C

28. B

Topic Chem 10 **Q# 141/** IB Chem/2017/s/TZ2/P1/SL/

27. A

Topic Chem 10 **Q# 142/** IB Chem/2017/s/TZ2/P1/SL/

24. D

25. A

26. D

Topic Chem 10 **Q# 143/** IB Chem/2017/s/TZ1/P1/SL/

27. C

Topic Chem 10 **Q# 144/** IB Chem/2017/s/TZ1/P1/SL/

25. C

26. C

Topic Chem 10 **Q# 145/** IB Chem/2017/s/TZ1/P1/SL/

24. B

Topic Chem 10 **Q# 146/** IB/P 1/2016/w/TZ0/SL/

23. C

24. A

25. A

26. B

Topic Chem 10 **Q# 147/** IB/P 1/2016/SP/TZ0/SL/

23. A

24. B

25. A

26. A

Topic Chem 10 **Q# 148/** IB/P 1/2016/s/TZ1/SL/

23. B

24. B

25. C

26. A

Topic Chem 11 **Q# 149/** IB/P 1/2019/w/TZ0/SL/

29. D

30. A

Topic Chem 11 **Q# 150/** IB Chem/2019/s/TZ2/P1/SL/

29. D

30. C

Topic Chem 11 **Q# 151/** IB Chem/2019/s/TZ2/P1/SL/

28. B

Topic Chem 11 **Q# 152/** IB Chem/2019/s/TZ1/P1/SL/

29. B

30. D

Topic Chem 11 **Q# 153/** IB Chem/2019/s/TZ1/P1/SL/

28. B

Topic Chem 11 **Q# 154/** IB/P 1/2018/w/TZ0/SL/

26. D

28. D

29. A

30. B

Topic Chem 11 **Q# 155/** IB Chem/2018/s/TZ2/P1/SL/

28. B

29. D

30. C

Topic Chem 11 **Q# 156/** IB Chem/2018/s/TZ1/P1/SL/

28. B

29. C

30. A

Topic Chem 11 **Q# 157/** IB/P 1/2017/w/TZ0/SL/

29. D

30. B

Topic Chem 11 **Q# 158/** IB Chem/2017/s/TZ2/P1/SL/

30. D

Topic Chem 11 **Q# 159/** IB Chem/2017/s/TZ2/P1/SL/

27. A

28. C

29. B

Topic Chem 11 **Q# 160/** IB Chem/2017/s/TZ1/P1/SL/

28. D

29. D

30. B

Topic Chem 11 **Q# 161/** IB/P 1/2016/w/TZ0/SL/

27. A

28. D

29. B

30. B

Topic Chem 11 **Q# 162/** IB/P 1/2016/SP/TZ0/SL/

27. D

28. A

29. D

30. A

Topic Chem 11 **Q# 163/** IB/P 1/2016/s/TZ1/SL/

27. D

28. C

29. A

30. C

Topic Chem 11 **Q# 164/** IB/P 1/2016/s/TZ1/SL/

27. D

28. C

29. A

30. C

Atomic number

Element

Relative atomic mass

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 **H** 1.01																	2 **He** 4.00
2	3 **Li** 6.94	4 **Be** 9.01											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
3	11 **Na** 22.99	12 **Mg** 24.31											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.07	17 **Cl** 35.45	18 **Ar** 39.95
4	19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.87	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.69	29 **Cu** 63.55	30 **Zn** 65.38	31 **Ga** 69.72	32 **Ge** 72.63	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.90	36 **Kr** 83.90
5	37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.96	43 **Tc** (98)	44 **Ru** 101.07	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.76	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.29
6	55 **Cs** 132.91	56 **Ba** 137.33	57 † **La** 138.91	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.84	75 **Re** 186.21	76 **Os** 190.23	77 **Ir** 192.22	78 **Pt** 195.08	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.38	82 **Pb** 207.20	83 **Bi** 208.98	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
7	87 **Fr** (223)	88 **Ra** (226)	89 ‡ **Ac** (227)	104 **Rf** (267)	105 **Db** (268)	106 **Sg** (269)	107 **Bh** (270)	108 **Hs** (269)	109 **Mt** (278)	110 **Ds** (281)	111 **Rg** (281)	112 **Cn** (285)	113 **Uut** (286)	114 **Uuq** (289)	115 **Uup** (288)	116 **Uuh** (293)	117 **Uus** (294)	118 **Uuo** (294)

†	58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** (145)	62 **Sm** 150.36	63 **Eu** 151.96	64 **Gd** 157.25	65 **Tb** 158.93	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.05	71 **Lu** 174.97
‡	90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np** (237)	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (262)