ANDERSON SERANGOON JUNIOR COLLEGE

2023 JC2 PRELIMINARY EXAMINATION WORKED SOLUTION

NAME:_____ ( ) **CLASS:** 23 /____

CHEMISTRY **9729/01**

Paper 1 Multiple Choice **21 September 2023**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil
Do not use staples, paper clips, glue or correction fluid.
Write your name, class and register number on the Answer Sheet.

There are **thirty** questions on this paper. Answer **all** questions. For each question, there are four possible answers, **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

Multiple Choice Answer Sheet

Write your name, class and NRIC / FIN number, **including** the reference letter.

Shade the NRIC / FIN number.

Exam Title: JC2 PRELIM

Exam Details: H2 Chemistry / Paper 1

Date: 21/09/2023

1 In which species are the number of protons, neutrons and electrons all different?

A $^{27}_{13}Al$ **B** $^{35}_{17}Cl^-$ **C** $^{32}_{16}S^{2-}$ **D** $^{39}_{19}K^+$

Ans **D**

Work out the number for each of the options as follow.

species	$^{27}_{13}Al$	$^{35}_{17}Cl^-$	$^{32}_{16}S^{2-}$	$^{39}_{19}K^+$
no. of protons	13	17	16	19
no. of electrons	13	18	18	18
no. of neutrons	14	18	16	20

2 The ionisation energies, IE, of five elements are given in the table.

	second IE /kJ mol^{-1}	third IE /kJ mol^{-1}	fourth IE /kJ mol^{-1}
B	2420	3660	25000
F	3370	6040	8410
Na	4560	6940	9540
Mg	1450	7740	10500
A*l*	1820	2740	11600

Which statement is correct?

A The 2nd IE of F is higher than the 3rd IE of A*l* because Al^{2+} has a higher nuclear charge than F^+.

B The 2nd IE of Mg is lower than 2nd IE of Na because there is inter-electronic repulsion between the paired electrons in Mg^+.

C The 4th IE of B is higher than the 4th IE of A*l* because the electron to be removed from Al^{3+} is further away from the nucleus.

D The successive IE of these elements increase because the shielding effect increases.

Ans **C**

F^+: $1s^2 2s^2 2p^4$
Al^{2+}: $1s^2 2s^2 2p^6 3s^1$
Option **A** is incorrect. Al^{2+} has a higher nuclear charge than F^+ but the 3rd electron that is removed from A*l* is also further away from nucleus than the 2nd electron that is removed from F. Hence it experiences weaker electrostatic forces of attraction and the 3rd ionisation energy of A*l* is lower than 2nd ionisation energy of F.

Na^+: $1s^2 2s^2 2p^6$
Mg^+: $1s^2 2s^2 2p^6 3s^1$

Option **B** is incorrect. The 2nd ionisation energy of Mg is lower than Na because the 3s electron to be removed from Mg^+ is at a higher energy level/further away from the nucleus.

B^{3+}: $1s^2$
Al^{3+}: $1s^2 2s^2 2p^6$

Option **C** is correct. As can be seen from the electronic configuration, the 2p electron to be removed from Al^{3+} is further away/at a higher energy level compared to the 1s electron to be removed from B^{3+}.

Option **D** is incorrect. As electrons are successively removed from the atom, number of protons remains the same ⇒ nuclear charge remains the same. Number of electrons decreases and could be removed from different shell and/or subshell ⇒ shielding effect decreases. Remaining electrons experience strong attraction by the nucleus. More energy is required to remove the electron leading to an increase in I.E.

3 Which statement about the electrons in a ground state germanium atom is correct?

A Electrons are present in four different energy levels.

B There are more electrons in d orbitals than there are in p orbitals.

C The occupied orbital of highest energy is spherical.

D The occupied orbital of lowest energy is spherical.

Ans **D**

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

Statement A is incorrect as electrons are present in eight different energy levels.

Statement B is incorrect as there are more electrons in p orbitals (14) than in the d orbitals (10).

Statement C is incorrect as the highest energy is 4p orbital which is not spherical.

4 Which species contains three π bonds?

1 Al_2Cl_6

2 SO_3

3 CH_3CH_2COOH

4 CH_2CHCH_2CN

A 2 and 3

B 2 and 4

C 1 only

D 2 only

Ans **B**

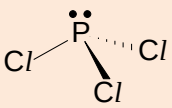
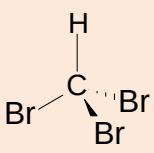
Al_2Cl_6	8 σ bonds
SO_3	3 σ bonds, 3 π bonds
CH_3CH_2COOH	10 σ bonds, 1 π bond
$CH_2{=}CHCH_2C{\equiv}N$	9 σ bonds, 3 π bond

5 The shape and polarity of four molecules are shown in the following table.

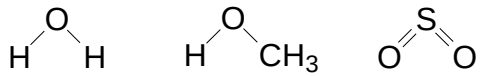
Which row is correct?

	molecule	molecular shape	polarity
A	beryllium chloride	bent	non-polar
B	phosphorus trichloride	trigonal pyramidal	non-polar
C	carbon dioxide	linear	polar
D	tribromomethane	tetrahedral	polar

Ans **D**

	$BeCl_2$	PCl_3	CO_2	$CHBr_3$
No. of bp, lp on central atom	2 bp, 0 lp	3 bp , 1 lp	2 bp, 0 lp	4 bp, 0 lp
Molecular shape	linear Cl—Be—Cl	trigonal pyramidal 	linear O=C=O	tetrahedral 
polarity	non–polar	polar	non-polar	polar

6 Water, methanol and sulfur dioxide have similarly shaped molecules.



What is the strongest intermolecular force in water, methanol and sulfur dioxide?

	H_2O	CH_3OH	SO_2
A	hydrogen bonds	hydrogen bonds	permanent dipoles
B	hydrogen bonds	hydrogen bonds	induced dipoles
C	permanent dipoles	permanent dipoles	induced dipoles
D	hydrogen bonds	permanent dipoles	induced dipoles

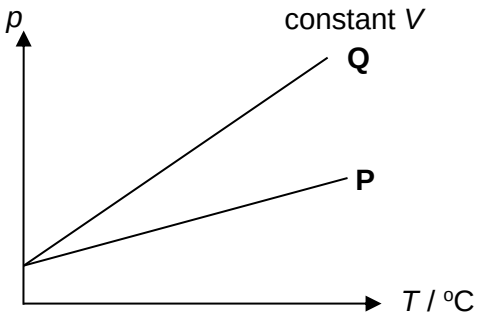
Ans **A**

Presence of H covalently bonded to O and available lone pairs of electrons on O in both water and methanol, hence hydrogen bonds will be the strongest IMF.

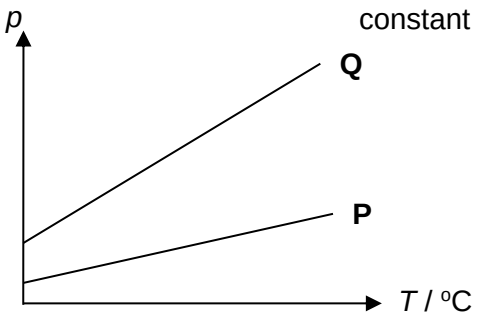
Sulfur dioxide does not have H covalently bonded to O, hence only permanent dipoles.

7 Which graph correctly describes the behaviour of two ideal gases **P** and **Q**, both having the same mass, where **P** has a larger M_r than **Q**?

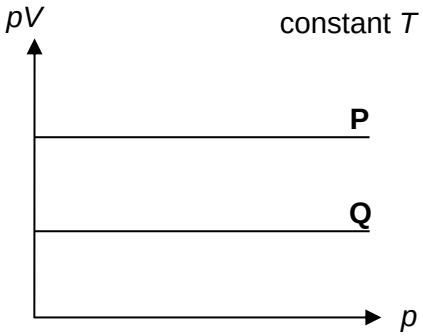
A



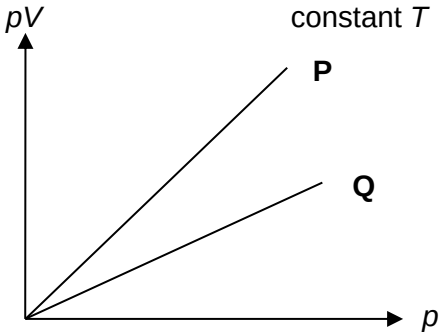
B



C



D

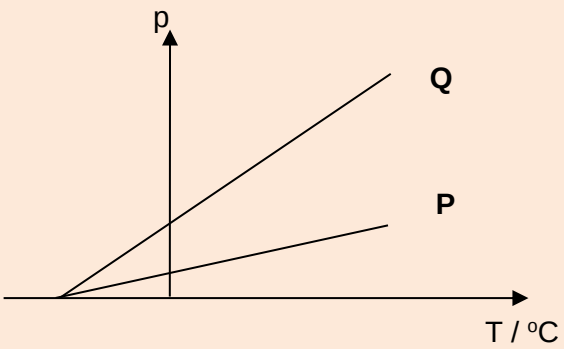


Ans **B**

$pV = nRT \Rightarrow pV = \frac{mRT}{M} \Rightarrow p = (\frac{mR}{VM})T$

For graph of p against T, gradient = $\frac{mR}{VM}$

Since **P** has a larger M_r than **Q**, the graph for **P** has a less steep gradient.



For a fixed mass of gas at constant T, $pV = \frac{mRT}{M}$ = constant

Hence, the graph of pV against p is a horizontal straight line (option D is incorrect).
Since **P** has a larger M_r than **Q**, the pV value for **P** is smaller than that for **Q** (option C is incorrect).

8 Which gas shows the greatest deviation from ideality?

A CH_4 **B** SO_3 **C** C_2H_2 **D** CO_2

Ans **B**

Deviation depends on IMF and molecular volume.

All 4 compounds are non-polar. SO_3 has the largest electron cloud size and hence strongest id-id forces of attraction between its molecules, hence deviating greatest from ideal gas behaviour.

9 When 25 cm^3 of 0.5 mol dm^{-3} hydrochloric acid is reacted with an equal volume of 0.5 mol dm^{-3} potassium hydroxide, the temperature of the mixture rose by 3.4 ^oC.

What will be the temperature change if 50 cm^3 of 1 mol dm^{-3} hydrochloric acid is mixed with an equal volume of 1 mol dm^{-3} potassium hydroxide?

A 1.7 ^oC **B** 3.4 ^oC **C** 6.8 ^oC **D** 13.6 ^oC

Ans **C**

When 25 cm^3 of 0.5 mol dm^{-3} HC*l* reacted with equal volume of 0.5 mol dm^{-3} KOH,
$\Delta H_1 = -(50 \times c \times 3.4) / (25 \times 10^{-3} \times 0.5)$ J mol^{-1}

When 50 cm^3 of 1 mol dm^{-3} HC*l* reacted with equal volume of 1 mol dm^{-3} KOH,

$\Delta H_2 = -(100 \times c \times \Delta T) / (50 \times 10^{-3} \times 1)$ J mol^{-1}

Both neutralisation reactions involve strong acid (HC*l*) and strong base (KOH). Hence
$\underline{\Delta H_1 = \Delta H_2}$ $\Delta T = 2 \times 3.4 = 6.8$ ^oC

10 Which equation corresponds to the enthalpy change stated?

A	$H_2SO_4(aq) + 2KOH(aq) \rightarrow K_2SO_4(aq) + 2H_2O(l)$	$\Delta H^{\theta}_{neutralisation}$
B	$Na^+(s) + aq \rightarrow Na^+(aq)$	$\Delta H^{\theta}_{hydration}(Na^+)$
C	$Al_2O_3(s) \rightarrow 2Al^{3+}(g) + 3O^{2-}(g)$	$\Delta H^{\theta}_{lattice\ energy}(Al_2O_3)$
D	$O_2(g) \rightarrow 2O(g)$	$2\Delta H^{\theta}_{atomisation}(O_2)$

Ans **D**

Option A: $H_2SO_4(aq) + 2KOH(aq) \rightarrow K_2SO_4(aq) + 2H_2O(l)$ $2\Delta H^{\theta}_{neutralisation}$

Option B: $Na^+(g) + aq \rightarrow Na^+(aq)$ $\Delta H^{\theta}_{hydration}(Na^+)$

Option C: $2Al^{3+}(g) + 3O^{2-}(g) \rightarrow Al_2O_3(s)$ $\Delta H^{\theta}_{lattice\ energy}(Al_2O_3)$

11 Given the following data in kJ mol^{-1}

enthalpy change of atomisation of Na(s)	+107
electron affinity of C*l* atom	–349
enthalpy change of formation of NaC*l*(s)	–411
enthalpy change of atomisation of C*l*(g)	+122
1st ionisation energy of Na atom	+494

What is the lattice energy of NaC*l*(s) in kJ mol^{-1}?

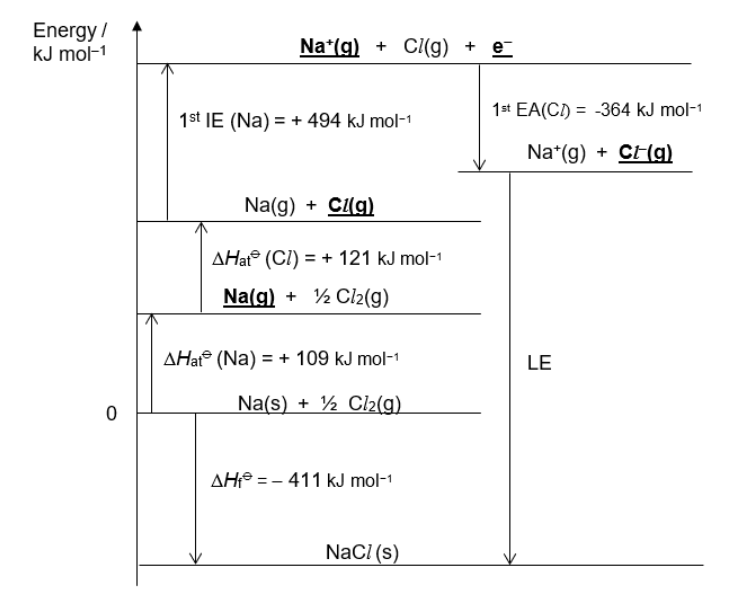
A –771

B –892

C –1269

D –1499

Ans A



By Hess's law,
-411 = +109 + 494 + 121 – 364 + LE

LE = **–771 kJ mol^{-1}**

12 The equation describes the equilibrium between solid silver chromate and its aqueous ions.

$Ag_2CrO_4(s) \rightleftharpoons 2Ag^+(aq) + CrO_4^{2-}(aq)$ $\quad \Delta H^\ominus = +61 \text{ kJ mol}^{-1}$, $\Delta S^\ominus = -30 \text{ J K}^{-1} \text{ mol}^{-1}$

What can be deduced from the information about this equilibrium?

1 At 25 °C, $\Delta G^\ominus$ is negative.

2 At 25 °C, silver chromate is insoluble in water.

3 At 95 °C, silver chromate is more soluble in water than at 25 °C.

A 2 only

B 1 and 3 only

C 2 and 3 only

D 1, 2 and 3

Ans **A**

$\Delta G^\ominus = \Delta H^\ominus - T\Delta S^\ominus$
$= +61 - 298 (-30 \times 10^{-3}) = +69.9 \text{ kJ mol}^{-1}$

$\Delta G^\ominus$ is positive.
A positive $\Delta G^\ominus$ indicates that dissolution is not spontaneous, hence silver chromate is insoluble in water.
Since $\Delta S^\ominus$ is negative, at a higher temperature, $\Delta G^\ominus$ tends towards a more positive value. Dissolution becomes less spontaneous at higher temperature.

13 *Use of the Data Booklet is relevant to this question.*

Bronze is an alloy of copper and tin. The following information is obtained for a sample of bronze.

mass number	63	65	118
% composition	f	68 – f	32

Naturally occurring copper contains only two isotopes, ^{63}Cu and ^{65}Cu.

Given the ratio of ^{63}Cu and ^{65}Cu in naturally occurring copper is the same as that in bronze, what is the value of f?

A 17

B 25

C 51

D 75

Ans **C**

Let a be the fraction of ^{63}Cu and (1 – a) be the fraction of ^{65}Cu in naturally occurring copper.

From the *Data Booklet*, the relative atomic mass of Cu is 63.5.

$63.5 = 63a + 65(1 - a) \Rightarrow a = 0.75$

Hence, in the sample of bronze,

$$\frac{\text{\% composition of } ^{63}\text{Cu}}{\text{\% composition of } ^{65}\text{Cu}} = \frac{f}{68 - \text{f}} = \frac{0.75}{0.25}$$

f = 51

14 Two reactions are shown.

Reaction 1 $X_2(g) + Y_2(g) \rightleftharpoons 2XY(g)$

Reaction 2 $XY(g) \rightleftharpoons \frac{1}{2} X_2(g) + \frac{1}{2} Y_2(g)$

The equilibrium constant, K_p, for Reaction 1 is 0.0052.

What is the value of K_p for Reaction 2?

A 2.6×10^{-3}

B 13.9

C 192.3

D 384.6

Ans **B**

Reaction 1	$K_p = \frac{(P_{XY})^2}{(P_{X_2})(P_{Y_2})}$
Reaction 2	$K_p = \frac{(P_{X_2})^{0.5}(P_{Y_2})^{0.5}}{(P_{XY})}$

K_p for Reaction 2 = $\frac{1}{\sqrt{\text{Kp reaction 1}}}$ = 13.9

15 Methanol, CH_3OH, can be produced industrially by reacting CO with H_2.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g) \qquad \Delta H = -91\ kJmol^{-1}$$

The process can be carried out at 4×10^3 kPa and 1150K.

Which statements of about this reaction are correct?

1 Increasing the temperature will increase the rate of reaction because more frequent effective collisions will occur.

2 Lowering the temperature will reduce the rate of reaction because the forward reaction is exothermic.

3 Increasing the pressure will reduce the rate of reaction because there are a larger number of moles on the left hand side of the equation.

A 1 only

B 1 and 2

C 1 and 3

D 2 and 3

Ans **A**

2 Incorrect.

Lowering the temperature will reduce the rate of reaction because the forward reaction is exothermic.

When **temperature decreases,** the average kinetic energy of the molecules decreases.

- the number of reactant molecules with energy greater than or equal to the activation energy, E_a, decreases significantly.
- This results in an decrease in the frequency of effective collisions.
- The rate constant, k, decreases and hence rate of reaction decreases.

3 Incorrect.

Increasing the pressure will reduce the rate of reaction because there are a larger number of moles on the left hand side of the equation.

An increase in pressure of gaseous reactants

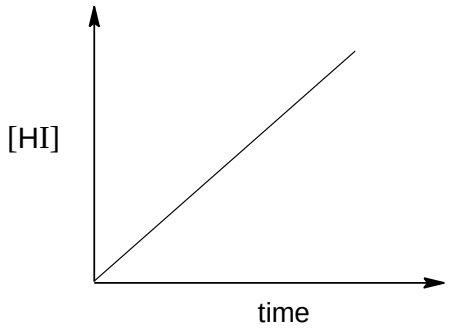
- larger number of molecules per unit volume
- frequency of effective collisions increases
- hence rate of reaction increases.

An increase in pressure will shift the <u>position of equilibrium</u> to the left hand side since there are a larger number of moles on the LHS.

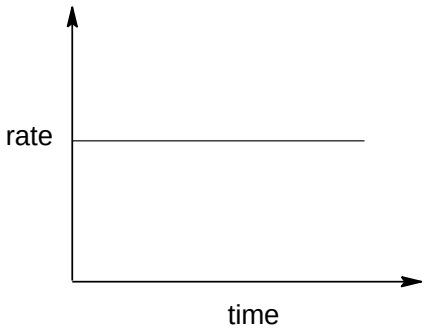
16 The decomposition of HI is a second order reaction.

Which graph correctly describes the kinetics of this reaction?

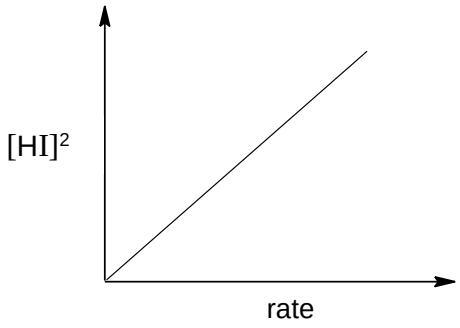
A



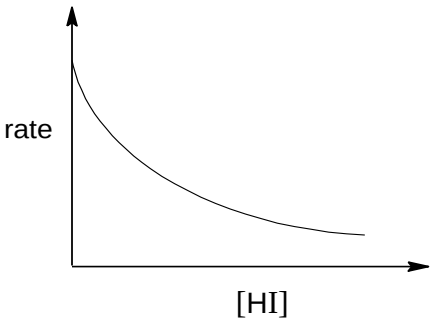
B



C



D



Ans **C**

Since reaction is second order with respect to HI , rate = k[HI]^2 and rate is directly proportional to [HI]^2.
The graph of [HI]^2 against rate will be an upward sloping straight line passing through the origin.

17 Sucrose has been used as a feedstock in the production of alcohol for use as a motor fuel. The initial reaction is its hydrolysis:

$$\underset{\text{sucrose}}{C_{12}H_{22}O_{11}} + H_2O \longrightarrow \underset{\text{glucose}}{C_6H_{12}O_6} + \underset{\text{fructose}}{C_6H_{12}O_6}$$

This reaction can be catalysed either by dilute acid or by an enzyme which occurs in yeast. The following results were obtained using hydrochloric acid as the catalyst.

Experiment	Initial [HC*l*] / mol dm^{-3}	Initial [sucrose] / mol dm^{-3}	Initial rate / mol dm^{-3} s^{-1}
I	0.10	0.10	0.024
II	0.20	0.10	0.048

The order of reaction with respect to HC*l* and sucrose are both one and the half-life of sucrose in experiment I was 3.0 s.

Predict the half-life of sucrose in experiment II.

A 1.5 s

B 2.0 s

C 3.0 s

D 6.0 s

Ans **A**

Rate = k[HC*l*][sucrose]
Since HC*l* is a catalyst, its concentration remains fairly constant
$\Rightarrow$ rate equation can be approximated to

rate = k' [sucrose], where $k' = k\,[HCl]_{expt\ 1}$

$$t_{1/2} = \frac{\ln 2}{k'} = \frac{\ln 2}{k[HCl]} = 3 \text{ s}$$

From the equation above, $t_{1/2}$ is only affected by the [HC*l*].

<u>In experiment III</u>
Since [HC*l*] doubles, the half–life will be halved.
Hence $t_{1/2}$ = **1.5 s**

18 Solutions **E**, **F**, **G** and **H** contain a strong monobasic acid, a weak monobasic acid, a strong base and a salt of the weak monobasic acid, but not necessarily in the same order. The concentration and pH at 25 ^{o}C for each solution are shown below.

Solution	Concentration /mol dm^{-3}	pH
E	1.0	4.0
F	1.0	9.4
G	0.01	12.0
H	0.01	2.0

Which one of the following produces an acidic buffer?

A Mixing 10 cm^3 of **E** and 50 cm^3 of **G**

B Mixing 10 cm^3 of **E** and 50 cm^3 of **H**

C Mixing 10 cm^3 of **F** and 1 dm^3 of **H**

D Mixing 10 cm^3 of **F** and 1 dm^3 of **G**

Ans **A**

A buffer is made up of a weak acid/ basic salt or weak base/ acidic salt

Solution	Concentration /mol dm^{-3}	pH	Type
E	1.0	4.0	Weak acid
F	1.0	9.4	Weak base
G	0.01	12.0	Strong Base
H	0.01	2.0	Strong Acid

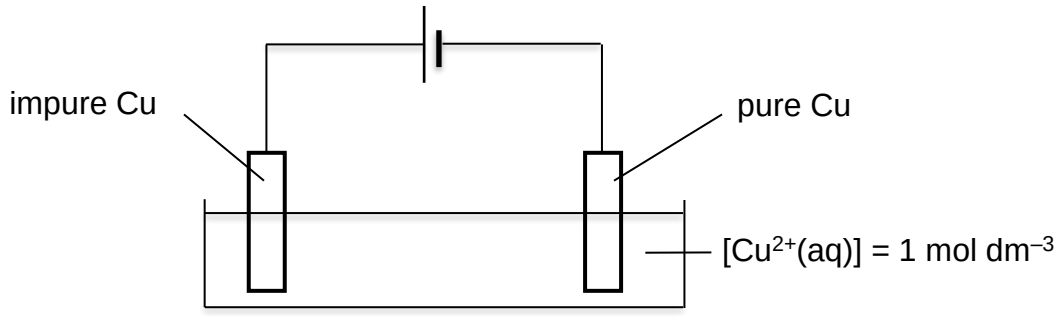
A: Excess weak acid + strong base ➔ weak acid/ basic salt (acidic buffer)

B: weak acid + strong acid ➔ not buffer

C: Weak base + excess strong acid ➔ strong acid/ acidic salt ➔ acidic solution

D: Weak base + strong base ➔ basic solution

19 An electrolytic cell is set up for the purification of a mass of impure copper as shown.



The sample of impure Cu is known to contain nickel and silver as minor impurities.

Using which of the following in a larger quantity will result in more pure copper deposit on the cathode?

A concentration of Cu^{2+} electrolyte

B mass of impure Cu

C temperature

D current

Ans: D

Using the equations Q=It

where n = amount of Cu deposited, z = 2 for $Cu^{2+} + 2e \rightarrow Cu$

The amount of charge supplied will affect the amount of Cu deposited. The amount of charge, Q, is affected by current used and the length of time for which the current is run.

20 An electric current is passed through two cells connected in series. One cell contains gold(III) chloride and the other contains aqueous copper(II) sulfate. If 4.00 g of gold is formed in the cell containing gold(III) chloride, what is the mass of copper deposited in the other cell?

A 0.64 g **B** 0.86 g **C** 1.29 g **D** 1.93 g

Ans **D**

For electrolytic cells connected in series, the same number of electrons will pass through each cell.
n(Au) deposited = 4.0 ÷ 197.0 = 0.0203 mol
n(e) transferred = 0.0203 × 3 = 0.0609 mol
Since 0.0609 mol of electrons was transferred, and 1 mol of Cu^{2+} requires 2 mol of electrons for reduction, 0.0305 mol of Cu was deposited.
Mass of Cu deposited = 0.0305 × 63.5 = 1.93 g

21 Which statement about Group 2 elements and their compounds is **incorrect**?

A Barium loses its valence electrons more easily than calcium hence it is a stronger reducing agent.

B The melting point of magnesium oxide is higher than calcium oxide due to the higher polarising power of Mg^{2+}.

C Magnesium carbonate decomposes at a lower temperature than calcium carbonate.

D Beryllium chloride can behave as a Lewis acid because there are only four bonding electrons around beryllium.

Ans **B**

Option A: Correct

Ba has more electron shells than Ca. Its valence electrons are further away from the nucleus, hence less attracted to the nucleus, and so need less energy to be removed.

Option B: Incorrect

$\left|\text{lattice energy}\right| \alpha \left|\frac{q_+ \times q_-}{r_+ + r_-}\right|$. Mg^{2+} has a smaller ionic radius (smaller inter-ionic distance) than Ca^{2+} which results in a greater magnitude of lattice energy. Ionic bonds in MgO are stronger than that in CaO and require <u>more energy</u> to break. Concept of charge density and polarising power is not applied here.

Option C: Correct

The charge density and hence polarising power of Mg^{2+} is higher than that of Ca^{2+} since Mg^{2+} is smaller than Ca^{2+}. Hence there is a greater distortion of the anionic charge cloud so the C-O covalent bond within the CO_3^{2-} is weakened to a greater extent by Mg^{2+}. Thus, $MgCO_3$ is less stable to heat and decomposes at a *lower* temperature than $CaCO_3$.

Option D: Correct

Be in $BeCl_2$ is electron deficient, hence it can accept lone pair of electrons to achieve stable octet configuration**.**

22 Due to its radioactive nature, the properties of astatine, At, have to be estimated based on its position in the Periodic Table.

Which predictions concerning At or its compounds are correct?

1 Astatine forms diatomic molecules which dissociate into atoms less readily than iodine molecules.

2 Astatine is a weaker oxidising agent than iodine.

3 Astatine is a solid at room temperature.

4 Hydrogen astatide has a higher decomposition temperature than hydrogen iodide.

A 1, 2 and 4

B 2, 3 and 4

C 2 and 3

D 1 and 4

Ans **C**

Statement 1 is incorrect.
Due to astatine's larger atomic radius, the extent of orbital overlap between two At atoms would be effective as compared to between two I atoms. Hence, the At–At bond would be weaker and hence At_2 would dissociate more readily than I_2.

Statement 2 is correct.
Oxidising power decreases down Group 17, so astatine should be a weaker oxidising agent than iodine.

Statement 3 is correct.
Boiling and melting point increases down the group. Iodine is already a solid at room temperature, hence astatine, with a higher melting point, would also exist as a solid at room temperature.

Statement 4 is incorrect.
Down the group, the valence orbital of halogen used in bonding with hydrogen becomes bigger and more diffused hence the overlap of the atomic orbitals becomes less effective.
BE: HF > HC*l* > HBr > HI > H-At
thermal stability: HF > HC*l* > HBr > HI > H-At
decomposition temperature : HF > HC*l* > HBr > HI > H-At

23 How many chiral carbon atoms are there in one molecule of 2,2,4,5-tetramethylhexan-3-ol?

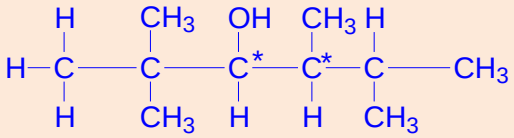
A 1

B 2

C 3

D 4

Ans **B**



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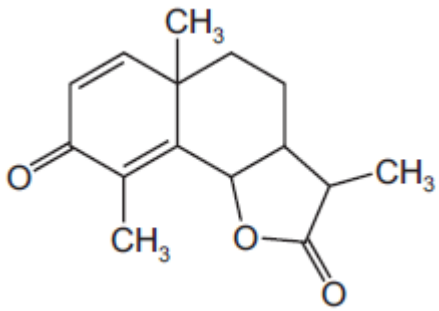


Santonin

Santonin is first heated with dilute H_2SO_4. The product of this reaction is treated with cold dilute acidified $KMnO_4$. A final product **Q** is obtained.

How many atoms of hydrogen in each molecule of product **Q** will react with sodium metal?

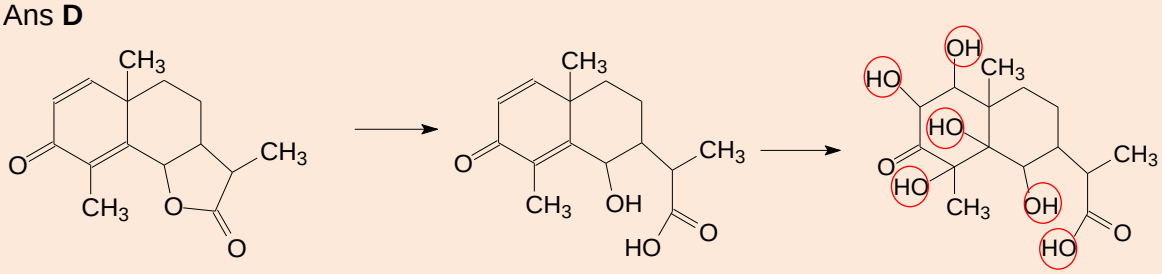
A 2

B 4

C 5

D 6

Ans **D**



Ester linkage will be hydrolysed

mild oxidation will occur for alkene

The alcohol and carboxylic acid will react with the sodium metal.

25 When dichlorodifluoromethane, CCl_2F_2, is released into the atmosphere, it accumulates in the upper part of the atmosphere where it reacts to form free radicals due to the action of ultraviolet light.

One of the chain reactions which can occur is shown, where X• represents the halogen radical.

$$X\bullet + O_3 \rightarrow XO\bullet + O_2$$
$$2XO\bullet + O_2 \rightarrow 2X\bullet + 2O_2$$

Which statement is correct?

A F• and •CCl_2F are the major free radical products made during the initiation step.

B The halogen radical acts as a catalyst in the breakdown of ozone.

C The halogen radical is formed during the termination step.

D The initiation step is exothermic in nature.

Ans **B**

A is incorrect. F• will not be formed as the C–F bonds is very strong and inert.

B **is correct**. As observed from the equations, X• is reacted in the first equation and regenerated in the second equation.

C is incorrect. Termination steps involve the reaction between two radicals to form a molecule. Hence no halogen radical is formed.

D is incorrect. Initiation step involves bond breaking, in the presence of UV light.

26 Compound **B**, $C_6H_{12}O_6$, is an important biomolecule abundant in the brain as it mediates cell signal transduction in response to a variety of hormones and neurotransmitters.

All the atoms (besides the hydrogen atoms) in **B** are sp^3 hybridised.

On adding excess sodium to **B**, hydrogen gas is liberated.

Which of the following statements about compound **B** is true?

A Compound **B** forms a purple colouration with neutral iron(III) chloride solution.

B Compound **B** forms a yellow precipitate with warmed alkaline iodine solution.

C Compound **B** forms a bright orange precipitate with 2,4-dinitrophenylhydrazine.

D Compound **B** forms a brick-red precipitate with Fehling's solution.

Ans **B**

Option A requires a phenol. But no phenol is present in B because "all the atoms (besides the hydrogen atoms) in B are sp^3 hybridised."

Option B requires a methyl ketone or a $–CH(CH_3)OH$ group. It is still possible for B to possess the latter.

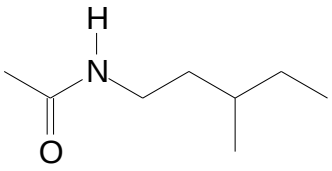
Option C requires an aldehyde or ketone. But no such functional groups are present in B because "all the atoms (besides the hydrogen atoms) in B are sp^3 hybridised."

Option D requires an aldehyde. But no aldehyde is present in B because "all the atoms (besides the hydrogen atoms) in B are sp^3 hybridised."

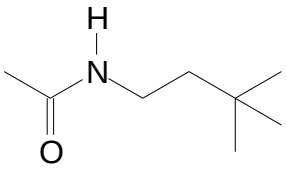
27 An amide, **M**, has the empirical formula $C_8H_{17}ON$. Molecules of **M** are chiral. When **M** is hydrolysed by heating under reflux with dilute hydrochloric acid, a carboxylic acid with empirical formula C_2H_4O is obtained as one of the products.

What could be the formula of **M**?

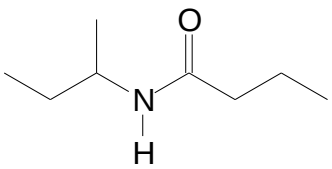
A



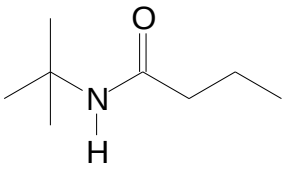
B



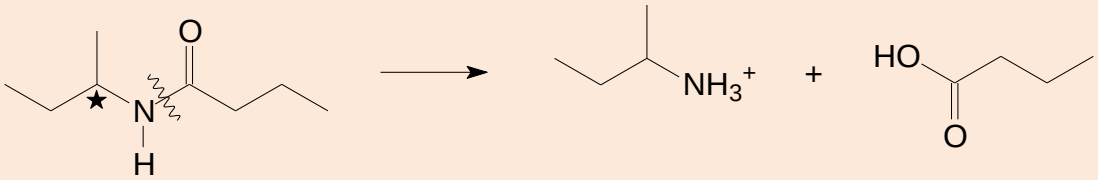
C



D



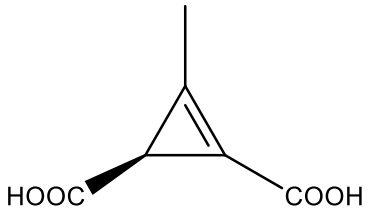
Ans **C**

A	Chiral carbon. Carboxylic acid produced has a molecular formula: $C_2H_4O_2$, empirical formula: CH_2O
B	Absence of Chiral carbon. Carboxylic acid produced has a molecular formula: $C_2H_4O_2$, empirical formula: CH_2O
C	 $C_4H_8O_2$
D	Absence of Chiral carbon. Carboxylic acid produced has an empirical formula: C_2H_4O

28 In 1893, a new compound Feist's acid was discovered and found to be optically active.

Based on the above information, which of the following could be the structures of Feist's acid?

1



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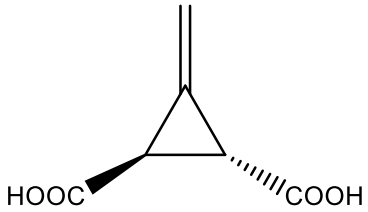
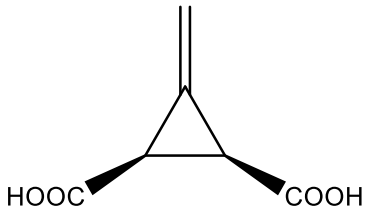


3



A 1 only **B** 1 and 2 only

C 1 and 3 only **D** 2 and 3 only

Ans **B**

1 has a chiral centre and no plane of symmetry, so it is optically active.
2 has two chiral centres and no plane of symmetry, so it is optically active.
3 has two chiral centres and a plane of symmetry,It is a meso compound which is optically inactive

29 A compound of chromium with the general formula $CrCl_3.6H_2O$ forms an aqueous solution. When this solution is treated with an excess of aqueous silver nitrate, only one third of the total chloride present is precipitated as AgCl.

What is the structure of the chromium ion present in the original compound?

A $Cr^{3+}(aq)$

B $[Cr(H_2O)_6]^{3+}$

C $[Cr(H_2O)_5Cl]^{2+}$

D $[Cr(H_2O)_4Cl_2]^{+}$

Ans **D**

Only one third of the total chloride present in compound is precipitated as AgCl
⇒ implies that for 1 mol of Cr compound , 1 mol of chloride exists as free chloride ions, 2 mol of chloride exist as ligands around the central metal ion.
⇒ Compound is **$[Cr(H_2O)_4Cl_2]^+Cl^-.2H_2O$**

30 A reaction scheme starting from aqueous cobalt(II) sulfate solution is shown below.

Both **G** and **H** are cobalt–containing species. **G** appears as a blue precipitate while **H** is a yellow brown solution, $[Co(NH_3)_6]^{2+}$.

$$CoSO_4(aq) \xrightarrow[I]{NH_3(aq)} \mathbf{G} \xrightarrow[II]{\text{excess } NH_3(aq)} \mathbf{H} \xrightarrow[III]{Na_4edta(aq)} [Co(edta)]^{2-}(aq)$$

Which of the following statements is correct?

A NH_3 is a ligand in reaction I.

B Reaction II is a ligand exchange reaction.

C Oxidation state of cobalt in $[Co(edta)]^{2-}$ is +6.

D The entropy of the system decreases when reaction III occurs.

Ans **B**

Step I: On adding ammonia to $CoSO_4(aq)$, (acid-base reaction)
$[Co(H_2O)_6]^{2+}(aq) + 2OH^-(aq) \rightleftharpoons [Co(OH)_2(H_2O)_4](s) + 2H_2O(l)$.....(1)
G (blue ppt)

Step II: Excess ammonia: (ligand exchange reaction)
$[Co(H_2O)_6]^{2+}(aq) + 6NH_3(aq) \rightleftharpoons [Co(NH_3)_6]^{2+}(aq) + 6H_2O(l)$ .....(2)
H

Step III:
$$\underbrace{[Co(NH_3)_6]^{2+} + edta^{4-}}_{\text{2 particles}} \longrightarrow \underbrace{[Co(edta)]^{2-} + 6NH_3}_{\text{7 particles}}$$
(entropy increases when chelate forms)

Oxidation state of Co remain at +2.