



Catholic Junior College
JC 2 Preliminary Examinations
Higher 1

CHEMISTRY

Paper 1 Multiple Choice

8873/01

18 September 2025

1 hour

Additional Materials: Multiple Choice Answer Sheet
Data Booklet

READ THESE INSTRUCTIONS FIRST

Write your name, HT group and NRIC/FIN number on the Answer Sheet in the spaces provided.

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

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.

WORKED SOLUTIONS

For each question there are **four** possible answers, **A**, **B**, **C** and **D**. Choose the **one** you consider to be correct.

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

Which of the following contains 1 mole of the stated particle?

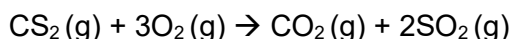
- A gold atoms in 79 g of solid gold
- B aqueous H^+ ions in 10 dm^3 of 0.10 mol dm^{-3} of H_2SO_4 solution
- C hydrogen atoms in 6 dm^3 of methane gas at r.t.p.
- D chlorine molecules in 22.4 dm^3 of chlorine gas at r.t.p.

Concept: Mole Concept and Stoichiometry

Answer: C

- A Amount of Au atoms = $\text{mass}/M_r = 79/197 = 0.401 \text{ mol}$
- B Amount of H^+ ions = $\text{concentration} \times \text{volume} = 2 \times 10 \times 0.10 = 2.0 \text{ mol}$
- C At r.t.p., 1 mol of any gas occupies 24 dm^3 .
Therefore, number of moles of gas in $6 \text{ dm}^3 = 0.25 \text{ mol}$
In 1 mol of methane, there are 4 mol of H atoms.
Amount of H atoms in 0.25 mol of methane = $4 \times 0.25 = 1 \text{ mol}$
- D At r.t.p., 1 mol of any gas occupies 24 dm^3 .
Therefore, number of moles of gas in $2.4 \text{ dm}^3 = 22.4/24 = 0.933 \text{ mol}$

2 Carbon disulphide vapour was burnt in oxygen according to the equation:



A fixed amount of carbon disulphide was completely burnt in 100 cm^3 of oxygen.

Upon cooling, the mixture of gases was treated with an excess of aqueous sodium hydroxide and the volume of gas reduced by 30 cm^3 .

All measurements were made at the same temperature and pressure.

What was the final volume of gas left?

- A 10 cm^3
- B 30 cm^3
- C 40 cm^3
- D 70 cm^3

Concept: Mole Concept and Stoichiometry**Answer: D**

CO_2 and SO_2 are both acidic gases, so both of them will react with NaOH in a neutralisation reaction.

$$\text{Vol. of } \text{CO}_2 (\text{g}) + \text{Vol. of } \text{SO}_2 (\text{g}) = 30 \text{ cm}^3$$

$$\text{Since } \text{CO}_2 \equiv 2 \text{ SO}_2$$

$$\text{Vol. of } \text{CO}_2 (\text{g}) = 10 \text{ cm}^3, \text{ Vol. of } \text{SO}_2 (\text{g}) = 20 \text{ cm}^3, \text{ Vol. of } \text{CS}_2 (\text{g}) = 10 \text{ cm}^3$$

$$\text{Vol. of } \text{O}_2 (\text{g}) \text{ reacted} = 10 \times 3 = 30 \text{ cm}^3$$

$$\text{Vol. of } \text{O}_2 (\text{g}) \text{ left} = 100 - 30 = 70 \text{ cm}^3$$

- 3 Element **X** can exist in a few oxidation states. It was found that 0.01 mol of X^{2+} requires 0.004 mol of acidified potassium manganate (VII), KMnO_4 for complete reaction.

What is the final oxidation state of **X** in the above reaction?

A +4**B** +3**C** 0**D** -1**Concept: Mole Concept and Stoichiometry (Redox)****Answer: A**

0.01 mol of X^{2+} reacts with 0.004 mol of MnO_4^-

$$\text{Thus } 5\text{X}^{2+} \equiv 2\text{MnO}_4^-$$



Since electrons transferred in a redox reaction is equal (i.e. the no. of e^- accepted = no. of electron donated),

thus 2 MnO_4^- gains 10e^- while 5 X^{2+} donates 10e^-

$\Rightarrow$ each X^{2+} loses 2e^-

$\Rightarrow$ **X** is oxidised from +2 to +4 oxidation state.

- 4 Use of the Data Booklet is relevant to this question.

Which of the following has more neutrons than electrons and more electrons than protons?

A $^{37}\text{Cl}^-$ **B** $^{48}\text{Tl}^{4+}$ **C** $^{79}\text{Br}^+$ **D** $^{32}\text{S}^{2-}$

Concept: Atomic Structure**Answer: A**

	$^{37}_{17}\text{Cl}^-$	$^{48}_{22}\text{Ti}^{4+}$	$^{79}_{35}\text{Br}^+$	$^{32}_{16}\text{S}^{2-}$
Protons:	7	22	35	16
Electrons:	18	18	34	18
Neutrons:	20	26	44	16

Note: Students should eliminate options B and C since the qns stated that there are "more electrons than protons". Thus the only options that required calculation of no. of neutrons and electrons are options A and D.

5 What is the electronic configuration of Fe^{3+} ion?

- A** $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$
B $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3 4s^2$
C $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$
D $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1$

Concept: Atomic Structure**Answer: A**

Iron has 26 protons, Fe has electronic configuration of $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$

Thus Fe^{3+} e.c. is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$ since electrons will be lost from 4s subshell first followed by electron from 3d subshell.

6 The successive ionisation energies (IE) of element **X** are given below:

IE/ kJ mol^{-1}	1 st	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th
X	550	1065	4138	5500	6910	8760	10230	11800

What is the likely formula of the compound that is formed when **X** reacts with fluorine?

- A** XF **B** XF_2 **C** X_2F **D** X_2F_3

Concept: Atomic Structure**Answer: B**

There is a sharp increase from the 2nd to 3rd ionisation energy, indicating that the 3rd electron is from the inner quantum shell. Hence, X has 2 valence electrons and will form X^{2+} ion.

- 7 In which pair of molecules is the bond angle in the first molecule smaller than that in the second molecule?

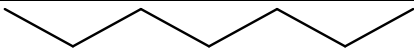
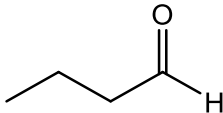
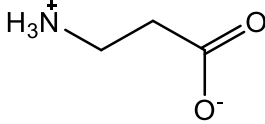
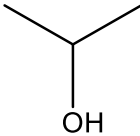
- A BF_3 and PH_3
 B BeCl_2 and H_2S
 C SO_3 and BCl_3
 D F_2O and SO_2

Concept: Chemical Bonding

Answer: D

- | | | |
|----------|----------------------------------|----------------------------------|
| A | BF_3 120° | PH_3 107° |
| B | BeCl_2 180° | H_2S 105° |
| C | SO_3 120° | BCl_3 120° |
| D | F_2O 105° | SO_2 119° |

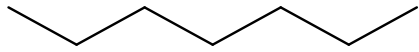
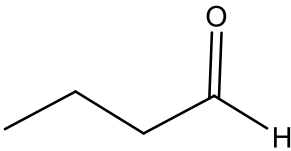
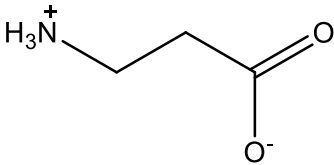
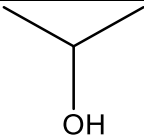
- 8 Which of the following correctly describes the dominant forces of attraction between two of the same compounds shown below?

	compound	dominant forces of attraction
A		covalent bonds
B		hydrogen bonding
C		ionic interaction
D		permanent dipole – permanent dipole

Concept: Chemical Bonding

Answer: C

Correct type of attraction is as follows:

	Compounds	Dominant forces of attraction
A		Instantaneous dipole – induced dipole
B		Permanent dipole-permanent dipole
C		Ionic interaction
D		Hydrogen bonding

9 Which statements help to explain the fact that magnesium has a higher melting point than sodium?

- 1 Magnesium ions have more protons than sodium ions.
- 2 Magnesium ions have a greater charge than sodium ions.
- 3 Magnesium ions have a smaller ionic radius than sodium ions.

A 1, 2 and 3

B 2 and 3

C 2 only

D 1 only

Concept: Chemical Bonding; Metallic bonding [2016 A level]

Answer: A

Magnesium ions have more protons than sodium ions and this results in magnesium ions having smaller ionic radii.

Since magnesium ions have a greater charge (and smaller radii) than sodium ions, the charge density of magnesium ions are higher.

This, along with the sea of delocalised electrons in magnesium is greater, will give rise to greater attraction between magnesium ions and the sea of delocalised electrons and hence higher melting point.

- 10 Which of the following sets of substances consists of simple molecular structure, giant ionic structure and giant covalent structure?

A SiCl_4 , MgCl_2 , $\text{C}(\text{graphite})$

B AlF_3 , MgCl_2 , $\text{C}(\text{graphite})$

C MgCl_2 , SO_2 , SiCl_4

D Al_2O_3 , Cu , PCl_5

Concept: Chemical Bonding; structure and bonding.

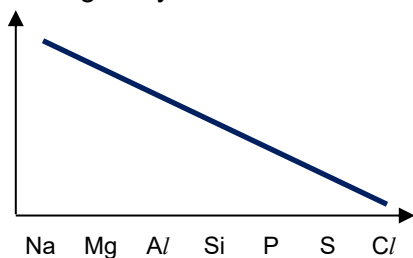
Answer: A

	simple molecular structure	giant ionic structure	giant covalent structure	metallic
A	SiCl_4	MgCl_2	$\text{C}(\text{graphite})$	
B		AlF_3 , MgCl_2	$\text{C}(\text{graphite})$	
C	SO_2 , SiCl_4	MgCl_2		Cu
D	PCl_5	Al_2O_3		

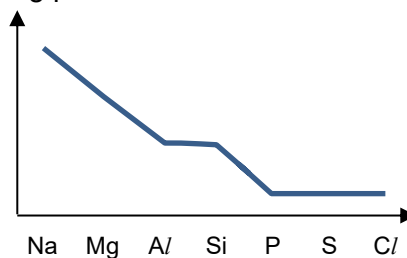
For students who do not recall that BeCl_2 is simple covalent, refer to Chemical Bonding Notes on pages 3-32 to 3-33.

- 11 Which of the following shows the correct trend for Period 3 elements?

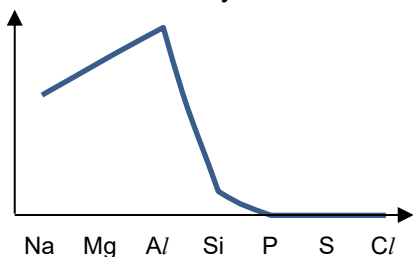
A electronegativity



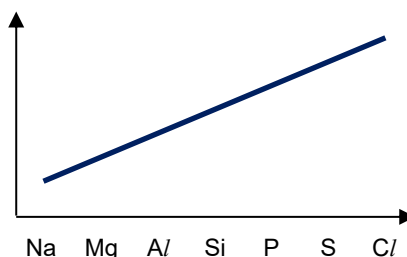
B boiling point

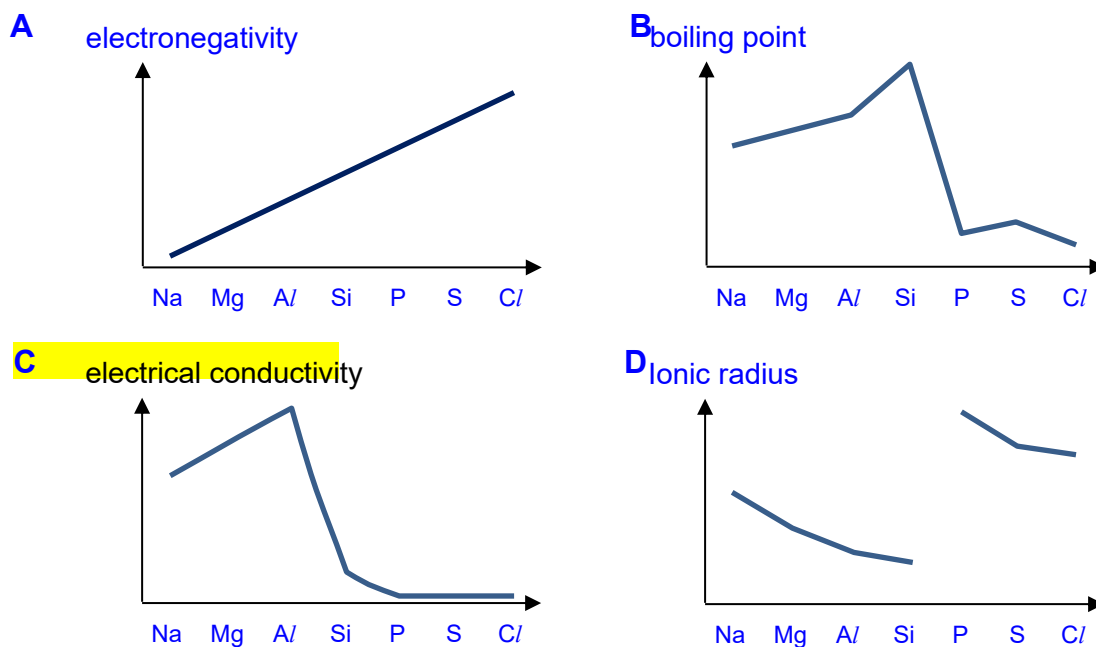


C electrical conductivity



D ionic radius



Concept: The Periodic Table**Answer: C**

- 12 The chloride of an element **R** of the third period is a solid at room temperature which dissolves in water to form a slightly acidic solution of pH 6.5.
Which group of the periodic table does **R** belong to?

A 1**B** 2**C** 13**D** 14**Concept: The Periodic Table****Answer: B**

MgCl_2 is a solid at room temperature which can be hydrolysed by water to give a slightly acidic solution.

NaCl will hydrolyse in water to produce a neutral solution while AlCl_3 and SiCl_4 (exist as a liquid at rtp) will hydrolyse in water to produce acidic solutions of pH 3 and 2 respectively.

Putting all the above together, the correct answer is **B**

13 Which statements are true about the elements in Group 1 of the Periodic Table?

- 1 They are oxidising agents.
- 2 Their electronegativities decrease down the Group.
- 3 Their ionic radii increase down the Group.

A 1, 2 and 3 **B 2 and 3** C 2 only D 1 only

Concept: The Periodic Table

Answer: B

Option 1 is incorrect as they are reducing agents as they are able to be oxidised easily by losing electrons.

Option 2 is correct as down the group, electronegativity will decrease due to the increase in number of quantum shells, distance between protons and valence electrons increase, valence electrons are less strongly attracted to the nucleus, it is harder for electrons to be attracted.

Option 3 is correct as the ionic radii increase down the group due to the increase in number of quantum shells

14 Which equation correctly shows the standard enthalpy change of formation of water?

- A $2 \text{H(g)} + \text{O(g)} \rightarrow \text{H}_2\text{O(l)}$
- B $\text{H}_2\text{(g)} + \frac{1}{2} \text{O}_2\text{(g)} \rightarrow \text{H}_2\text{O(g)}$
- C $\text{H}_2\text{(g)} + \frac{1}{2} \text{O}_2\text{(g)} \rightarrow \text{H}_2\text{O(l)}$**
- D $\text{H}^+\text{(aq)} + \text{OH}^-\text{(aq)} \rightarrow \text{H}_2\text{O(l)}$

Concept: Chemical Energetics

Answer: C

Standard enthalpy change of formation of water is the enthalpy change when **one mole of water** is formed from hydrogen gas and oxygen gas at standard conditions of 298 K and 1 atm.

At 298 K, water exists as a liquid.

- 15 The table shows the enthalpy change of neutralisation, ΔH_n , for various acids and bases.

acid	base	$\Delta H_n / \text{kJ mol}^{-1}$
hydrochloric acid	potassium hydroxide	-57.0
X	potassium hydroxide	-55.5
hydrochloric acid	Y	-53.0
nitric acid	Z	-57.4

What is the identity of **X**, **Y** and **Z** respectively?

	X	Y	Z
A	sulfuric acid	aqueous ammonia	calcium hydroxide
B	ethanoic acid	aqueous ammonia	calcium hydroxide
C	ethanoic acid	potassium hydroxide	aqueous ammonia
D	sulfuric acid	potassium hydroxide	aqueous ammonia

Concept: Chemical Energetics

Answer: B

Enthalpy change of neutralisation is the enthalpy change when **1 mole of water is formed** from the reaction of acid and base at standard conditions of 298 K and 1 atm.

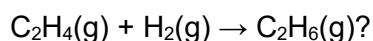
For strong acid and strong base reaction, $\Delta H_n = -57.0 \text{ kJ mol}^{-1}$

X has to be weak acid as the ΔH_n is less negative than $-57.0 \text{ kJ mol}^{-1}$

Y has to be weak base as the ΔH_n is less negative than $-57.0 \text{ kJ mol}^{-1}$

- 16 The enthalpy changes of formation (at 298 K) of gaseous ethene (C_2H_4) and gaseous ethane (C_2H_6) are $+52 \text{ kJ mol}^{-1}$ and -85 kJ mol^{-1} respectively.

What is the enthalpy change of reaction (at 298 K) for the process

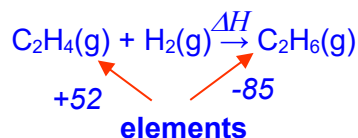


- A** $+137 \text{ kJ mol}^{-1}$ **B** $+33 \text{ kJ mol}^{-1}$ **C** -137 kJ mol^{-1} **D** -33 kJ mol^{-1}

Concept: Chemical Energetics

Answer: C

Example explained on page 5-28 of notes



Using Hess' law,

$$+52 + \Delta H = -85$$

$$\Delta H = -85 - 52 = -137 \text{ kJ mol}^{-1}$$

17 What is meant by a reaction in dynamic equilibrium?

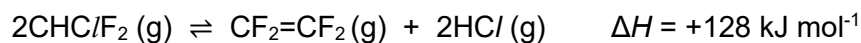
- A** An equilibrium that is constantly changing its position.
- B** An equilibrium that can take place in both an open and closed system.
- C** An equilibrium where the activation energy for the forward reaction is low.
- D** An equilibrium where the rate of the forward and reverse reactions is the same.

Concept: Chemical Equilibria

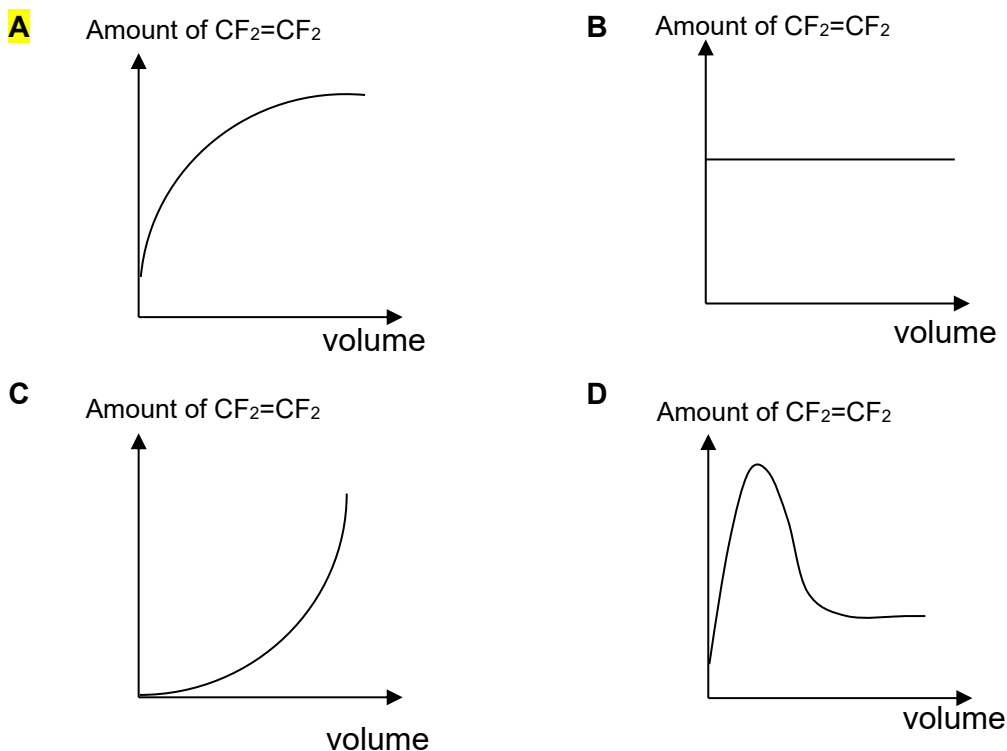
Answer: D

Dynamic equilibrium takes place in a closed system only. Whilst the activation energy is expected to be low, it is not part of the definition of dynamic equilibrium.

18 Given the following equilibrium,



Which of the following graphs best describes how the amount of $\text{CF}_2=\text{CF}_2(\text{g})$ varies with the volume of the system at constant temperature?

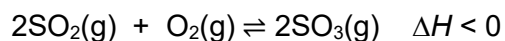


Concept: Chemical Equilibria

Answer: A

Increasing vol. will reduce pressure. According to Le Chatelier's Principle, the position of equilibrium will shift to the right to establish a new equilibrium, forming more $\text{CF}_2=\text{CF}_2$, thus increasing the amount of $\text{CF}_2=\text{CF}_2$ (Option B and D is incorrect). Option C is incorrect because the graph suggested an infinite increase in amount of $\text{CF}_2=\text{CF}_2$ which is not possible.

- 19 An equilibrium is represented by the following equation:



Which of the following changes would increase both the percentage yield of $\text{SO}_3(\text{g})$ and the value of the equilibrium constant?

- A increasing the amount of $\text{O}_2(\text{g})$
- B decreasing the amount of $\text{O}_2(\text{g})$
- C decreasing the temperature**
- D increasing the temperature

Concept: Chemical Equilibria

Answer: C

Only temperature will affect equilibrium constant.

Decreasing the temperature will favour the forward exothermic reaction. Hence percentage yield of $\text{SO}_3(\text{g})$ and the value of the equilibrium constant will increase.

- 20 The rate of decay of a radioactive isotope (a first order reaction) was found to decrease from 200 counts per minute to 12.5 counts per minute after 48 hours.
What is the half-life of this isotope?

- A 6 hours
- B 12 hours**
- C 18 hours
- D 24 hours

Concept: Reaction Kinetics

Answer: B

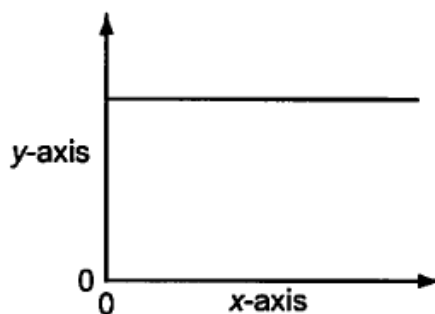


Total number of half-lives = 4

Total time taken for 4 half-lives = 48 hours

Thus, 1 half-life = $48 / 4 = 12$ hours

- 21 The reaction $A \rightarrow B$ was found to be a zero order reaction.
What would be the x and y axes that would give rise to the following graph?



	y-axis	x-axis
A	rate	concentration
B	concentration	rate
C	concentration	time
D	time	concentration

Concept: Reaction Kinetics

Answer: A

Zero order reaction means that the rate of the reaction is independent of the concentration of the reactant **A**. So, even when concentration changes (x-axis), the rate is constant (y-axis).

- 22 Which statements about the rate constant are correct?

- 1 The rate constant increases when a catalyst is used.
- 2 The rate constant increases when temperature is increased.
- 3 The rate constant increases when concentration of reactants are increased.

A 1, 2 and 3 **B** 3 only **C** 1 and 2 only **D** 1 only

Concept: Reaction Kinetics

Answer: C

Rate constant, k is only dependent on the catalyst used and the temperature.
Concentrations of reactants have no effect on rate constant.

23 Which of the following statements about graphene is not true?

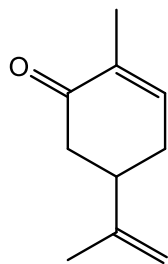
- A** Graphene has instantaneous dipole – induced dipole forces of attraction between layers.
- B** Graphene is able to conduct electricity.
- C** Graphene is macromolecular.
- D** There is a trigonal planar geometry around each carbon atom.

Concept: Nanomaterials

Answer: A

Option A: Graphene is a single layer of atoms. This option describes graphite and not graphene.

24 Carvone is the main active ingredient of the flavouring agent oil of spearmint.



carvone

Which of the following reactions will **not** be applicable for Carvone?

- A** Addition of $\text{H}_2(\text{g})$
- B** Addition of Br_2 in hexane
- C** Reduction
- D** Elimination

Concept: Polymers

Answer: D

The $\text{C}=\text{C}$ can undergo addition.

$\text{C}=\text{O}$ can undergo reduction to secondary alcohol.

There is no functional groups that can undergo elimination.

25 How many structural isomers can C_4H_9Cl form?

A 3

B 4

C 5

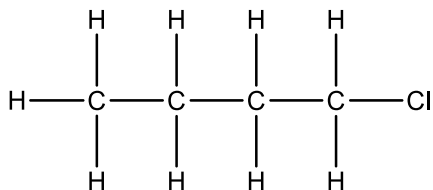
D 6

Concept: Polymers

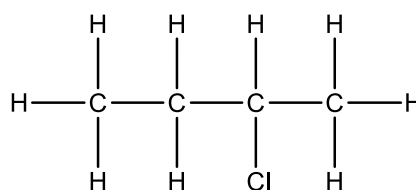
Answer: B

In total, there are 4 structural isomers that C_4H_9Cl forms. The isomers are as follows:

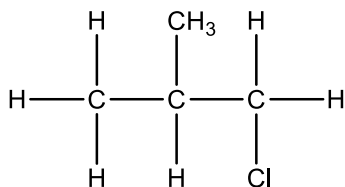
1-chlorobutane



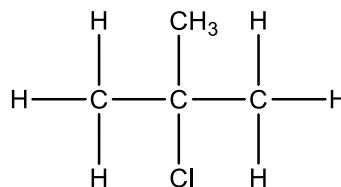
2-chlorobutane



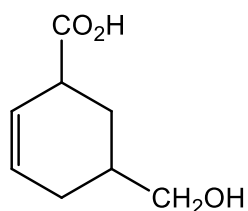
1-chloro-2-methylpropane



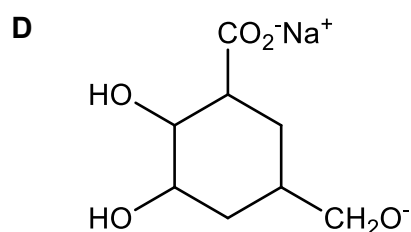
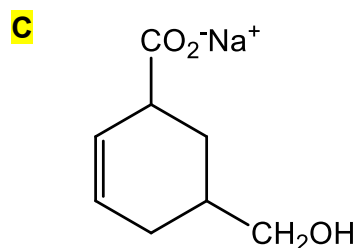
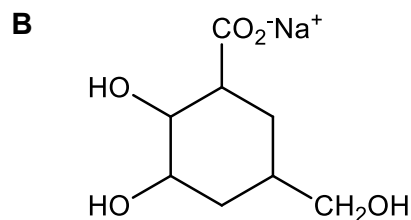
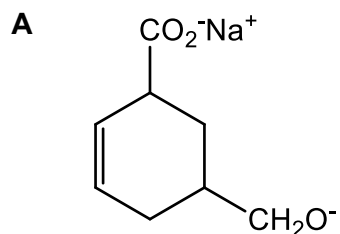
2-chloro-2-methylpropane



26 Excess aqueous sodium hydroxide is added to the molecule shown as follows.



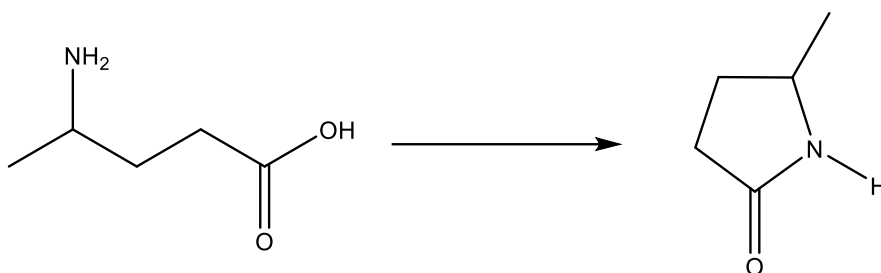
Which structure represents the organic ion produced?



Concept: Polymers**Answer: C**

There are 3 functional groups present in the molecule, namely, alkene ($C=C$), alcohol and carboxylic acid. Out of these 3, only carboxylic acid is able to react with NaOH, therefore C is the correct answer.

- 27 What conditions are necessary for the following reaction to take place?



- A NaOH(aq), heat under reflux
- B concentrated H_2SO_4 , heat under reflux
- C presence of DCC**
- D acidified $KMnO_4$, heat under reflux

Concept: Polymers**Answer: C**

An amide functional group is formed from a carboxylic acid and an amine. The conditions are DCC.

Option A: Usually used to hydrolyse an ester or amide

Option B: Used in the synthesis of ester (esterification)

Option D: Oxidising agent. Usually used to oxidise primary alcohol to carboxylic acids.

- 28 High density polyethylene (HDPE) is commonly used as shampoo bottles while low density polyethylene (LDPE) is used in plastic bags. Which statement is true regarding HDPE and LDPE?

- A HDPE is a thermoset polymer while LDPE is a thermoplastic polymer.
- B HDPE has more branching in its polymer chains than LDPE.
- C HDPE has stronger hydrogen bonding between its polymer chains compared to the instantaneous dipole – induced dipole forces between LDPE chains.
- D HDPE has more closely packed polymer chains compared to LDPE.**

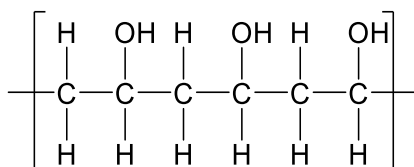
Concept: Polymers**Answer: D**

Option A: Both are thermoset polymers.

Option B: HDPE has **LESS** branching in its polymer chains than LDPE. Hence HDPE chains can pack more closely together.

Option C: Both HDPE and LDPE have instantaneous dipole – induced dipole forces of attraction between chains. HDPE does not have the functional group to form hydrogen bonding.

- 29 Poly(vinyl alcohol), PVA, is a common ingredient used in eye drops and has the structure shown below.



Which of the following statements about PVA are correct?

- 1 It is soluble in water.
- 2 It is an addition polymer.

- 3 It can be made from poly(vinyl acetate), $\left[\begin{array}{cc} \text{H} & \text{OCOCH}_3 \\ | & | \\ -\text{C} & -\text{C}- \\ | & | \\ \text{H} & \text{H} \end{array} \right]_n$.

A 1, 2 and 3 **B** 1 and 2 only **C** 2 and 3 only **D** 1 only

Concept: Polymers**Answer: A**

Statement 1 is true as seen from the structure of PVA. The polymer chains of PVA contains OH groups that can form hydrogen bonding with water, making the polymer chains soluble in water.

Statement 2 is true, PVA is an addition polymer. Condensation polymers have ester and amide bonds in the main polymer chains.

Statement 3 is true. PVA can be made from poly(vinyl acetate) through hydrolysis of poly(vinyl acetate) using dilute acids or bases and heat.

- 30 Plastic bottles can be used to store acids and bases, but not all plastics are suitable for this purpose.

Which of the following plastics should not be used to store acids or bases?

- 1 polymethylpentene
- 2 poly(propene)
- 3 poly(ethylene terephthalate)

- | | | | |
|---|--------------|---|--------------|
| A | 2 only | B | 3 only |
| C | 1 and 3 only | D | 1 and 2 only |

Concept: Polymers (Part 3). Hydrolysis of polyesters

Answer: B

- 1 From the name of the polymer, polymethylpentene, it can be derived that the monomer is an alkene. Hence the polymer will be an addition polymer that will **not** hydrolyse in acids and bases. Therefore it is suitable to be used as a storage bottle.
- 2 Poly(propene) is in syllabus. It is suitable as a storage bottle for the same reason given in the explanation for polymethylpentene above.
- 3 Poly(ethylene terephthalate) is a polyester (in syllabus) and will hydrolyse in the presence of acids or bases. The bottle is expected to react with its contents, hence it is not suitable as a storage bottle.