

Cambridge International AS & A Level

9701/12

May/June 2026

1 hour 15 minutes

CHEMISTRY

Paper 1 Multiple Choice



You must answer on the multiple choice answer sheet.

You will need: Multiple choice answer sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

INSTRUCTIONS

- There are **forty** 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 multiple choice answer sheet.
- Follow the instructions on the multiple choice answer sheet.
- Write in soft pencil.
- Write your name, centre number and candidate number on the multiple choice answer sheet in the spaces provided unless this has been done for you.
- Do **not** use correction fluid or tape.
- Do **not** write on any bar codes.
- You may use a calculator.

INFORMATION

- The total mark for this paper is 40.
- Each correct answer will score one mark.
- Any rough working should be done on this question paper.
- The Periodic Table is printed in the question paper.
- Important values, constants and standards are printed in the question paper.

This document has **20** pages. Any blank pages are indicated.

$$\text{mass of Al}_2\text{Cl}_6 = 0.10 \times 267 = 26.7 \text{ g}$$

- 1 Which mass of aluminium is needed to produce 0.10 mol of Al_2Cl_6 ?

A 0.54 g B 2.7 g C 5.4 g D 10.8 g

$$\text{mass of Al} = \frac{2 \times 27}{267} \times 26.7 = 5.4 \text{ g}$$

- 2 Compound Q contains the elements C, H and O only.

When completely combusted, 2.00 g of Q produces 4.00 g of carbon dioxide and 1.63 g of water.

$$\text{mass of C} = \left(\frac{12}{44}\right) \times 4.00 = 1.091 \text{ g}$$

$$\text{mass of O} = 2.00 - (1.091 + 0.181) = 0.728 \text{ g}$$

What is the empirical formula of Q?

A CHO_2 B $\text{C}_2\text{H}_2\text{O}$ C $\text{C}_2\text{H}_4\text{O}$ D CH_2O_2

$$\text{C} : \text{H} : \text{O} \\ \frac{1.091}{12} : \frac{0.181}{1} : \frac{0.728}{16}$$

$$0.0909 : 0.181 : 0.0456 \\ 2 : 4 : 1$$

- 3 Which row correctly describes the ion $^{35}_{16}\text{S}^{2-}$?

	neutrons	electrons
A	16	16
B	16	18
C	19	16
D	19	18

$$n = 35 - 16$$

$$e^- = 16 + 2$$

- 4 Element X has a higher first ionisation energy than element Y.

Two students state **one** factor that helps to explain this.

student 1 'X has a higher first ionisation energy than Y because an atom of X has more protons in its nucleus than an atom of Y.'

student 2 'X has a higher first ionisation energy than Y because X has a smaller atomic radius than Y.'

Only **one** of the two students is correct.

Which elements could X and Y be?

	X	Y
A	carbon	boron
B	magnesium	aluminium
C	oxygen	nitrogen
D	oxygen	sulfur

$$1) Z_X > Z_Y \text{ and } r_X > r_Y$$

$$2) Z_X < Z_Y \text{ and } r_X < r_Y$$

$$\begin{matrix} 8 & 16 \\ 2, 6 & 2, 8, 6 \end{matrix} : Z_X < Z_Y$$

$$: r_X < r_Y$$



- 5 In which substance, when in pure liquid form, are instantaneous dipole-induced dipole forces the only intermolecular force in the substance?

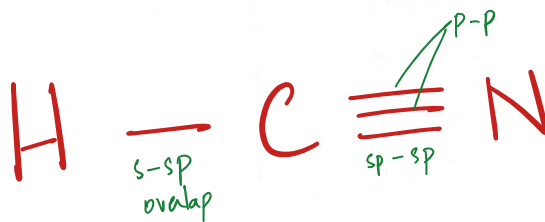
A ethyl ethanoate *X polar*
 B helium
 C hydrogen chloride *X polar*
 D water *X hydrogen bonding*

- 6 Descriptions of some covalent bonds are given.

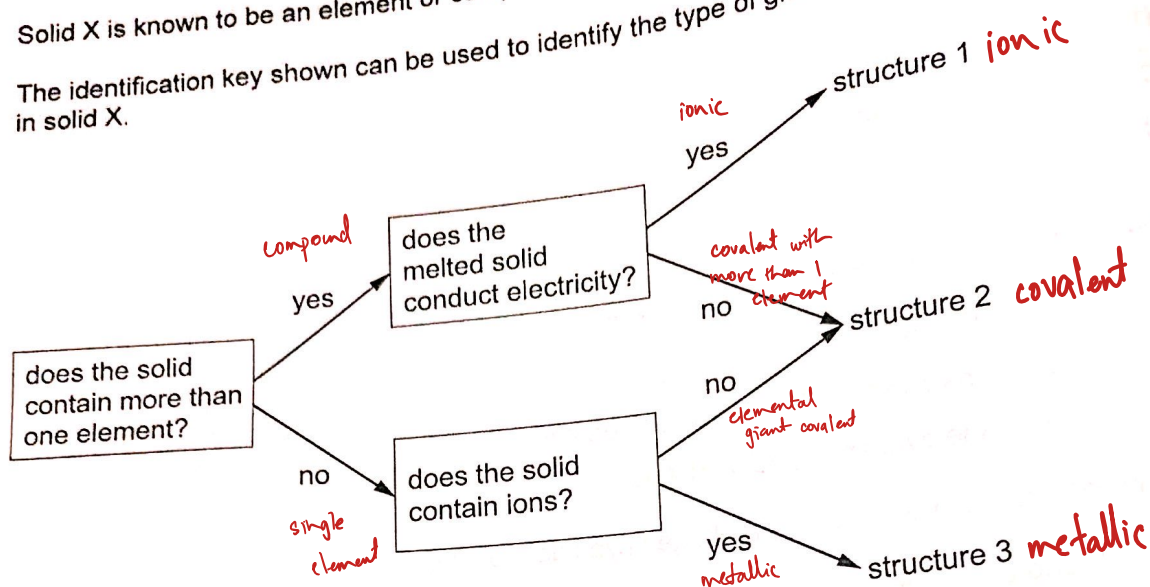
- 1 the overlap of two p orbitals
- 2 the overlap of two sp hybrid orbitals
- 3 the overlap of two s orbitals *X*

Which bonds are present in the hydrogen cyanide molecule, HCN?

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



- 7 Solid X is known to be an element or compound with a giant lattice structure. The identification key shown can be used to identify the type of giant lattice structure in solid X.



What are structures 1, 2 and 3, to complete this identification key?

	structure 1	structure 2	structure 3
A	covalent	ionic	metallic
B	ionic	covalent	metallic
C	metallic	covalent	ionic
D	ionic	metallic	covalent

- 8 In this question, you should assume that nitrogen behaves as an ideal gas.

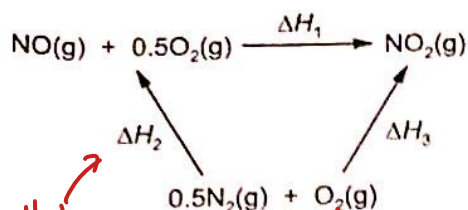
What is the volume of 15.0 g of nitrogen at a temperature of 70.0 °C and a pressure of 192 kPa?

- A 1.62 dm³ B 7.95 dm³ C 15.9 dm³ D 27.7 dm³

$$PV = nRT$$

$$V = \left[\frac{(15/28) \times 8.31 \times (70 + 273)}{192 \times 10^3} \right] \div (10^{-1})^3$$

- 9 An energy cycle is shown.



enthalpy change of formation

$$\Delta H_2 = \Delta H_3 - \Delta H_1$$

Which expression equals the enthalpy change of formation of NO?

- A $\Delta H_1 - \Delta H_3$ B $-\Delta H_1 - \Delta H_3$ C $\Delta H_3 + \Delta H_1$ D $\Delta H_3 - \Delta H_1$

- 10 50 cm³ of 2.50 mol dm⁻³ hydrochloric acid was placed in a polystyrene beaker of negligible heat capacity. The temperature of the acid was recorded and then 50 cm³ of 2.50 mol dm⁻³ NaOH at the same temperature was quickly added, with stirring. The temperature rose by 17 °C.



The resulting solution may be considered to have a specific heat capacity of 4.2 J g⁻¹ K⁻¹.

What is an approximate value for the molar enthalpy change of neutralisation of hydrochloric acid with sodium hydroxide from this experiment?

A $\frac{-(50 \times 4.2 \times 17)}{(0.050 \times 2.5)} \text{ J mol}^{-1}$

B $\frac{-(50 \times 4.2 \times 17)}{(0.10 \times 2.5)} \text{ J mol}^{-1}$

C $\frac{-(100 \times 4.2 \times 17)}{(0.050 \times 2.5)} \text{ J mol}^{-1}$

D $\frac{-(100 \times 4.2 \times 17)}{(50 \times 2.5)} \text{ J mol}^{-1}$

$$\Delta H = - \frac{q}{n} \leftarrow \text{of water}$$

$$= - \frac{(50+50) \times 4.2 \times 17}{\left(\frac{50}{1000}\right) \times 2.5}$$

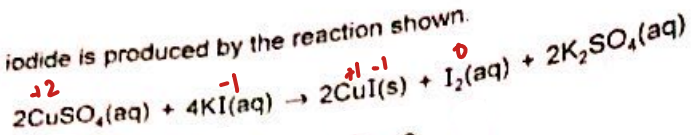
- 11 ⁺⁴TiO₂ is obtained from iron(II) titanate, ⁺⁴FeTiO₃.
 $+2 + x + 3(-2) = 0$

What is the change, if any, in the oxidation number of titanium?

- A It is oxidised from +3 to +4.
 B It is reduced from +3 to +2.
 C It is reduced from +6 to +4.
 D There is no change in the oxidation number.



12 Copper(I) iodide is produced by the reaction shown.



Which statement about this reaction is correct?

- A All iodide ions act as oxidising agents.
B All iodide ions act as reducing agents.

D All copper ions act as reducing agents.

13 A chemist adds 3.0 mol of nitrogen dioxide to a container. The container is maintained at a constant temperature and equilibrium is reached.



The equilibrium mixture contains 2.3 mol of NO_2 .

What is the amount of N_2O_4 in the equilibrium mixture?

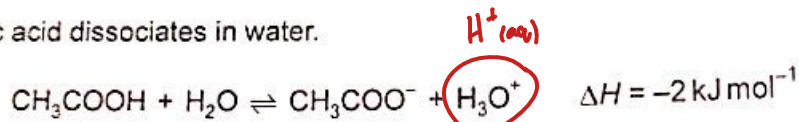
- B 0.70 mol C 1.40 mol

D 1.50 mol

	NO_2	N_2O_4
I	3.0	0
C	-x	+ $\frac{1}{2}x$
E	2.3	$\frac{1}{2}(0.7) = 0.35$

$3.0 - x = 2.3$
 $x = 0.7$

14 Ethanoic acid dissociates in water.



Which change causes the pH of this aqueous solution to decrease? $[\text{H}_3\text{O}^+] \uparrow$ $\therefore$ position of equilibrium to right

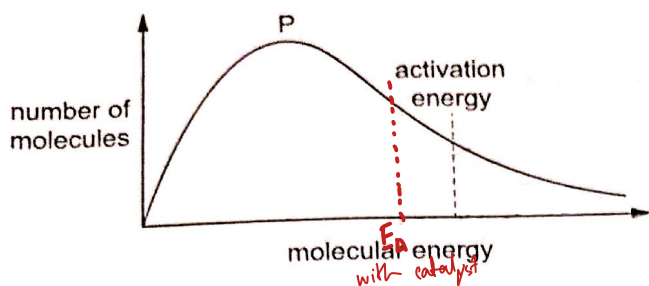
A adding a catalyst X

B dissolving a small amount of potassium hydroxide into the mixture X $\text{H}_3\text{O}^+ + \text{OH}^- \rightarrow 2\text{H}_2\text{O}$
so $[\text{H}_3\text{O}^+] \downarrow$
equilibrium pos shifts to right

D dissolving a small amount of sodium ethanoate into the aqueous ethanoic acid reactant shifts to left



- 15 The diagram shows a Boltzmann distribution of molecular energies for a gaseous mixture. The distribution has a peak, labelled P.



What happens when an effective catalyst is added to the mixture?

- A The height of the peak decreases and the activation energy moves to the right. ~~X~~
- B The height of the peak ~~X~~ decreases and the activation energy moves to the left.
- C The height of the peak remains the same and the activation energy moves to the right. ~~X~~
- D The height of the peak remains the same and the activation energy moves to the left.
- 16 Which statement about the Period 3 elements sodium to phosphorus and their compounds is correct?
- A All the chlorides of the elements are hydrolysed by water to form ~~X~~ HCl.
- B As the nuclear charge of the element increases, the electrons in the outer shell are further from the nucleus. ~~X~~ atomic radius ↓ across a period
- C The structure and bonding of all of the elements is either giant ionic or simple covalent. ~~X~~ metallic Na, Mg, Al
- D Only one of the oxides can form a solution with a pH greater than 12 when it is added to water. ✓
Na₂O
- $\text{NaCl(s)} \xrightarrow{\text{H}_2\text{O}} \text{Na}^+(\text{aq}) + \text{Cl}^-(\text{aq})$
pH = 7



17 X, Y and Z are elements in Period 3

Metallie
bond strength: $Mg > Na$

Some physical properties of X, Y and Z are shown

element	melting point /°C	electrical conductor
X	98	yes
Y	650	yes
Z	113	no

Na

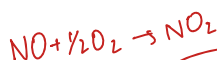
Mg

S₈

What are X, Y and Z?

	X	Y	Z
A	magnesium	sodium	sulfur
B	magnesium	sulfur	sodium
C	sodium	sulfur	magnesium
D	sodium	magnesium	sulfur

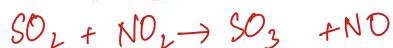
18 Two procedures are described.



- 1 Sulfur is burned in an excess of oxygen then NO is added to the product mixture.
- 2 Sulfur is burned in an excess of oxygen then NO₂ is added to the product mixture

Which procedures will produce some sulfur trioxide, SO₃?

A both 1 and 2



B 1 only

C 2 only

D neither 1 nor 2

19 The chloride of element J is added to a beaker of water. The oxide of element J is then added to the same beaker. A neutralisation reaction occurs.

What is element J?

A Al

B Mg

C P

D S

$AlCl_3 / Al_2Cl_6$ — acidic

Al_2O_3 — amphoteric





$$n_{\text{O}_2} = \frac{0.50}{2}$$

$$V = 0.25 \times 24 = 6 \text{ dm}^3$$

- 20 When calcium nitrate thermally decomposes, oxygen is one of the products.

Which volume of oxygen is produced at room conditions when 0.50 mol of calcium nitrate thermally decomposes?

- A 6.0 dm³ B 12.0 dm³ C 18.0 dm³ D 30.0 dm³

- 21 Two 0.20 g samples of different Group 2 compounds are each shaken with 10 cm³ of water in separate test-tubes.

Which pair of compounds form clear solutions and then become cloudy when mixed together?

- A barium hydroxide and barium sulfate ~~insoluble~~
 B barium sulfate and magnesium hydroxide
 C magnesium sulfate and barium hydroxide
 D magnesium sulfate and magnesium hydroxide



- 22 The volatility of the halogens decreases down the group.

What is the explanation for this trend?

- A decreasing strength of covalent bonds
 B increasing strength of covalent bonds
 C decreasing strength of London dispersion forces
 D increasing strength of London dispersion forces

- 23 Which is the strongest oxidising agent?

A Cl_2

B Cl^-

C I_2

D I^-

They act as reducing agents



- 24 Ammonia can be made by a suitable reaction using ammonium chloride as one of the reactants

Two statements are given about this reaction.

- 1 This reaction takes place when ammonium chloride is heated with KOH(aq).
- 2 The H-N-H bond angle decreases.

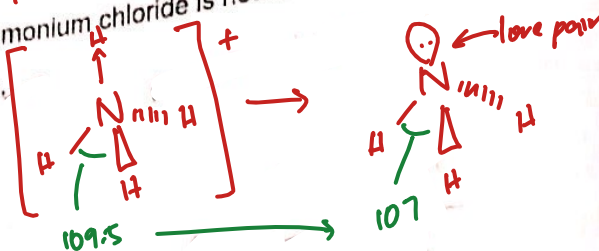
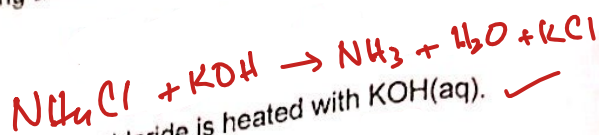
Which statements are correct?

A both 1 and 2

B 1 only

C 2 only

D neither 1 nor 2



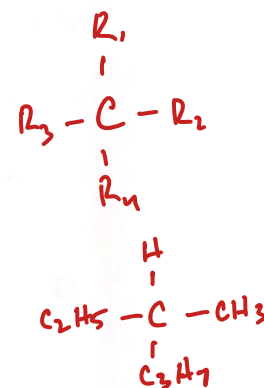
- 25 What is the least number of carbon atoms in a non-cyclic alkane molecule that has a chiral centre?

A 7

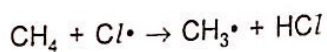
B 8

C 9

D 10



- 26 The first propagation step in the reaction between methane and chlorine is shown.



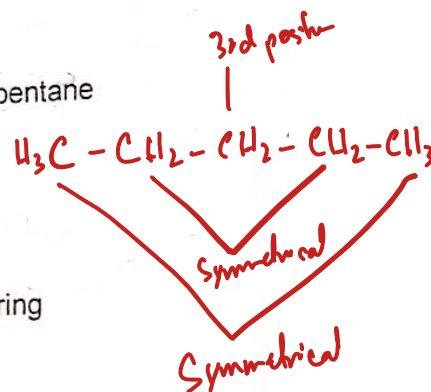
How many different first propagation steps are possible in the reaction between pentane and chlorine?

A 2

B 3

C 4

D 5



- 27 Structural isomerism and stereoisomerism should be considered when answering this question.

Several isomers with molecular formula $\text{C}_5\text{H}_{10}\text{O}$ give an orange precipitate with 2,4-DNPH reagent.

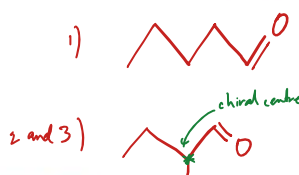
Which statement is correct?

A There are eight isomers only. All of the isomers produce a brick-red precipitate with Fehling's reagent.

B There are eight isomers only. Five of the isomers produce a silver mirror with Tollens' reagent.

C There are six isomers only. Two of the isomers produce a yellow precipitate with alkaline $\text{I}_2(\text{aq})$.

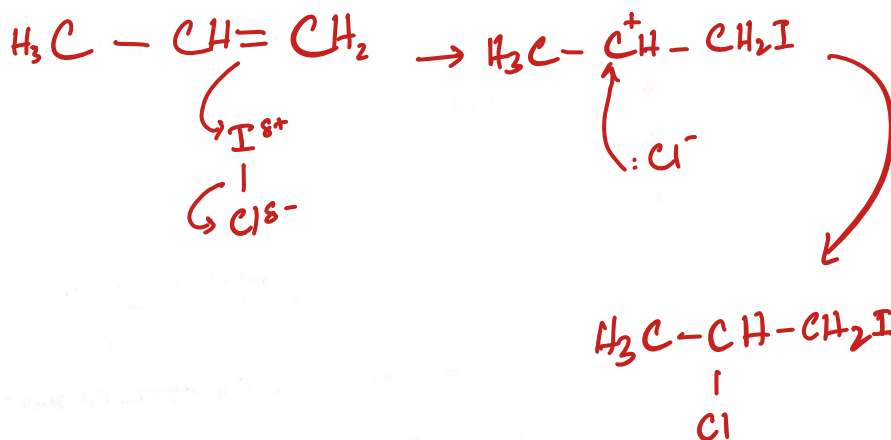
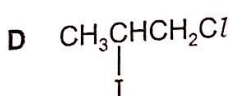
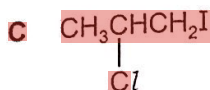
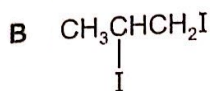
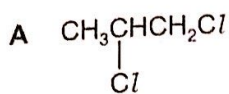
D There are six isomers only. Four of the isomers turn acidified $\text{K}_2\text{Cr}_2\text{O}_7$ from orange to green on warming.



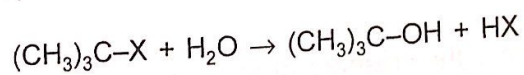
- 28 Hydrogen iodide undergoes an addition reaction with propene forming 2-iodopropane.

When propene is bubbled through iodine monochloride, ICl , dissolved in a suitable solvent, a similar reaction occurs.

Which product will be present in the greatest yield?



- 29 Tertiary halogenoalkanes undergo a hydrolysis reaction with water. In the equation, X represents either an iodine atom or a chlorine atom.



Which statement is correct for this reaction?

- A The C-I bond is weaker than the C-Cl bond and so the reaction is faster when X is I. ✓
Bond enthalpy of $\text{C}-\text{Cl} > \text{C}-\text{I}$
- B The reaction tends to proceed by the $\text{S}_{\text{N}}2$ mechanism. ✗
- C After the attack on the intermediate by an H_2O molecule, the last stage of the mechanism is the transfer of a proton from another water molecule. ✗
- D The planar intermediate has an unpaired electron which attacks a water molecule to form a C-O bond. ✗

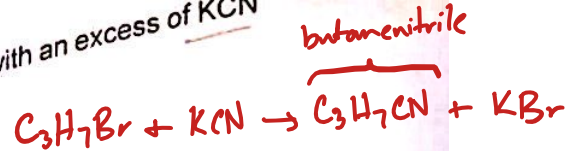


- 30 A sample of 1-bromopropane, C_3H_7Br , of mass 36.9 g is heated with an excess of KCN in ethanol.

The reaction gives a 78.0% yield of the desired organic product.

Which row is correct?

	mass of product /g	name of product
A	16.2	butanenitrile
B	16.2	propanenitrile
C	28.8	butanenitrile
D	28.8	propanenitrile



$$122.9g \longrightarrow 69.0$$

$$36.9g \longrightarrow x$$

$$x = 20.71684g$$

(Theoretical mass)

$$\text{Actual mass} = \frac{78}{100} \times 20.71684$$

$$\approx 16.2g$$

- 31 Which reaction has ethanol as the major organic product?

A C_2H_4 is reacted with cold dilute acidified $KMnO_4$.

B C_2H_5Br is heated with a concentrated solution of $NaOH$ in ethanol.

C CH_3CHO is heated with $NaBH_4$.

D $C_2H_5COOCH_3$ is heated under reflux with dilute acid.



- 32 Methylpropene reacts with steam in the presence of an H_3PO_4 catalyst.

The major product of this reaction is then heated with an excess of acidified $KMnO_4$.

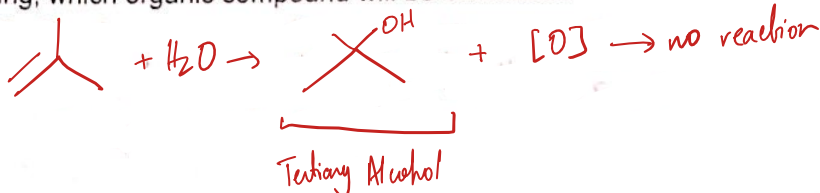
If the mixture is distilled after heating, which organic compound will be collected?

A butanone

B methylpropan-2-ol

C methylpropanal

D methylpropanoic acid



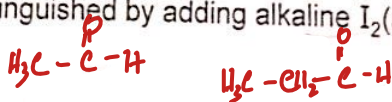
- 3 Which pair of compounds can be distinguished by adding alkaline $I_2(aq)$?

A ethanal and propanal

B ethanol and propan-2-ol

C methanol and propan-1-ol

D propanone and butanone



34 Two reactions are described.

- 1 Ethanoic acid reacts with methanol.
- 2 Ethanoic acid reacts with sodium carbonate.

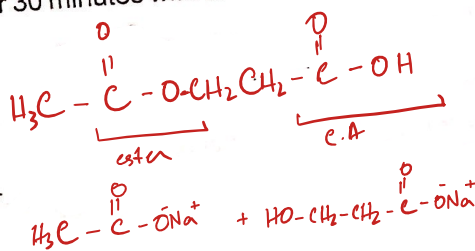
Which statement is correct?

- C's an. remains same*
Acid-base neutralization, not redox
- A Both reactions are redox.
 B Only reaction 1 is redox.
 C Only reaction 2 is redox.
 D Neither reaction is redox.

35 Compound Z has the structural formula $\text{CH}_3\text{CO}_2\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$.

What is produced when compound Z is heated for 30 minutes with an excess of aqueous sodium hydroxide?

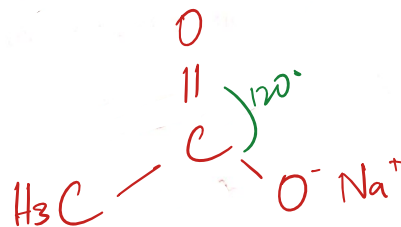
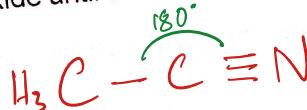
- A $\text{CH}_3\text{CO}_2^-\text{Na}^+$ and $\text{HOCH}_2\text{CH}_2\text{CO}_2\text{H}$
 B $\text{CH}_3\text{CO}_2^-\text{Na}^+$ and $\text{HOCH}_2\text{CH}_2\text{CO}_2^-\text{Na}^+$
 C $\text{CH}_3\text{CO}_2^-\text{Na}^+$ and $\text{Na}^+\text{OCH}_2\text{CH}_2\text{CO}_2^-\text{Na}^+$
 D $\text{CH}_3\text{CH}_2\text{OH}$ and $\text{Na}^+\text{O}_2\text{CCH}_2\text{CO}_2^-\text{Na}^+$



36 Ethanenitrile is heated with an excess of sodium hydroxide until the reaction is complete, giving organic compound X.

Which row is correct?

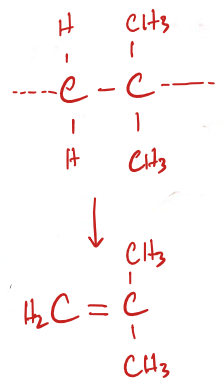
	C-C-N bond angle in ethanenitrile	C-C-O bond angle in compound X
A	120°	109°
B	120°	120°
C	180°	109°
D	180°	120°



37 An addition polymer has the repeat unit $-\text{CH}_2\text{C}(\text{CH}_3)_2-$.

Which monomer is this polymer produced from?

- A but-1-ene
B but-2-ene
C methylpropene
D buta-1,3-diene

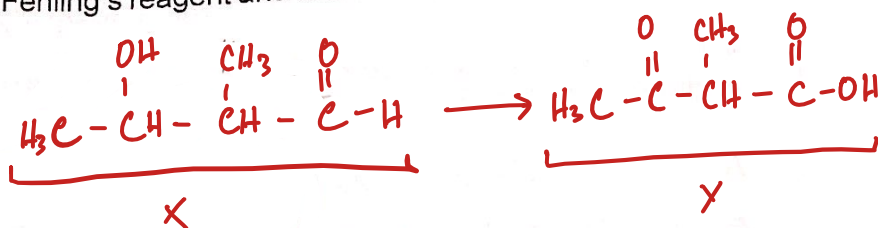


38 Compound X, $\text{CH}_3\text{CH}(\text{OH})\text{CH}(\text{CHO})\text{CH}_3$, is heated under reflux with an excess of acidified $\text{K}_2\text{Cr}_2\text{O}_7$ to form compound Y.

Both X and Y are separately warmed with Fehling's reagent and the observations noted.

What are the observations?

- A Both X and Y give a red precipitate.
B Only X gives a red precipitate.
C Only Y gives a red precipitate.
D Neither X nor Y gives a red precipitate.



9 Structural isomerism and stereoisomerism should be considered when answering this question.

How many isomeric hydrocarbon molecules:

- are non-cyclic
- contain exactly four carbon atoms
- contain two sp^2 hybridised carbon atoms $\text{C}=\text{C}$
- contain two sp^3 hybridised carbon atoms? $\text{C}-\text{C}$

A 2

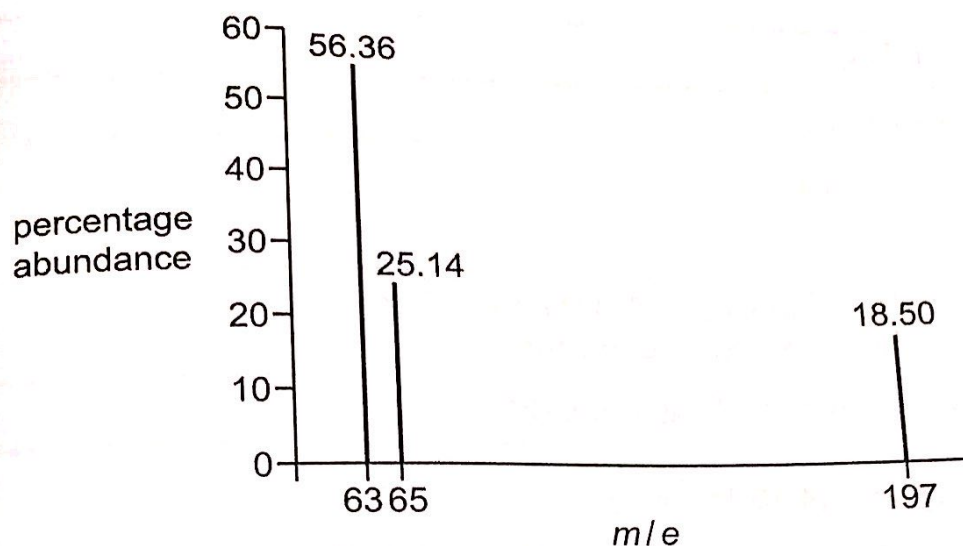
B 3

C 4

D 5



The mass spectrum of an alloy of copper and gold is shown.



Which expression can be used to calculate the relative atomic mass, A_r , of copper present in this sample?

- A $\frac{(56.36 \times 63) + (25.14 \times 65)}{(56.36 + 25.14 + 18.50)}$
- B $\frac{(56.36 \times 63) + (25.14 \times 65) + (18.50 \times 197)}{(56.36 + 25.14 + 18.50)}$
- C $\frac{(56.36 \times 63) + (25.14 \times 65)}{(56.36 + 25.14)}$
- D $\frac{(56.36 \times 63) + (25.14 \times 65)}{(63 + 65)}$

← relative abundance of Cu atoms only