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CONVENT OF THE HOLY INFANT JESUS SECONDARY
Preliminary Examination in preparation for
the General Certificate of Education Ordinary Level 2025

CANDIDATE NAME			
CLASS		REGISTER NUMBER	

CHEMISTRY 6092/01

Paper 1 Multiple Choice **29 August 2025**

1 hour

Additional Materials: Multiple Choice Answer Sheet

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 Multiple Choice Answer Sheet provided.

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 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 on the question paper.
A copy of the Periodic Table is printed on page 16.
The use of an approved scientific calculator is expected, where appropriate.

1 An experiment is done to determine the rate of decomposition of hydrogen peroxide.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

Which pieces of apparatus are needed for this experiment?

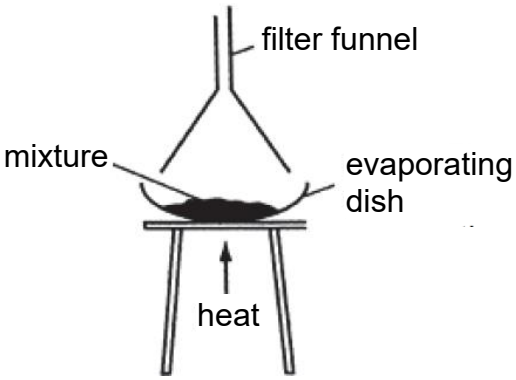
A conical flask, gas syringe, stopwatch

B conical flask, gas syringe, thermometer

C conical flask, stopwatch, thermometer

D gas syringe, stopwatch, thermometer

2 The diagram shows a set-up used to separate two substances in a mixture.



Which mixtures can be separated using this set-up?

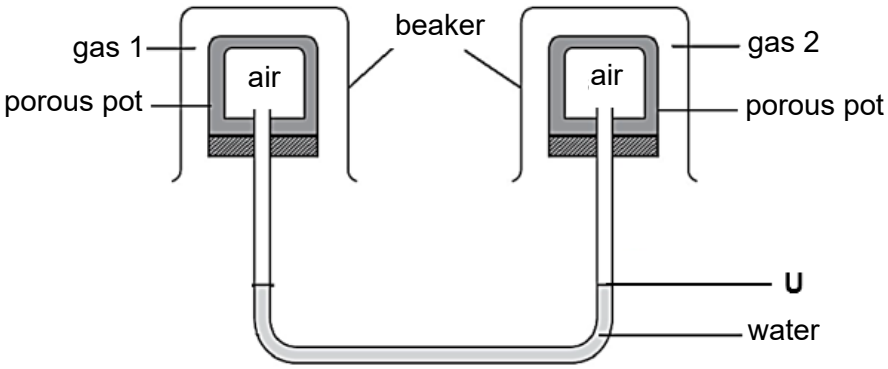
A ammonium chloride and iodine

B ammonium chloride and sodium chloride

C copper(II) sulfate and sodium carbonate

D lead(II) chloride and potassium chloride

3 The apparatus shown in the diagram was set up.



Which row correctly shows the pair of gases that will cause the water level at **U** to rise?

	gas 1	gas 2
A	carbon dioxide	nitrogen
B	methane	sulfur dioxide
C	nitrogen	carbon monoxide
D	sulfur dioxide	methane

4 An atom of one isotope of chlorine is represented by the symbol ^{37}Cl.

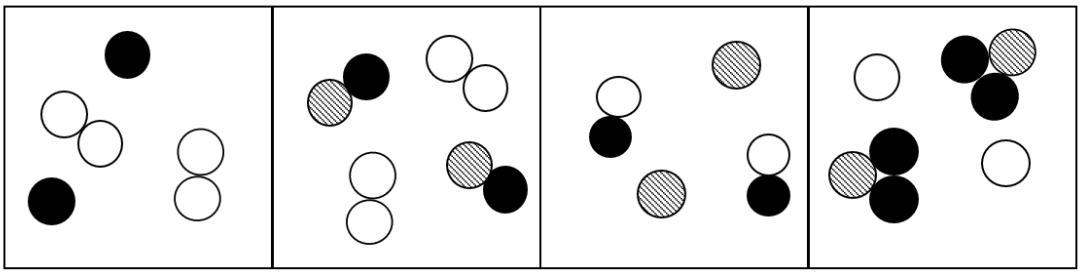
Particle R has one more neutron, two more protons and one more electron than this isotope of chlorine.

Which symbol represents R?

A $^{38}Cl^{+}$ **B** $^{38}Cl^{-}$ **C** ^{39}K **D** $^{40}K^{+}$

5 Which diagram best represents a mixture of neon and hydrogen bromide?

A **B** **C** **D**



[Turn over

6 Elements X and Y react to form an ionic compound of formula XY_2.

Which row correctly shows the electronic configurations of atoms X and Y?

	atom X	atom Y
A	2, 1	2, 5
B	2, 4	2, 6
C	2, 8, 1	2, 8, 6
D	2, 8, 8, 2	2, 8, 7

7 Which compound contains an element that does **not** achieve the electronic configuration 2,8?

A Al_2O_3 **B** CF_4 **C** CO_2 **D** H_2O

8 Which particles are responsible for the conduction of electricity through metals?

A electrons only **B** electrons and positive ions

C negative and positive ions **D** positive ions only

9 When heated, 4 moles of compound Z produced 2 moles of oxygen gas and 4 moles of chlorine gas as the only products.

What is likely to be the molecular formula of compound Z?

A ClO_2 **B** Cl_2O_4

C Cl_2O **D** Cl_4O_2

10 Hydrated sodium carbonate crystals have the formula $Na_2CO_3 \cdot 10H_2O$ in which one mole of sodium carbonate is combined with 10 moles of water.

What is the percentage by mass of oxygen in hydrated sodium carbonate crystals?

[A_r: Na, 23: C, 12; O, 16; H, 1]

A $\frac{10 \times 16}{124} \times 100$

B $\frac{10 \times 16}{286} \times 100$

C $\frac{13 \times 16}{124} \times 100$

D $\frac{13 \times 16}{286} \times 100$

11 Carbon monoxide and oxygen gas react to form carbon dioxide according to the equation shown.

$$2CO(g) + O_2(g) \rightarrow 2CO_2(g)$$

20 cm^3 of carbon monoxide is reacted with 20 cm^3 of oxygen gas to form carbon dioxide, at room temperature and pressure.

What are the volumes of gases remaining, at room temperature and pressure, at the end of the reaction?

	carbon monoxide	oxygen gas	carbon dioxide
A	0 cm^3	0 cm^3	20 cm^3
B	0 cm^3	10 cm^3	40 cm^3
C	0 cm^3	10 cm^3	20 cm^3
D	10 cm^3	0 cm^3	30 cm^3

12 The empirical formula of an oxide of element X is X_2O_5.

106.5 g of X_2O_5 contains 60 g of oxygen.

What is the identity of X?

A $^{31}_{15}P$

B $^{40}_{20}Ca$

C $^{70}_{31}Ga$

D $^{175}_{71}Lu$

13 What volume of water must be added to dilute 100 cm^3 of 8.0 mol/dm^3 hydrochloric acid to a concentration of 2.0 mol/dm^3?

A 200 cm^3

B 300 cm^3

C 400 cm^3

D 500 cm^3

14 Aqueous sodium chloride and aqueous lead(II) nitrate react according to the equation shown.

$$2NaCl(aq) + Pb(NO_3)_2(aq) \rightarrow PbCl_2(s) + 2NaNO_3(aq)$$

20 cm^3 of 2 mol/dm^3 aqueous sodium chloride is reacted with excess aqueous lead(II) nitrate.

3.34 g of lead(II) chloride precipitate is formed.

What is the percentage yield for the reaction?

A 6% **B** 12%

C 30% **D** 60%

15 Dilute methanoic acid reacts with aqueous potassium hydroxide as shown.

$$HCOOH(aq) + KOH(aq) \rightarrow HCOOK(aq) + H_2O(l)$$

What is the ionic equation for this reaction?

A $COOH^-(aq) + K^+(aq) \rightarrow HCOOK(aq)$

B $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

C $HCOO^-(aq) + K^+(aq) \rightarrow HCOOK(aq)$

D $HCOOH(aq) + K^+(aq) \rightarrow HCOOK(aq)$

16 Zinc oxide was added separately to dilute solutions of an acid and an alkali.

What row gives the correct observations?

	acid	alkali
A	no reaction	no reaction
B	no reaction	salt formed
C	salt formed	no reaction
D	salt formed	salt formed

17 Different solids were added to separate portions of warm dilute sulfuric acid.

Which row shows the solid with the correct result?

	solid	result
A	ammonium chloride	gas evolved that turns damp red litmus paper blue
B	copper	gas evolved that 'pops' with a lighted splint
C	magnesium oxide	solid dissolves to form a colourless solution
D	zinc carbonate	gas evolved that relights a glowing splint

18 Some statements about two strong acids, HX and H_2Y, of the same concentration are given.

1 H_2Y has a lower pH than HX.

2 The rate of production of carbon dioxide is faster for H_2Y than HX when equal volumes of both acids are reacted with sodium carbonate.

3 More hydrogen gas is produced for HX than H_2Y when equal volumes of both acids are reacted with excess magnesium.

Which statements are correct?

A 1 and 2 only

B 1 and 3 only

C 2 and 3 only

D 1, 2 and 3

19 Different salts can be made by adding different reagents together.

Which row shows the correct reagents used to safely make the salt?

	salt	reagents
A	calcium nitrate	calcium chloride and nitric acid
B	copper(II) sulfate	copper(II) nitrate and sodium sulfate
C	magnesium carbonate	magnesium nitrate and potassium carbonate
D	sodium chloride	sodium and hydrochloric acid

20 Ammonia is manufactured by the Haber Process.

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

Which statement is **not** correct?

A Finely divided iron is used as a catalyst.

B Hydrogen is obtained from the cracking of petroleum.

C Nitrogen is obtained from the fractional distillation of crude oil.

D The rate of reaction increases if a higher temperature is used.

21 An aqueous solution containing two salts is found.

A student tests the mixture to determine which ions are present. The results are shown.

test number	test	observations
1	add dilute nitric acid then	no observable change
	add aqueous silver nitrate	a white precipitate is formed
2	add aqueous sodium hydroxide drop by drop till excess, then	a white precipitate is formed, insoluble in excess sodium hydroxide
	warm the mixture	gas evolved turns damp red litmus paper blue
3	to the solution from Test 2, add aluminium foil, then warm the mixture.	gas evolved turns damp red litmus paper blue

What is present in the mixture?

A aluminium chloride and ammonium nitrate

B aluminium nitrate and ammonium iodide

C ammonium chloride and calcium nitrate

D ammonium nitrate and calcium iodide

22 Which reaction does **not** involve oxidation and/or reduction?

A $C + O_2 \rightarrow CO_2$

B $2NH_3 + 3CuO \rightarrow N_2 + 3Cu + 3H_2O$

C $K_2CO_3 + 2HNO_3 \rightarrow CO_2 + 2KNO_3 + H_2O$

D $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

23 Aqueous chlorine was added separately to aqueous potassium iodide and acidified potassium manganate(VII).

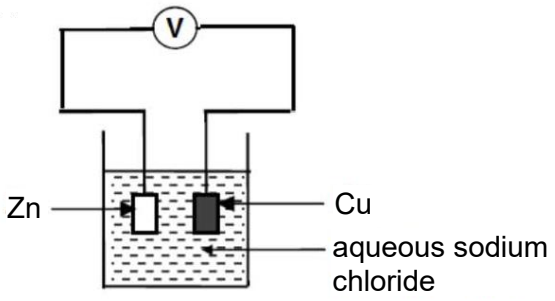
Which row correctly shows the role of aqueous chlorine, and the colour changes of both potassium iodide and potassium manganate(VII)?

	role of aqueous chlorine	colour change	
		potassium iodide	potassium manganate(VII)
A	oxidising agent	brown to colourless	purple to colourless
B	oxidising agent	colourless to brown	remains purple
C	reducing agent	brown to colourless	purple to colourless
D	reducing agent	colourless to brown	remains purple

24 The diagrams show four simple cells.

Which simple cell will produce the greatest reading on the voltmeter?

A



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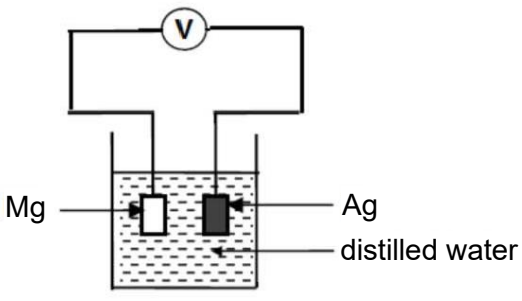

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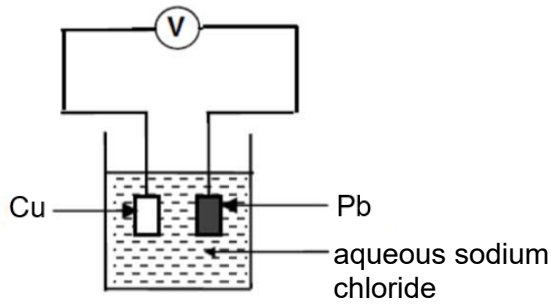
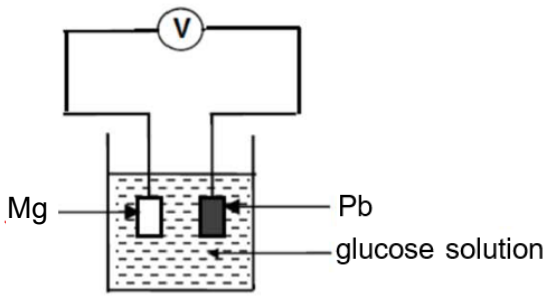


D



25 In an electrolysis experiment, the same amount of charge deposited 54.0 g of silver and 6.375 g of vanadium.

What is the charge on the vanadium ion?

A 1+ **B** 2+

C 3+ **D** 4+

26 Elements X, Y and Z are in the same period of the Periodic Table.

Some statements about these elements are given:

1 X has a greater tendency to gain electrons compared to Y.

2 Z forms a basic oxide, ZO.

3 Y does not conduct electricity

In which order, from left to right, do the elements appear in the Periodic Table?

A $X \rightarrow Y \rightarrow Z$ **B** $Y \rightarrow Z \rightarrow X$

C $Z \rightarrow X \rightarrow Y$ **D** $Z \rightarrow Y \rightarrow X$

[Turn over

27 Five statements about common trends in physical and chemical properties are given.

1 Melting point increases down the group.

2 Melting point decreases down the group.

3 Reactivity decreases down the group.

4 Reactivity increases down the group.

Which statements are correct for Group 1 and Group 17 elements?

	Group 1	Group 17
A	1, 3	2, 4
B	1, 4	2, 3
C	2, 3	1, 4
D	2, 4	1, 3

28 Some of the reactions of four metals, W, X, Y and Z, are described.

Only metals W, Y and Z react with dilute sulfuric acid to produce hydrogen gas.

Only the oxides of W and X are reduced by heating with hydrogen.

Y displaces Z from an aqueous solution of the sulfate of Z.

Which row correctly shows the reactivity of W, X, Y and Z?

	most reactive ⟶ least reactive			
A	W	X	Y	Z
B	W	Y	Z	X
C	Y	Z	W	X
D	Z	Y	W	X

29 Which statement describes what happens when hydrogen and oxygen are used in a fuel cell?

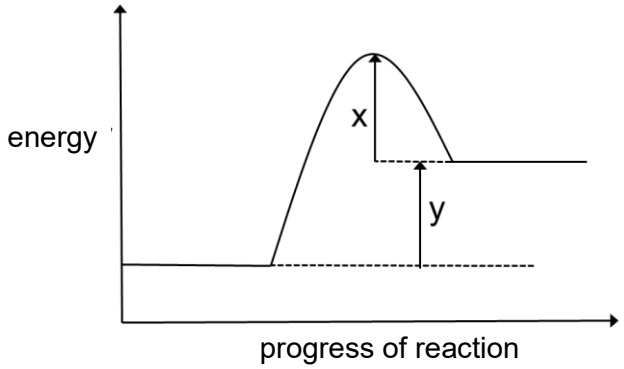
A Electricity is generated directly.

B Electrical energy is converted to chemical energy.

C Hydrogen is burned to form steam.

D Hydrogen reacts to form a hydrocarbon fuel.

30 The energy profile diagram for a reaction is shown.



Which statement is correct?

A The energy absorbed in breaking bonds is labelled x.

B The reaction could be between sodium hydroxide and dilute nitric acid.

C The temperature of the reaction mixture decreases during the reaction.

D The value of y decreases in the presence of a catalyst.

31 The position of metal Z in the reactivity series is shown.

K, Na, Mg, Zn, Fe, Z, Cu

Which statement about metal Z is correct?

A It can be displaced from solutions containing its ions by copper.

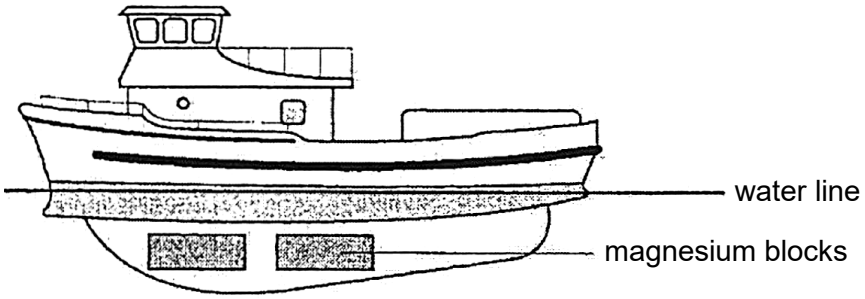
B It can be extracted from its ore by electrolysis.

C It cannot be extracted from its ore by reduction with carbon.

D It forms a carbonate that takes a longer time to decompose as compared to the carbonate of magnesium.

32 Most boats are built with a hull that consists of a high percentage of iron.

Magnesium blocks are often attached to the hull below the water line to prevent the iron from rusting.



Which statement explains why magnesium prevents the iron from rusting?

A Magnesium forms an alloy with iron.

B Magnesium gains electrons more readily than iron.

C Magnesium loses electrons more readily than iron.

D Magnesium reacts with oxygen to form a protective coating over the iron.

33 Which statement about the fractional distillation of crude oil is correct?

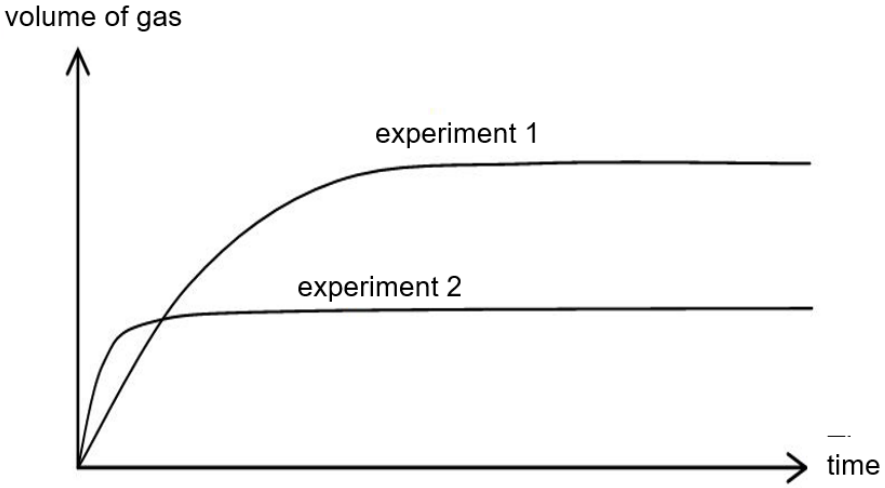
A At each level of the fractionating column, only one compound is collected.

B The fraction at the top of the column is the least flammable.

C The fraction collected at the bottom of the column has the highest viscosity.

D The higher up the fractionating column, the higher the temperature.

34 In experiment 1, excess powdered magnesium carbonate was reacted with dilute nitric acid at 30 °C. The total volume of gas produced is measured. The results for experiment 1 are plotted on the graph.

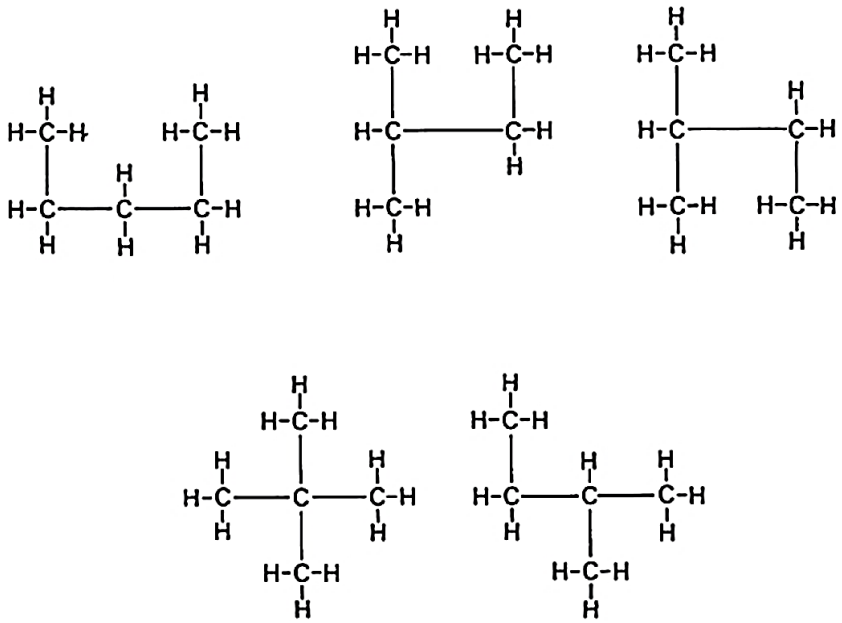


The experiment is repeated with a different set of conditions. The results for experiment 2 are plotted on the graph.

Which row shows the correct set of conditions that will give the graph for experiments 1 and 2?

	experiment 1	experiment 2
A	50 cm^3 of 0.10 mol/dm^3 dilute nitric acid at 30 °C	25 cm^3 of 0.10 mol/dm^3 dilute nitric acid at 30 °C
B	50 cm^3 of 0.10 mol/dm^3 dilute nitric acid at 30 °C	25 cm^3 of 0.10 mol/dm^3 dilute nitric acid at 50 °C
C	50 cm^3 of 0.05 mol/dm^3 dilute nitric acid at 30 °C	50 cm^3 of 0.10 mol/dm^3 dilute nitric acid at 30 °C
D	50 cm^3 of 0.05 mol/dm^3 dilute nitric acid at 30 °C	25 cm^3 of 0.10 mol/dm^3 dilute nitric acid at 50 °C

35 Five structural formulae are shown.



How many of the structural formulae are isomers?

A 2 **B** 3

C 4 **D** 5

36 The compound, C_8H_{18}, undergoes the following process.

$$1 \text{ mole of } C_8H_{18} \xrightarrow{\text{process X}} 1 \text{ mole of ethane} + 2 \text{ moles of compound Y}$$

Which row correctly identifies process X and compound Y?

	process X	compound Y
A	cracking	propane
B	cracking	propene
C	distillation	propane
D	distillation	propene

37 An ester of molecular formula $C_4H_8O_2$ was produced by the reaction of an alcohol with a carboxylic acid.

	alcohol	carboxylic acid
1	methanol	propanoic acid
2	ethanol	ethanoic acid
3	propanol	methanoic acid

Which pair(s) of reactants could be the alcohol and the carboxylic acid?

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

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

38 An alcohol, X, was fully oxidised to a carboxylic acid.

Neutralisation of the acid with magnesium carbonate gave a salt of formula $(CH_3CO_2)_2Mg$.

What was alcohol X?

A CH_3OH **B** CH_3CH_2OH

C $CH_3CH_2CH_2OH$ **D** $CH_3CH_2CH_2CH_2OH$

39 An unsaturated fatty acid has structural formula $C_{17}H_{31}CO_2H$.

How many carbon-carbon double bonds are present in one molecule of the unsaturated fatty acid?

A 1 **B** 2

C 3 **D** 4

40 Which atmospheric pollutants, emitted by internal combustion engines, are reacted together to convert them to less harmful products?

A carbon monoxide and nitrogen dioxide

B carbon monoxide and unburned hydrocarbons

C nitrogen dioxide and sulfur dioxide

D sulfur dioxide and unburned hydrocarbons

End of Paper

The Periodic Table of Elements

Group																	
1	2											13	14	15	16	17	18
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9		Key: proton (atomic) number / atomic symbol / name / relative atomic mass									5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24	3	4	5	6	7	8	9	10	11	12	13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).
The Avogadro constant, $L = 6.02 \times 10^{23}\ mol^{-1}$.

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Preliminary Examination in preparation for
the General Certificate of Education Ordinary Level 2025

CANDIDATE NAME			
CLASS		REGISTER NUMBER	

CHEMISTRY 6092/02

Paper 2 **28 August 2025**

1 hour 45 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions.
Write your answers in the spaces provided.

Section B
Answer **one** question.
Write your answers in the spaces provided.

The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 24.

The use of an approved scientific calculator is expected, where appropriate.

Section A

Answer **all** questions.

1 Fig. 1.1 shows some elements in the Periodic Table.

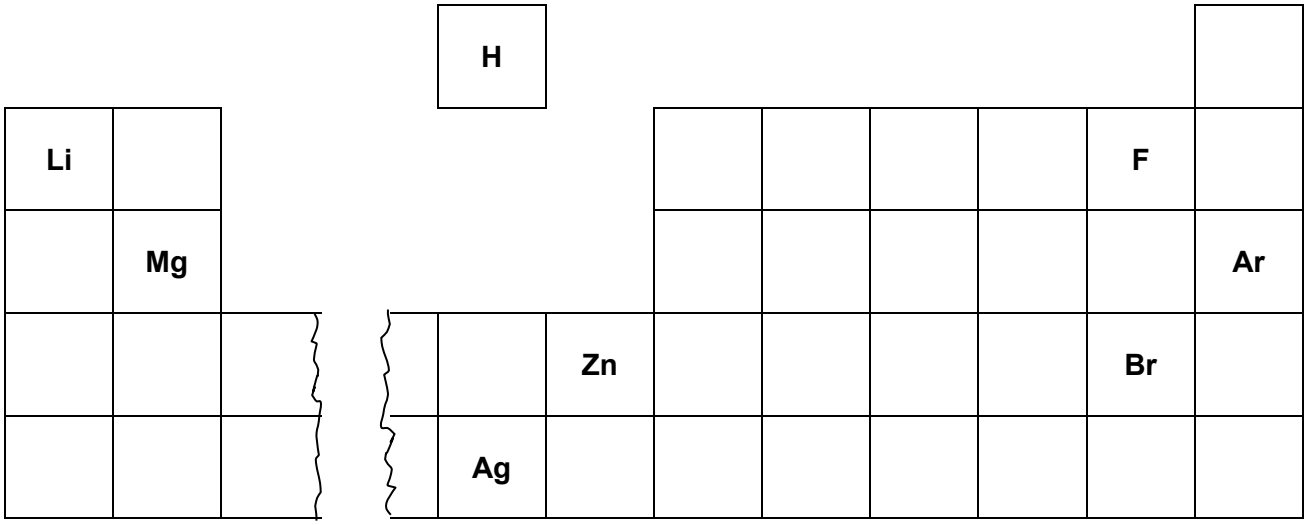


Fig. 1.1

Use the symbols from the table to identify the following elements. Each element may be used once, more than once or not at all.

(a) This element forms an amphoteric oxide.

……..…….….. [1]

(b) This element has a melting point below room temperature but a boiling point above room temperature.

……..…….….. [1]

(c) This is the **least** reactive element in its group.

……..…….….. [1]

(d) This element is used to provide an inert environment in industrial reactions.

……..…….….. [1]

(e) This element forms coloured compounds.

……..…….….. [1]

[Total: 5]

2 Chromatography can be used to separate and identify components of a mixture. Synthetic dyes are examples of mixtures that can be separated using paper chromatography.

A student wanted to find out whether a sample of black dye is pure. She carried out the following procedure:

Step 1: A start line was drawn using a pencil, on a sheet of chromatography paper.

Step 2: She placed spots of known dyes, **A**, **B**, **C**, **D** and **E** and the black dye on the start line.

Step 3: The chromatography was allowed to run using ethanol as a solvent.

Fig. 2.1 shows the results of the experiment.

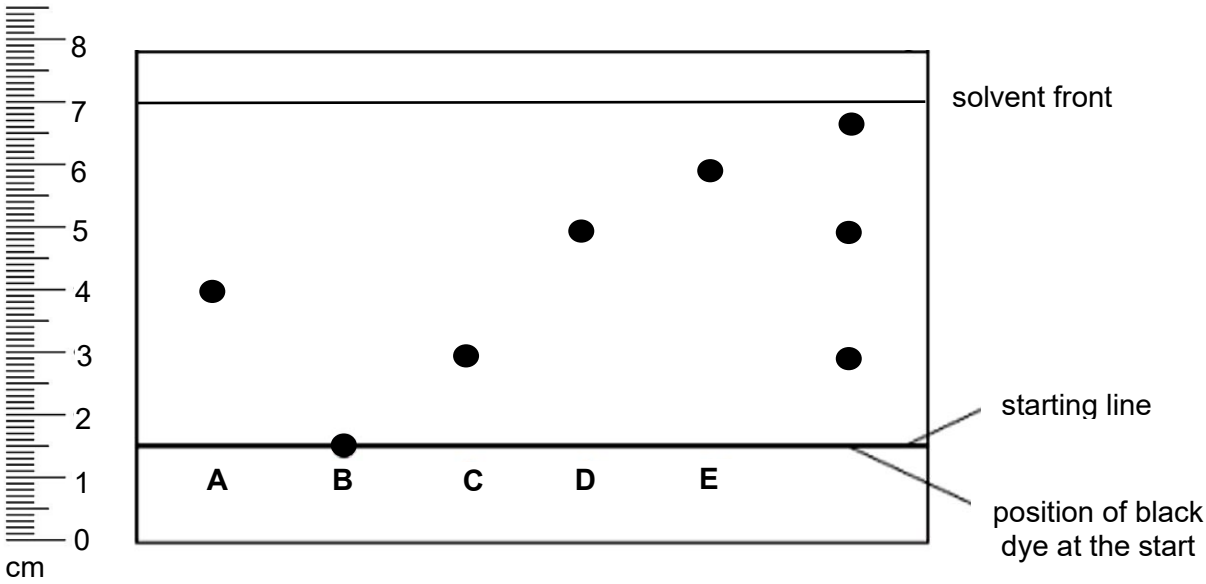


Fig. 2.1

(a) Using the results of the chromatography in Fig. 2.1, explain whether the sample of black dye is pure.

……..

…….. [1]

(b) Suggest another method that the student can use to determine whether the sample of black dye is pure. State the expected observations clearly.

……..

…….. [2]

(c) Explain why dye **B** remains on the starting line at the end of the experiment.

…….. [1]

(d) In chromatography, R_f values can be used to identify substances.

The R_f value of an industrial dye, safranin, in ethanol is 0.45.

Using the results from Fig 2.1, suggest which of the dyes, **A**, **B**, **C**, **D**, or **E** could be safranin.

Show your working clearly.

dye .....

working

[2]

[Total: 6]

3 Table 3.1 shows information about some gases in the atmosphere of the planets Mars and Earth.

Table 3.1

gas	density of pure gas at room temperature and pressure in g/dm^3	percentage composition of atmosphere on Mars (%)	percentage composition of atmosphere on Earth (%)
argon	1.67	1.9	<1
carbon dioxide	1.83	95.1	0.04
nitrogen	1.17	2.6	
oxygen		0.2	
other gases	–	<1	<1

(a) Complete the last column of Table 3.1. [1]

(b) Calculate the density of pure oxygen at room temperature and pressure in g/dm^3.

density of oxygen …… g/dm^3 [1]

(c) In Table 3.1, the term 'other gases' includes nitrogen oxides (NO_x). NO and NO_2 are examples of nitrogen oxides.

(i) Scientists have found much more nitrogen oxides in the atmosphere of Earth than on Mars.

Use the information in Table 3.1 and your knowledge about how nitrogen oxides are formed to suggest why this is so.

……..……...……....

……..……...……....

……..……...……....

……..……... [2]

(ii) The breakdown of ozone, O_3, is typically a slow process.

Nitrogen oxides such as nitrogen monoxide, NO, in the upper atmosphere can cause damage to the ozone layer by rapidly reacting with ozone in a two-step reaction.

Step 1 $NO + O_3 \rightarrow NO_2 + O_2$

Step 2 $NO_2 + O_3 \rightarrow NO + 2O_2$

Use the equations to explain how nitrogen monoxide acts as a catalyst for the breakdown of ozone.

……..……...…….....

……..……...…….....

……..……...…….... [2]

(d) Scientists predicted the surface temperature on Mars by calculating its distance from the Sun. The measured surface temperature is higher than the predicted value.

Use the information in Table 3.1 to suggest a reason why the measured surface temperature of Mars is higher than its predicted temperature.

……..……..

……..…… [1]

[Total: 7]

4 Fig. 4.1 shows an electrolysis experiment made up of two cells.

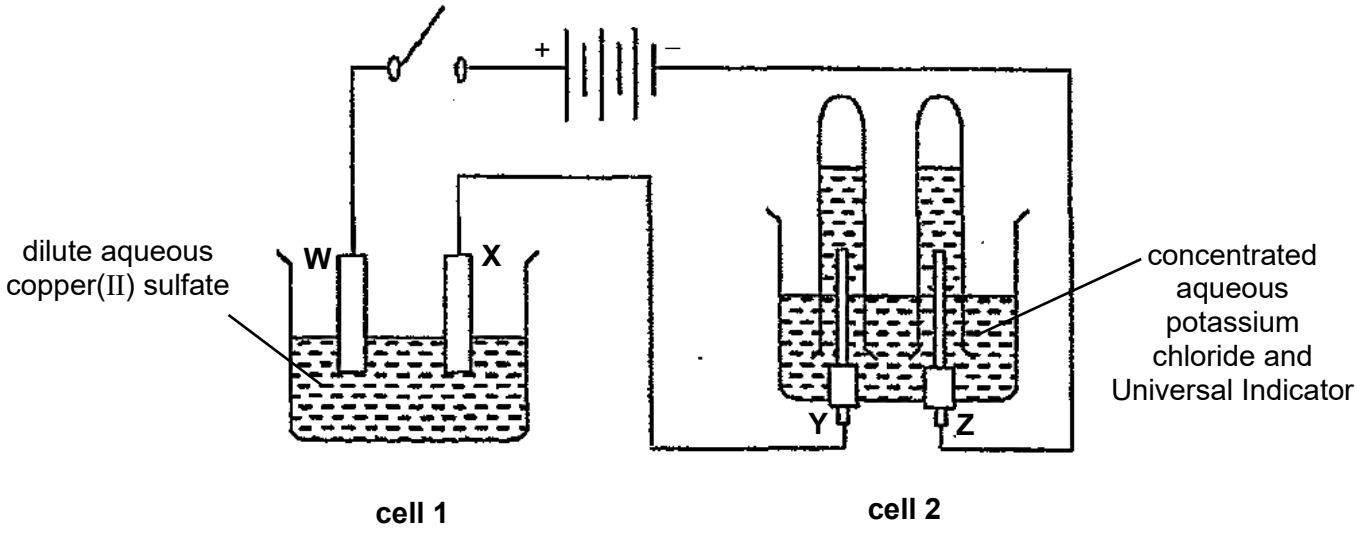


Fig. 4.1

Electrodes **W**, **X**, **Y** and **Z** are made of graphite.

(a) (i) Give the half-equations for the reactions at electrodes **Y** and **Z** in **cell 2**.

electrode **Y**: …….. [1]

electrode **Z**: …….. [1]

(ii) Describe and explain the colour change of the Universal Indicator in **cell 2** during the electrolysis.

……..……...……..…….....

……..……...……..…….....

……..……...……..…….....

……..……...……..…….... [2]

(b) Electrodes **W** and **X** are replaced with copper electrodes.

Give **one** similarity and **one** difference in the observations in **cell 1** when copper electrodes are used as compared to when graphite electrodes are used. Explain your reasoning.

……

……

……

……

……

……

……

…… [4]

[Total: 8]

5 The apparatus shown in Fig. 5.1 is used to investigate the reduction of a metal oxide by hydrogen.

Hydrogen gas is passed over the heated metal oxide in a boiling tube.

The unreacted hydrogen gas is burnt as it leaves the tube.

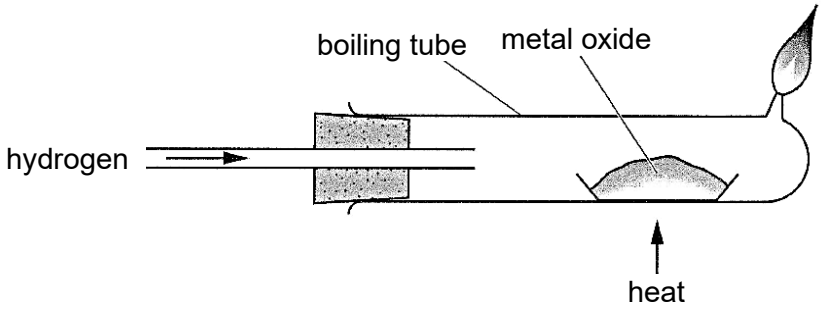


Fig. 5.1

(a) An oxide of iron is reduced by hydrogen gas using the apparatus shown in Fig. 5.1.

Table 5.1 shows the mass change when the oxide of iron is reduced.

Table 5.1

initial mass of oxide of iron / g	6.00
final mass of iron / g	4.20

Deduce the empirical formula of the oxide of iron. Show your working.

empirical formula ……

[3]

(b) The experiment is carried out with lead(II) oxide, magnesium oxide and copper(II) oxide.

(i) Complete Table 5.2 to show the observations when hydrogen gas is passed over heated magnesium oxide and heated copper(II) oxide.

Table 5.2

metal oxide	observations when hydrogen gas is passed over heated metal oxide
lead(II) oxide	yellow solid turns grey
magnesium oxide	
copper(II) oxide	

[2]

(ii) Which metal oxide, magnesium oxide, lead(II) oxide, or copper(II) oxide, takes the shortest time for complete reduction? Explain your answer.

metal oxide ……...…….

explanation ……...…….

……..……..…….....

……..……..……... [3]

[Total: 8]

6 Amines are a homologous series of organic compounds containing nitrogen atoms.

Table 6.1 shows the names, formulae and melting and boiling points of some amines.

Table 6.1

name of amine	formula	melting point/°C	boiling point/°C
methylamine	CH_3NH_2	–93	–6.3
ethylamine	$C_2H_5NH_2$	–81	16.6
propylamine	$C_3H_7NH_2$	–70	48.6
butylamine	$C_4H_9NH_2$	–49	78.0

(a) Use the information in the table to give **two** pieces of evidence that suggest that the amines are a homologous series.

……..……..

……..……..

……..……..

……..…… [2]

(b) Describe the differences in arrangement and movement of the particles in methylamine and propylamine at room temperature and pressure.

……..……..

……..……..

……..……..

……..…… [2]

(c) Amines are compounds that have similar chemical properties as ammonia.

For example, methylamine, CH_3NH_2, partially ionises when dissolved in water to form the methylammonium ion and hydroxide ion as shown in the equation below:

$$CH_3NH_2(aq) + H_2O(l) \rightleftharpoons CH_3NH_3^+(aq) + OH^-(aq)$$

(i) Deduce the formula of the product formed when aqueous methylamine reacts with dilute sulfuric acid.

…… [1]

(ii) Aqueous methylamine is added to a solution of copper(II) sulfate slowly with shaking, until no further change is seen.

Describe the expected observations.

……

…… [2]

[Total: 7]

7 Polylactic acid (PLA) is a polyester that is made from renewable, plant-based materials like corn and sugarcane. It is a bioplastic that can be chemically recycled by depolymerisation.

Fig. 7.1 shows the structure of PLA and how it can be depolymerised.

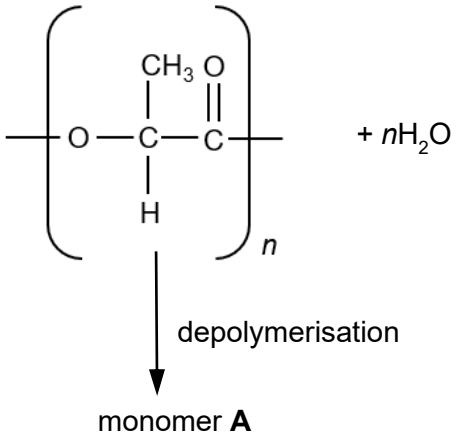


Fig. 7.1

(a) Explain how the structure of PLA shows that it is a polyester.

……..

……..…. [1]

(b) Describe the process of depolymerisation. Include names of reagents and conditions in your answer.

……..

……..…. [2]

(c) Draw the full structural formula of monomer **A**.

[1]

(d) Depolymerisation is an endothermic process that is sped up with the use of a catalyst.

Sketch a labelled energy profile diagram for the reaction.

Your diagram should show and label
- the activation energy for the uncatalysed, E_a, and catalysed reactions, E_a',
- the enthalpy change of the reaction, ΔH

[3]

(e) The use of PLA is more sustainable as compared to other plastics like polypropene due to its biodegradability. Polypropene is a non-biodegradable plastic.

(i) Polypropene is formed by the addition polymerisation of propene.

Draw the structure of the repeat unit of polypropene.

[1]

(ii) Describe **one** environmental problem caused by using non-biodegradable plastics.

……..……...…….....

……..……...…….... [1]

[Total: 9]

8 Chemical Kinetics

Chemical kinetics is the study of the rate of reactions and the factors that affect them.

In general, the rate of a reaction depends on the concentration of its aqueous reactants.

Rate Law

The rate law provides information on how the rate of a reaction depends on the concentration of all its reactants.

For example, in the reaction

$$x\mathbf{A} + y\mathbf{B} \rightarrow \text{products}$$

where **A** and **B** are the reactants, the rate law can be expressed as:

$$\text{rate} = k\,[\mathbf{A}]^m\,[\mathbf{B}]^n$$

where k is a constant;
m is the order of reaction with respect to reactant **A**;
n is the order of reaction with respect to reactant **B**.
[**A**] and [**B**] denote the concentrations of reagents **A** and **B**, respectively.

Order of Reactions

The reaction order is the extent to which the concentration of a reagent affects the rate of reaction.

For example, in the same reaction above, if the rate law is:

$$\text{rate} = k\,[\mathbf{A}]\,[\mathbf{B}]^2$$

The reaction is first-order with respect to reagent **A** and second-order with respect to reagent **B**, meaning that the rate of reaction is

- proportional to the concentration of reagent **A**: if the concentration of **A** is doubled, the rate of reaction would double.
- proportional to the square of the concentration of reagent **B**: if the concentration of **B** is doubled (×2), the rate of reaction would increase by four times ($\times 2^2 = 4$).

Bromination of Alkenes

When alkenes undergo addition reaction with halogens like bromine, they produce halogenoalkanes.

For example, in the reaction between ethene and aqueous bromine:

$$C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$$

The results investigating the chemical kinetics of this reaction are shown in Table 8.1. An organic solvent was used for this reaction.

Table 8.1

experiment	concentration of C_2H_4 / moldm^{-3}	concentration of Br_2 / moldm^{-3}	rate of reaction / mol/dm^{-3}s^{-1}
1	0.10	0.20	0.10
2	0.20	0.10	0.10
3	0.20	0.20	0.20
4	0.40	0.10	0.20

Bromination of Alkynes

Alkynes are a homologous series of unsaturated hydrocarbons which contain a carbon-carbon triple bond (–C≡C–).

Alkynes can also undergo addition reaction with halogens like bromine. At high bromine concentrations, they react to produce halogenoalkanes.

For example, in the reaction between ethyne, C_2H_2, and bromine:

$$C_2H_2 + 2Br_2 \rightarrow C_2H_2Br_4$$

The results investigating the chemical kinetics of this reaction are shown in Table 8.2.

Table 8.2

experiment	concentration of C_2H_2 / moldm^{-3}	concentration of Br_2 / moldm^{-3}	rate of reaction / moldm^{-3}s^{-1}
1	0.10	0.20	0.10
2	0.10	0.40	0.40
3	0.20	0.20	0.20
4	0.20	0.40	0.80

(a) (i) Explain, in terms of collisions between reacting particles, how the rate of reaction changes with concentration.

……..

……..

……..

…….. [2]

(ii) The student looks at the data in Table 8.1 and suggests the following relationship.

$$\text{rate} = k\,[C_2H_4]\,[Br_2]$$

Use the data to show that this relationship is correct.

……..

……..

……..

……..

……..

…….. [3]

(iii) The rate of a reaction can be calculated using the following equation.

$$\text{rate of reaction} = \frac{1000}{\text{reaction time}}$$

Calculate the reaction time, in seconds, if 0.80 mol/dm^3 of ethene, C_2H_4, was reacted with 0.30 mol/dm^3 of bromine.

reaction time = ……. s [1]

(iv) Write the rate law expression for the reaction between ethyne, C_2H_2, and bromine.

rate = k

[1]

(b) **(i)** Draw a 'dot-and-cross' diagram to show the bonding in one molecule of ethyne, C_2H_2.

Show only the outer shell electrons.

[2]

(ii) State the observation you would expect when excess ethyne is reacted with bromine.

……..

……..…….. [1]

(iii) Predict the rate of reaction if 0.10 mol/dm^3 of ethyne was reacted with 0.20 mol/dm^3 of **chlorine**.

Explain your reasoning.

rate of reaction …… moldm^{-3}s^{-1}

……..

……..…….. [2]

[Total: 12]

9 Butanol reacts with ethanoic acid to form an ester.

(a) **(i)** Describe the conditions required to prepare this ester in the laboratory, and state how you would obtain the ester from the reaction mixture.

……..

……..

…….. [2]

(ii) Draw the full structural formula of the ester formed.

[1]

(b) A student carried out some experiments to compare the relative strengths of dilute ethanoic acid and dilute hydrochloric acid.

He reacts excess calcium carbonate with 1.0 mol/dm^3 of ethanoic acid and 1.0 mol/dm^3 of hydrochloric acid, separately.

(i) Write the chemical equation for the reaction between ethanoic acid and calcium carbonate.

…….. [1]

(ii) Describe the difference in the observation between the reaction of ethanoic acid with calcium carbonate and the reaction of hydrochloric acid with calcium carbonate.

Using ideas about ions, explain the difference in the observation.

……..

……..

……..

……..

…….. [3]

(iii) Describe one other method to distinguish ethanoic acid from hydrochloric acid.

……..

…….. [1]

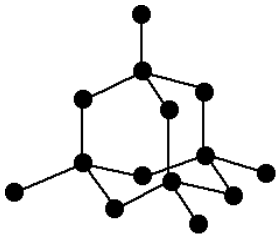
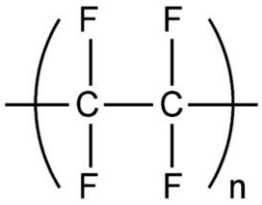
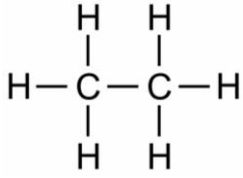
[Total: 8]

Section B

Answer **one** question from this section.

10 Table 10.1 shows the structures and melting points of three compounds, diamond, Teflon and ethane.

Table 10.1

	diamond	Teflon	ethane
melting point / °C	4500	327	–183
structure			

(a) Use ideas about bonding and structure to explain why the melting points of the three compounds differ from each other.

……

……

……

……

……

……

……

……. [4]

(b) Calculate the percentage by mass of fluorine in Teflon.

percentage by mass of fluorine = ……% [1]

(c) A sample of Teflon was found to have an average relative molecular mass of 89 000.

Calculate the number of carbon atoms that are present in an average Teflon chain.

number of carbon atoms = …… [2]

(d) A student makes the following statement:

"Teflon can be produced by reacting 1 mole of ethane with 2 moles of fluorine under UV light, then causing the resulting product to undergo addition polymerisation."

(i) Write the chemical equation for the reaction between 1 mole of ethane and 2 moles of fluorine under UV light.

…… [1]

(ii) Do you agree with the student's statement? Explain your reasoning.

……..……..

……..……..

……..……..

……..…… [2]

[Total: 10]

11 The radii of atoms and ions can be measured.

Table 11.1 shows some information about atomic radii and ionic radii of some Group 1 and Group 17 elements.

Table 11.1

element	number of electron shells in atom	atomic radius / pm	number of electron shells in ion	ionic radius / pm
lithium	2	152		68
sodium	3	185		98
potassium	4	227		133

element	number of electron shells in atom	atomic radius / pm	number of electron shells in ion	ionic radius / pm
fluorine	2	71		133
chlorine	3	99		181
bromine	4	115		196

(1×10^9 pm = 1 m)

(a) Complete the tables to show the number of electron shells in the **ions** of the Group 1 and Group 17 elements. [2]

(b) Describe the trend in **atomic radii** for Group 17 and use the data to explain this trend.

……..

……..

……..

……..…. [2]

(c) Describe the change in the radius when a lithium atom forms a lithium ion.

Suggest why the radius changes in this way.

……..

……..

……..

……..…. [2]

(d) The melting points and densities of lithium and fluorine are shown in Table 11.2.

Table 11.2

element	melting point / °C	density at room temperature and pressure / gcm^{-3}
lithium	181	0.534
fluorine	–220	0.0017

Use ideas about bonding and structure to explain why the physical properties of lithium and fluorine differ from each other.

……

……

……

……

……

……

……

…… [4]

[Total: 10]

End of Paper

The Periodic Table of Elements

Group																	
1	2											13	14	15	16	17	18
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24	3	4	5	6	7	8	9	10	11	12	13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).
The Avogadro constant, $L = 6.02 \times 10^{23}\ mol^{-1}$.

CHIJ SECONDARY

Sec 4 Preliminary Examination 20**25**

Chemistry 6092 **Mark Scheme**

Updated on 14/09/2025

Total Score = (P1/40×30%) + (P2/80×50%) + (P3/40×20%)

Paper 1 (40 marks)

No	*Answer*	*No*	*Answer*	***No***	*Answer*	*No*	*Answer*
1	A	11	C	21	C	31	B
2	B	12	A	22	C	32	C
3	B	13	B	23	B	33	C
4	D	14	D	24	A	34	B
5	C	15	B	25	D	35	B
6	D	16	D	26	D	36	B
7	D	17	C	27	D	37	A
8	A	18	A	28	C	38	B
9	C	19	C	29	A	39	B
10	D	20	C	30	C	40	A

Abbreviations:

ORA: or reverse argument

AW: alternate wording

ECF: error carried forward (for calculations only)

Paper 2
Section A (70 marks)

Question			Answers	Marks	Total	Comment
1	(a)		Zn	1	5	
	(b)		Br	1		
	(c)		Li	1		
	(d)		Ar	1		
	(e)		Ag	1		ZnO is white when hot and yellow when cold, so it only forms 1 coloured compound.
2	(a)		The black dye is <u>impure</u>. (no mark) There is <u>more than one component/spot</u> on the chromatogram.	1	6	
	(b)		<u>Boil/freeze</u> the black dye / Determine the <u>boiling point/freezing point</u> of the black dye. If the black dye boils/freezes at a <u>fixed temperature, it is pure</u>. or If the black dye boils/freezes <u>over a range of temperatures, it is not pure</u>.	1 1		Reject methods relating to melting.
	(c)		Dye B is <u>insoluble in the solvent/ethanol</u>.	1		
	(d)		Dye <u>A</u> Distance of A from start line = <u>2.5</u> cm Distance of solvent front from start line = <u>5.5</u> cm (values must be correct) Rf value = <u>2.5 / 5.5</u> = 0.45 OR 0.45 = distance moved by solute ÷ (7 – 1.5) distance moved by solute = 0.45 × 5.5 = 2.475 Position on chromatogram = 2.475 + 1.5 = 3.975 ≈ 4cm	1 1		
3	(a)		nitrogen = 78% oxygen = 21%	1	7	% sign is not required
	(b)		32 / 24 = 1.33 g/dm^3	1		
	(c)	(i)	The total percentage composition of nitrogen and oxygen on Mars is much lower at 2.8% as compared to 99% on Earth / The percentage composition of nitrogen and oxygen on Mars is much lower at 2.6% and 0.3% compared to 78% and 21% on Earth. At <u>high temperatures</u> (in engines of vehicles or in factories or during lightning activity), <u>nitrogen and oxygen</u> in the air can <u>react</u> together to form nitrogen monoxide, <u>forming more nitrogen oxides</u> on Earth.	1 1		

Question			Answers	Marks	Total	Comment
		(ii)	In step 1, NO increased the rate of breakdown of ozone by providing alternative reaction pathway of lower activation energy; In step 2, the regeneration of NO showed that it remained chemically unchanged at the end of the reaction.	1 1		
	(d)		Mars has a high composition of carbon dioxide which traps heat/causes global warming.	1		
4	(a)	(i)	**Y** (Anode): $2Cl^- \rightarrow Cl_2 + 2e^-$ **Z** (Cathode): $2H^+ + 2e^- \rightarrow H_2$	1 1		
		(ii)	Universal Indicator turns from green to purple/violet. Since Cl^- and H^+ ions are discharged, K^+ and OH^- ions (or KOH) are left behind / the relative concentration of OH^- ions increases, forming a strong alkali.	1 1		
	(b)		**Similarity**: A red-brown deposit/coating forms at electrode X (cathode) / electrode X (cathode) increases in size. **Reasoning** (Similarity): In both cases, copper is less reactive than hydrogen, so copper(II) ions from the solution are preferentially discharged/reduced over hydrogen ions, and are reduced to form copper metal. **Difference**: When copper electrodes are used, electrode **W** decreases in size. When graphite electrodes are used, effervescence is observed at **W** / the electrodes do not change in size. **Reasoning** (Difference): • When copper electrodes are used, copper anode **W** oxidises to form Cu^{2+}. • When graphite electrodes are used, the OH^- ions are preferentially discharged over SO_4^{2-} ions to form oxygen gas, Or **Difference**: When copper electrodes are used, the blue solution does not decolourise. When graphite electrodes are used, the blue solution decolourises. **Reasoning** (Difference) :	1 1 1 1 1	8	Similarity 1M Difference 1M Reasoning 1M (for similarity) 1M (for difference)

<table>
<tr><th colspan="3">Question</th><th>Answers</th><th>Marks</th><th>Total</th><th>Comment</th></tr>
<tr><td></td><td></td><td></td><td>• When copper electrodes are used, the <u>concentration of Cu^{2+} ions in the solution remains unchanged</u>.
• When graphite electrodes are used, the <u>concentration of Cu^{2+} ions decreases</u>.</td><td>1</td><td></td><td></td></tr>
<tr><td>5</td><td>(a)</td><td></td><td><table><tr><td>element</td><td>Fe</td><td>O</td></tr><tr><td>mass / g</td><td>4.2</td><td>1.8</td></tr><tr><td>Ar</td><td>56</td><td>16</td></tr><tr><td>no. of moles</td><td>0.075</td><td>0.1125</td></tr><tr><td>mole ratio</td><td>1</td><td>1.5</td></tr></table>[1] for each correct no. of moles calculated

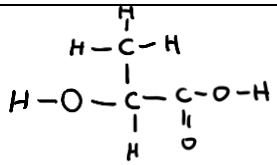
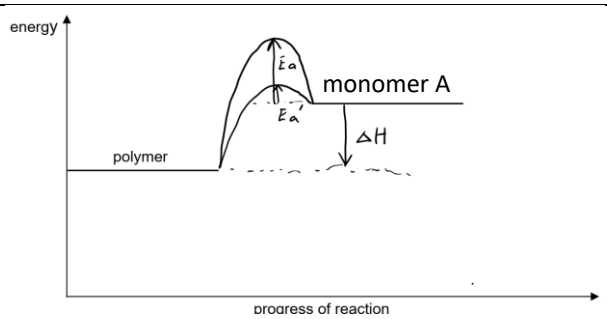
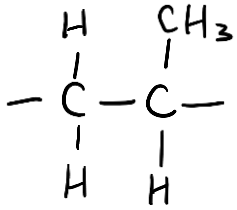
empirical formula is Fe_2O_3</td><td>2

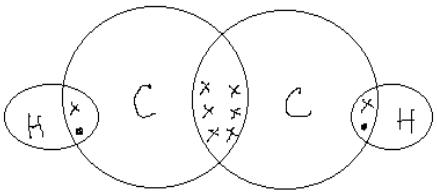
1</td><td rowspan="4">8</td><td></td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>magnesium oxide – no visible change / solid remains white
copper(II) oxide – <u>black</u> solid turns <u>red</u>-<u>brown</u></td><td>1

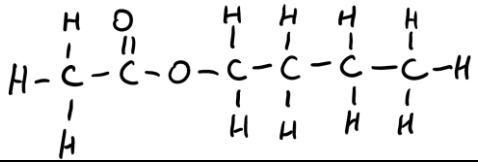
1</td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Copper(II) oxide
<u>Copper</u> is the <u>least reactive</u> compared to magnesium and lead.
<u>Copper(II) oxide</u> is the <u>least stable</u> metal oxide and will undergo reduction at the fastest rate.</td><td>1
1

1</td><td></td></tr>
<tr><td>6</td><td>(a)</td><td></td><td>• Compounds have the same general formula of $C_nH_{2n+1}NH_2$
• Compounds have the same functional group $-NH_2$
(may consider)
• Successive members differ from one another by a $-CH_2-$ unit</td><td>1

1</td><td rowspan="4">7</td><td>Reject: Gradual increase in physical properties like boiling point down the series.</td></tr>
<tr><td></td><td>(b)</td><td></td><td>Every 2 points is 1 mark:
• Particles in methylamine are very <u>far apart in a disorderly manner</u>
• while those in propylamine are <u>closely packed in a disorderly arrangement</u>
• Particles in methylamine are moving <u>rapidly and randomly in all directions</u>
• while those in propylamine are <u>sliding past one another</u>.</td><td>2</td><td>Must show comparison of arrangement and movement.</td></tr>
<tr><td></td><td>(c)</td><td>(i)</td><td>$(CH_3NH_3)_2SO_4$</td><td>1</td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Blue precipitate forms.
Soluble in excess methylamine to form a dark blue solution.</td><td>1
1</td><td></td></tr>
</table>

Question			Answers	Marks	Total	Comment
7	(a)		It is a long-chain molecule / macromolecule with many ester linkages	1	9	Both ideas for 1M
	(b)		Water is added to the polymer, with acid as a catalyst Which causes the polymer to break down into its monomers.	1 1		
	(c)			1		
	(d)		 [1] correct shape [1] correctly labelled activation energies [1] correctly labelled enthalpy change	3		
	(e)	(i)		1		
		(ii)	Non-biodegrable plastics leads to increase in built-up waste in landfills when disposed by burying, causing land pollution; or When burnt, plastics can release toxic gases into the atmosphere, causing air pollution. or When thrown into water bodies, plastics can cause marine organisms to mistake them as food and choke on them, causing death.	1		

			Answers	Marks	Total	Comment
8	**(a)**	**(i)**	The higher the <u>concentration</u>, the faster the <u>rate of reaction</u>. (ORA) [1] The more <u>reacting particles per unit volume</u>, the higher <u>frequency of effective collisions</u>. [1]	2	**12**	Question was generally well done. A number of students mentioned activation energy, which was not relevant for concentration.
		(ii)	When the <u>concentration of C_2H_4 doubles</u> from 0.10mol/dm^3 in Experiment 1 to 0.20mol/dm^3 in Experiment 3 / 2 to 4, the <u>rate of reaction doubles</u> from 0.10 moldm^{-3}s^{-1} to 0.20 moldm^{-3}s^{-1}. [1] When the <u>concentration of Br_2 doubles</u> from 0.10mol/dm^3 in <u>Experiment 2 to</u> 0.20mol/dm^3 in <u>Experiment 3</u>, the <u>rate of reaction doubles</u> (from 0.10 moldm^{-3}s^{-1} to 0.20 moldm^{-3}s^{-1}). [1] Hence the reaction is <u>first order</u> with respect to <u>C_2H_4</u> and <u>first order</u> with respect to <u>Br_2.</u> [1]	3		Students must either cite the experiments or concentrations/ rates they are making reference to clearly. Answers that calculated the constant k to show that it was consistently 5 across at least 2 experiments were awarded max. 2 marks (1 mark per experiment). Answers where the value of constant k was incorrectly calculated were not given credit. A few students cited data without any explanation, so no credit was given. Very few students linked their explanation back to the order of reaction for each reactant.
		(iii)	Concentration of C_2H_4 doubles and concentration of Br_2 triples from experiment 4. Rate = 0.2 × 2 × 3 = 1.2 Time = 1000/1.2 ≈ <u>833 s</u>	1		Question was not well done.
		(iv)	Rate = k $[C_2H_2][Br_2]^2$	1		Question was not well done. Answers that used ( ) instead of [ ] were not given credit.
	(b)	**(i)**	 [1] correct bonding between C atoms [1] correct bonding between C and H atoms	2		There were some students who did not check that the C and H atoms had the correct number of valence electrons and had full valence shells, resulting in incorrect answers.
		(ii)	The aqueous bromine would change from <u>reddish-brown</u> (**R: brown**) to <u>colourless</u>.	1		Brown is rejected as the colour is used to describe aq. iodine.
		(iii)	Any value between 0.1 and 1.0 [1] The rate of reaction would be <u>faster</u> because <u>chlorine is more reactive than bromine</u>. [1]	2		Some students correctly stated that chlorine was more reactive than bromine but gave a slower rate; no credit was

			Answers	Marks	Total	Comment
						given for such answers due to contradiction.
9	**(a)**	**(i)**	Heat/warm butanol and ethanoic acid in the presence of concentrated sulfuric acid. [1] The ester can be obtained using a separating funnel (**A: fractional distillation**) [1]	2		Question was not well done.
		(ii)		1		
	(b)	**(i)**	$2CH_3COOH + CaCO_3 \rightarrow (CH_3COO)_2Ca + H_2O + CO_2$	1		Several equations were not balanced, or with incorrect products.
		(ii)	Effervescence is more vigorous (owtte) in the reaction with hydrochloric acid than in the reaction with ethanoic acid. [1] Hydrochloric acid undergoes complete ionisation while ethanoic acid undergoes only partial ionisation [1] hence hydrochloric acid has a higher concentration of hydrogen ions than ethanoic acid, resulting in a faster rate of reaction. [1]	3	**8**	Many students did not predict an observation but simply stated that the reaction would be faster or more vigorous. Some students incorrectly said that the yield of products would be greater for HCl than CH_3COOH. Answers that did not mention "concentration" (e.g. more ions) were not accepted. A few students used the term "deionised" which is incorrect.
		(iii)	Universal indicator: ethanoic acid will turn orange/yellow (**R: lighter red**) while hydrochloric acid will turn red.	1		Question was not well done. Many students knew to use universal indicator but did not provide the expected results for each acid.

Section B (10 marks)

			Answers	Marks	Total	Comment
10	**(a)**		Relationship between amount of energy to overcome forces/break bonds and melting point is correctly stated [1] Every 2 points is 1 mark: 1. Ethane has a <u>simple molecular structure</u> 2. held together by <u>weak intermolecular forces</u> of attraction that require very little energy to overcome, resulting in a low melting point. 3. Teflon has a <u>macromolecular structure</u>. 4. Because Teflon has a <u>larger molecule size</u> than ethane, it has <u>stronger intermolecular forces</u> that require more energy to overcome. Hence its melting point is higher than ethane. 5. Diamond has a <u>giant covalent structure</u> 6. where all the <u>atoms</u> are held together by <u>strong covalent bonds</u> that require a lot of energy to break, resulting in a very high melting point.	4	**10**	Question was generally well done except for the explanation for Teflon. Some students incorrectly thought that Teflon had a giant covalent structure like diamond or a simple molecular structure like ethane. Few mentioned the reason for the higher melting point of Teflon compared to ethane.
	(b)		% mass = 2(19)÷[2(19)+12]x100% = 76%	1		
	(c)		M_r of CF_2 = 12 + 2(19) = 50 [1] no. of C atoms = no. of CF_2 units = 89 000 ÷ 50 = 1780 [1] OR M_r of C_2F_4 = 2(12) + 4(19) = 100 no. of C atoms = (89 000 ÷ 100) × 2 = 1780 [1] OR total mass of C atoms = 24% × 89 000 = 21 360 [1] no. of C atoms = 21 360 ÷ 12 = 1780 [1]	2		Question was generally well done.
	(d)	**(i)**	$C_2H_6 + 2F_2 \rightarrow C_2H_4F_2 + 2HF$	1		Question was poorly done. Most students thought that the product of substitution was H_2. Many also wrote 2 mol of fluorine as 2F in an attempt to balance the equation.

			Answers	Marks	Total	Comment
		(ii)	No (no mark) Ethane undergoes a <u>substitution reaction</u> with fluorine [1] to <u>form a saturated product</u> / a product <u>without any C=C bonds</u> which <u>cannot undergo addition polymerisation</u>. [1]	2		Very few answers identified that the reaction was substitution, which would result in a saturated product. A few incorrectly identified the reaction as addition. Many students misread the question and thought that it was asking whether ethane (instead of the "resulting product") could undergo polymerisation to form Teflon. Such answers were not given credit. Answers that mentioned that the resulting product still had H atoms, making it impossible to form Teflon were given max. 1 mark credit.
11	**(a)**		Li: 1, Na: 2, K: 3 [1] F: 2, Cl: 3, Br: 4 [1]	2	**10**	The number of electron shells for Group 17 was often incorrect.
	(b)		Going down the group, the <u>number of electron shells increases</u> from <u>F to Br</u> from <u>2 to 4</u>. [1] Hence the <u>atomic radius increases</u> from <u>F to Br</u> / <u>down Group 17</u> from 71pm to 115pm. [1]	2		The instruction was given to "use the data to explain this trend", which many students ignored.
	(c)		When a lithium atom forms a lithium ion, the <u>radius decreases</u> because the <u>number of electron (**R: valence**) shells decreases</u> from <u>2 to 1</u>. [1] This is due to the <u>lithium atom losing its valence electron</u> to achieve a <u>stable electronic configuration</u>. [1]	2		While many students correctly stated that the Li atom loses an electron, the reason was often not provided. It was also common to see students stating that the number of valence shells decreased / lost a valence shell, which is incorrect.
	(d)		Relationship between amount of energy to overcome forces/break bonds and melting point is correctly stated [1] Every 2 points is 1 mark: 1. Fluorine has a <u>simple molecular structure</u> 2. held together by <u>weak intermolecular forces</u> of attraction that require very little	4		Question was generally well done, but a few students kept referring to the structure and bonding of lithium as metallic structure and bonding, which was not specific enough. Several answers also omitted the explanation for the difference in densities.

			Answers	Marks	Total	Comment
			energy to overcome, resulting in a low melting point. 3. Lithium has a positive ionic lattice surrounded by a 'sea' of delocalised electrons 4. held together by strong electrostatic forces of attraction that require a lot of energy to overcome, resulting in a relatively high melting point. Lithium has a higher density than fluorine because lithium exists as a solid while fluorine exists as a gas at room temperature. [1]			