Surname _____

Forename(s) _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

I declare this is my own work.

GCSE

CHEMISTRY

H

Higher Tier Paper 1

8462/1H

Friday 17 May 2024 Morning

Time allowed: 1 hour 45 minutes

[Turn over]

JUN248462 1H01

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On the front of this book, write your surname and forename(s), your centre number, your candidate number and add your signature.

MATERIALS

For this paper you must have:

- **a ruler**
- **a scientific calculator**
- **the periodic table (enclosed).**

[Turn over]

INSTRUCTIONS

- **Use black ink or black ball-point pen.**
- **Pencil should only be used for drawing.**
- **Answer ALL questions in the spaces provided. Do not write on blank pages.**
- **If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).**
- **Do all rough work in this book. Cross through any work you do not want to be marked.**

INFORMATION

- **The maximum mark for this paper is 100.**
- **The marks for questions are shown in brackets.**
- **You are expected to use a calculator where appropriate.**
- **In all calculations, show clearly how you work out your answer.**
- **You are reminded of the need for good English and clear presentation in your answers.**

DO NOT TURN OVER UNTIL TOLD TO DO SO

0 1

A student produced a salt by reacting copper carbonate with sulfuric acid.

This is the method used.

1. **Measure 50 cm^3 of sulfuric acid into a beaker.**
2. **Add copper carbonate powder.**
3. **Stir the mixture.**
4. **Repeat steps 2 and 3 until copper carbonate is in excess.**
5. **Filter the mixture.**
6. **Warm the filtrate gently until crystals start to appear.**
7. **Leave the solution to cool and crystallise.**

0 1 . 1

Complete the word equation for the reaction. [2 marks]

copper carbonate + sulfuric acid ⟶

+ +

carbon dioxide

0 1 . 2

Give ONE observation the student could make during STEP 4 which shows that the copper carbonate is in excess.
[1 mark]

0 1 . 3

Give ONE reason for filtering the mixture in STEP 5, on page 6. [1 mark]

0 1 . 4

Name the equipment that can be used to warm the filtrate GENTLY in STEP 6, on page 6. [1 mark]

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[Turn over]

0 1 . 5

The maximum theoretical mass of the salt that could be produced using 50 cm^3 of the sulfuric acid is 12.5 g.

The percentage yield of the salt is 92.8%.

Calculate the mass of salt actually produced.

Use the equation:

$$\%\ \text{yield} = \frac{\text{mass of salt actually produced}}{\text{maximum theoretical mass of salt that could be produced}} \times 100$$

[3 marks]

Mass of salt actually produced = _____ g

[Turn over]

0 1 . 6

Some salts can be produced by reacting sulfuric acid with a metal.

Neither copper nor sodium is used to produce a salt with sulfuric acid.

Give ONE reason why each metal is NOT used. [2 marks]

Copper _____

_____

_____

Sodium _____

_____

10

0 2

This question is about the periodic table.

Sodium and potassium are in Group 1 of the periodic table.

0 2 . 1

Give ONE similarity and ONE difference between the electronic structures of sodium and potassium. [2 marks]

Similarity _____

_____

Difference _____

_____

_____

[Turn over]

Group 1 elements react with water.

0 2 . 2

Give TWO observations made when potassium reacts with water. [2 marks]

1

2

0 2 . 3

Potassium hydroxide solution is produced when potassium reacts with water.

What is the colour of universal indicator when added to potassium hydroxide solution?

Give ONE reason for your answer.
[2 marks]

Colour of universal indicator

_____

Reason _____

_____

_____

[Turn over]

TABLE 1 shows the densities of some of the elements in Group 0 of the periodic table.

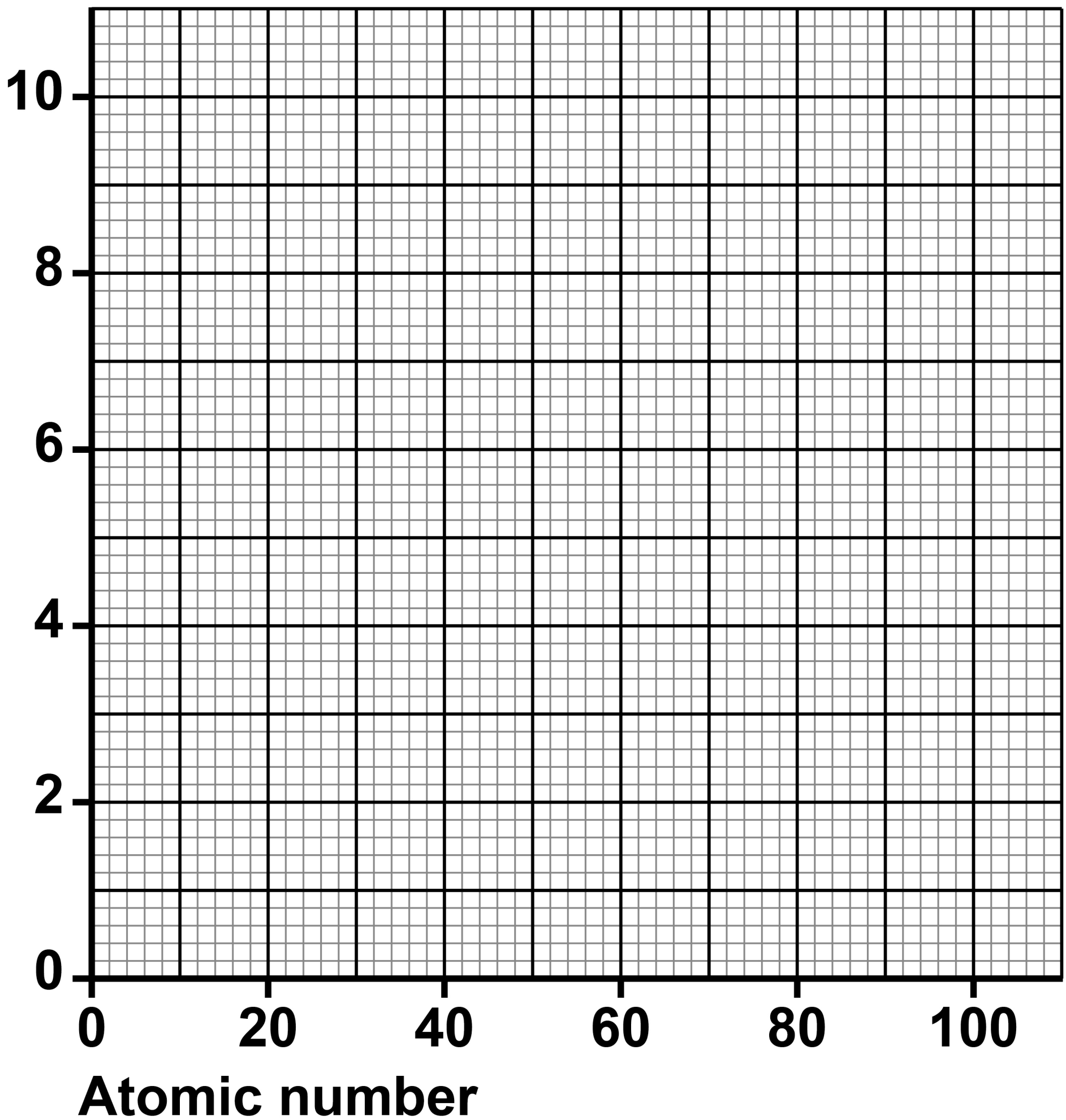
TABLE 1

ELEMENT	ATOMIC NUMBER	DENSITY IN mg/cm^3
Helium	2	0.2
Neon	10	0.8
Argon	18	1.6
Krypton	36	X
Xenon	54	5.4
Radon	86	9.1

0 2 . 4

Plot the data from TABLE 1 on FIGURE 1, on the opposite page. [2 marks]

FIGURE 1



[Turn over]

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0 2 . 5

Estimate the density (X) of krypton.

Use FIGURE 1 and TABLE 1, on pages 16–17. [1 mark]

Density = _____ mg/cm^3

[Turn over]

0 2 . 6

The elements in Group 7 are called the halogens.

A more reactive halogen can displace a less reactive halogen from a solution of its salt.

Which combination of solutions will produce a reaction when mixed?
[1 mark]

Tick (✓) ONE box.

☐ **Chlorine and potassium fluoride**

☐ **Chlorine and potassium bromide**

☐ **Bromine and potassium fluoride**

☐ **Bromine and potassium chloride**

0 2 . 7

Which of the following describes the trends going down Group 7? [1 mark]

Tick (✓) ONE box.

☐ **Relative molecular mass decreases and boiling point decreases.**

☐ **Relative molecular mass decreases and boiling point increases.**

☐ **Relative molecular mass increases and boiling point decreases.**

☐ **Relative molecular mass increases and boiling point increases.**

[Turn over]

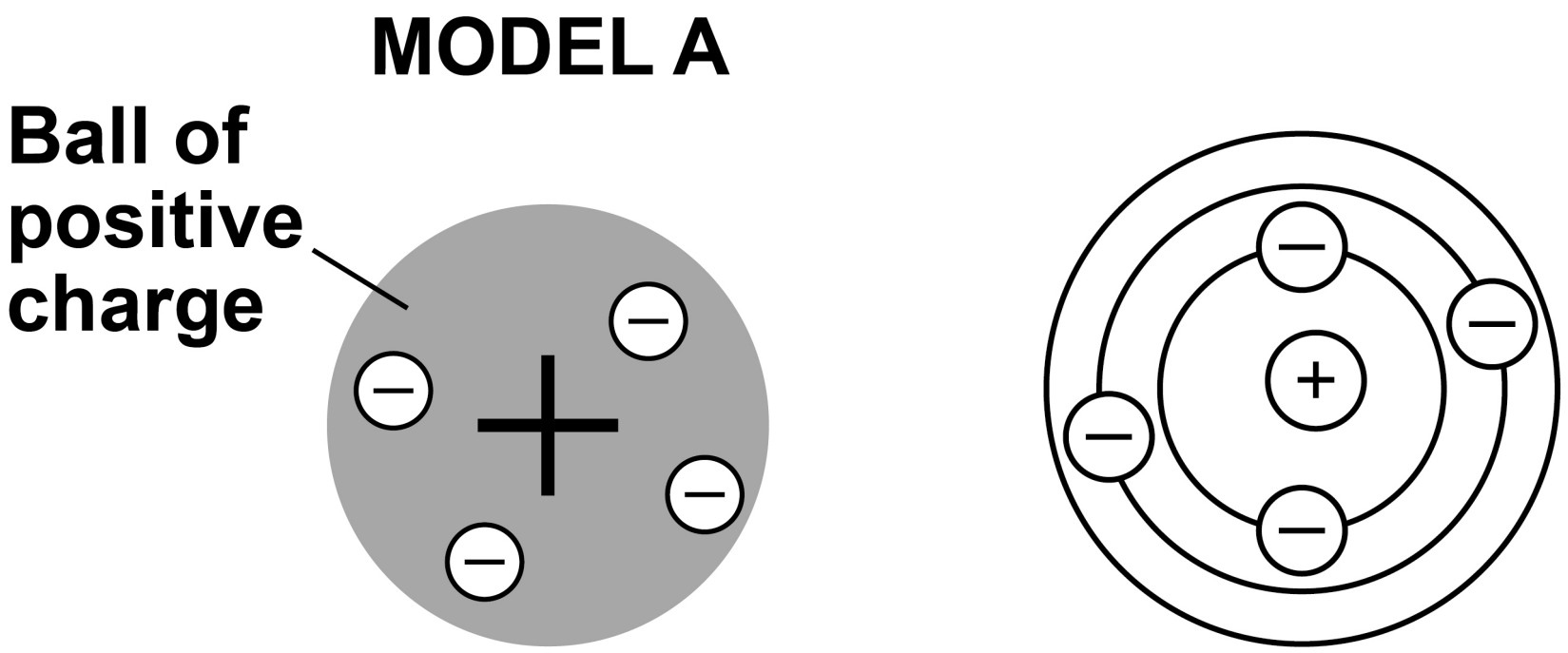
11

0 3

This question is about models of the atom.

FIGURE 2

MODEL A **MODEL B**



0 3 . 1

Name the models of the atom shown in FIGURE 2. [2 marks]

Model A _____

Model B _____

0 3 . 2

Compare model A with the model of the atom used today.

Use FIGURE 2. [4 marks]

_____

_____

_____

_____

_____

[Turn over]

24

0 3 . 3

Chadwick's experiments showed the existence of neutrons in an atom.

This led to an understanding of isotopes.

Define the term 'isotopes'.

Refer to subatomic particles in your answer. [2 marks]

BLANK PAGE

0 4

A student investigated the energy change of the reaction between zinc and copper sulfate solution.

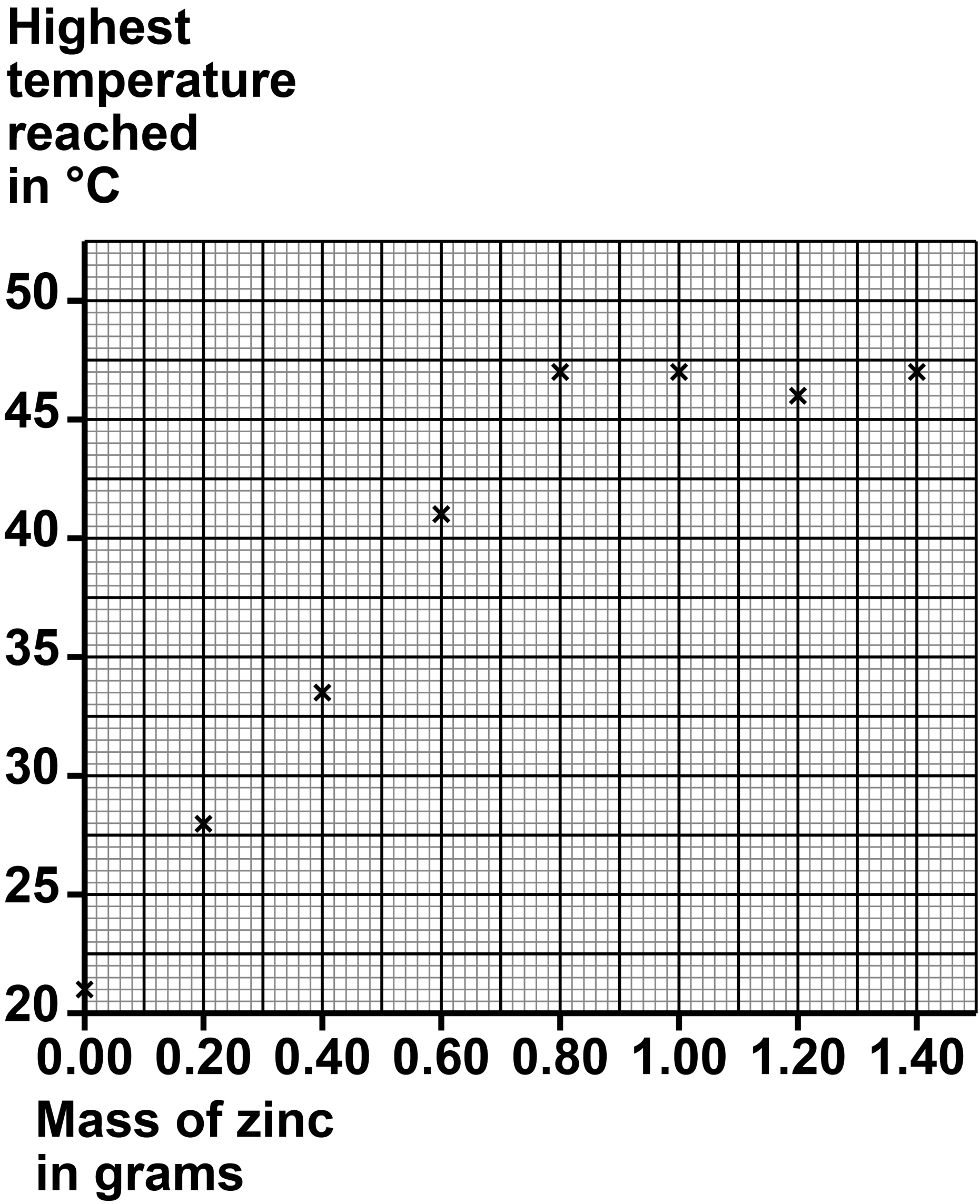
This is the method used.

1. **Measure 25 cm^3 of copper sulfate solution into a polystyrene cup.**
2. **Measure the temperature of the copper sulfate solution.**
3. **Add 0.20 g of zinc powder to the copper sulfate solution.**
4. **Stir the reaction mixture.**
5. **Record the highest temperature reached.**
6. **Repeat steps 1 to 5 with different masses of zinc powder.**

[Turn over]

FIGURE 3 shows the results.

FIGURE 3



0 4 . 1

Draw TWO lines of best fit on FIGURE 3.

The lines should cross. [2 marks]

0 4 . 2

Explain the results shown in FIGURE 3.

Do NOT refer to anomalous points.

Use data from FIGURE 3. [4 marks]

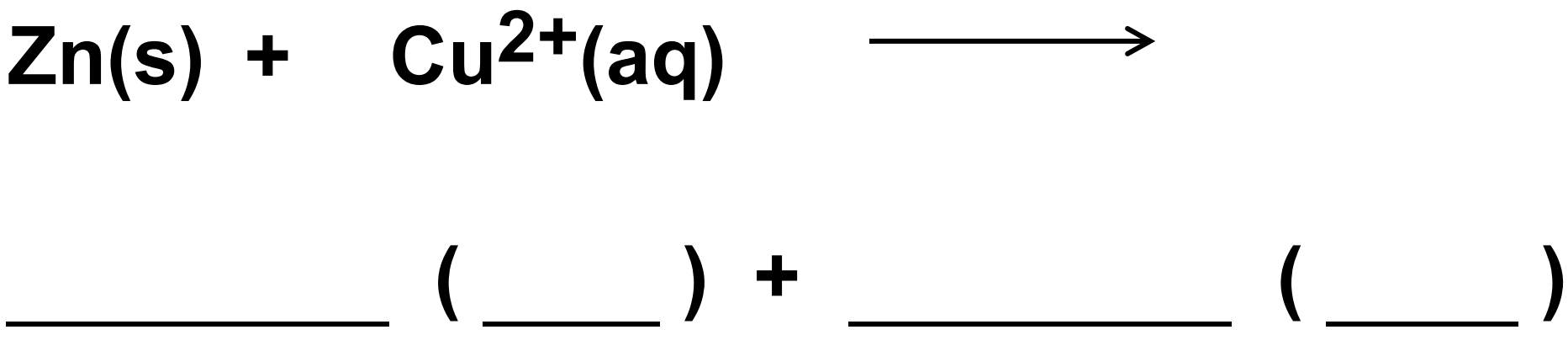
0 4 . 3

Explain why using a polystyrene cup gives more accurate results than using a glass beaker. [2 marks]

0 4 . 4

Complete the ionic equation for the reaction between zinc and copper sulfate solution.

Include state symbols. [2 marks]



[Turn over]

A different student repeated steps 1 to 5 of the method four times using 0.50 g of zinc powder.

TABLE 2 shows the results.

TABLE 2

	Trial 1	Trial 2	Trial 3	Trial 4
Highest temperature reached in °C	37.6	37.2	37.8	37.4

0 4 . 5

Calculate the mean highest temperature reached.

Include the uncertainty in your answer.
[3 marks]

Mean highest temperature reached =

_____ ± _____ °C

[Turn over]

0 4 . 6

The results show random errors.

The student did not make any measuring errors.

Suggest ONE reason for the random errors in this experiment. [1 mark]

14

BLANK PAGE

[Turn over]

0 5

This question is about ionic compounds and electrolysis.

Calcium chloride is an ionic compound.

0 5 . 1

Calcium and chlorine react to produce calcium chloride.

Describe what happens to calcium atoms and chlorine atoms when the ionic compound calcium chloride is formed.
[4 marks]

0 5 . 2

Solid calcium chloride CANNOT be electrolysed.

Give ONE reason why. [1 mark]

0 5 . 3

Name the product formed at the negative electrode when aqueous calcium chloride solution is electrolysed.
[1 mark]

0 5 . 4

What is the half equation for the reaction at the positive electrode when aqueous calcium chloride solution is electrolysed? [1 mark]

Tick (✓) ONE box.

☐ $2\,Cl^- \longrightarrow Cl_2 + 2\,e^-$

☐ $Cl_2 + 2\,e^- \longrightarrow 2\,Cl^-$

☐ $4\,OH^- \longrightarrow O_2 + 2\,H_2O + 4\,e^-$

☐ $O_2 + 2\,H_2O + 4\,e^- \longrightarrow 4\,OH^-$

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0 5 . 5

A student investigated the electrolysis of green copper chromate solution.

FIGURE 4 shows the apparatus.

FIGURE 4

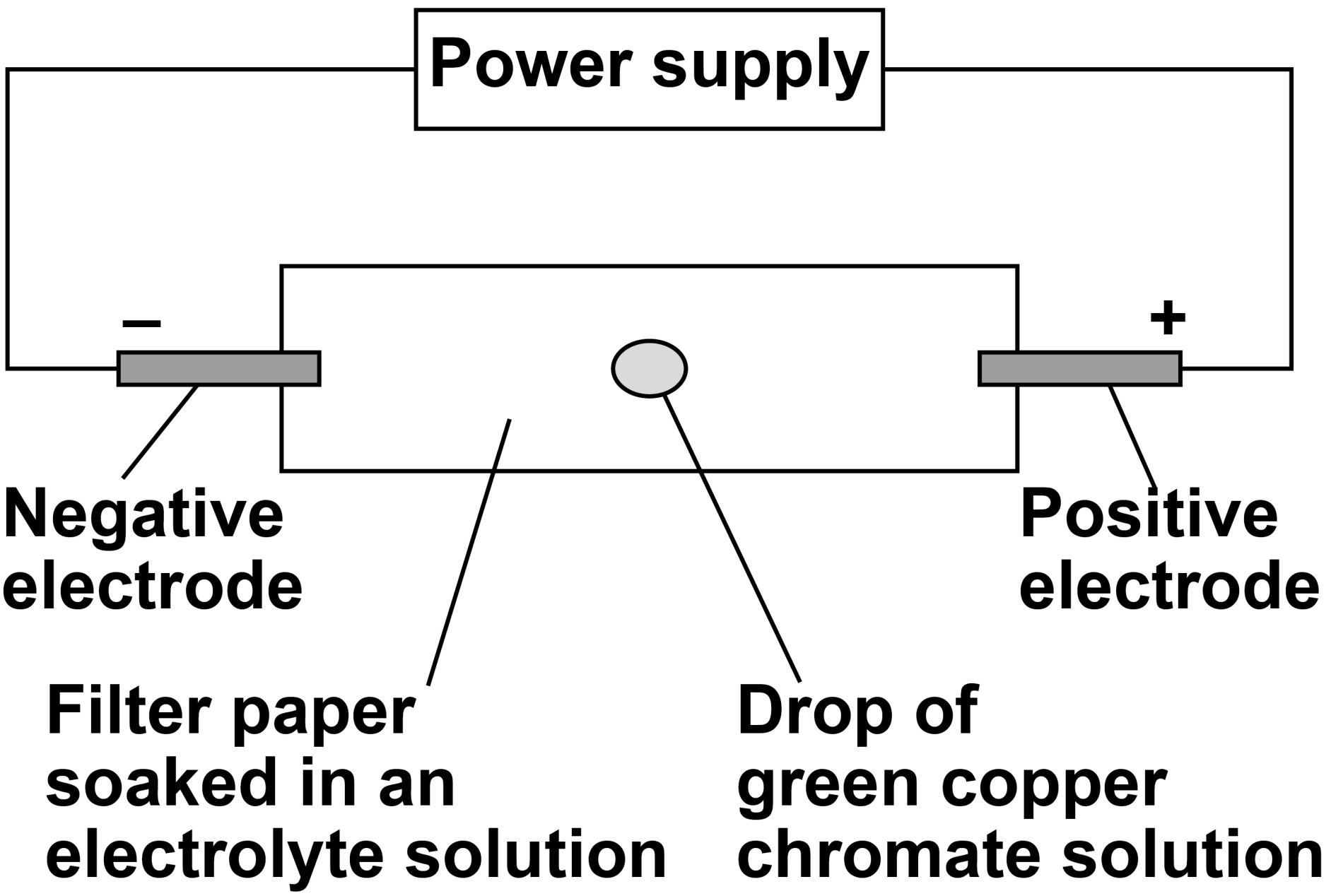
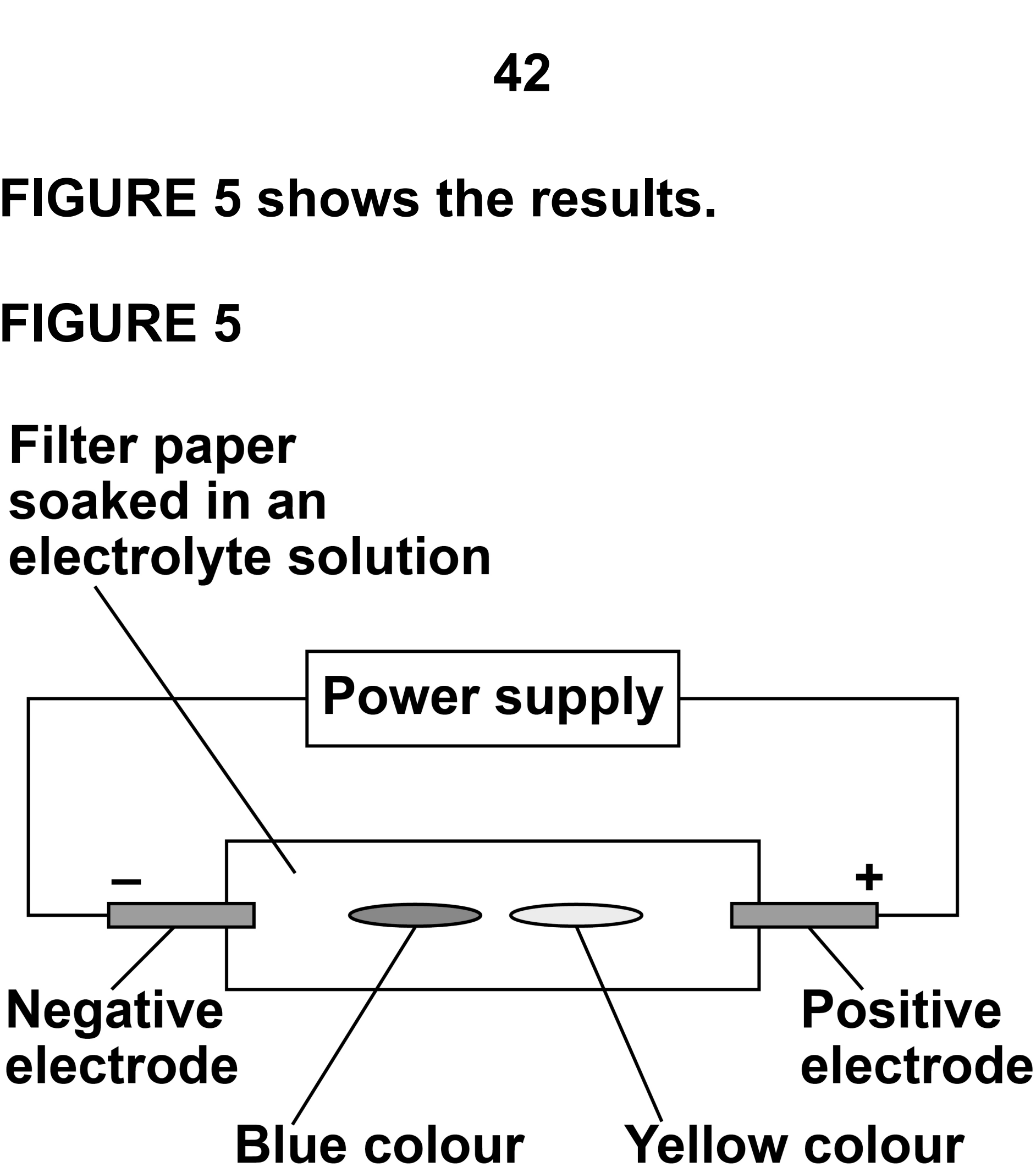


FIGURE 5 shows the results.

FIGURE 5



Copper chromate solution contains the ions Cu^{2+} and CrO_4^{2-}

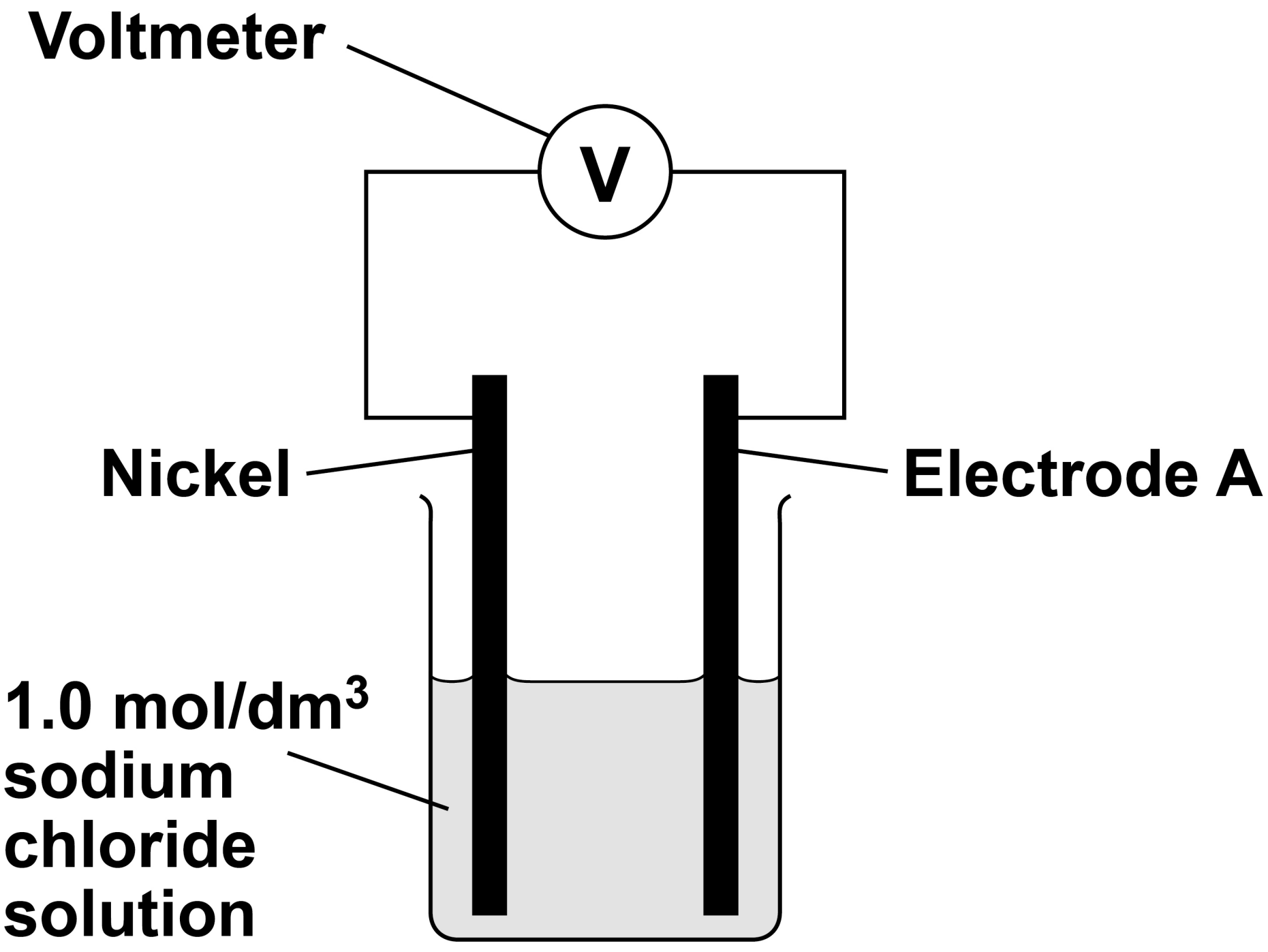
Explain the results shown in FIGURE 5.
[3 marks]

0 6

A student investigated the voltage produced by different pairs of metal electrodes in a chemical cell.

FIGURE 6, on the opposite page, shows the apparatus.

FIGURE 6


Voltmeter
V
Nickel
Electrode A
1.0 mol/dm3 sodium chloride solution

This is the method used.

1. **Place a nickel electrode and an electrode made from a different metal (electrode A) in 1.0 mol/dm^3 sodium chloride solution.**
2. **Measure the voltage produced.**
3. **Repeat using different metals for electrode A.**

TABLE 3, on page 48, shows the results.

BLANK PAGE

[Turn over]

TABLE 3

ELECTRODE A	SYMBOL OF METAL	VOLTAGE IN VOLTS
COPPER	Cu	–0.59
MAGNESIUM	Mg	2.12
NICKEL	Ni	0.00
SILVER	Ag	–1.05
ZINC	Zn	0.51

0 6 . 1

Write the symbols of the five metals in TABLE 3 in order of reactivity.

Justify your answer. [3 marks]

Most reactive _____ _____ _____ _____ _____ **Least reactive**

Justification _____

_____

_____

0 6 . 2

The voltage produced by a chemical cell depends on the concentration of the electrolyte solution.

Plan an experiment to investigate how the voltage produced by a chemical cell varies with the CONCENTRATION of the electrolyte solution.

The following substances are available:

- **the metal electrodes in TABLE 3, on page 48**
- **1.0 mol/dm^3 sodium chloride solution**
- **pure water.**

[6 marks]

[Turn over]

0 6 . 3

Describe how a hydrogen fuel cell produces a potential difference.
[2 marks]

11

0 7

This question is about iron.

0 7 . 1

Iron is a metal.

Describe how iron conducts thermal energy. [2 marks]

0 7 . 2

Pure iron is too soft for many uses.

Explain why mixing iron with other metals makes alloys which are harder than pure iron. [3 marks]

0 7 . 3

When iron reacts with chlorine, 0.12 mol of iron reacts with 0.18 mol of chlorine (Cl_2).

Which is the correct equation for the reaction? [1 mark]

Tick (✓) ONE box.

☐ $Fe + Cl_2 \longrightarrow FeCl_2$

☐ $Fe + 3\,Cl_2 \longrightarrow FeCl_6$

☐ $2\,Fe + Cl_2 \longrightarrow 2\,FeCl$

☐ $2\,Fe + 3\,Cl_2 \longrightarrow 2\,FeCl_3$

The most common oxides of iron are Fe_2O_3 and Fe_3O_4

0 7 . 4

What is the ratio of the numbers of ions in Fe_3O_4? [1 mark]

Tick (✓) ONE box.

☐ $2\,Fe^{2+} : 1\,Fe^{3+} : 4\,O^{2-}$

☐ $1\,Fe^{2+} : 2\,Fe^{3+} : 4\,O^{2-}$

☐ $3\,Fe^{2+} : 4\,O^{2-}$

☐ $3\,Fe^{3+} : 4\,O^{2-}$

0 7 . 5

Calculate the percentage (%) by mass of iron in Fe_3O_4

Relative atomic masses (A_r):

O = 16 Fe = 56

[3 marks]

Percentage by mass of iron =

_____ %

[Turn over]

0 7 . 6

Fe_2O_3 reacts with carbon to produce carbon dioxide.

The equation for the reaction is:

$$2\,Fe_2O_3(s) + 3\,C(s) \longrightarrow 4\,Fe(s) + 3\,CO_2(g)$$

Calculate the volume of carbon dioxide gas at room temperature and pressure that is produced from 40.0 kg of Fe_2O_3 using excess carbon.

Relative formula mass (M_r): Fe_2O_3 = 160

The volume of 1 mole of any gas at room temperature and pressure is 24 dm^3.
[5 marks]

Volume of carbon dioxide =

_____ dm^3

[Turn over]

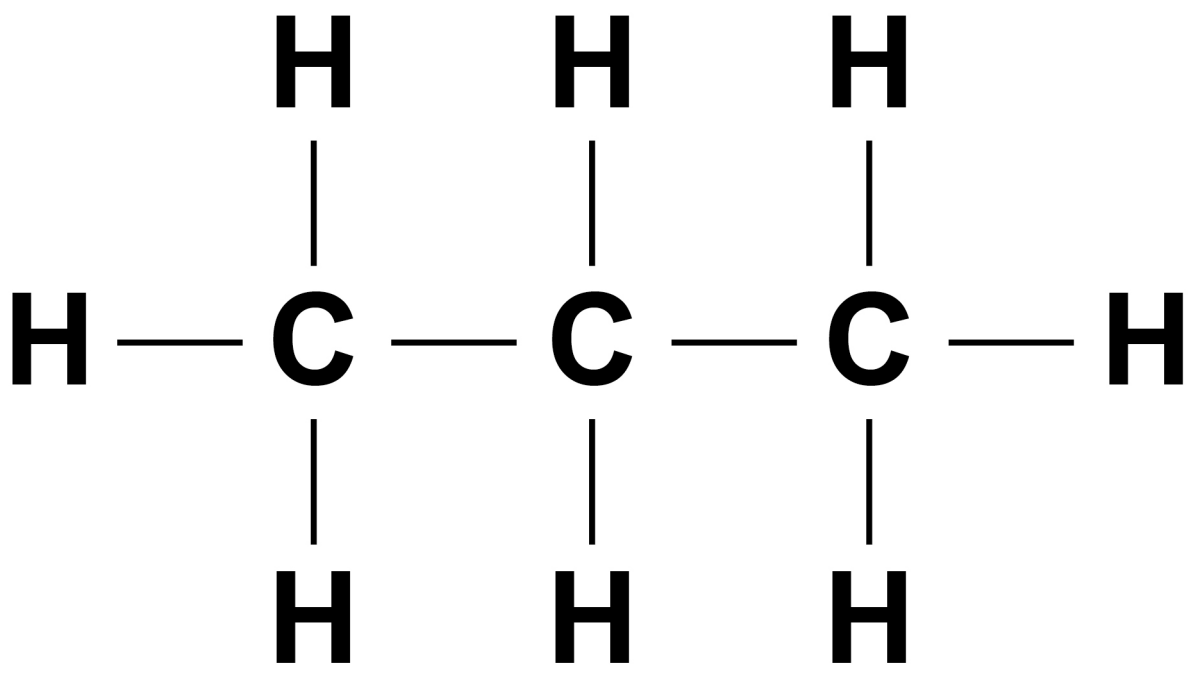
15

0 8

This question is about propane (C_3H_8).

FIGURE 7 shows the displayed structural formula of propane.

FIGURE 7



0 8 . 1

Explain why propane has a low boiling point. [3 marks]

[Turn over]

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Propane reacts with oxygen to produce carbon dioxide and water.

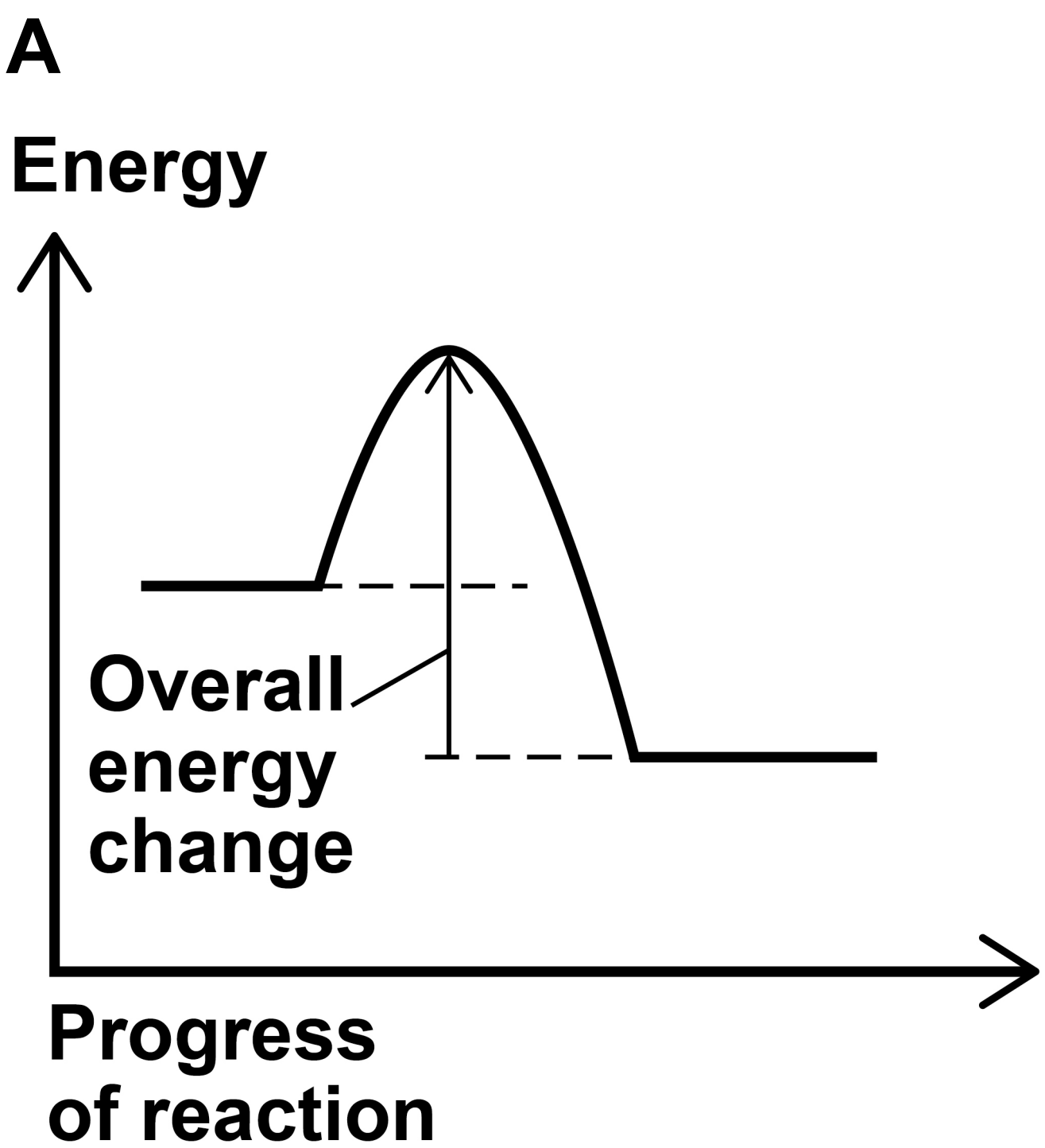
The reaction is exothermic.

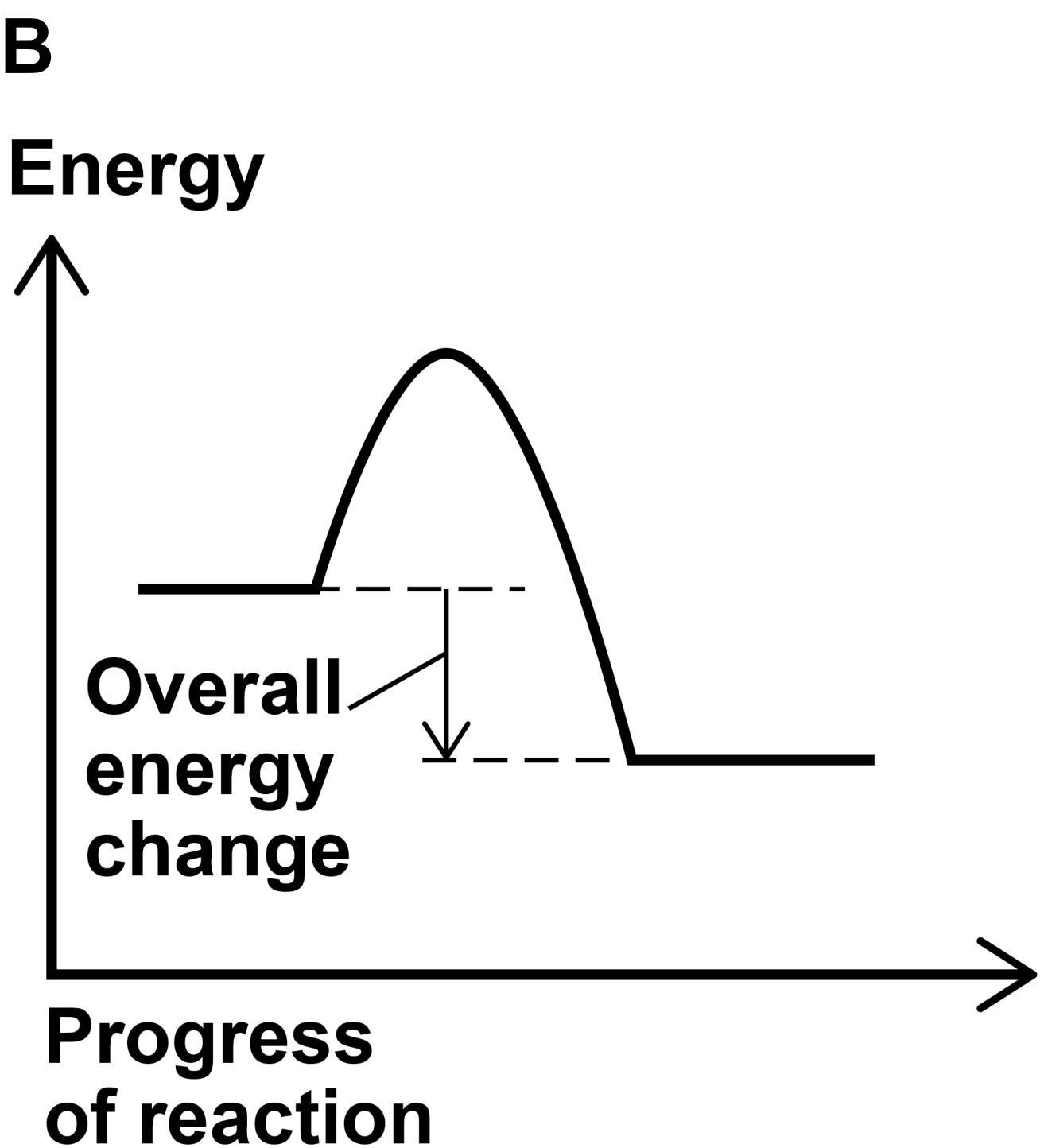
0 8 . 2

FIGURE 8, on pages 64 and 65, shows four reaction profiles.

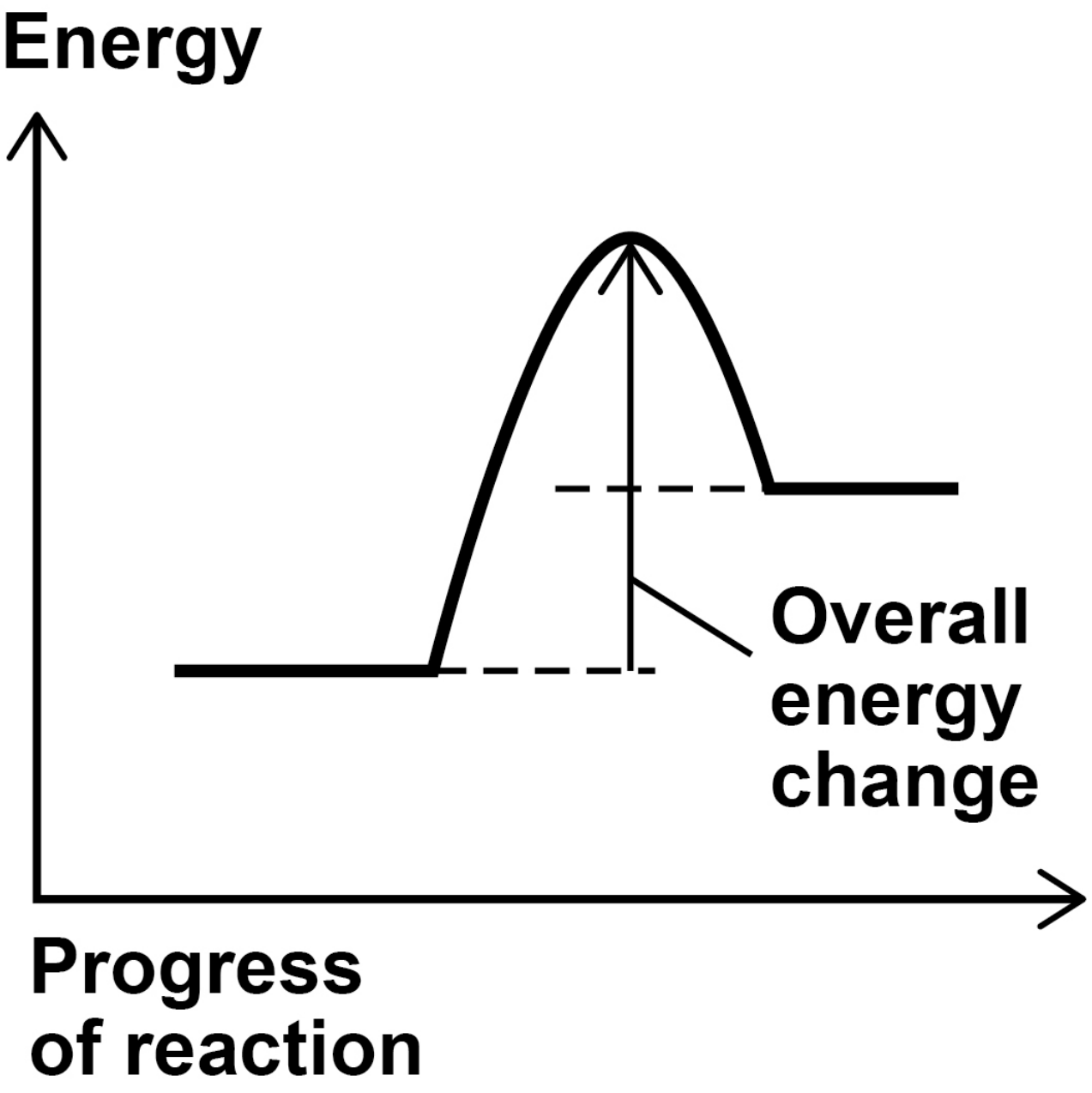
[Turn over]

FIGURE 8

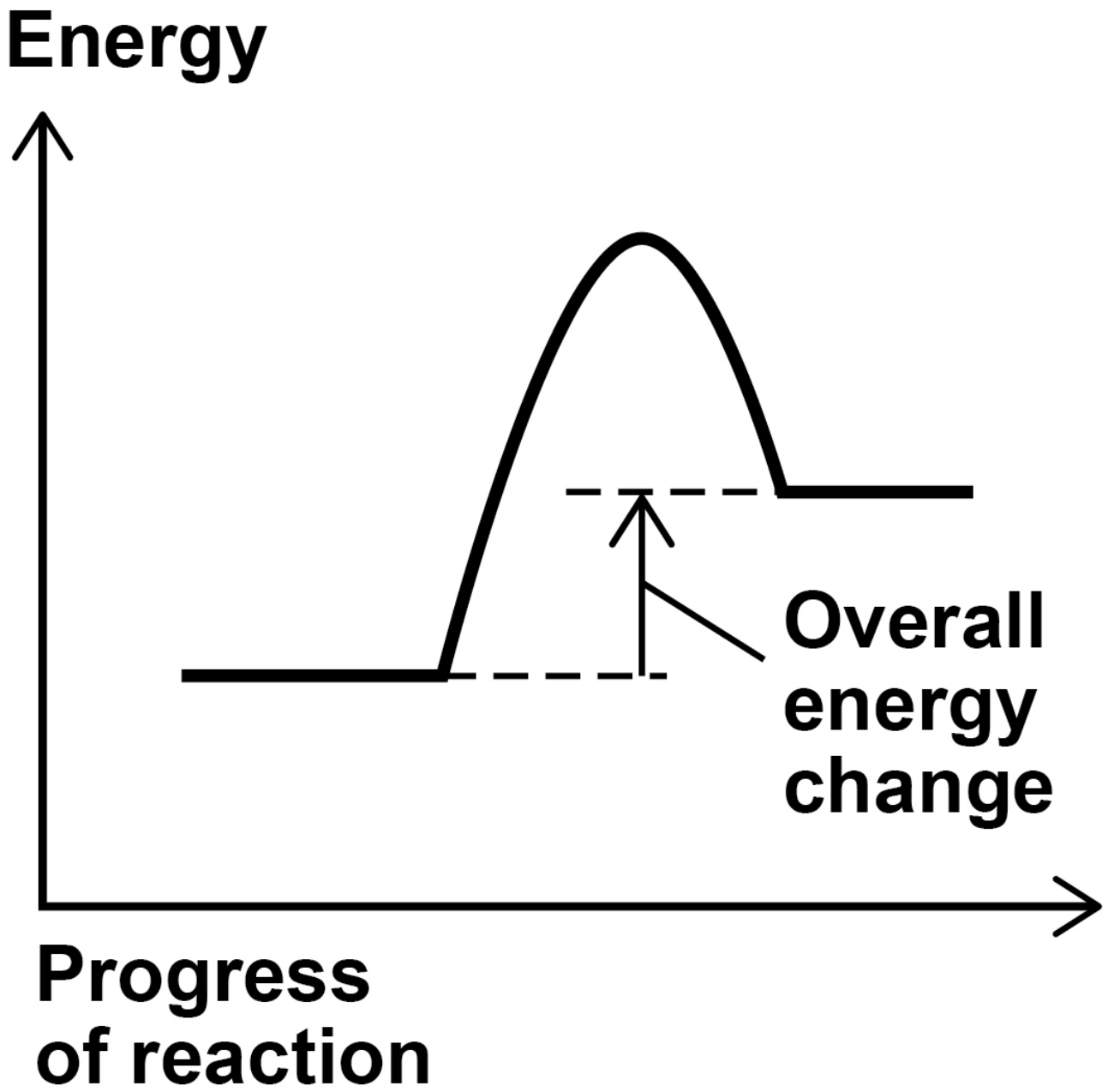

A
Energy
Overall
energy
change
Progress
of reaction


B
Energy
Overall
energy
change
Progress
of reaction

C


Energy
Overall
energy
change
Progress
of reaction

D


Energy
Overall
energy
change
Progress
of reaction

[Turn over]

BLANK PAGE

6 7

Using FIGURE 8, on pages 64 and 65, which is the correct reaction profile and labels for the reaction between propane and oxygen? [1 mark]

Tick (✓) ONE box.

☐ **A**

☐ **B**

☐ **C**

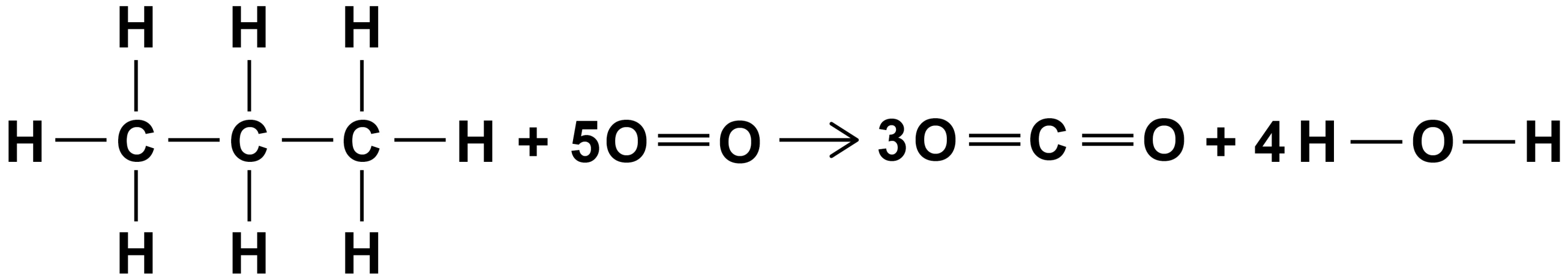
☐ **D**

67

0 8 . 3

FIGURE 9 shows the displayed formula equation for the reaction between propane and oxygen.

FIGURE 9



The overall energy change of this exothermic reaction is 2219 kJ/mol.

TABLE 4, on the opposite page, shows the bond energies of the bonds in the reaction.

TABLE 4

	C — C	C — H	O = O	C = O	O — H
Energy in kJ/mol	347	X	498	805	464

69

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Calculate the bond energy of the C — H bond (X). [5 marks]

Bond energy of the C — H bond (X) = _____ kJ/mol

[Turn over]

9

0 9

This question is about acids and their reactions.

Acids can be either weak or strong.

0 9 . 1

What is meant by ‘a WEAK acid’?
[2 marks]

0 9 . 2

Explain what happens to the pH of an acid as the acid is diluted with water.
[2 marks]

0 9 . 3

A student does a titration to find the volume of acid needed to neutralise an alkali.

The student fills a burette with the acid.

Give THREE more steps the student must do before adding the acid to the alkali from the burette.

You should name any equipment used.
[3 marks]

1 _____

2 _____

3 _____

_____

_____

[Turn over]

0 9 . 4

The student titrated a solution containing 0.0045 moles of sodium hydroxide with 0.15 mol/dm^3 hydrochloric acid.

The equation for the reaction is:

$$NaOH + HCl \longrightarrow NaCl + H_2O$$

Calculate the volume of hydrochloric acid in cm^3 needed in the titration.
[2 marks]

Volume of acid = _____ cm^3

0 9 . 5

A calcium atom is larger than a magnesium atom.

Explain why calcium reacts more vigorously than magnesium with hydrochloric acid of the same concentration. [3 marks]

END OF QUESTIONS

12

Additional page, if required.

Write the question numbers in the left-hand margin.

7 8

Additional page, if required.

Write the question numbers in the left-hand margin.

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For Examiner's Use	
Question	Mark
1	
2	
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9	
TOTAL	