AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE CHEMISTRY

H

Higher Tier Paper 1

Friday 17 May 2024 Morning Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:
- a ruler
- a scientific calculator
- the periodic table (enclosed).

Instructions

- Use black ink or black ball-point pen.
- Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. Do not write outside the box around each page or 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.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
TOTAL	

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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**.

[1 mark]

_____

_____

Do not write outside the box

0 1 . 4 Name the equipment that can be used to warm the filtrate **gently** in **Step 6**.

[1 mark]

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

Question 1 continues on the next page

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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

Do not write outside the box

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 _____

_____

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.

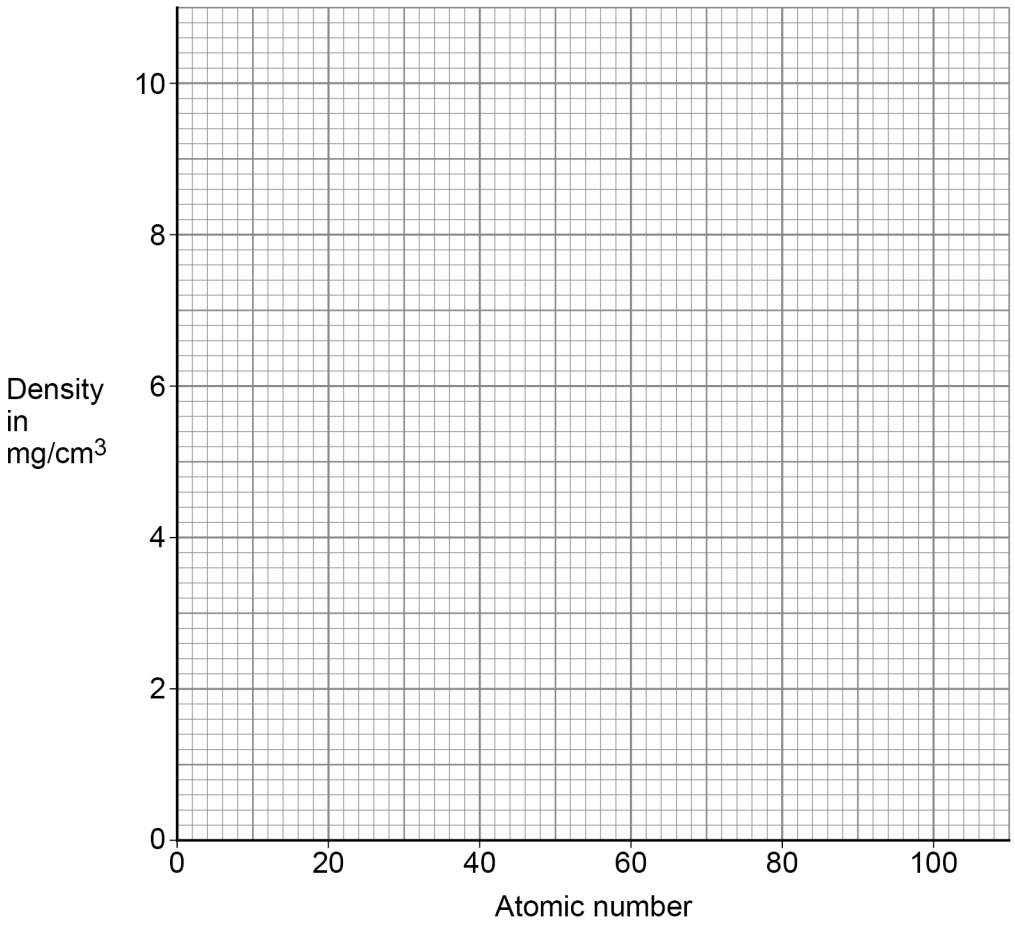
Table 1

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**.

[2 marks]

Figure 1



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0 2 . 5 Estimate the density (**X**) of krypton.

Use **Figure 1** and **Table 1**.

[1 mark]

Density = _____ mg/cm^3

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. ☐

11

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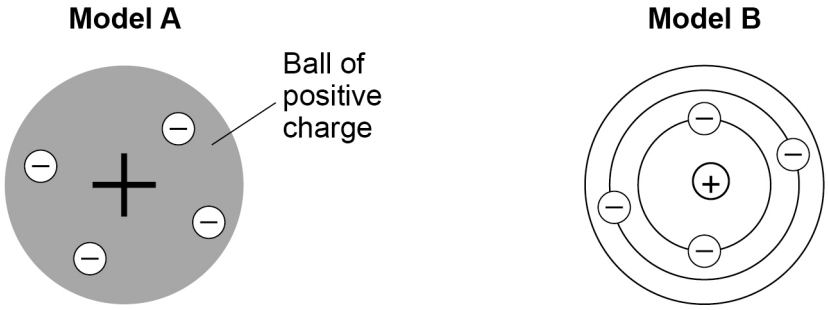
0 3 This question is about models of the atom.

Figure 2 shows two early models of the atom.

Figure 2



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]

_____

_____

_____

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Do not write outside the box

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]

8

Turn over for the next question

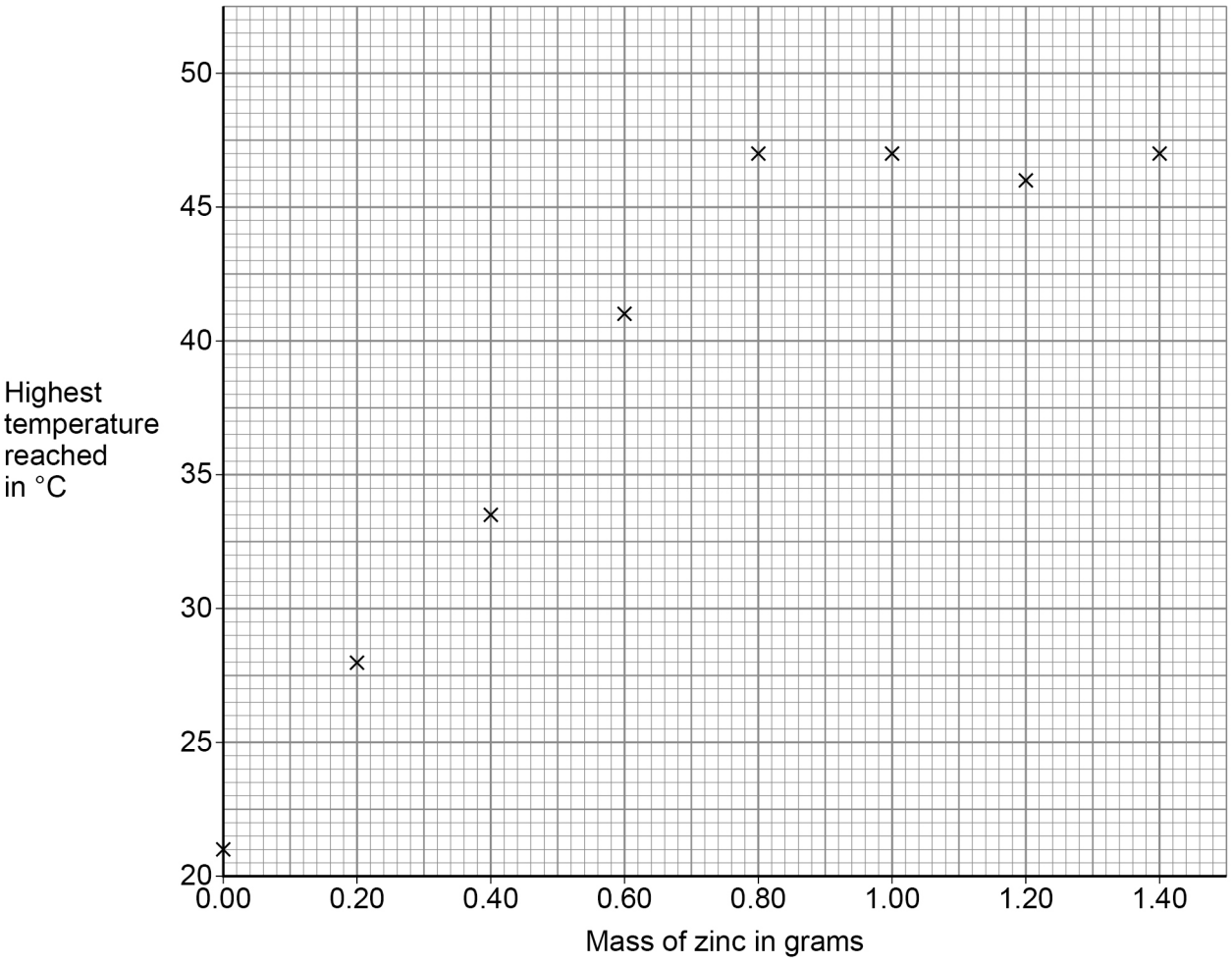
0 4 A student investigated the energy change of the reaction between zinc and copper sulfate solution.

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.

Figure 3 shows the results.

Figure 3



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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]

$$Zn(s) + Cu^{2+}(aq) \rightarrow \_\_\_\_(\_\_) + \_\_\_\_(\_\_)$$

Turn over ►

Do not write outside the box

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

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

Turn over for the next question

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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]

Do not write outside the box

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.

$2Cl^- \rightarrow Cl_2 + 2e^-$ ☐

$Cl_2 + 2e^- \rightarrow 2Cl^-$ ☐

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

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

Question 5 continues on the next page

Do not write outside the box

0 5 . 5 A student investigated the electrolysis of green copper chromate solution.

Figure 4 shows the apparatus.

Figure 4

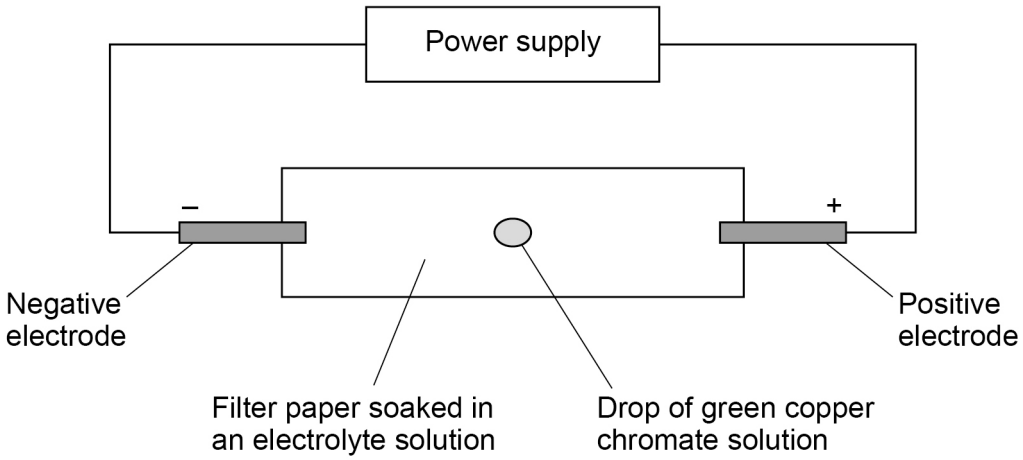
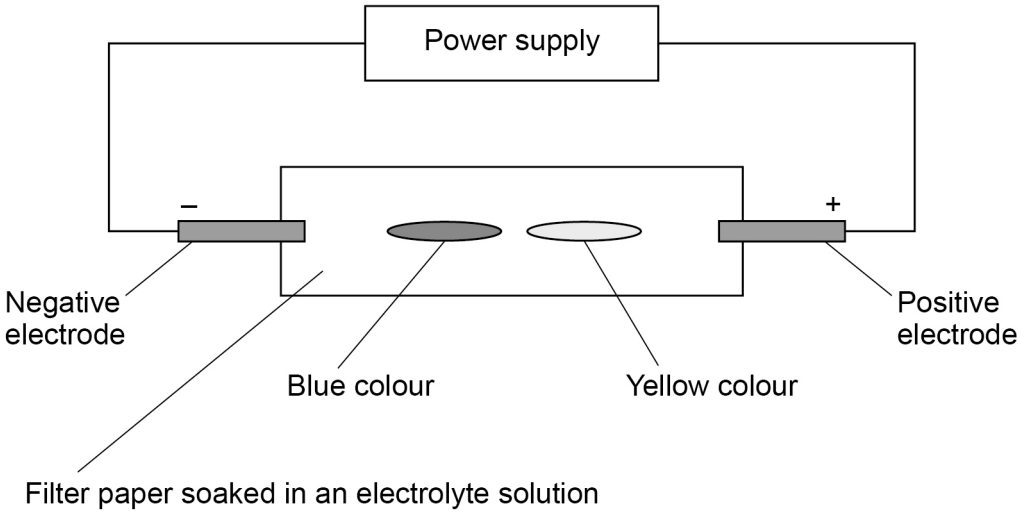


Figure 5 shows the results.

Figure 5



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

Explain the results shown in **Figure 5**.

[3 marks]

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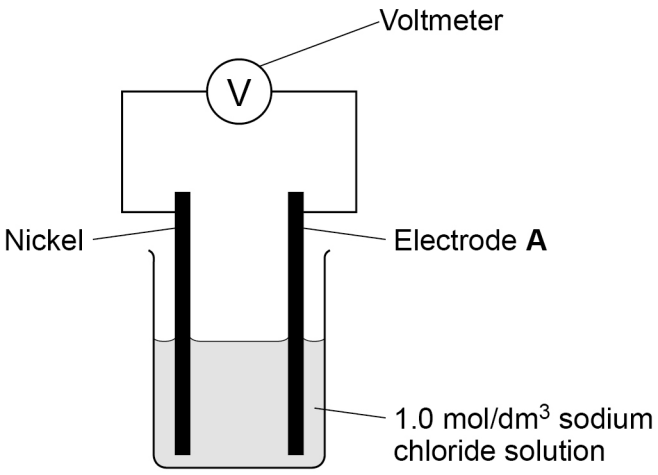
10

Turn over for the next question

0 6 A student investigated the voltage produced by different pairs of metal electrodes in a chemical cell.

Figure 6 shows the apparatus.

Figure 6



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 shows the results.

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

Do not write outside the box

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**
- 1.0 mol/dm^3 sodium chloride solution
- pure water.

[6 marks]

_____

_____

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0 6 . 3 Describe how a hydrogen fuel cell produces a potential difference.

[2 marks]

11

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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]

Question 7 continues on the next page

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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.

$Fe + Cl_2 \rightarrow FeCl_2$ ☐

$Fe + 3Cl_2 \rightarrow FeCl_6$ ☐

$2Fe + Cl_2 \rightarrow 2FeCl$ ☐

$2Fe + 3Cl_2 \rightarrow 2FeCl_3$ ☐

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-} ☐

Do not write outside the box

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 = _____ %

0 7 . 6 Fe_2O_3 reacts with carbon to produce carbon dioxide.

The equation for the reaction is:

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

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]

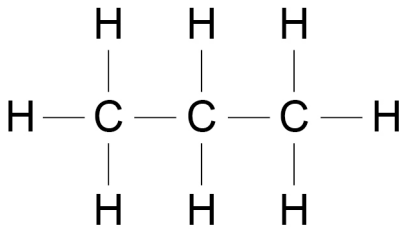
Volume of carbon dioxide = _____ dm^3

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.

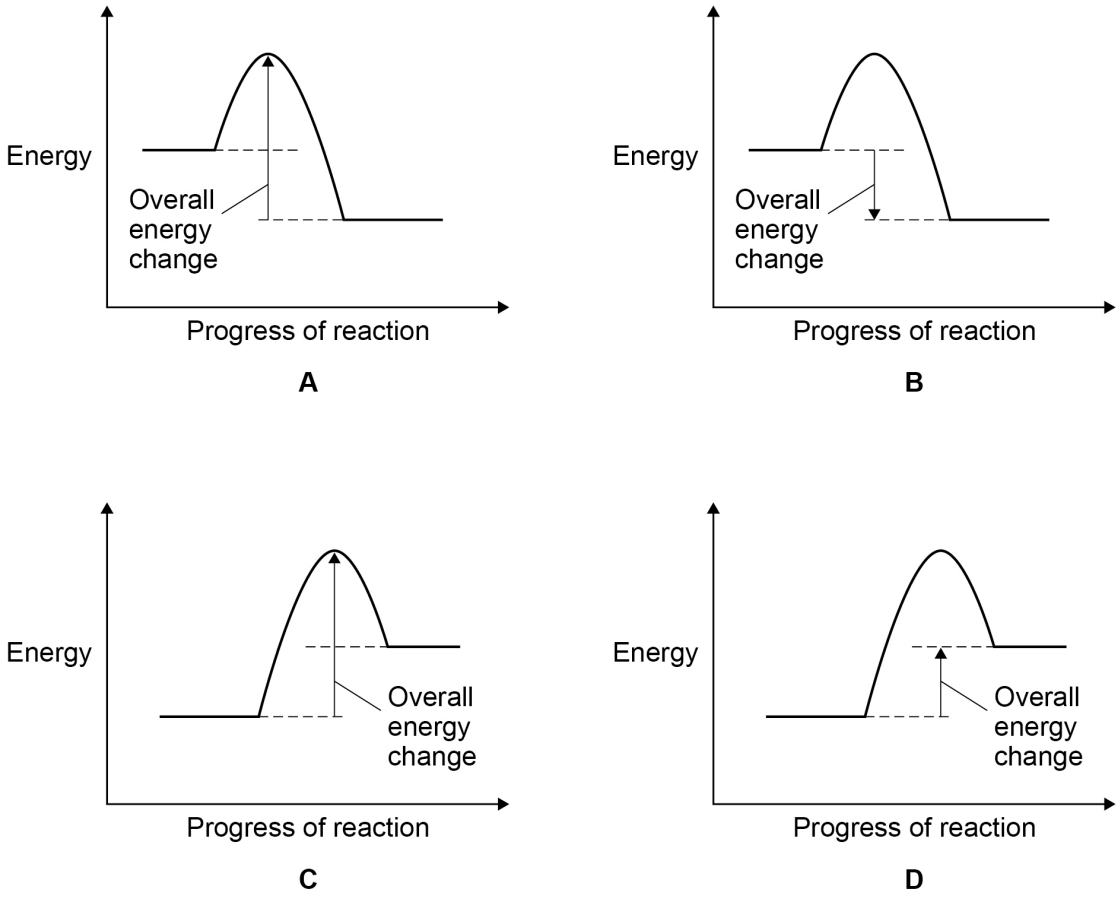
[3 marks]

Propane reacts with oxygen to produce carbon dioxide and water.

The reaction is exothermic.

0 8 . 2 **Figure 8** shows four reaction profiles.

Figure 8



Which is the correct reaction profile and labels for the reaction between propane and oxygen?

Tick (✓) **one** box.

[1 mark]

A ☐ **B** ☐ **C** ☐ **D** ☐

Question 8 continues on the next page

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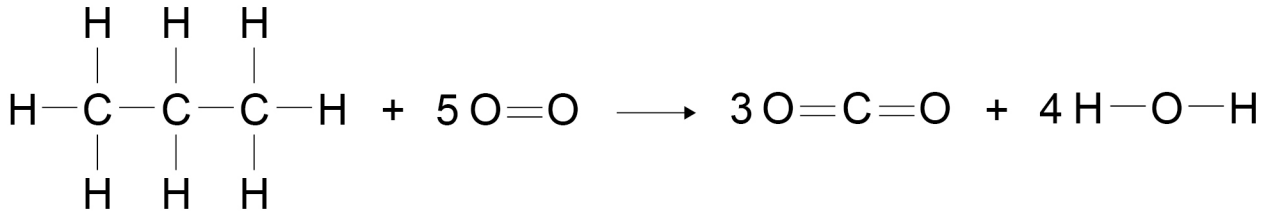
0 8 . 3 **Figure 9** shows the displayed formula equation for the reaction between propane and oxygen.

Figure 9



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

Table 4 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

Calculate the bond energy of the C — H bond (**X**).

[5 marks]

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

9

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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]

Question 9 continues on the next page

Do not write outside the box

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 _____

_____

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:

$$NaOH + HCl \rightarrow NaCl + H_2O$$

Calculate the volume of hydrochloric acid in cm^3 needed in the titration.

[2 marks]

_____

_____

_____

Volume of acid = _____ cm^3

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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]

12

END OF QUESTIONS

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