

Please write clearly in block capitals.

Centre number

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Candidate number

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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	



0 1

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

This is the method used.

1. Measure 50 cm³ 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]



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 cm³ 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

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 _____

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.

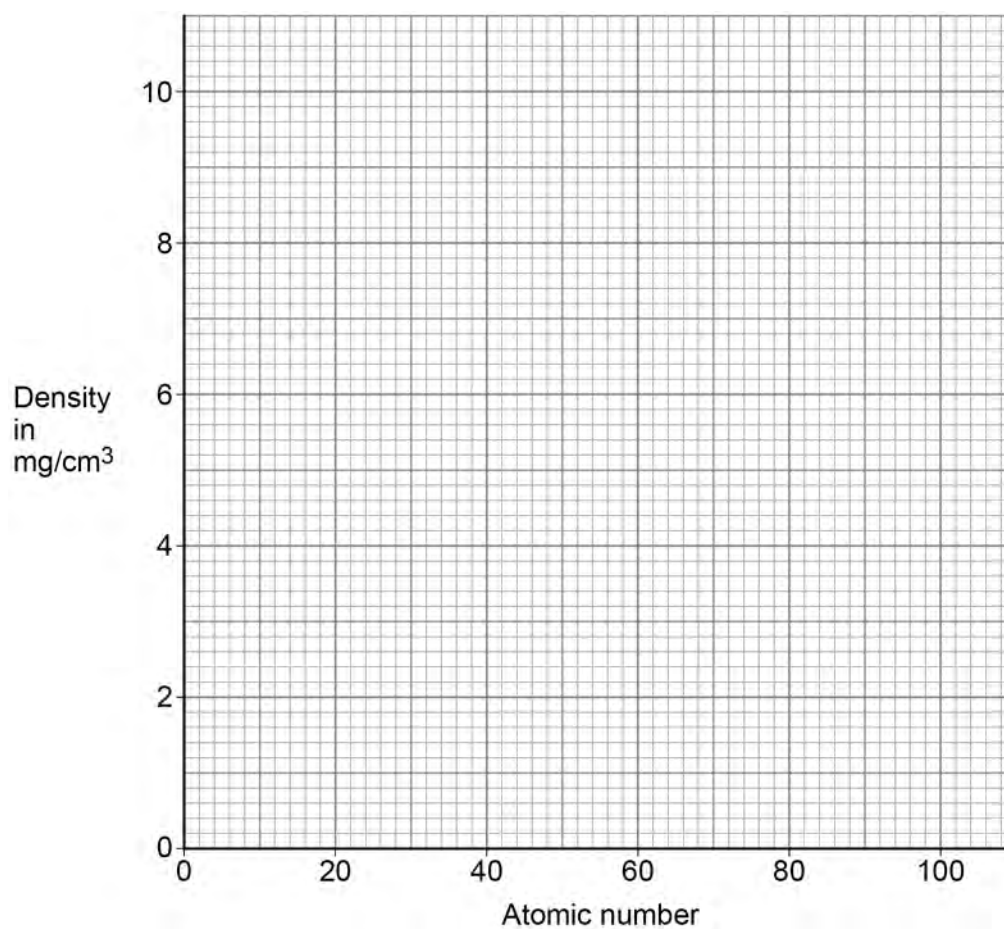
Table 1

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



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

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

[1 mark]

Density = _____ mg/cm³

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

Turn over ►

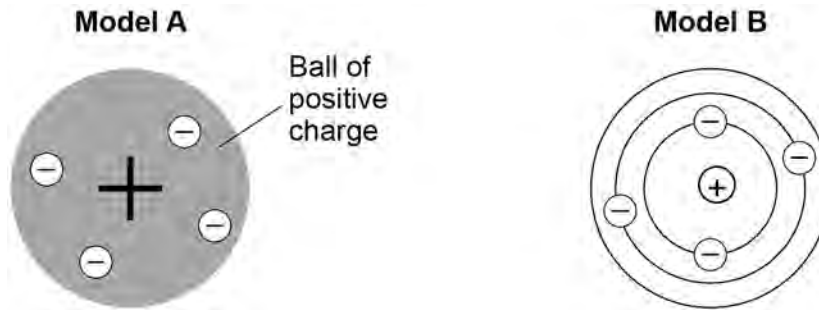


0 3

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]



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

Turn over ►



0 4

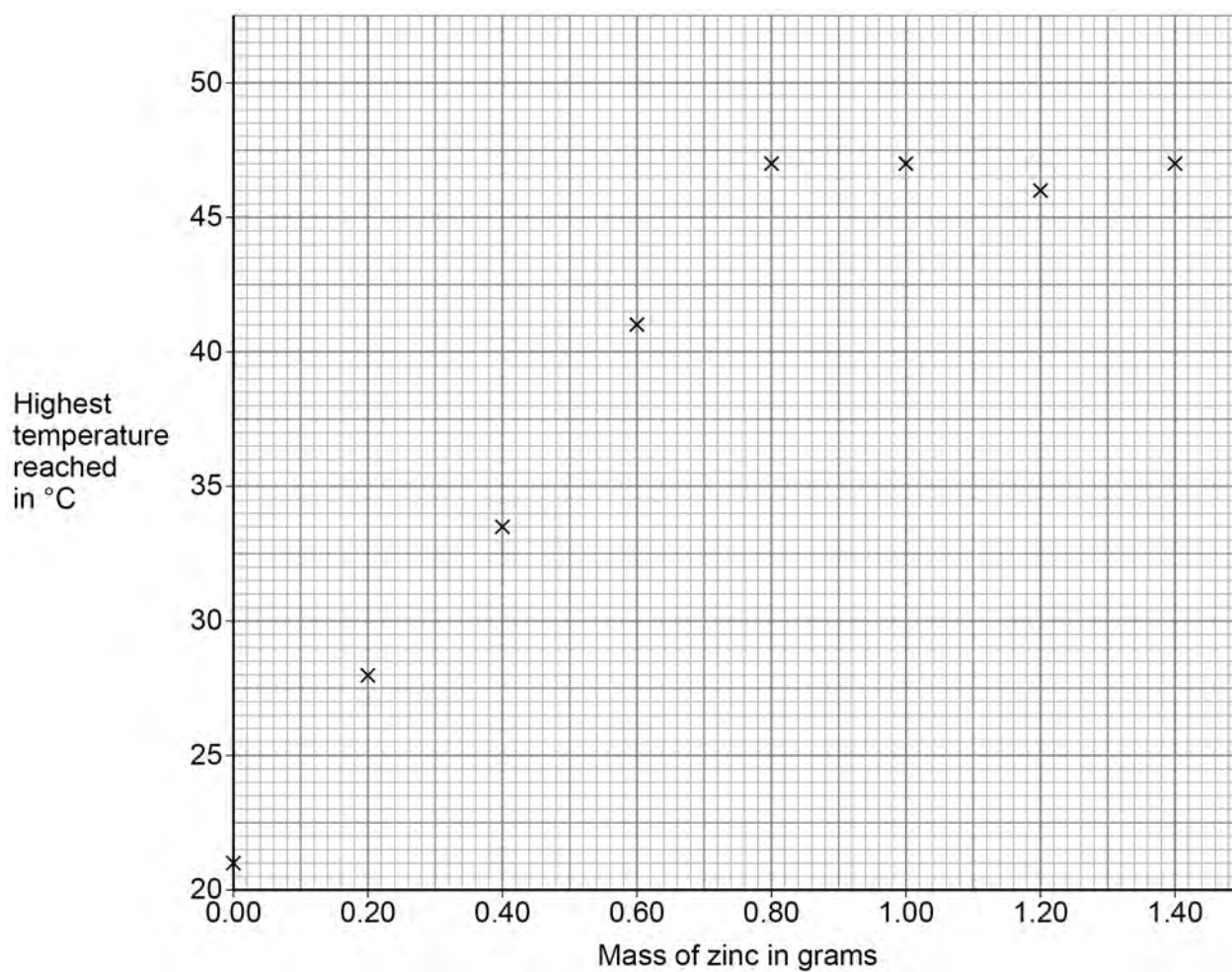
A student investigated the energy change of the reaction between zinc and copper sulfate solution.

This is the method used.

1. Measure 25 cm³ 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



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]

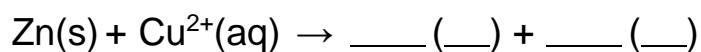
0 4 . 3 Explain why using a polystyrene cup gives more accurate results than using a glass beaker.

[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 = _____ \pm _____ °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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ANSWER IN THE SPACES PROVIDED**

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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

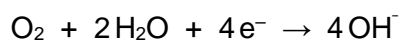
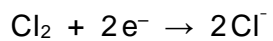
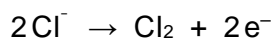
Name the product formed at the negative electrode when aqueous calcium chloride solution is electrolysed.

[1 mark]



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.

Question 5 continues on the next page

Turn over ►

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

Figure 4 shows the apparatus.

Figure 4

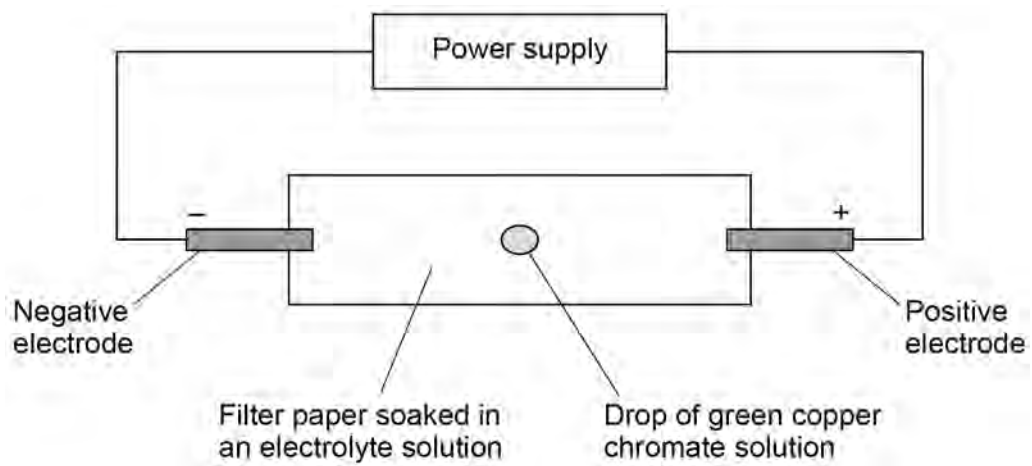
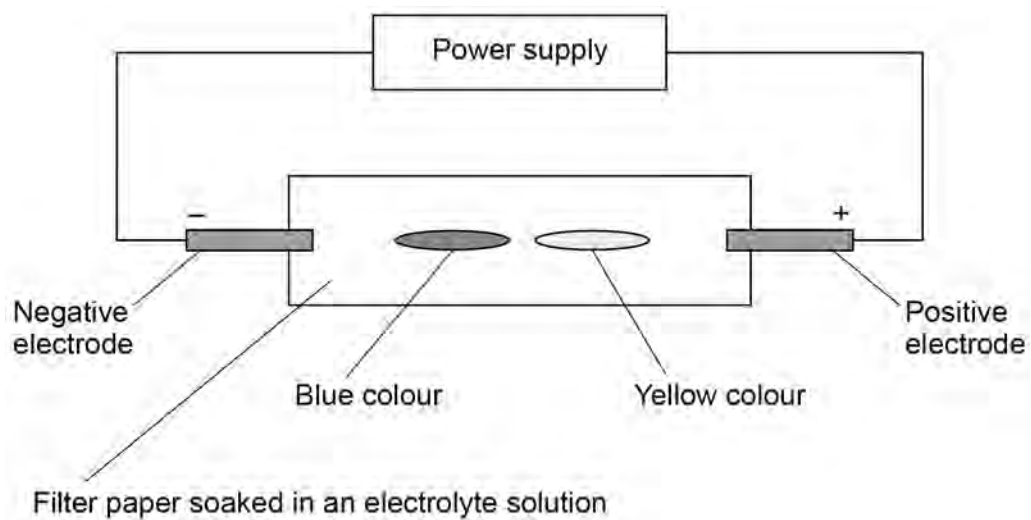


Figure 5 shows the results.

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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outside the
box*

10

Turn over for the next question

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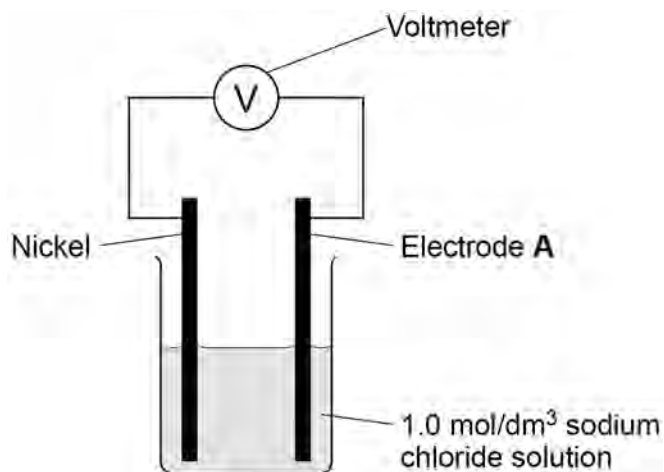


0 6

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/dm³ 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



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/dm³ sodium chloride solution
- pure water.

[6 marks]

Turn over ►



06.3

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]

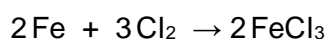
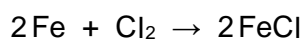
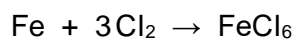
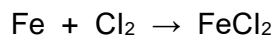
Question 7 continues on the next page**Turn over ►**

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.

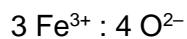
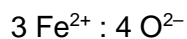
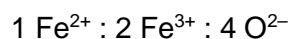


The most common oxides of iron are Fe_2O_3 and Fe_3O_4

0 7 . 4 What is the ratio of the numbers of ions in Fe_3O_4 ?

[1 mark]

Tick (✓) **one** box.



0 7 . 5 Calculate the percentage (%) by mass of iron in Fe_3O_4

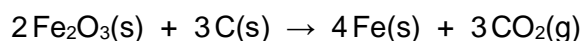
Relative atomic masses (A_r): O = 16 Fe = 56

[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:



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): $\text{Fe}_2\text{O}_3 = 160$

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

Turn over ►

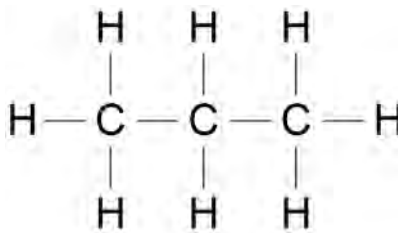


0 8

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]

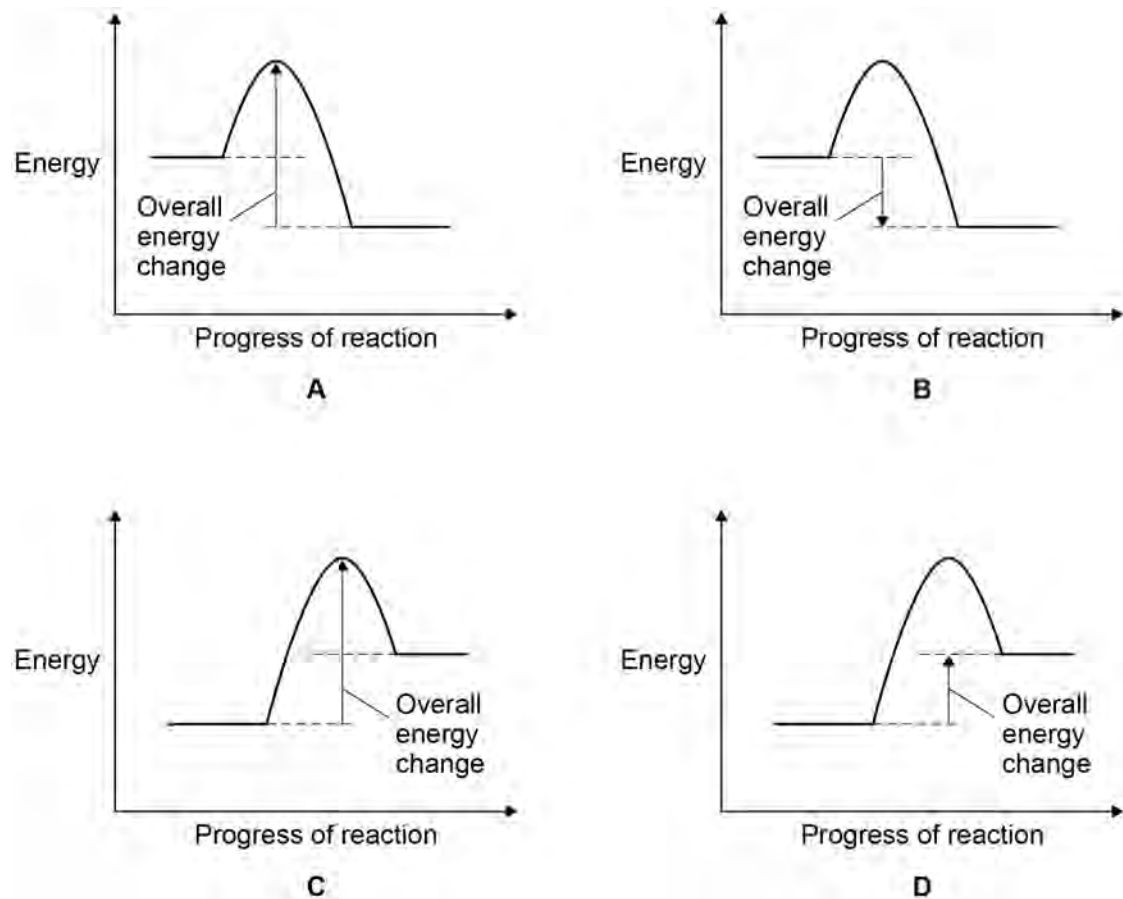


Propane reacts with oxygen to produce carbon dioxide and water.

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

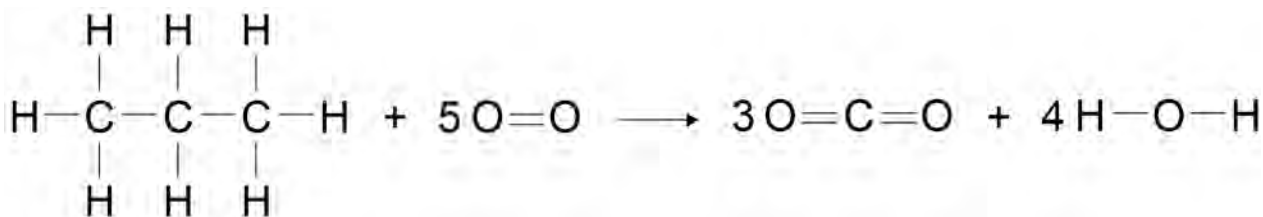
Question 8 continues on the next page

Turn over ►



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



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

Turn over ►

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 _____

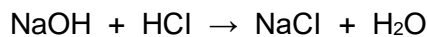
2 _____

3 _____

0 9 . 4

The student titrated a solution containing 0.0045 moles of sodium hydroxide with 0.15 mol/dm³ hydrochloric acid.

The equation for the reaction is:



Calculate the volume of hydrochloric acid in cm³ needed in the titration.

[2 marks]

Volume of acid = _____ cm³

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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