



General Certificate of Secondary Education  
2025

Centre Number

--	--	--	--	--

Candidate Number

--	--	--	--

---

## GCSE Chemistry

Unit 2

Higher Tier

<b>MV24</b>
-------------

[GCM22]

FRIDAY 13 JUNE, MORNING

---

### Time

1 hour 30 minutes, plus your additional time allowance.

### Instructions to Candidates

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

**You must answer the questions in the spaces provided.**

**Do not write on blank pages.**

Complete questions in black ink and use a dark HB pencil for drawings and graphs.

**Do not write with a gel pen.**

Answer all **six** questions.

---

## Information for Candidates

The total mark for this paper is 100.

Figures in brackets printed at the end of each question indicate the marks awarded to each question or part question.

You may use a scientific calculator.

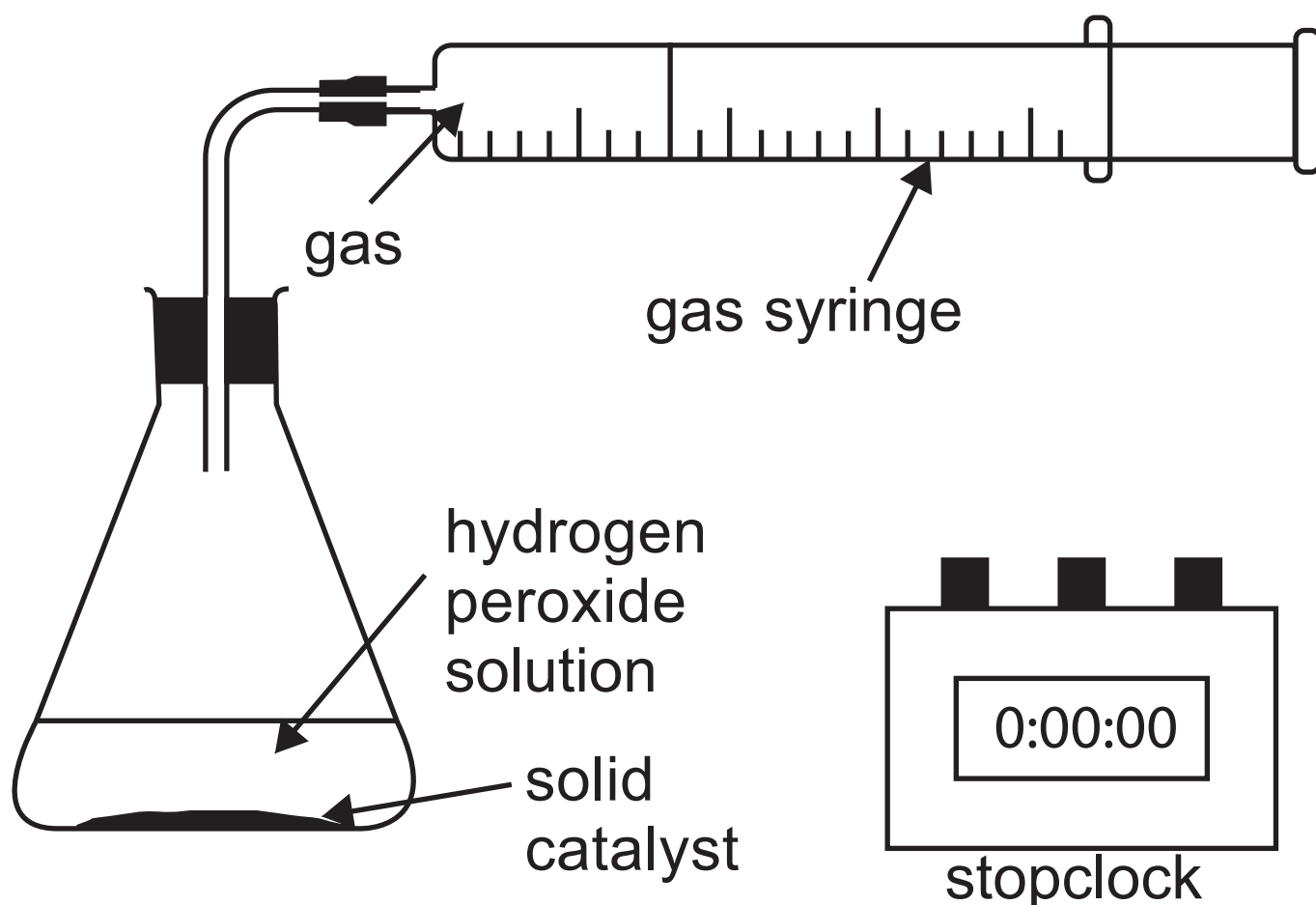
Quality of written communication will be assessed in Question **3(c)**.

A Data Leaflet, which includes a Periodic Table of the Elements, is included in this question paper.

**Blank Page**

**(Questions start overleaf)**

- 1 (a) An experiment was set up to investigate the effect of four different solid catalysts on the decomposition of hydrogen peroxide. A diagram of the apparatus used is shown below.  $25.0\text{ cm}^3$  of hydrogen peroxide solution and  $1\text{ g}$  of solid catalyst were used in the reaction and the time taken to produce  $100\text{ cm}^3$  of gas was recorded.



## Results of experiment

Solid catalyst	Time taken to collect 100 cm <sup>3</sup> of gas /s
A	120
B	35
C	11
D	54

- (i) Name the products formed in the decomposition of hydrogen peroxide.  
[1 mark]

---

---

- (ii) State and explain which solid (A, B, C or D) is the most effective catalyst.  
[1 mark]

---

---

---

**(iii)** Name one compound which could be used as a catalyst for the decomposition of hydrogen peroxide.  
[1 mark]

---

**(iv)** In the first experiment, 1 g of solid A was used. Describe how it could be shown experimentally at the end of the reaction that solid A was a catalyst and not a reactant.  
[3 marks]

---

---

---

**Blank Page**

**(Questions continue overleaf)**

**(b)** The experiment was repeated using the same apparatus and the gas volume collected was recorded at intervals of 20 seconds. Catalyst A was used.

The graph opposite shows the results obtained.

**(i)** What volume of gas was produced in the first 10 seconds? [1 mark]

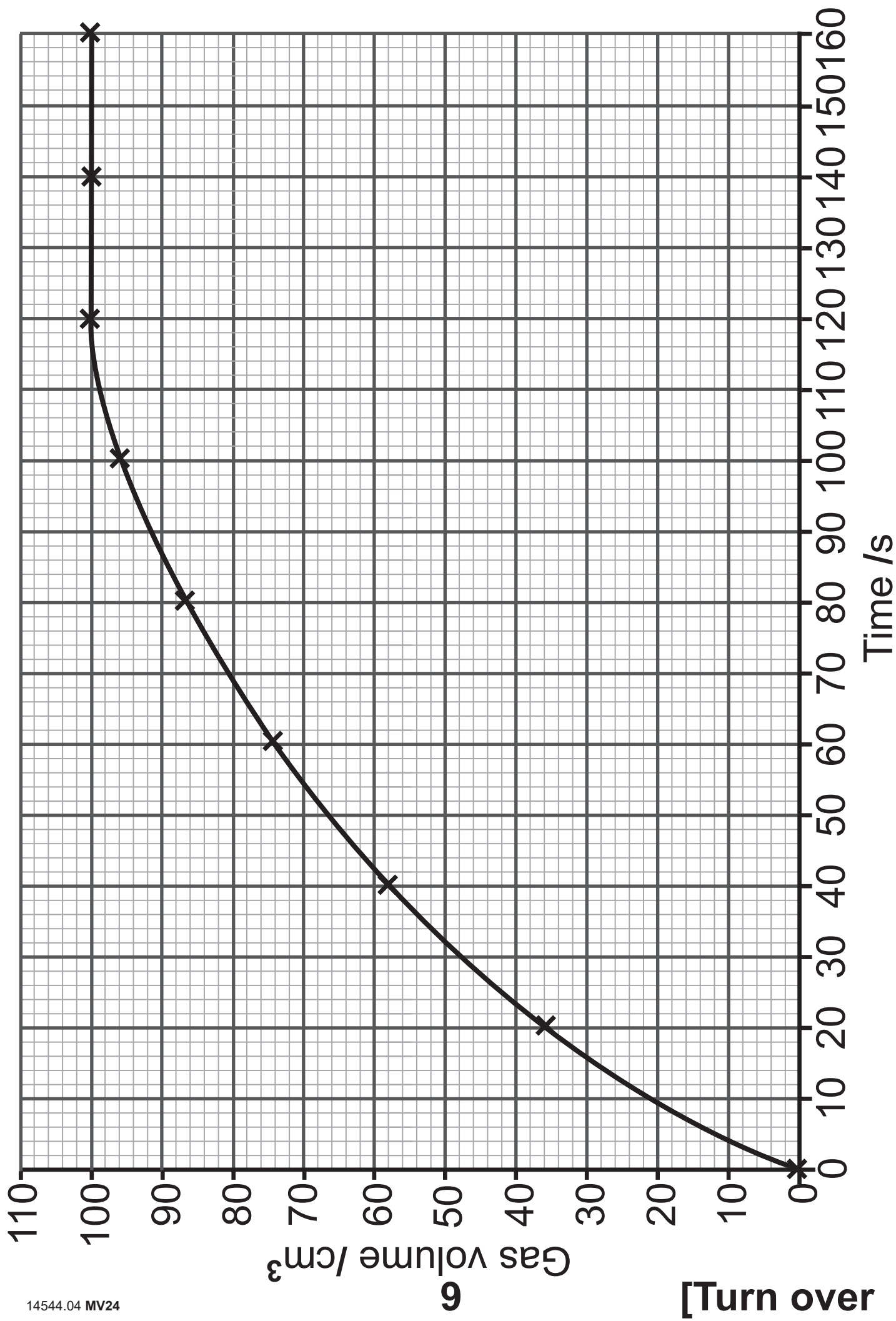
---

**(ii)** Describe fully how the gas volume produced changes with time. [2 marks]

---

---

---



**(iii)** Explain, in terms of particles, why the rate of this reaction increases if the temperature of the hydrogen peroxide is increased and all other factors remain the same. [3 marks]

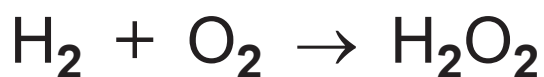
---

---

---

---

**(c)** Hydrogen peroxide can be produced industrially from hydrogen and oxygen as shown in the equation below.



**(i)** This reaction has a 100% atom economy. Explain how you can tell this from the equation. [1 mark]

---

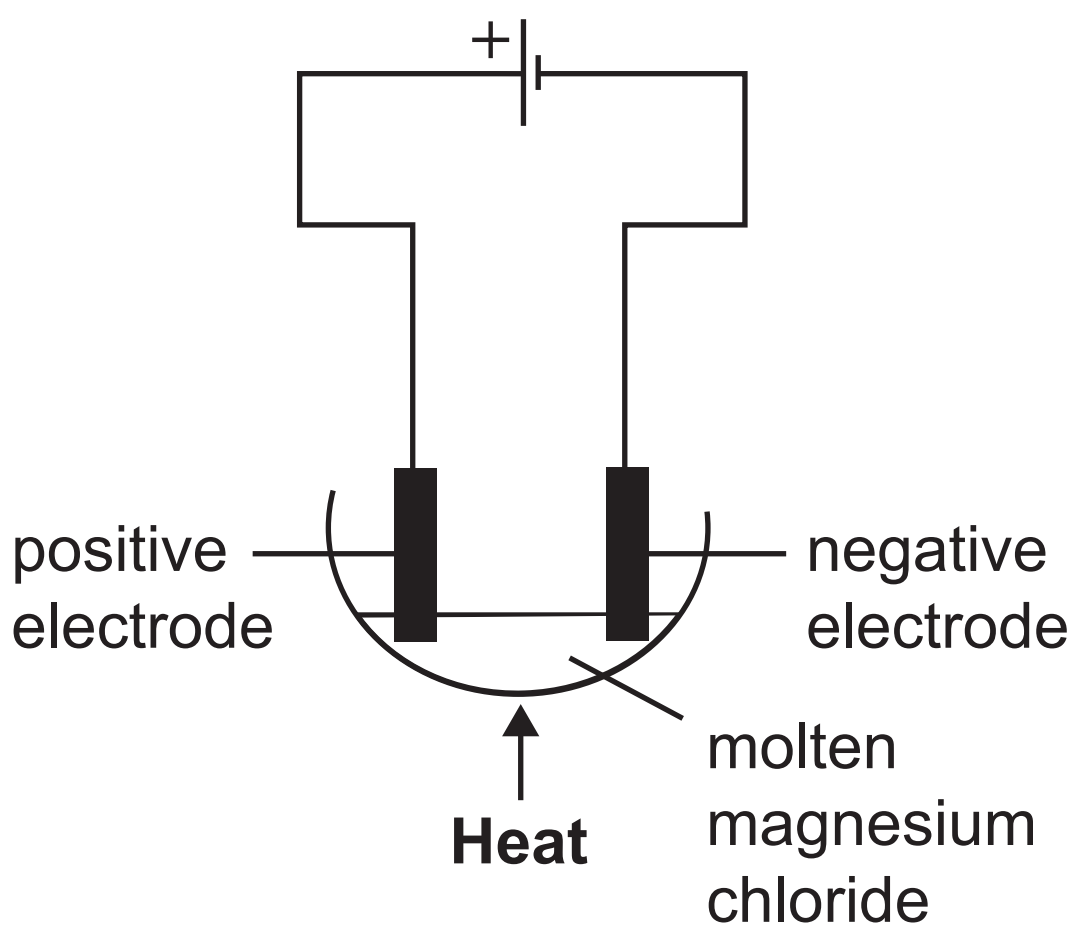
---

**(ii)** Explain why industrial chemical processes should have as high an atom economy as possible.  
[1 mark]

---

---

2 Molten magnesium chloride undergoes electrolysis. The diagram below shows the apparatus which can be used to carry out this electrolysis. Molten magnesium is formed at the negative electrode and chlorine gas is formed at the positive electrode.



(a) What is meant by the term electrolysis?  
[1 mark]

---

---

**(b)** Explain why molten magnesium chloride can undergo electrolysis. [1 mark]

---

---

**(c)** What is the name of the positive electrode? [1 mark]

---

**(d)** Write a half equation for the formation of chlorine gas at the positive electrode. [3 marks]

---

**(e)** What is observed at the positive electrode? [1 mark]

---

**(f)** Magnesium is formed at the negative electrode. Explain how this process happens. [2 marks]

---

---

---

**(g)** The overall equation for the electrolysis of molten magnesium chloride is:



Calculate the volume of chlorine gas, in  $\text{cm}^3$ , which is formed from the electrolysis of 0.38 g of magnesium chloride. [3 marks]

volume = \_\_\_\_\_  $\text{cm}^3$

**3** The alcohols are a homologous series of organic compounds.

**(a)** The table below shows information about three different alcohols.

<b>Alcohol</b>	<b>Melting point /°C</b>	<b>Boiling point /°C</b>
CH <sub>3</sub> OH	-94	65
C <sub>2</sub> H <sub>5</sub> OH	-118	78
C <sub>3</sub> H <sub>7</sub> OH	-129	97

**(i)** State two pieces of evidence from the table which show that the three alcohols belong to the same homologous series. [2 marks]

1. \_\_\_\_\_

2. \_\_\_\_\_

\_\_\_\_\_

(ii) Which alcohol(s) will be liquid at  $-100^{\circ}\text{C}$ ? [1 mark]

---

(iii) There are two alcohols which have the molecular formula  $\text{C}_3\text{H}_7\text{OH}$ . Complete the table below by giving the structural formula and name of each alcohol. [2 marks]

	Structural formula	Name
1		
2		

**(iv)**Alcohols contain a functional group.  
What is meant by the term functional group? [1 mark]

A functional group is \_\_\_\_\_

---

---

**(b)** Alcohols can be oxidised when exposed to air. Alcohols are often stored in glass bottles rather than bottles made of polymers such as PVC, since air cannot penetrate glass.

**(i)** Draw the structural formula and state the name of the organic product formed when  $\text{CH}_3\text{OH}$  is oxidised by air. [2 marks]

Structural formula

Name \_\_\_\_\_

**(ii)** Write an equation to show the formation of the polymer PVC.  
[3 marks]

**(c)** Alcohols undergo complete combustion. Describe the complete combustion of  $\text{CH}_3\text{OH}$ , name the products and describe chemical tests for the products.

[6 marks]

In your answer you should:

- define the term combustion
- name the two products of the complete combustion of  $\text{CH}_3\text{OH}$
- describe a chemical test to identify each combustion product stating all observations for a positive test.

**In this question you will be assessed on the quality of your written communication skills, including the use of specialist scientific terms.**

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

(d) The alcohol  $C_2H_5OH$  can be manufactured from glucose,  $C_6H_{12}O_6$ , by fermentation according to the following equation.



State the three conditions required for this fermentation reaction. [3 marks]

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

**(e)** The alcohol  $C_2H_5OH$  can also be manufactured by the reaction shown in the equation below.



**(i)** Complete the equation above by inserting state symbols. [1 mark]

**(ii)** State the name of  $C_2H_4$ . [1 mark]

---

**(iii)** Name the type of reaction shown in the equation above. [1 mark]

---

**Blank Page**

**(Questions continue overleaf)**

- 4 An interhalogen compound contains two or more different halogen atoms and no atoms of any other elements. Iodine monochloride (ICl) is an interhalogen compound, formed when iodine reacts with chlorine as shown in the following equation.



**(a)** Calculate the overall energy change for the reaction between iodine and chlorine to form iodine monochloride, using the bond energy values given below.

[4 marks]

(Bond energies in kJ: I—I = 151;  
Cl—Cl = 242; I—Cl = 208)

**Show your working out.**

energy change = \_\_\_\_\_ kJ

**(b)** Circle the formula of one other interhalogen compound in the list below.  
[1 mark]

HCl

Br<sub>2</sub>

NaBr

BrF<sub>3</sub>

CCl<sub>4</sub>

**(c)** Iodine monochloride reacts with water to form hydrochloric acid, iodine, and iodic acid (HIO<sub>3</sub>). Insert the two missing balancing numbers into the equation below for this reaction. [1 mark]



**(d)** Iodine monochloride reacts in an exothermic reaction with more chlorine to form iodine trichloride (ICl<sub>3</sub>).  
A dynamic equilibrium forms.  
Le Châtelier's Principle can be used to predict how the position of equilibrium changes if the conditions of the reaction are changed.



**(i)** State two features of a dynamic equilibrium. [2 marks]

1. \_\_\_\_\_

2. \_\_\_\_\_

**(ii)** What is meant by the term exothermic? [1 mark]

\_\_\_\_\_

(iii) State and explain how the yield of iodine trichloride would change if the pressure is increased. [3 marks]

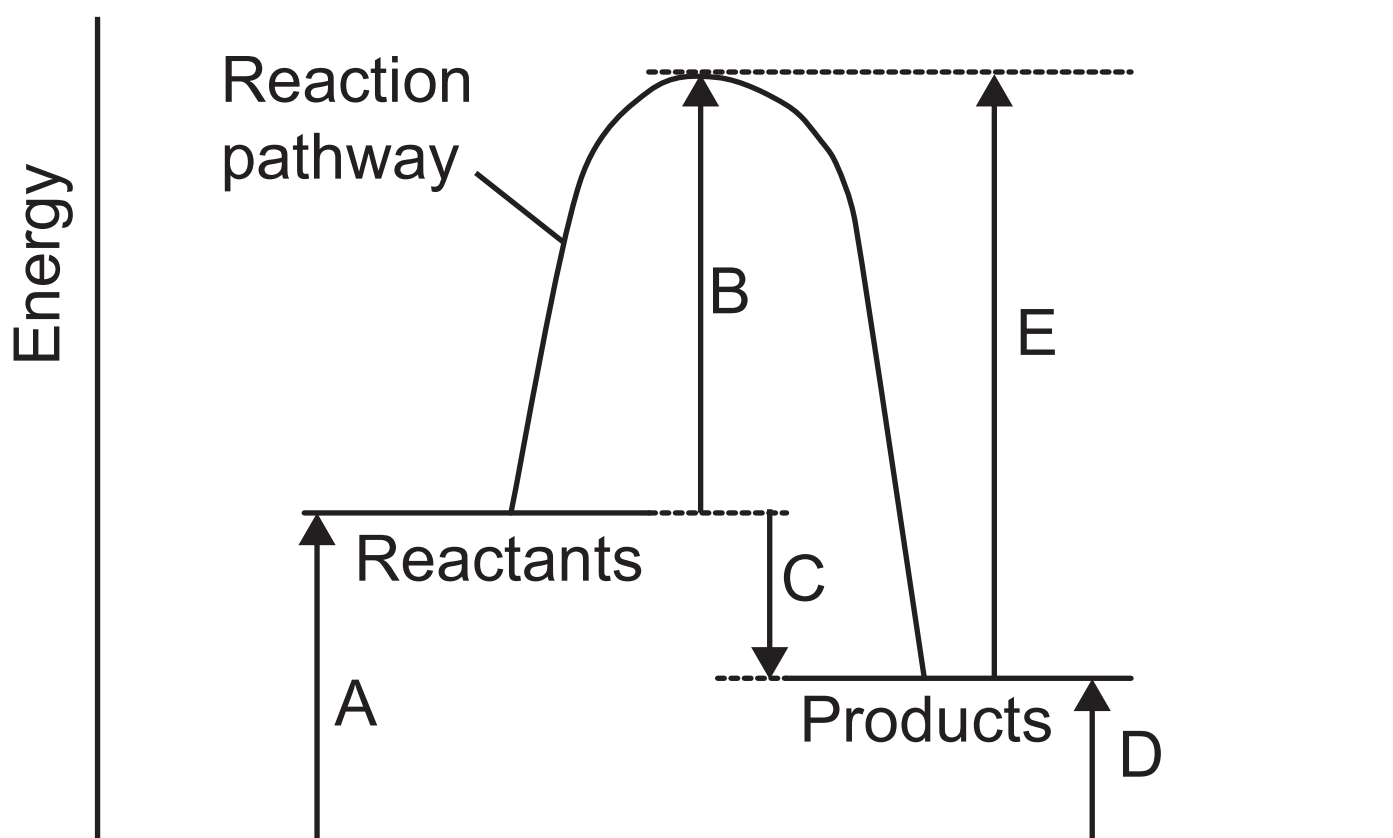
---

---

---

---

(e) The reaction profile for another reaction is shown below.



**(i)** State and explain if the reaction is exothermic or endothermic.  
[1 mark]

---

---

---

**(ii)** What label is missing from the x axis?  
[1 mark]

---

**(iii)** Select the letter (A, B, C, D or E) which represents the activation energy for the forward reaction.  
[1 mark]

---

**5** Some metals, such as gold, can be found uncombined in nature.

**(a)** Suggest why gold metal is found uncombined in nature. [1 mark]

---

---

**(b)** Other metals such as aluminium, copper, zinc and iron are found combined with other elements in rocks called ores. These metals can be extracted from their ore by electrolysis or by chemical reduction.

**(i)** Cuprite is an ore of copper which contains copper(I) oxide. Copper(I) oxide contains the copper(I) ion,  $\text{Cu}^+$ . Write the formula of copper(I) oxide. [1 mark]

---

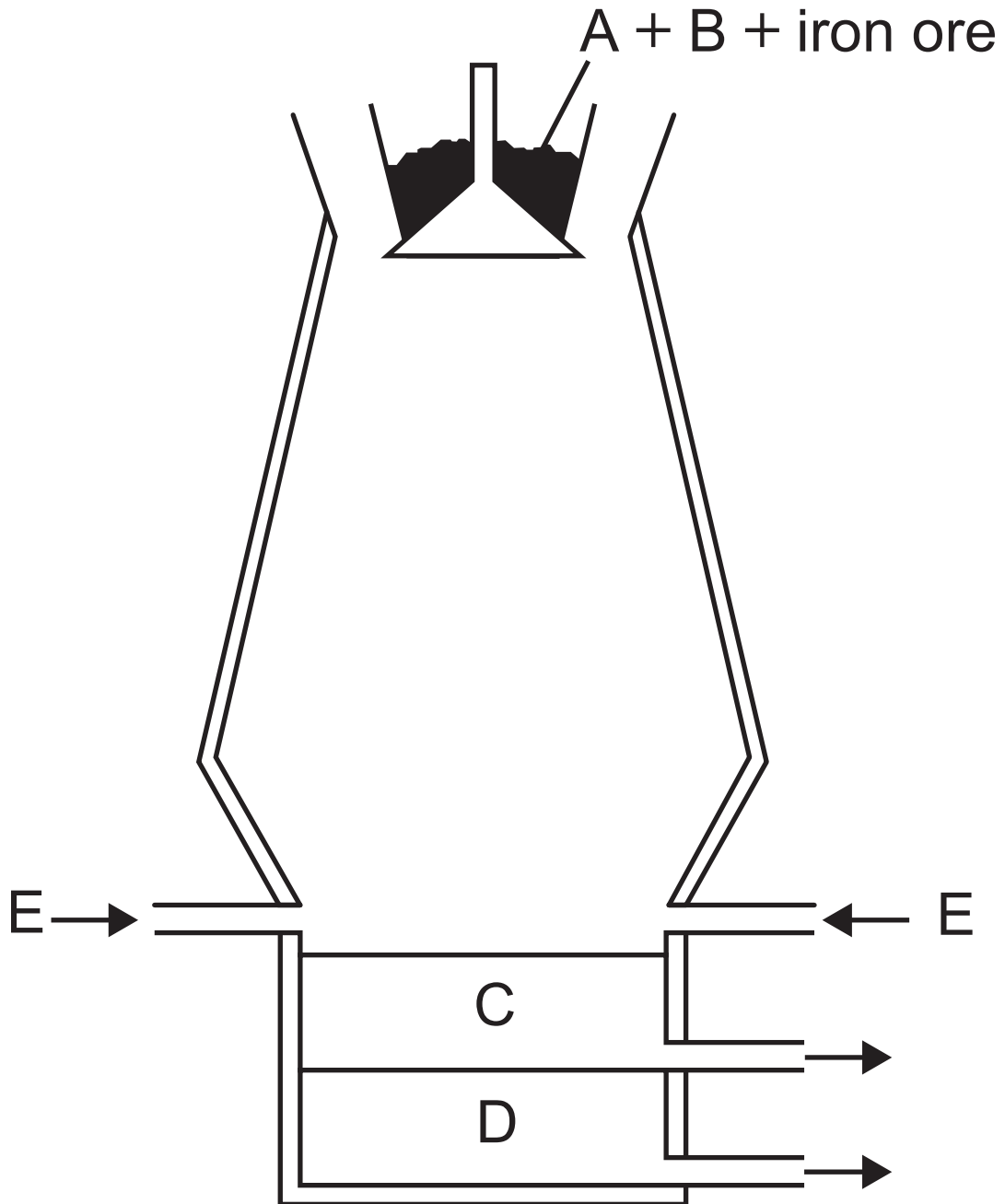
**(ii)** Name the ore from which aluminium is extracted. [1 mark]

---

**(iii)** For each metal in the table below, select the correct method of extraction, electrolysis or chemical reduction. Place a tick (✓) in one box in each row. [3 marks]

<b>Metal</b>	<b>Electrolysis</b>	<b>Chemical reduction</b>
Aluminium		
Copper		
Zinc		

(c) The diagram below shows a Blast Furnace used for the extraction of iron from iron ore.



(i) Raw material A is used to produce the reducing agent in the Blast Furnace. Name A and name the reducing agent. [2 marks]

A: \_\_\_\_\_

Reducing agent \_\_\_\_\_

\_\_\_\_\_

(ii) Describe how the reducing agent is produced in the Blast Furnace. [2 marks]

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

(iii) What is the common name for iron ore? [1 mark]

\_\_\_\_\_

(iv) Write a balanced symbol equation for the reduction of iron ore in the Blast Furnace. [3 marks]

\_\_\_\_\_

**(v)** Name the raw material B added to the Blast Furnace to help remove the impurities from the iron ore.

[1 mark]

---

**(vi)** Identify C and E. [2 marks]

C: \_\_\_\_\_

E: \_\_\_\_\_

**(d)** Supplies of some metal ores are limited and only low-grade ores containing a small percentage of metal compounds remain. Copper can be extracted from these ores using phytomining. In this process a solution of copper(II) sulfate is produced and iron metal is added to extract the copper.

**(i)** Write a balanced symbol equation for the reaction of copper(II) sulfate with iron to produce copper and iron(II) sulfate. [2 marks]

---

**(ii)** Write an ionic equation for the reaction of copper(II) sulfate with iron. [2 marks]

---

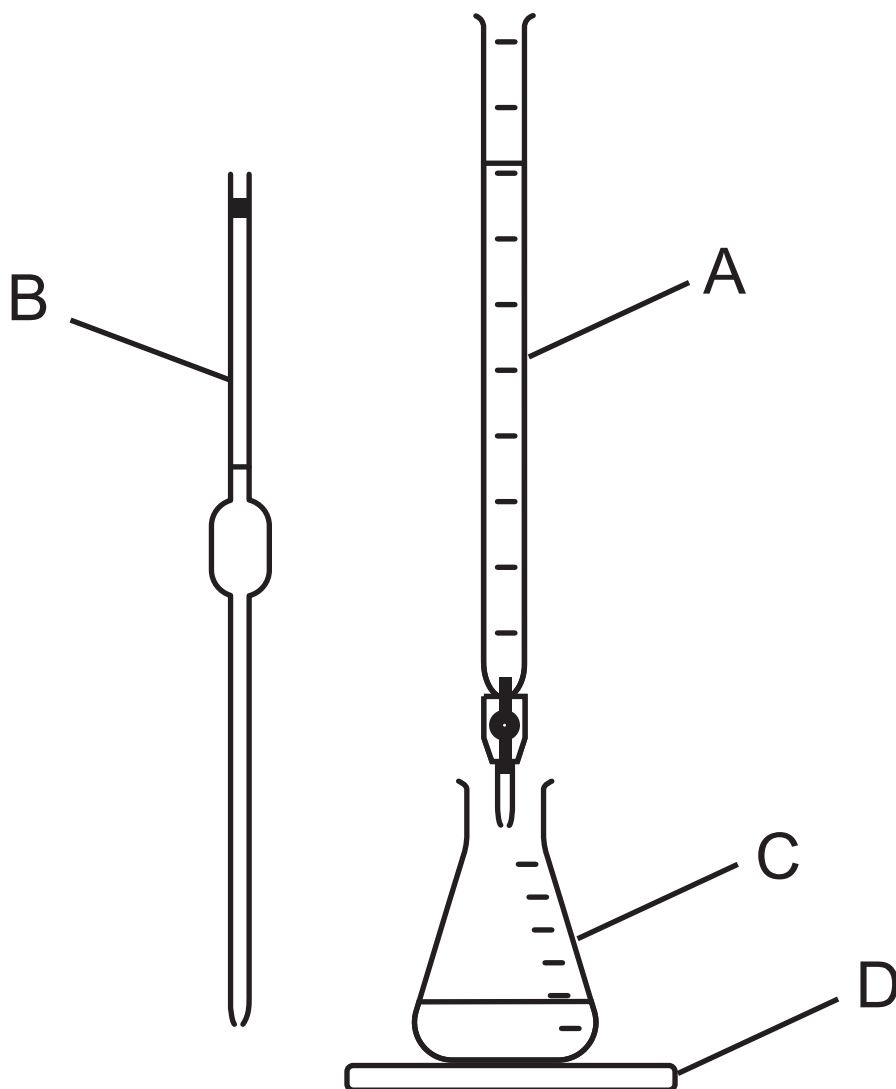
**(iii)** Write a half equation for the reduction process in this reaction. [3 marks]

---

**6** Citric acid is found in many fruit juices. A titration was carried out to determine the concentration of a solution of citric acid.

25.0 cm<sup>3</sup> of the citric acid solution were titrated against **2.0 g/dm<sup>3</sup>** sodium hydroxide solution. 33.0 cm<sup>3</sup> of the sodium hydroxide solution were needed for neutralisation. The indicator used was phenolphthalein.

(a) Some of the pieces of apparatus used in the titration are labelled A, B, C and D in the diagram below.



(i) Name the pieces of apparatus labelled A, B, C and D. [4 marks]

A \_\_\_\_\_

B \_\_\_\_\_

C \_\_\_\_\_

D \_\_\_\_\_

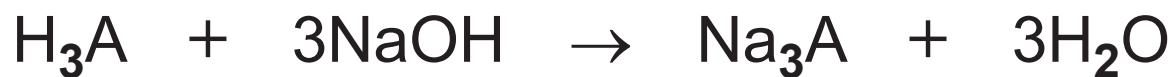
(ii) Apart from the apparatus on page 37 and a retort stand, boss and clamp, state one other essential piece of apparatus for the titration. [1 mark]

---

(iii) State the colour change at the end point in this titration. [2 marks]

From \_\_\_\_\_ to \_\_\_\_\_

**(b)** The equation below shows the titration reaction. The citric acid is represented by  $\text{H}_3\text{A}$ .



**(i)** Calculate the number of moles of sodium hydroxide used in the titration.  
[2 marks]

moles of sodium hydroxide = \_\_\_\_\_

(ii) Calculate the number of moles of citric acid ( $\text{H}_3\text{A}$ ) present in  $25.0 \text{ cm}^3$  of solution. [1 mark]

moles of  $\text{H}_3\text{A}$  in  $25.0 \text{ cm}^3 =$  \_\_\_\_\_

(iii) Calculate the concentration of the citric acid solution in  $\text{mol/dm}^3$ . [1 mark]

concentration = \_\_\_\_\_  $\text{mol/dm}^3$

(iv) Citric acid has a relative formula mass ( $M_r$ ) of 192. Calculate the concentration of the citric acid solution in  $\text{g/dm}^3$ . [1 mark]

concentration = \_\_\_\_\_  $\text{g/dm}^3$

---

**This is the end of the  
question paper**

---

**Blank Page**

**Blank Page**

For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	
5	
6	
<b>Total Marks</b>	

Examiner Number

Permission to reproduce all copyright material has been applied for.  
 In some cases, efforts to contact copyright holders may have been unsuccessful and CCEA will be happy to rectify any omissions of acknowledgement in future if notified.