OCR
Oxford Cambridge and RSA

Tuesday 13 June 2023 – Morning

GCSE (9–1) Combined Science (Chemistry) A (Gateway Science)

J250/04 Paper 4 (Foundation Tier)

Time allowed: 1 hour 10 minutes

F

You must have:
- a ruler (cm/mm)
- the Data Sheet for GCSE (9–1) Combined Science (Chemistry) A (inside this document)

You can use:
- a scientific or graphical calculator
- an HB pencil

Please write clearly in black ink. **Do not write in the barcodes.**

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

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **60**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **24** pages.

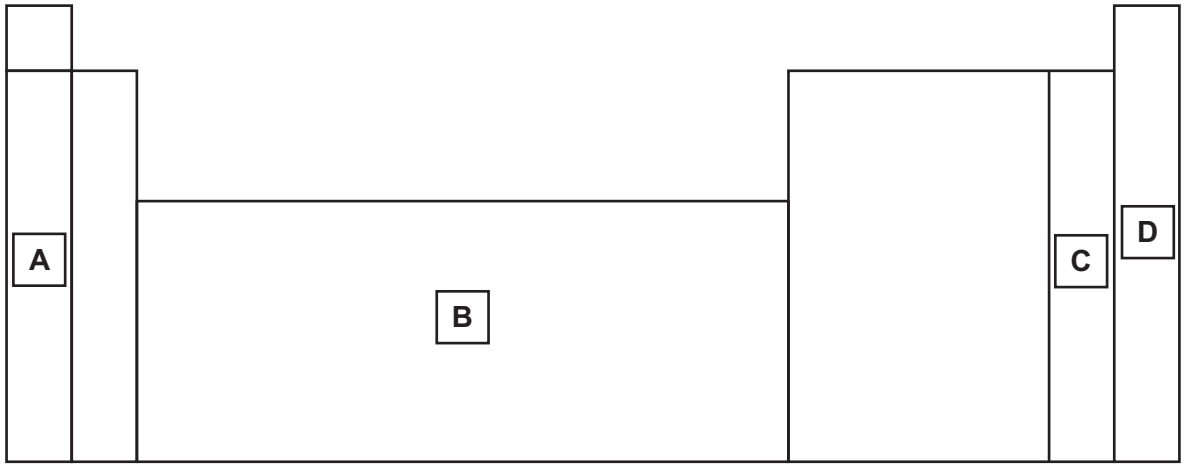
ADVICE
- Read each question carefully before you start your answer.

Section A

You should spend a **maximum** of **20 minutes** on this section.

Write your answer to each question in the box provided.

1 Which part of the Periodic Table contains the **most reactive** metals?



Your answer ☐ **[1]**

2 Which process traps heat from the Sun in the Earth's atmosphere?

A Combustion

B Displacement

C Greenhouse effect

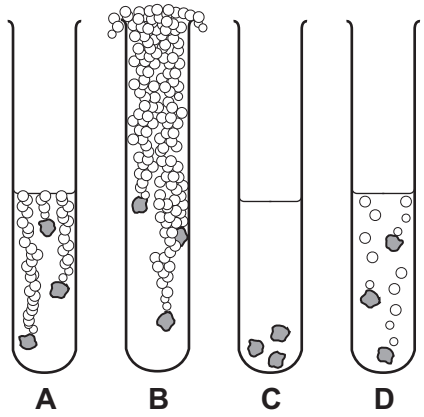
D Photosynthesis

Your answer ☐ **[1]**

3 The list is part of the reactivity series of metals.

Calcium	most reactive
Magnesium	↕
Zinc	
Lead	least reactive

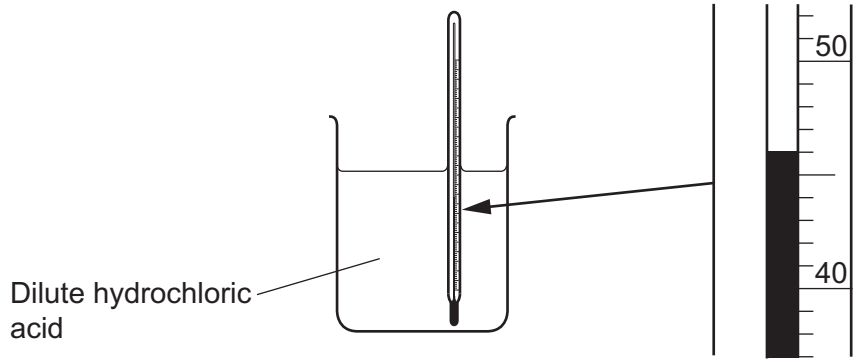
The diagram shows these four metals reacting with dilute hydrochloric acid.



Which test tube shows the reaction of calcium?

Your answer ☐ **[1]**

4 What is the temperature of the dilute hydrochloric acid shown in the diagram?



A 41 °C

B 46 °C

C 51 °C

D 54 °C

Your answer ☐ **[1]**

5 The Earth's atmosphere contains 78% nitrogen and 21% oxygen.
The remaining 1% is listed in the table.

Gas	Percentage (%)
argon	0.94
carbon dioxide	
other gases	0.02
Total	1.00

What is the percentage of carbon dioxide in the Earth's atmosphere?

A 0.01%

B 0.04%

C 0.06%

D 0.08%

Your answer ☐ **[1]**

6 The table shows the boiling points of three Group 1 elements.

Element	Boiling point (°C)
caesium	669
potassium	760
rubidium	686

How many of these elements are gases at 700 °C?

A 0

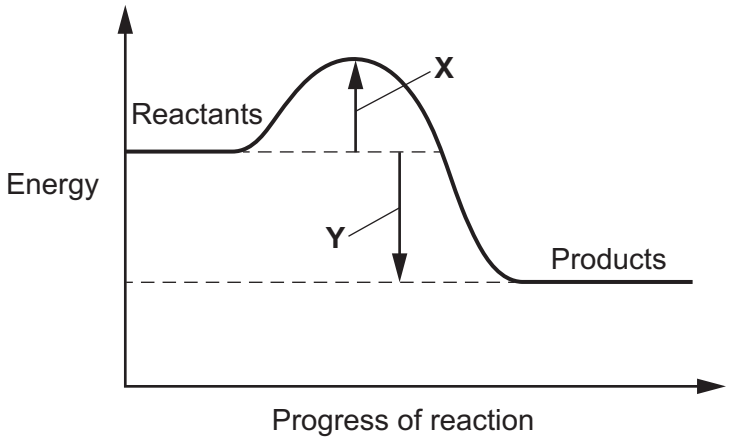
B 1

C 2

D 3

Your answer ☐ **[1]**

7 The diagram shows the reaction profile for an **uncatalysed** reaction.



How does adding a catalyst to the reaction change the reaction profile?

A **X** is larger

B **X** is smaller

C **Y** is larger

D **Y** is smaller

Your answer ☐ **[1]**

8 Which particles do atoms in Group 7 **gain** when they react?

A Electrons

B Ions

C Neutrons

D Protons

Your answer ☐ **[1]**

9 Which reactions can be catalysed by an enzyme?

A Combustion reactions

B Electrolysis of metal ores

C Reactions in biological systems

D Reactions of metals with acids

Your answer ☐ **[1]**

10 The rate of reaction between magnesium and dilute hydrochloric acid depends on the concentration of the dilute hydrochloric acid.

Which concentration of dilute hydrochloric acid reacts **slowest** with magnesium?

A $0.089\,mol/dm^3$

B $0.500\,mol/dm^3$

C $0.038\,mol/dm^3$

D $0.630\,mol/dm^3$

Your answer ☐ **[1]**

Section B

11 The table shows the equations for four different reactions.

Reaction	Equation
A	aluminium oxide → aluminium + oxygen
B	potassium + bromine → potassium bromide
C	copper sulfate + iron → iron sulfate + copper
D	hydrogen + chlorine ⇌ hydrogen chloride

Match each statement with one of the reactions by writing **A**, **B**, **C** or **D** in the box.

You may use the letters once, more than once, or not at all.

(a) The reversible reaction.

☐ **[1]**

(b) The reaction of a very reactive metal.

☐ **[1]**

(c) The reaction of a green gas.

☐ **[1]**

(d) The reaction where a more reactive metal displaces a less reactive metal.

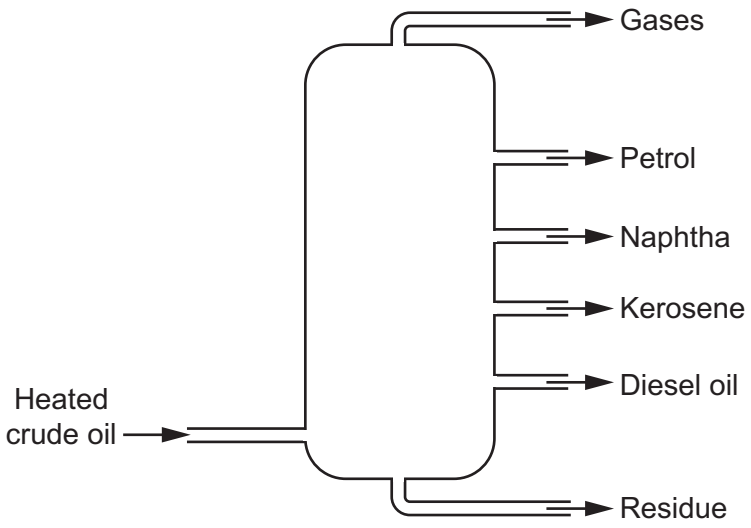
☐ **[1]**

(e) The reaction where a metal is extracted using electrolysis.

☐ **[1]**

12 (a) **Fig. 12.1** shows the separation of the chemicals found in crude oil.

Fig. 12.1



(i) What is the name of the process shown in **Fig. 12.1**?

..... **[1]**

(ii) Crude oil is heated and vaporised as it enters the column.

Describe what happens to the vapours as they rise up the column.

.....

.....

.....

..... **[2]**

(iii) Which of the chemicals separated from crude oil has the **smallest** molecules?

Tick (✓) **one** box.

Gases ☐

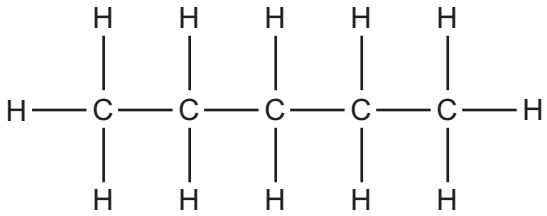
Naphtha ☐

Residue ☐

[1]

(b) **Fig. 12.2** shows the structure of a molecule found in crude oil.

Fig. 12.2



(i) Which words describe the molecule?

Tick (✓) **two** boxes.

Alkane ☐

Hydrocarbon ☐

Mixture ☐

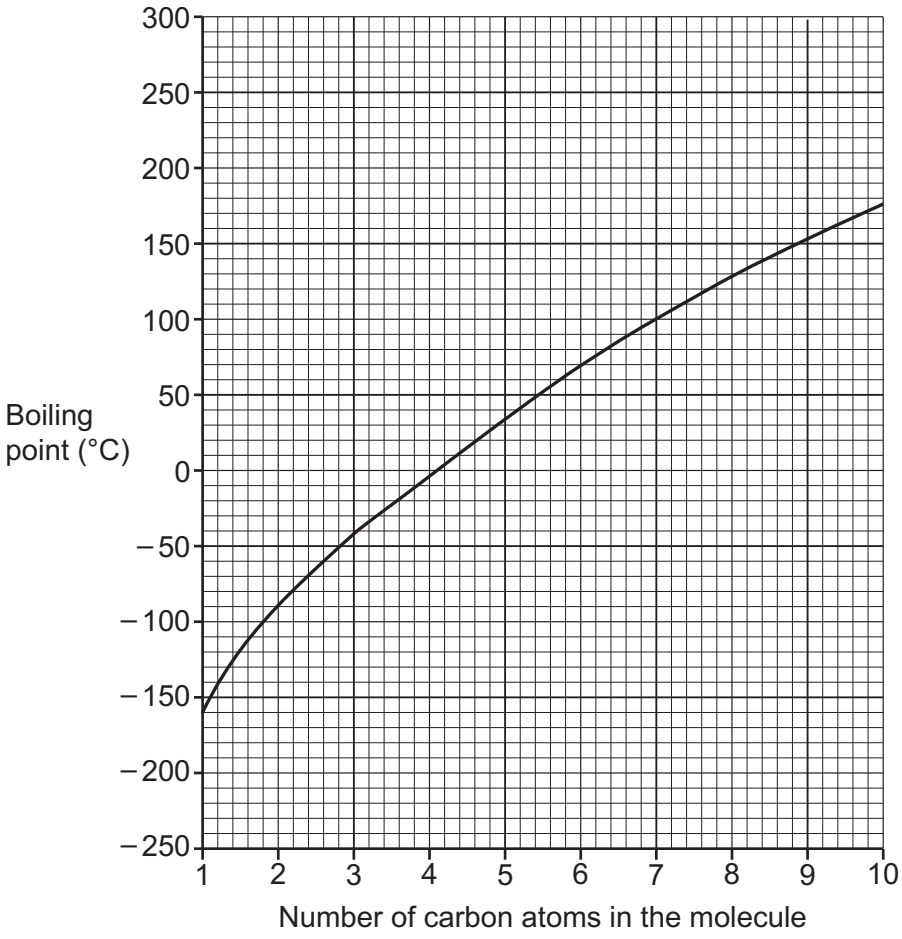
Polymer ☐

[2]

(ii) There are other molecules similar to **Fig. 12.2** but with different numbers of carbon atoms.

Fig. 12.3 shows how the boiling point of these molecules changes with the number of carbon atoms in the molecule.

Fig. 12.3



Use the graph to estimate the boiling point of the molecule shown in **Fig. 12.2**.

Boiling point = ... °C **[1]**

(c) 160 litres of crude oil contains 75 litres of petrol.

Calculate the percentage of petrol in the crude oil.

Give your answer to **2** significant figures.

Percentage of petrol = ... % **[3]**

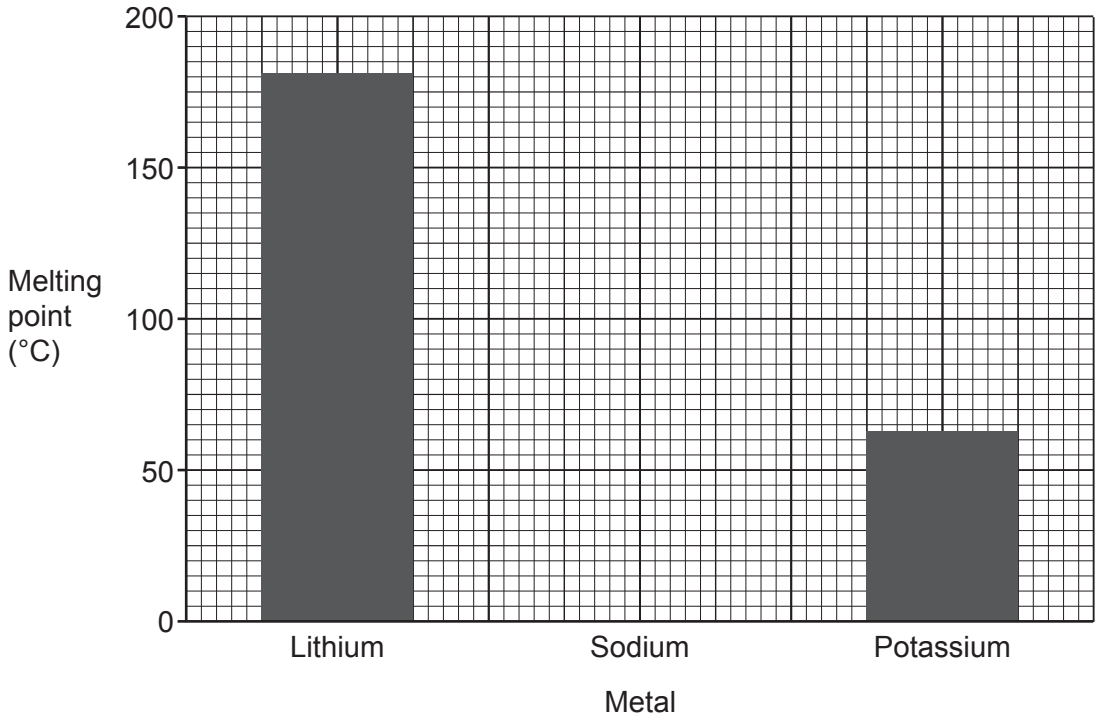
13 Lithium, sodium and potassium are metals in Group 1 of the Periodic Table.

Table 13.1 shows the melting points of lithium, sodium and potassium.

Table 13.1

Metal	Melting point (°C)
lithium	181
sodium	98
potassium	63

(a) Complete the bar chart to show the melting point of sodium. **[1]**



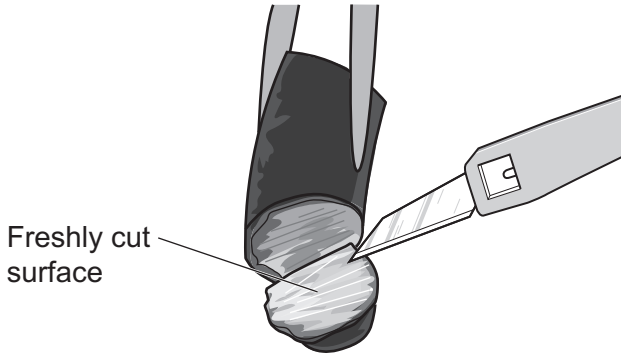
(b) State and explain which of the metals lithium, sodium or potassium is the softest.
Use information from **Table 13.1**.

Metal .....

Reason .....

..... **[2]**

(c) Lithium, sodium and potassium can be cut with a knife as shown in the diagram.



At first the freshly cut surface looks shiny, but then begins to go dull.

(i) Complete **Table 13.2** by estimating the times for lithium and potassium surfaces to go dull.

Table 13.2

Metal	Time for freshly cut surface to go dull (s)
lithium	.....
sodium	17
potassium	.....

[1]

(ii) Lithium, sodium and potassium are stored in oil to prevent them reacting with gases in the air.

Which gases in the air react with lithium, sodium and potassium?

Tick (✓) **two** boxes.

Argon ☐

Nitrogen ☐

Oxygen ☐

Water vapour ☐

[2]

14* Cars can burn petrol or diesel as a fuel. The composition of the exhaust fumes depends on the type of fuel used.

The table shows the percentages of some substances found in the exhaust fumes of petrol and diesel cars.

Substance	Percentage in the exhaust fumes (%)	
	Petrol	Diesel
carbon dioxide	14	12
carbon monoxide	1	0.05
sulfur dioxide	0.001	0.03
oxides of nitrogen	0.25	0.15

Describe **one** advantage and **one** disadvantage of using petrol as a fuel.
Use information from the table.

Explain your answer using your knowledge of the environmental problems caused by these substances.

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..... **[6]**

15 In industry, iron can be extracted from iron ore. Iron ore contains iron oxide, Fe_2O_3.

(a) Iron is extracted from iron oxide by reduction.

The equation for one reaction is

$$Fe_2O_3 + 3C \rightarrow \text{.....} Fe + \text{.....} CO$$

(i) Complete the **balanced symbol** equation for the reaction. **[2]**

(ii) Why does this reaction happen?

Tick (✓) **one** box.

Carbon and iron have the same reactivity. ☐

Carbon is more reactive than iron. ☐

Iron is more reactive than carbon. ☐

[1]

(iii) Explain how the equation shows that the iron oxide is reduced.

.....

..... **[1]**

(iv) Which chemical reduces the iron oxide, Fe_2O_3?

Tick (✓) **one** box.

C ☐

Fe ☐

CO ☐

[1]

(b) Iron can be recycled in 5 stages.

Stage 1 Different types of waste metals are put in a recycling bin.

Stage 2 These waste metals are collected.

Stage 3 .....

Stage 4 The iron is compressed and shredded.

Stage 5 The iron is melted and formed into new products.

Describe what happens in **Stage 3**. Write your answer on the line next to **Stage 3**.

[1]

(c) In industry, iron is extracted from iron ore in a blast furnace.

The table shows information about the production of iron in a blast furnace and from recycling.

In a blast furnace	From recycling
1 tonne of iron ore makes 0.63 tonnes of iron	1 tonne of recycled iron makes 0.96 tonnes of iron
2×10^7 kJ of energy is needed to make 1.0 tonne of iron	5×10^6 kJ of energy is needed to make 1.0 tonne of iron

(i) Give **two** reasons why it is better to produce iron from recycling than in a blast furnace.

Use the information from the table.

1 .....

.....

2 .....

.....

[3]

(ii) Calculate the mass of iron made from 250 tonnes of iron ore in the blast furnace. Give your answer in kilograms.

(1 tonne = 1000 kg)

Mass of iron = ... kg **[2]**

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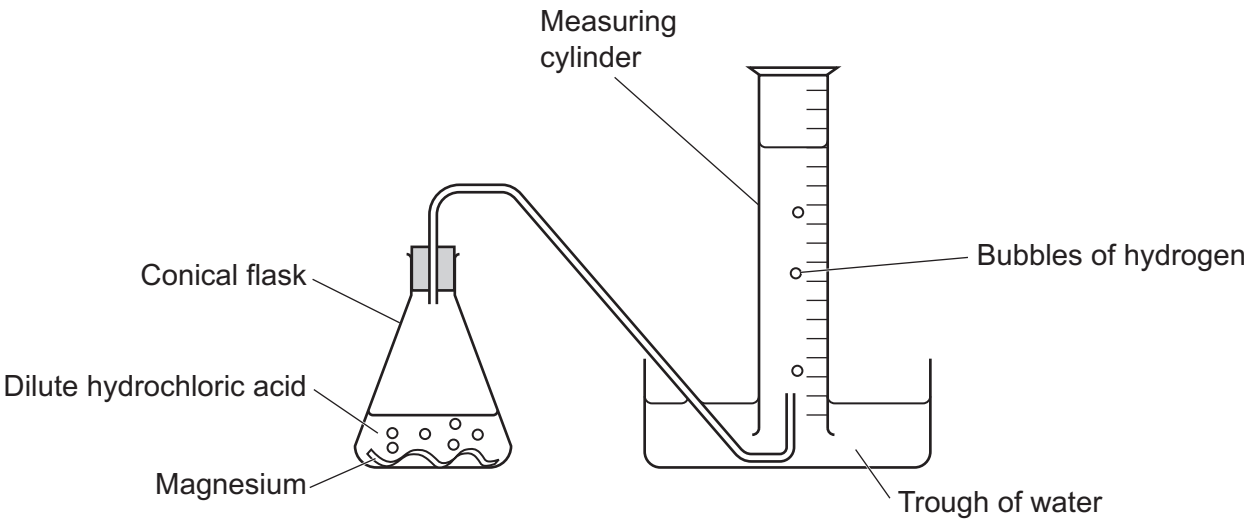
16 A student investigates the rate of reaction between magnesium and an **excess** of dilute hydrochloric acid.

The diagram shows the apparatus they use.

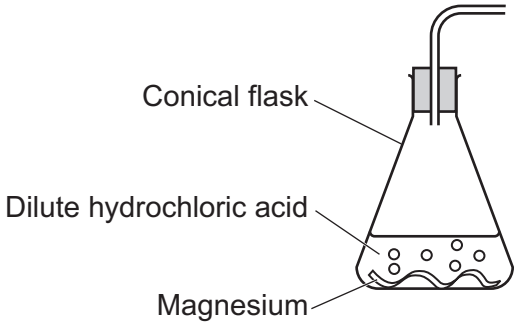


(a) The student has difficulty filling the measuring cylinder with water.

They change the measuring cylinder for a different piece of apparatus which allows them to measure the volume of hydrogen more accurately.

Name the piece of apparatus they use and complete the diagram below to show this apparatus.

Name of piece of apparatus .....



[3]

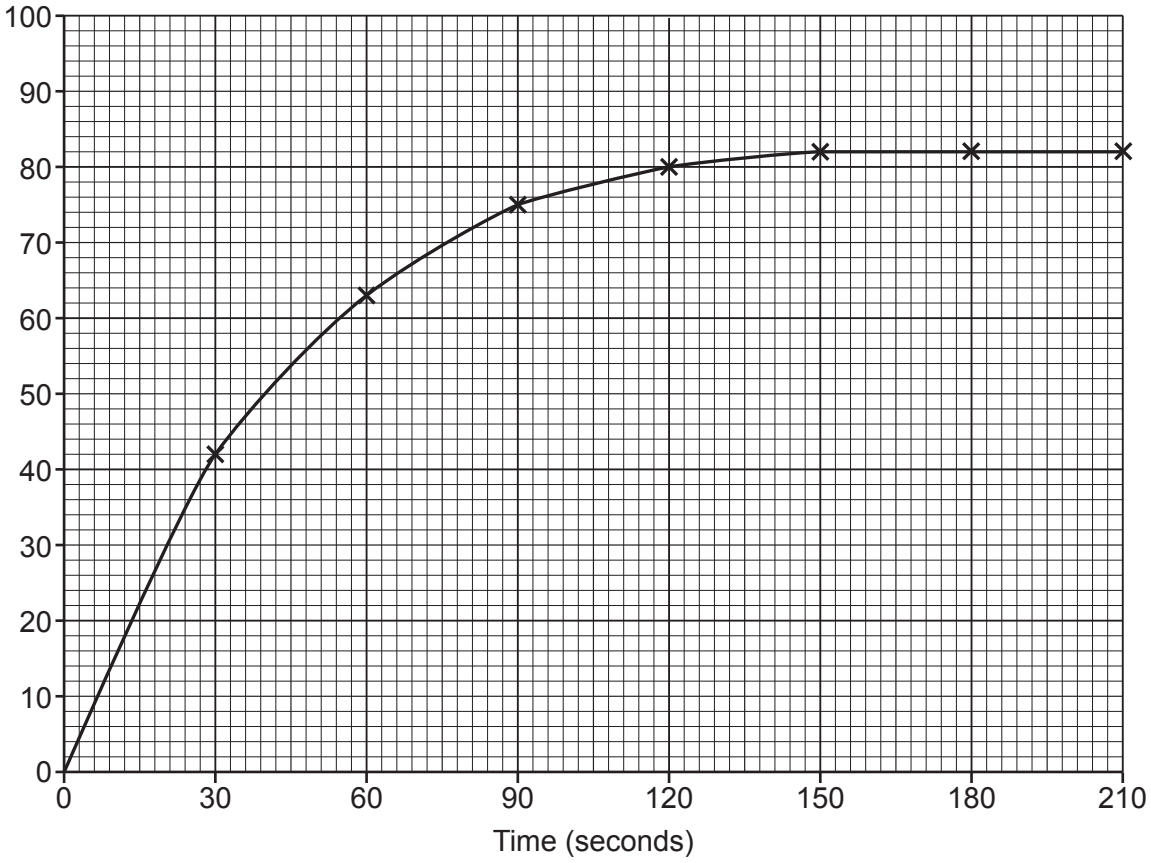
(b) Complete the **balanced symbol** equation for the reaction.

$$Mg(s) + 2HCl(.....) \rightarrow ..... (aq) + H_2(g)$$

[2]

(c) The student records the results of the experiment every 30 seconds. The graph shows the student's results.

Write the correct label, including the units, for the y-axis on the graph. **[2]**



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(d) The student repeats the experiment. The only difference is they use a **higher** concentration of acid.

Draw a line on the graph to show the results of this experiment. **[2]**

(e) If the experiment is repeated at a **higher** temperature, the rate of reaction increases.

Explain why. Use ideas about particles and collisions.

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..... **[3]**

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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