OCR
Oxford Cambridge and RSA

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Monday 29 November 2021 – Morning

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

J250/04 Paper 4 (Foundation Tier)

Time allowed: 1 hour 10 minutes

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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

J250604

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

Answer **all** the questions.

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

Write your answer to each question in the box provided.

1 The burning of fossil fuels can produce gases that cause **acid rain**.

Which gas causes acid rain?

A Carbon monoxide

B Nitrogen

C Oxygen

D Sulfur dioxide

Your answer ☐ **[1]**

2 The table shows information about four different elements.

	Description of element at room temperature	**Description of reactivity**
A	colourless gas	reactive
B	pale yellow gas	very reactive
C	silvery liquid	unreactive
D	shiny solid	very reactive

Which element, **A**, **B**, **C** or **D**, is in Group 7 of the Periodic Table?

Your answer ☐ **[1]**

3 The diagram shows the main stages in a life-cycle assessment of a product.

What is the name of **Stage X**?

A Disposal

B Extraction

C Packaging

D Production

Your answer ☐ **[1]**

4 The Earth's early atmosphere contained little or no oxygen.

Which process produced the oxygen found in the Earth's atmosphere today?

A Burning fossil fuels

B Photosynthesis by plants and algae

C Respiration by bacteria

D Volcanic activity

Your answer ☐ **[1]**

5 Which statement about the Group 0 elements is correct?

A They exist as simple molecules.

B They exist as single atoms.

C They react to form giant covalent molecules.

D They react to form ionic compounds.

Your answer ☐ **[1]**

6 Many scientists believe that increased levels of methane in the atmosphere are contributing to global warming.

What causes increased levels of methane in the atmosphere?

A Cutting down trees

B Exhaust gases from car engines

C Incomplete combustion of fossil fuels

D Waste gases from cows and landfill sites

Your answer ☐ **[1]**

7 Octane, C_8H_{18}, is a compound in petrol.

Which statement about octane is correct?

A It is a hydrocarbon with a relative molecular mass of 66.

B It is a hydrocarbon with the empirical formula C_4H_9.

C It is extracted from crude oil by filtration.

D It is in the bitumen fraction of crude oil.

Your answer ☐ **[1]**

8 Sodium reacts with water to form sodium hydroxide and hydrogen.

What is the correctly balanced symbol equation for this reaction?

A $Na(s) + H_2O(l) \longrightarrow NaOH(aq) + H_2(g)$

B $Na(s) + 2H_2O(l) \longrightarrow NaOH(aq) + 2H_2(g)$

C $2Na(s) + H_2O(l) \longrightarrow 2NaOH(aq) + H_2(g)$

D $2Na(s) + 2H_2O(l) \longrightarrow 2NaOH(aq) + H_2(g)$

Your answer ☐ **[1]**

9 A copper ore contains 66.4% copper. The ore is CuS.

What is the maximum mass of copper that can be extracted from 500 tonnes of the ore?

A 7.53 tonnes

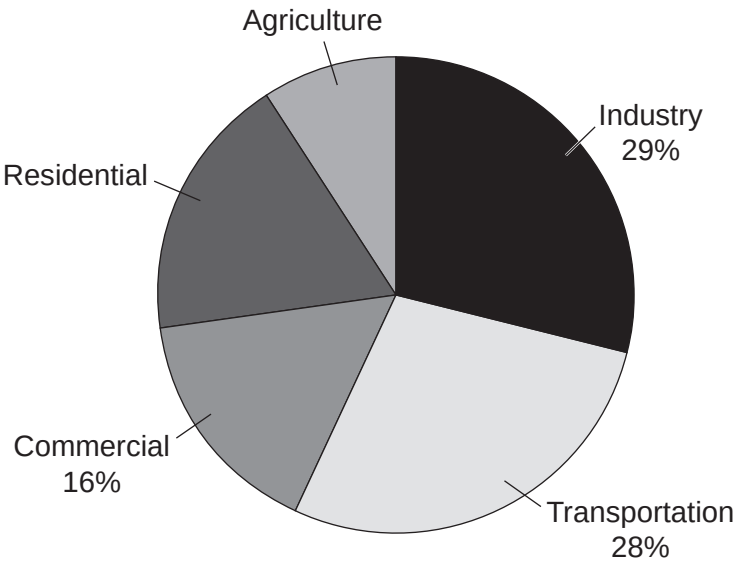
B 66.4 tonnes

C 332 tonnes

D 33 200 tonnes

Your answer ☐ **[1]**

10 The diagram shows the percentage of greenhouse gases made from different sources.



The percentage of greenhouse gases produced from Residential is **twice** that produced from Agriculture.

What is the percentage of greenhouse gases produced from Residential?

A 9%

B 18%

C 27%

D 36%

Your answer ☐ **[1]**

SECTION B

Answer **all** the questions.

11 In 2010, scientists discovered a new Group 7 element called tennessine. Its symbol is Ts.

The diagram shows where tennessine is placed in Group 7 of the Periodic Table.

F fluorine
Cl chlorine
Br bromine
I iodine
At astatine
Ts tennessine

Use your knowledge of the properties and trends of the Group 7 elements to **predict** the answer to the following questions.

(a) How many outer shell electrons are there in an atom of tennessine?

Put a ring around the correct answer.

1 **7** **17**

[1]

(b) What is the reactivity of tennessine compared to astatine?

Put a ring around the correct answer.

less reactive **more reactive** **the same**

[1]

(c) What is the physical state of tennessine at room temperature?

Put a ring around the correct answer.

gas **liquid** **solid**

[1]

(d) What is the melting point of tennessine compared to astatine?

Put a (ring) around the correct answer.

higher **lower** **the same**

[1]

12 This question is about the Group 1 metals.

(a) A teacher adds a small piece of a Group 1 metal to a trough of water, as shown in **Fig. 12.1**.

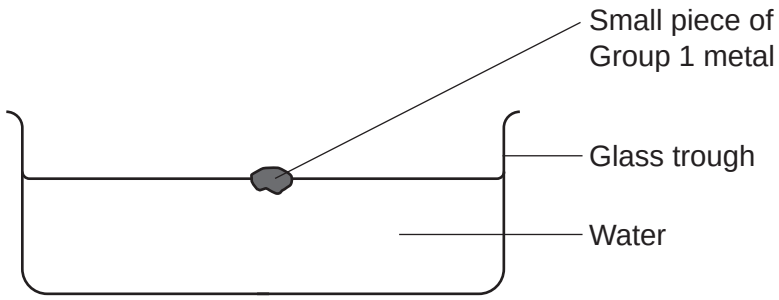


Fig. 12.1

The metal burns with a lilac flame, sparks and explodes.

Which Group 1 metal did the teacher add to the water in **Fig. 12.1**?

Put a (ring) around the correct answer.

lithium **sodium** **potassium** **rubidium** **caesium**

[1]

(b) Sodium is a soft metal with a dull coating.

It is shiny when it is freshly cut.

After several seconds, the shiny surface goes dull.

(i) Which gas in the air reacts with the sodium as it goes dull?

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

(ii) What is the name of the chemical compound made as the sodium goes dull?

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

(iii) How long would it take a piece of freshly cut lithium to go dull compared to sodium?

Give a reason for your answer.

.....

.....

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

(c) **Fig. 12.2** shows the trend in the density of the Group 1 metals from lithium to caesium.

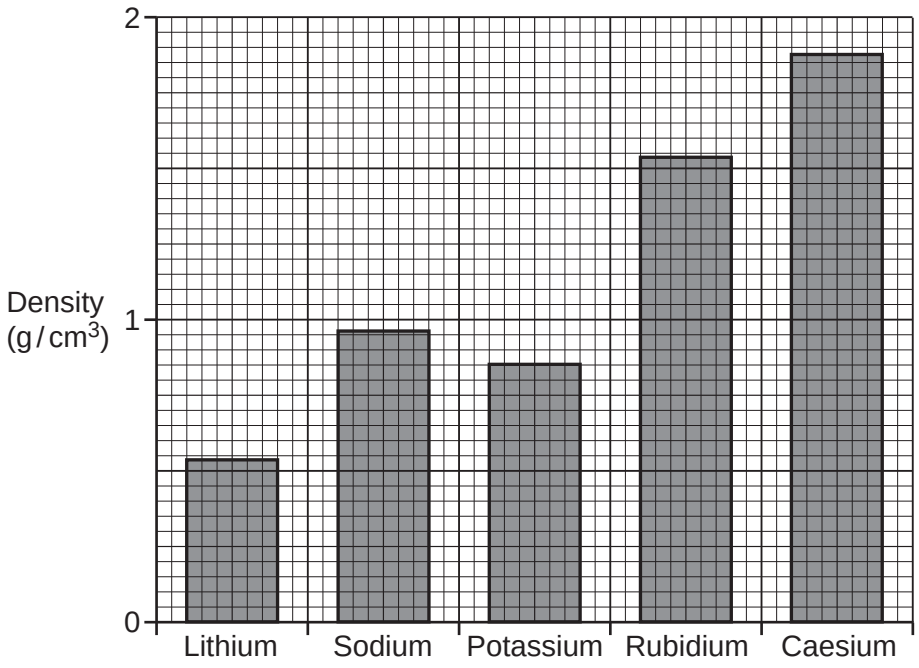


Fig. 12.2

Which Group 1 metal does not fit the general trend?

Give a reason for your answer using information from **Fig. 12.2**.

.....

.....

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

13 Crude oil is a mixture of different chemicals called fractions.

(a) What is the name of the process used to separate crude oil into fractions?

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

(b) **Table 13.1** shows the stages in the separation of crude oil into fractions.

The stages are **not** in the correct order.

	Stages in the separation of crude oil into fractions
W	The vapours are piped into the bottom of the fractionating column.
X	The vapours cool and the fractions condense at different temperatures.
Y	Crude oil is heated and vaporised.
Z	The vapours rise up the column.

Table 13.1

Write **W**, **X**, **Y** and **Z** in the boxes to show the correct order of the stages.

[1]

(c) **Table 13.2** shows information about the different gases in the LPG (liquefied petroleum gas) fraction separated from crude oil.

Gas in the LPG fraction	Formula	Boiling point (°C)
Methane	CH_4	−162
Ethane	C_2H_6	−89
Propane	C_3H_8	−42
Butane	C_4H_{10}	

Table 13.2

(i) Write the name of the homologous series of the gases in the LPG fraction.

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

(ii) What is the correct general formula for this homologous series?

Put a (ring) around the correct answer.

C_nH_n C_nH_{2n} C_nH_{2n+2} $C_{2n}H_{2n}$ $C_{2n}H_{2n+2}$

[1]

(iii) Use the data in **Table 13.2** to estimate the boiling point of butane.

Estimated boiling point = ... °C **[1]**

(d) The equation shows the reaction for methane burning in a limited amount of oxygen.

$2CH_4(g) + 3O_2(g) \rightarrow 2CO(g) + 4H_2O(g)$

(i) Write down the name of the hazardous gas formed in this reaction.

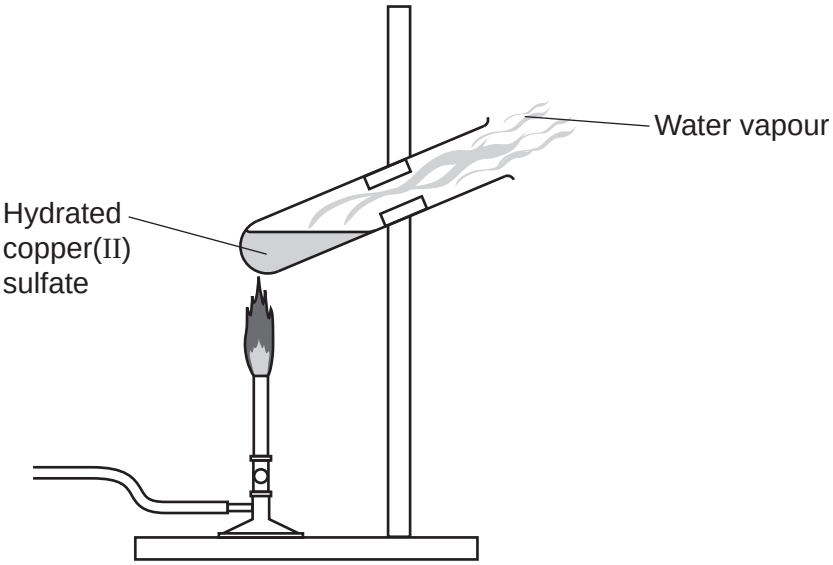
..... **[1]**

(ii) State why the gas identified in **(d)(i)** is hazardous to humans.

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

14 A student investigates heating hydrated copper(II) sulfate, $CuSO_4.5H_2O$.

The diagram shows the experiment they do.



The student:

- Measures the mass of a boiling tube.
- Puts about 5 g of hydrated copper(II) sulfate in the boiling tube and measures the mass.
- Gently heats the boiling tube for one minute.
- Lets the boiling tube cool down and measures the mass.

During the experiment the hydrated copper(II) sulfate turns from blue to white and water vapour is produced.

Look at the student's results.

Mass of boiling tube (g)	69.1
Mass of boiling tube and copper(II) sulfate **before** heating (g)	74.2
Mass of boiling tube and copper(II) sulfate **after** heating (g)	73.4

(a) Calculate the mass of water produced in the experiment.

Mass of water = ... g **[1]**

(b) The student expected a greater mass of water to be produced.

How could they improve the experiment so a greater mass of water vapour is produced?

.....

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

(c) Look at the equation for the reaction.

$CuSO_4.5H_2O(s) \rightleftharpoons$ ..... (s) + ... $H_2O(g)$

blue solid white solid

(i) **Complete** and **balance** the symbol equation. **[2]**

(ii) The student adds a few drops of water to a boiling tube containing some of the **white** solid.

Describe what the student observes happening to the white solid.

Give a reason for your answer.

Observation .....

.....

Reason .....

.....

[2]

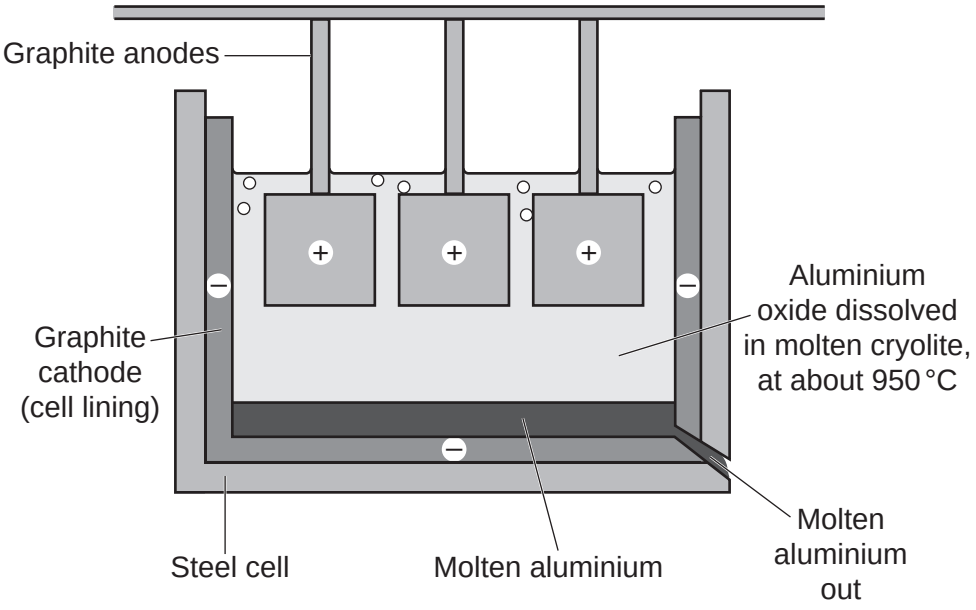
(iii) As water reacts with the white solid, the temperature of the boiling tube increases.

What name is given to this type of reaction where heat is transferred to the surroundings?

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

15 Aluminium is produced from aluminium oxide by electrolysis.

The diagram shows the industrial electrolysis of aluminium oxide.



(a) Look at the equation for the electrolysis of aluminium oxide.

..... Al_2O_3 → ..... Al + ... O_2

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

(b) Molten aluminium oxide contains Al^{3+} and O^{2-} ions.

(i) Explain why the aluminium oxide must be molten during electrolysis.

.....

.....

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

(ii) Explain why aluminium is produced at the cathode.

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

(c) Aluminium melts at 650 °C.

Describe **two** reasons why it is cheaper to recycle aluminium than to produce it from electrolysis.

Reason 1 .....

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.....

Reason 2 .....

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[2]

16* **Fig. 16.1** shows how the atmospheric carbon dioxide concentration changed between 1970 and 2010.

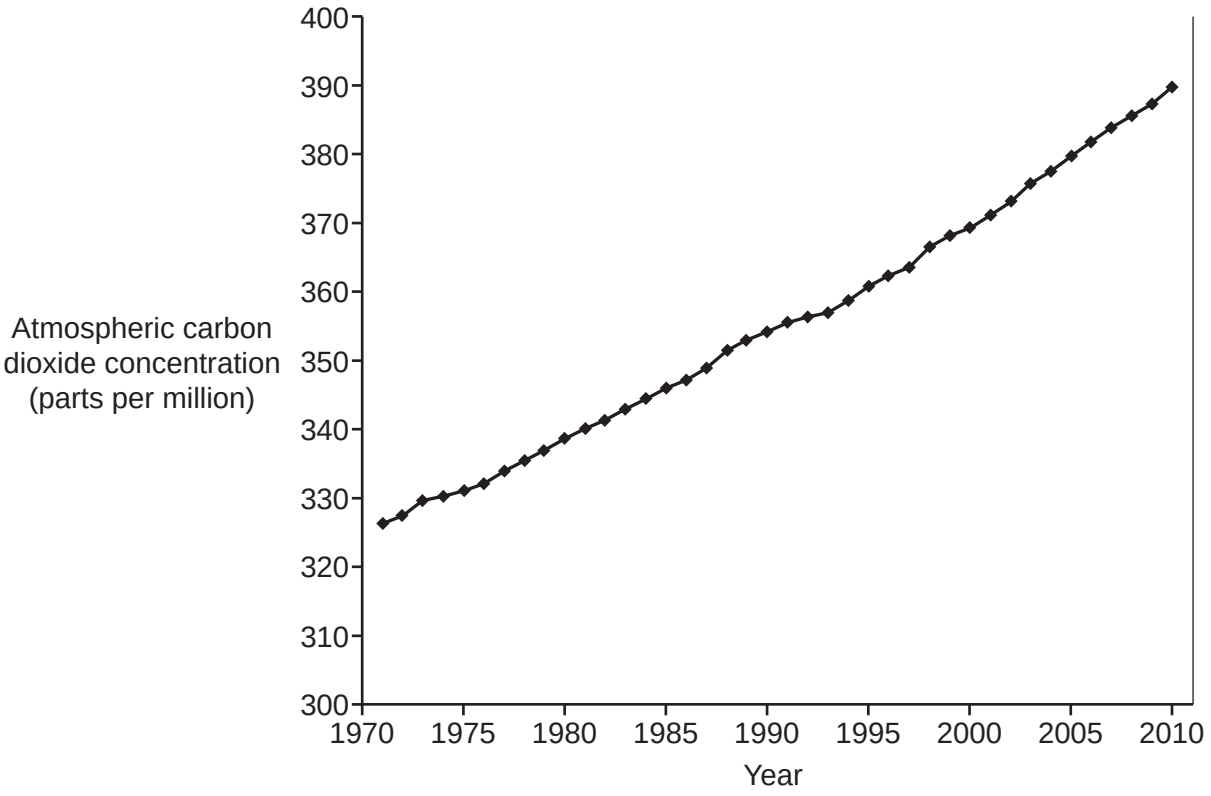

Fig. 16.1

Fig. 16.2 shows how the global consumption of fossil fuels changed between 1990 and 2010.

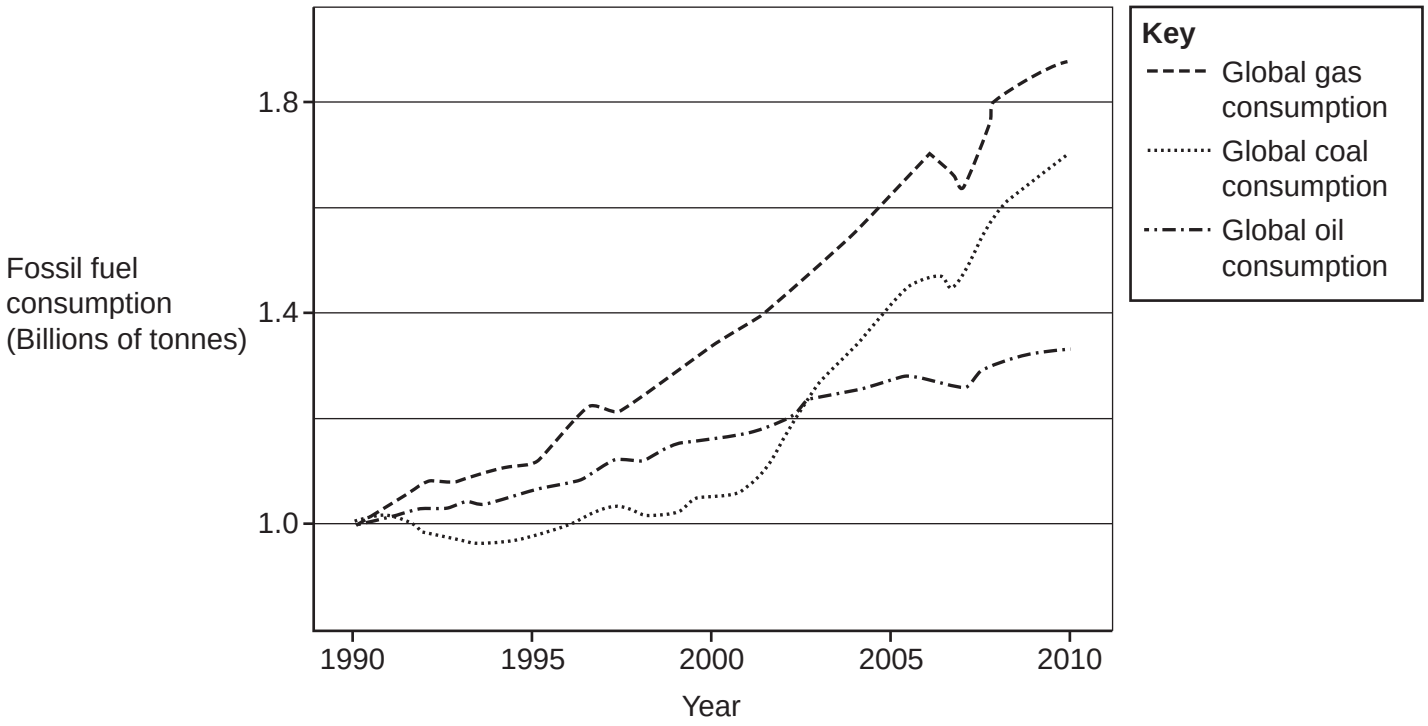

Fig. 16.2

A student thinks that the increase in atmospheric carbon dioxide is because of the increased consumption of fossil fuels.

Describe and **explain** if the graphs in **Fig. 16.1** and **Fig. 16.2** support this statement.

Use information from **Fig. 16.1 and Fig. 16.2** in your answer.

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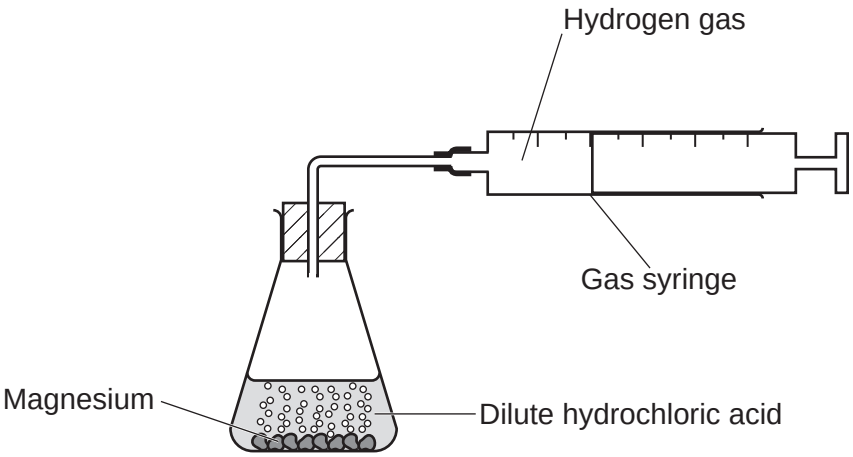
..... **[6]**

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

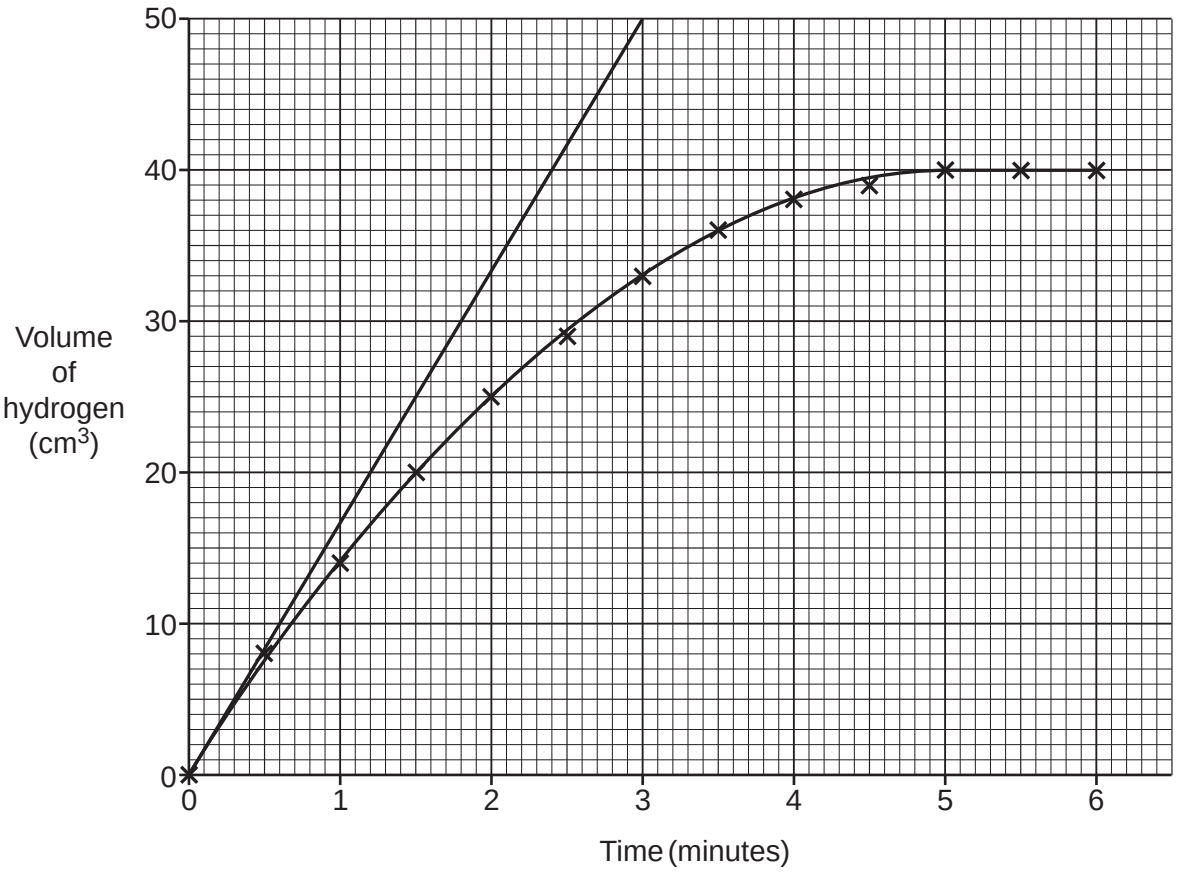
The diagram shows the equipment they use.



The student measures the total volume of hydrogen gas produced every 30 seconds.

The student plots a graph of their results.

They want to calculate the rate of reaction at the start of the reaction. They draw a tangent on the graph at the start of the reaction.



(a) The gradient of the tangent gives the rate of reaction. Use the tangent to calculate the rate of reaction at the start of the reaction.

Give your answer to **1** decimal place.

Rate of reaction = ... cm^3 / minute **[3]**

(b) What happens to the **rate of reaction** as the reaction progresses?

Explain your answer using ideas about particles and collisions.

.....

.....

.....

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

(c) Another student repeats the experiment.

They increase the concentration of the dilute hydrochloric acid. They keep everything else in the experiment the same.

(i) Does the gradient of the graph at the start of this student's reaction decrease, increase or stay the same compared to the first student's experiment?

Tick (✓) **one** box.

Decrease ☐

Increase ☐

Stay the same ☐

Give a reason for your answer.

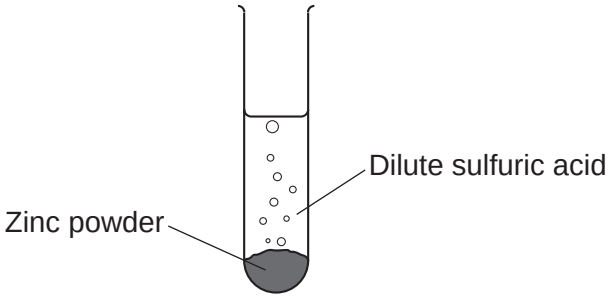
.....

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

(ii) Write down the volume of hydrogen gas that is produced at the end of this reaction.

Volume = ... cm^3 **[1]**

18 A student investigates the reaction between zinc and dilute sulfuric acid.



The student observes that bubbles are produced slowly during the reaction.

They want to find a catalyst for the reaction. They repeat the experiment, but each time they add a small piece of a different metal, **R**, **S** and **T**.

Look at the student's results.

Metal	Appearance of metal at start of reaction	Observations
R	silvery-white	fast bubbling the silvery-white metal disappears
S	reddish-brown	fast bubbling the metal remains reddish-brown
T	dark grey	slow bubbling the metal remains dark grey

State if the metals, **R**, **S** and **T** are catalysts or not.

Explain your answers using the information in the table and your knowledge of catalysts.

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..... **[4]**

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).