OCR
Oxford Cambridge and RSA

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Friday 27 May 2022 – Morning

GCSE (9–1) Combined Science B (Twenty First Century Science)

J260/02 Chemistry (Foundation Tier)

Time allowed: 1 hour 45 minutes

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

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

J260002

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 **95**.
- 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 **28** pages.

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

Answer **all** the questions.

1 Cold packs are used to treat some sports injuries.

They contain ammonium nitrate and water.

(a) The formula of ammonium nitrate is NH_4NO_3.

(i) Name the **three** elements present in ammonium nitrate.

1 .....

2 .....

3 .....

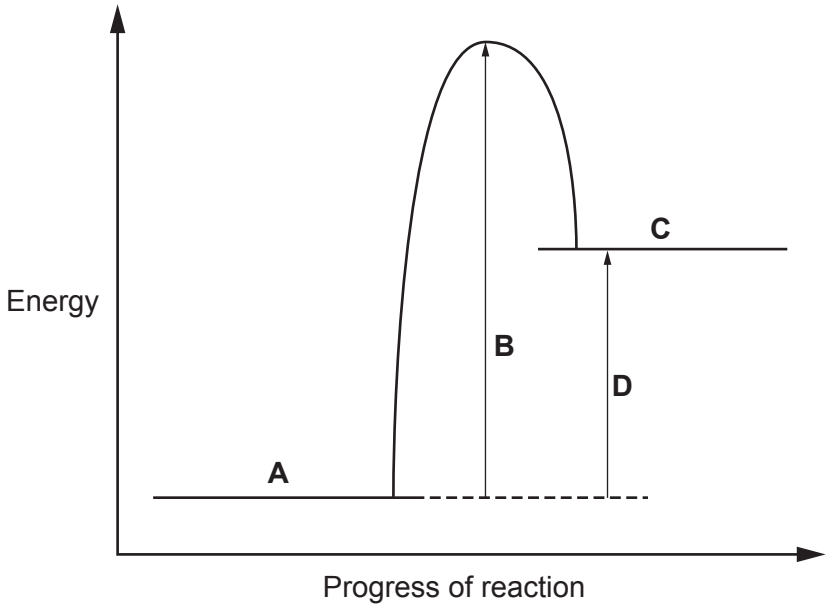
[3]

(ii) What is the total number of atoms shown in the formula?

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

(b) When the ammonium nitrate and water mix in the cold pack, the temperature of the mix decreases.

The diagram shows the reaction profile for this reaction.



(i) What is the name given to a change which makes the temperature of the mix decrease?

Put a (ring) around the correct option.

Combustion **Endothermic** **Exothermic** **Freezing**

[1]

(ii) Draw lines to connect each **label** with its correct **position** on the diagram.

Label	Position
Activation energy	**A**
Energy of reaction	**B**
Products	**C**
Reactants	**D**

[3]

(c) Kofi plans an experiment to find the energy change when the ammonium nitrate from a cold pack dissolves in water.

The energy change depends on the mass of water and the temperature change.

What apparatus will he need to take the measurements?

Tick (✓) **two** boxes.

- Balance ☐
- Burette ☐
- Gas syringe ☐
- pH meter ☐
- Pipette ☐
- Thermometer ☐

[2]

(d) Here are Kofi's results.

Mass of water used = 250 g
Temperature of water before adding ammonium nitrate = 20.2 °C
Temperature of water after adding ammonium nitrate = 4.8 °C

Calculate the energy change when the ammonium nitrate from the cold pack dissolves in water.

Use the formula: Energy change (J) = 4.2 × mass of water (g) × temperature change (°C)

Give your answer to **3** significant figures.

Energy change = ... J **[3]**

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2 Harmful gases such as NO, CO and SO_2 are emitted from car engines running on fossil fuels.

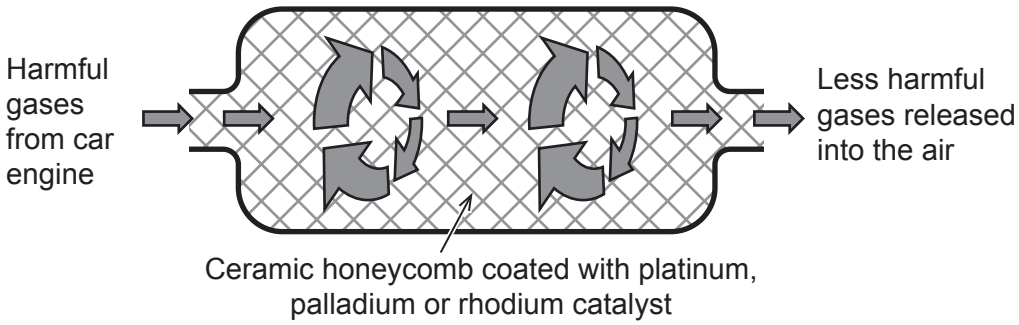
(a) These gases are produced in the car engine.

Draw lines to connect each **gas** with its **formula** and **how it is formed**.

Gas	Formula	How it is formed
Sulfur dioxide	CO	Combustion of sulfur impurities in the fuel
Carbon monoxide	NO	From air at high temperature
Nitrogen monoxide	SO_2	Incomplete combustion of the fuel

[4]

(b) Some harmful gases are removed by a catalytic converter before leaving the exhaust pipe of the car. The diagram shows gases passing through a catalytic converter coated with a catalyst.



The harmful gases from the car engine do not react with each other until they are in contact with the hot catalyst.

(i) Why do the gases not react with each other until they are in contact with the hot catalyst?

Tick (✓) **one** box.

The reaction has a high activation energy. ☐

The reaction is exothermic. ☐

The reaction is too fast. ☐

The catalyst is used up in the reaction. ☐

[1]

(ii) Suggest why the catalyst is coated on a ceramic honeycomb.

.....

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

(c) The equation shows one reaction of the gases in the catalytic converter.

$2CO + 2NO \longrightarrow 2CO_2 + N_2$

Identify which gas is oxidised.

Explain your answer.

Gas which is oxidised .....

Explanation .....

.....

.....

[2]

3 Magnesium hydroxide reacts with hydrochloric acid in a neutralisation reaction.

(a) (i) Complete the balanced symbol equation for the reaction between magnesium hydroxide and hydrochloric acid.

$Mg(OH)_2$ + ...HCl ⟶ $MgCl_2$ + ...H_2O **[1]**

(ii) Draw lines to connect each **compound** from the reaction with its correct **description**.

Compound	Description
HCl	Acid
H_2O	Alkali
$MgCl_2$	Salt
$Mg(OH)_2$	Water

[3]

(b) Complete the sentence about neutralisation.

Use the symbols and words from the list.

acid	**alkali**	**water**	**Cl^-**	**H^+**	**Mg^{2+}**	**OH^-**

Neutralisation occurs when ..... ions from an

..... react with ..... ions from an

..... to form ..... .

[3]

(c) Milk of magnesia is a medicine used to neutralise excess acid in the stomach.

Milk of Magnesia

One 15 cm^3 spoonful contains 1200 mg of magnesium hydroxide.

Leo does a titration with hydrochloric acid to check the amount of magnesium hydroxide in one spoonful of Milk of Magnesia.

This is the method:

- Add 15 cm^3 of Milk of Magnesia into a conical flask
- Add a few drops of indicator
- Add hydrochloric acid from a measuring cylinder until all of the magnesium hydroxide is neutralised.

When should Leo stop adding the acid?

Tick (✓) **one** box.

When all the acid has been added. ☐

When he has added 15 cm^3 of acid. ☐

When the conical flask is full. ☐

When the indicator changes colour. ☐

[1]

(d) Leo decides to measure the acid with a more accurate piece of apparatus instead of the measuring cylinder.

Which piece of apparatus should he use?

Put a (ring) around the correct answer.

Beaker **Burette** **Flask** **Thermometer**

[1]

(e) Leo repeats the titration with the more accurate piece of apparatus.

Here are his results.

	1	**2**	**3**	**4**	**5**
Volume of acid used (cm^3)	29.30	27.20	27.30	27.20	27.30

(i) Calculate the mean volume of acid used.

Mean volume of acid used = ... cm^3 **[2]**

(ii) The label says that there is 1200 mg of magnesium hydroxide in one 15 cm^3 spoonful.

Calculate the volume of hydrochloric acid needed to react with the magnesium hydroxide in the spoonful.

Use the formula:

Mass of magnesium hydroxide(g) = volume of hydrochloric acid(cm^3) × 0.044

Volume of hydrochloric acid = ... cm^3 **[3]**

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4 Sodium is a metal and oxygen is a non-metal.

(a) Complete the table to describe the difference in the properties of metals and non-metals.

Use words from the list.

dull	**high**	**low**	**shiny**

Property	**Metals**	**Non-metals**
Melting point	high	low
Boiling point	.....	.....
Density	.....	.....
Appearance	.....	.....
Electrical conductivity	good	none

[3]

(b) Complete the sentence to explain why sodium is a good conductor of electricity.

Put a (ring) around the **two** correct answers.

Sodium is a good conductor of electricity because it has **electrons / ions / molecules** which are **fixed / mobile / static**. **[2]**

(c) Sodium has an electronic structure 2.8.1 and oxygen has an electronic structure 2.6.

(i) Complete the table to show the position of these two elements in the Periodic Table.

Use the Data Sheet.

	Period	**Group**
Sodium	.....	.....
Oxygen	.....	.....

[2]

(ii) Sodium and oxygen react together to form sodium oxide.

Complete the table to show the electronic structures and charges of the ions formed.

	Electronic structure	**Charge**
Sodium ion	.....	.....
Oxide ion	.....	.....

[3]

5 Paper chromatography can be used to identify dyes in a mixture.

(a) Complete the sentence to describe how chromatography works.

Use words from the list.

condensed	distributed	dyes	mobile	paper	solvent	stationary

The ..... in the mixture are separated when they are

..... between the ..... which is the

..... phase and the ..... which is the

..... phase.

[4]

(b) Rf values are used to identify dyes. They are calculated using this equation:

$$\text{Rf} = \frac{\text{distance moved by the substance}}{\text{distance moved by the solvent}}$$

The Rf value of a dye can be calculated from the result of an experiment and compared with Rf values in a data book.

Table 5.1 shows the results of an experiment to identify an unknown dye.

Table 5.2 shows the Rf values of some dyes in a data book.

Distance moved by the dye (cm)	3.5
Distance moved by the solvent (cm)	8.3

Table 5.1

	Rf value
Marigold Orange	0.36
Mustard Yellow	0.89
Sunshine Yellow	0.42

Table 5.2

Which dye has been identified from the experimental results in **Table 5.1**?

Use a calculation to explain your answer.

.....

.....

.....

.....

.....

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

(c)* A student checks the Rf value of sunshine yellow using chromatography.

The chromatogram produced by the student is shown for the sunshine yellow dye.

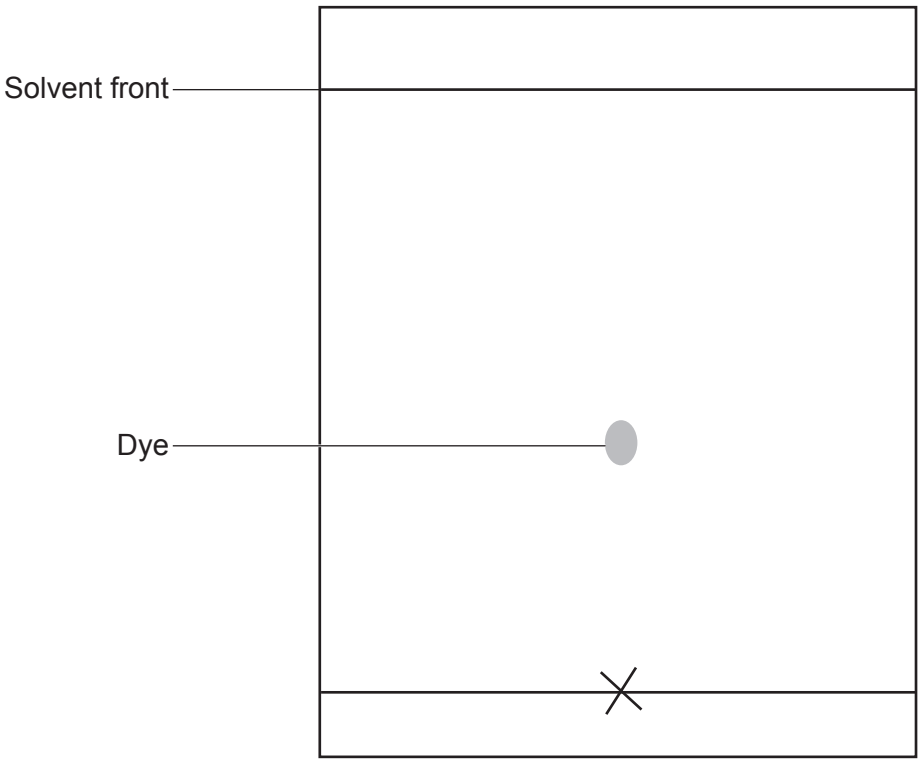


Fig. 5.1

Describe how the student did the experiment to find the Rf value of the dye.

Include the apparatus used and any measurements taken.

.....

.....

.....

.....

.....

.....

.....

.....

.....

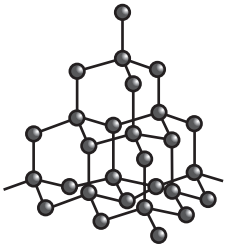
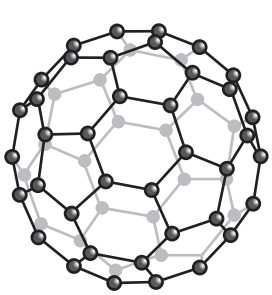
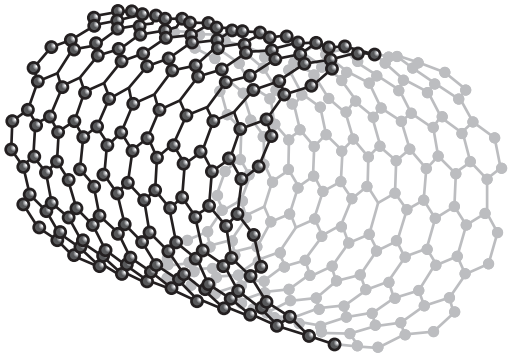
.....

.....

.....

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

6 The diagrams show the structures of some forms of carbon.

	 
Diamond	**Fullerenes**

(a) (i) How do the diagrams show that all the structures are the same element?

Tick (✓) **one** box.

There is only one type of atom in all of the structures. ☐

They are all the same shape. ☐

They are all 3 dimensional. ☐

They all have the same number of atoms. ☐

[1]

(ii) Which statements about these structures are **true only for diamond**, which are **true only for fullerenes**, and which are **true for all the structures**?

Tick (✓) **one** box in each row.

	True only for diamond	True only for fullerenes	True for all the structures
Each carbon atom is bonded to 3 others.			
All atoms are held together by covalent bonds.			
Carbon atoms are arranged in a tetrahedral (pyramidal) shape.			

[3]

(b) Fullerenes are nanoparticles.

(i) What is the approximate size of a nanoparticle?

Put a (ring) around the correct answer.

≤100 nm **1000 nm** **10 000 nm** **≥10 000 nm**

[1]

(ii) Fullerenes can be used to carry drugs into the body.

Which **two** statements explain why?

Tick (✓) **two** boxes.

They are small enough to pass through body tissues. ☐

They are made of carbon atoms. ☐

They can fit molecules inside them. ☐

They are good for you. ☐

They can act as catalysts. ☐

[2]

(iii) Some people do not agree with the use of nanoparticles to carry drugs into the human body. Others think that the benefits outweigh the risks.

Suggest **one** risk and **one** benefit to a person's health of using fullerenes to carry drugs into the body.

Risk .....

.....

Benefit .....

.....

[2]

7 **Table 7.1** shows some information about the elements in Group 17(7) of the Periodic Table.

	State and colour at 20 °C	**Reaction with iron wool**	**Product**
Fluorine	pale yellow gas	Reacts instantly.	Iron fluoride
Chlorine	yellow-green gas	Reacts with heated iron wool very quickly, although not as quickly as fluorine does.	Iron chloride
Bromine	deep red liquid	Has to be warmed and the iron wool heated. The reaction is faster than that of iodine but slower than that of chlorine.	Iron bromide
Iodine	grey solid	Has to be heated strongly and so does the iron wool. The reaction is slow.	Iron iodide

Table 7.1

(a) **(i)** Name the most reactive member of Group 17(7).

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

(ii) Name **one** member of Group 17(7) that is not shown in **Table 7.1**.

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

(iii) Predict the state and colour at 20 °C, the reaction with iron wool and the product of the reaction for the element identified in **(ii)**.

State and colour at 20 °C .....

Reaction with iron wool .....

.....

Product formed with iron wool .....

[3]

(b) The elements in Group 17(7) form compounds with other metals.

Table 7.2 shows information about some of these compounds.

Ions	Formula	Relative formula mass
.....	KF	58.1
Ca^{2+} and Br^{-}	.....	199.9
Fe^{3+} and F^{-}	FeF_3	

Table 7.2

(i) Complete the table to show the missing ions and formula. **[2]**

(ii) Calculate the relative formula mass for FeF_3.

Use the Data Sheet.

Relative formula mass = ... **[2]**

8 The table gives information about some of the compounds present in crude oil.

Number of carbon atoms	Molecular formula	Empirical formula	Melting point (°C)	Boiling point (°C)	State at room temperature
4	C_4H_{10}	C_2H_5	–138	0	Gas
5	.....	C_5H_{12}	–130	36	
6	C_6H_{14}	C_3H_7	–95	69	Liquid
7	C_7H_{16}	C_7H_{16}	–90		Liquid
8	C_8H_{18}	.....	–57	126	Liquid

(a) (i) Complete the table to show the missing molecular formula and empirical formula. **[2]**

(ii) Predict the boiling point for the compound with 7 carbon atoms.

Boiling point = ... °C **[1]**

(iii) Predict the state of the 5 carbon compound at room temperature (20 °C).

Explain your answer.

State .....

Explanation .....

.....

.....

[2]

(b) All the compounds in the table are in the same homologous series.

All members of a homologous series have the same general formula.

(i) Give **two** other characteristics of a homologous series that are shown in the table.

1 .....

.....

2 .....

.....

[2]

(ii) Complete the sentences to describe the compounds present in crude oil that are shown in the table.

Put a (ring) around each correct answer.

Crude oil is a mixture of **hydrocarbons / polymers / salts**.

The compounds are from the homologous series **allotropes / alkanes / alkenes**.

They all have the general formula $\mathbf{C_nH_{2n}}$ / $\mathbf{C_nH_{2n+1}}$ / $\mathbf{C_nH_{2n+2}}$.

[3]

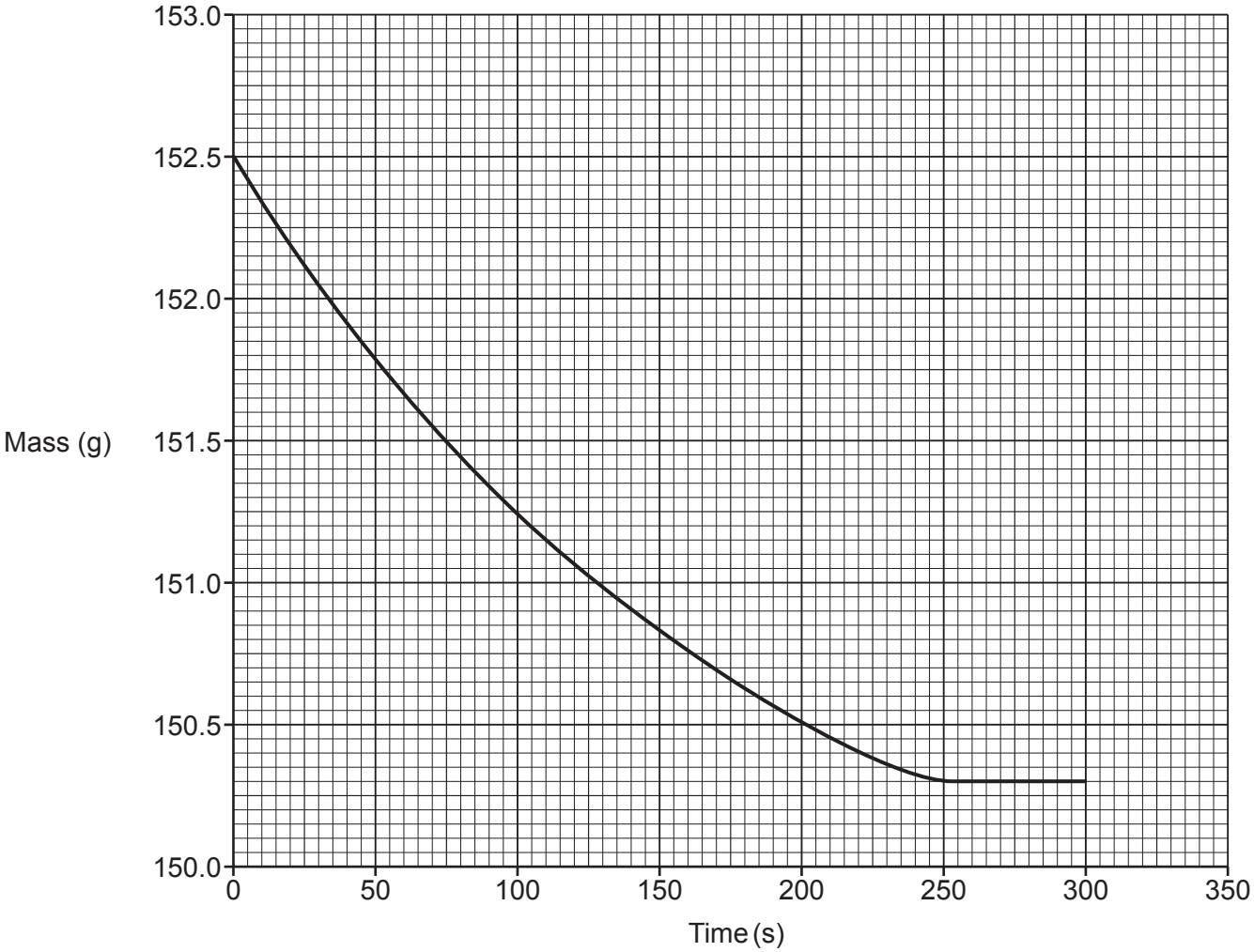
9 Solid calcium carbonate reacts with dilute hydrochloric acid to form calcium chloride, carbon dioxide and water.

$CaCO_3(s) + 2HCl(aq) \longrightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$

(a) Jane investigates the rate of this reaction. She measures the change in mass during the reaction over five minutes.

She uses 10 g of calcium carbonate lumps and 50 cm^3 of dilute hydrochloric acid.

The graph shows Jane's results.



(i) What was the time taken for the reaction to finish?

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

(ii) What was the total mass lost during the reaction?

Total mass lost = ... g **[2]**

(iii) Calculate the average rate of the reaction.

Rate of reaction = ... g / s **[2]**

(b) Jane repeats the experiment with 10 g of calcium carbonate **powder** instead of 10 g of lumps. She keeps everything else the same.

Sketch a line on the graph to show the results she should expect. **[2]**

(c) Complete the sentences to explain why the rate of reaction changes when powdered calcium carbonate is used instead of lumps.

Put a (ring) around each correct answer.

The surface area of 10 g of powdered calcium carbonate is **larger than / smaller than / the same as** 10 g of lumps.

The total volume of 10 g of powdered calcium carbonate is **larger than / smaller than / the same as** 10 g of lumps.

[2]

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).