OCR
Oxford Cambridge and RSA

Friday 17 May 2024 – Morning

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

J260/02 Chemistry (Foundation Tier)

Time allowed: 1 hour 45 minutes

F

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

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 **24** pages.

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

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1

(a) **Table 1.1** shows information about some of the elements in the Periodic Table.

Table 1.1

Element	Atomic Number	Group Number	Period	Electron Configuration
.....	8	16(6)	2	2.6
Sodium	11	.....	.....	2.8.1
Chlorine	.....	17(7)	3	2.8.7
Calcium	20	2	4	.....

(i) Complete **Table 1.1**.

Use the Data Sheet. **[5]**

(ii) When atoms lose or gain electrons, they form charged particles called ions.

State the electron configuration of Na^+ **ions** and Cl^- **ions**.

Na^+ .....

Cl^- .....

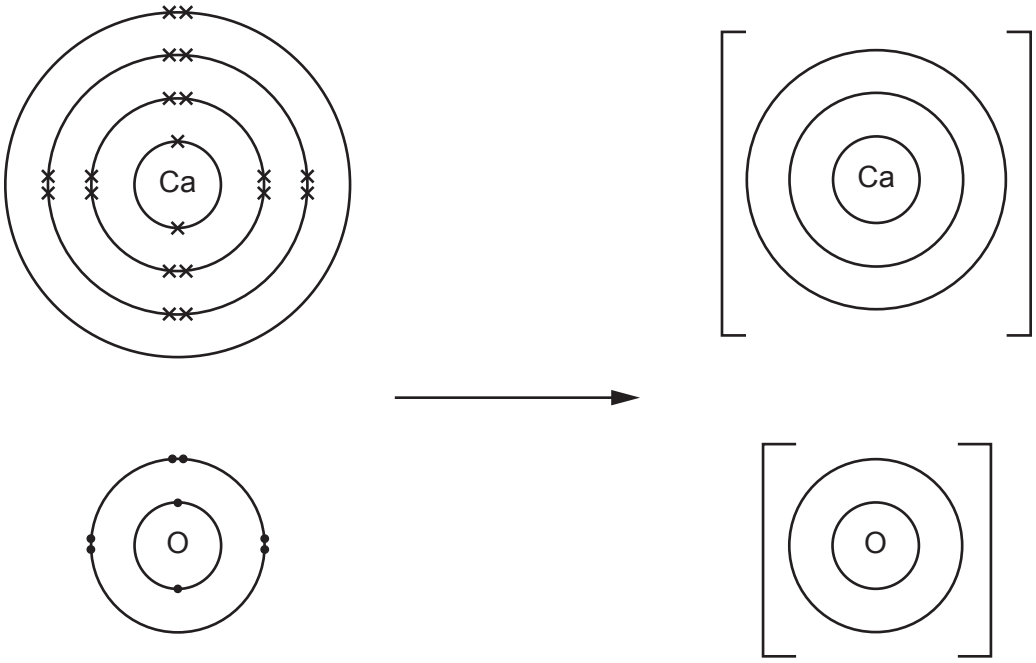
[2]

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(b) Ionic compounds form when electrons are transferred from one atom to another.

A dot and cross diagram is a model used to show the formation of an ionic compound.

Complete the diagram to show the **arrangement of electrons** and the **charge of the ions** in calcium oxide.



[2]

(c) **Table 1.2** gives information about some other ionic compounds.

Table 1.2

Compound	Ions Present	Formula	Relative Formula Mass
.....	Na^+ and Cl^-	$NaCl$	58.5
Magnesium chloride	.....	$MgCl_2$	.....
.....	Mg^{2+} and O^{2-}	.....	40.3

Complete **Table 1.2**.

Use these relative atomic masses: Mg = 24.3, Cl = 35.5.

[5]

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2 This question is about climate change.

(a)

(i) Complete the sentence to describe how the presence of carbon dioxide in the atmosphere causes an increase in global temperatures.

Put a (ring) around each correct option.

Global warming occurs when **infrared / ultra violet / visible** radiation coming from

the Earth / the Sun / space is absorbed by carbon dioxide which prevents heat leaving

the atmosphere.

[2]

(ii) Name **one other** greenhouse gas.

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

(b) One method to reduce the amount of carbon dioxide in the atmosphere is called carbon capture. Carbon dioxide from power stations is collected and buried deep underground.

State **one** other method to reduce the amount of carbon dioxide in the atmosphere.

.....

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

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(c) In 2002, scientists announced that they had made hydrocarbons from carbon dioxide using dilute acid.

Their next step was to have a peer review of their findings.

(i) Who carries out a peer review?

Tick (✓) **one** box.

Members of the public. ☐

Other scientists. ☐

The media. ☐

[1]

(ii) Why is peer review important?

Tick (✓) **one** box.

To make sure it is cost effective. ☐

To make sure it will be popular. ☐

To make sure results can be repeated. ☐

[1]

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3 A student investigates the reaction between zinc carbonate and dilute acids.

(a)

(i) Complete the balanced symbol equation for the reaction between solid zinc carbonate and dilute acid.

Include state symbols. **[4]**

$ZnCO_3(s)$ + ...HCl(.....) → $ZnCl_2$(.....) + CO_2(.....) + H_2O(.....)

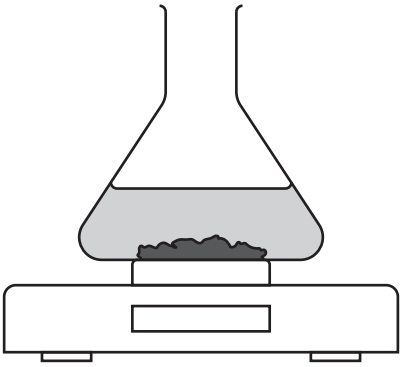
(ii) Name the acid used and the salt formed in this reaction.

Acid .....

Salt .....

[2]

(b) The student adds zinc carbonate to dilute acid in a conical flask. The flask is on a mass balance.



(i) Which statement explains what will happen to the reading on the mass balance as the reaction goes on?

Tick (✓) **one** box.

The mass will go down because carbon dioxide gas leaves the flask. ☐

The mass will go down because the water dilutes the acid. ☐

The mass will go up because carbon dioxide is denser than air. ☐

The mass will go up because some of the reactants are still present. ☐

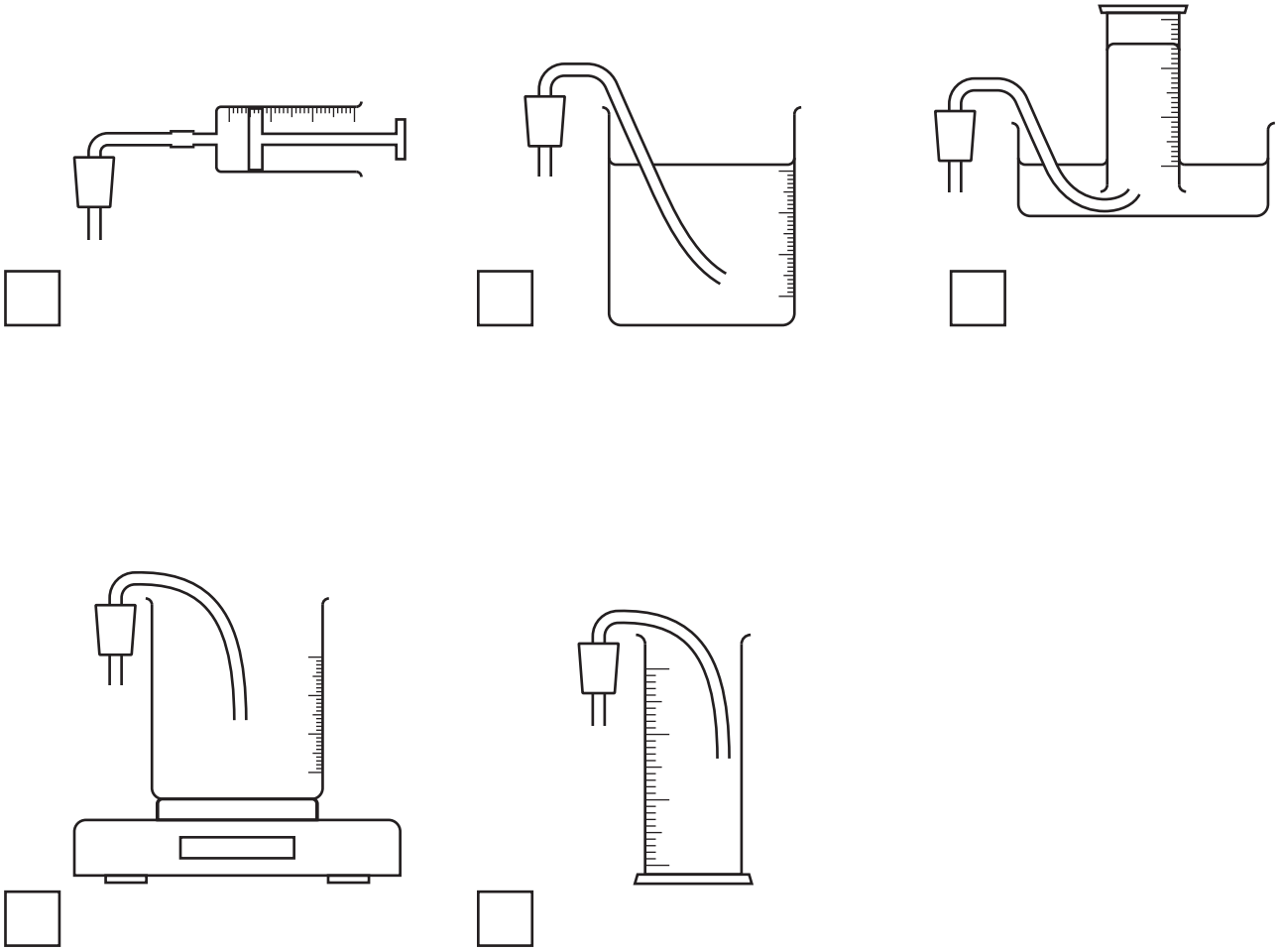
[1]

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(ii) The student decides to measure the volume of carbon dioxide gas.

Which **two** pieces of apparatus should be used?

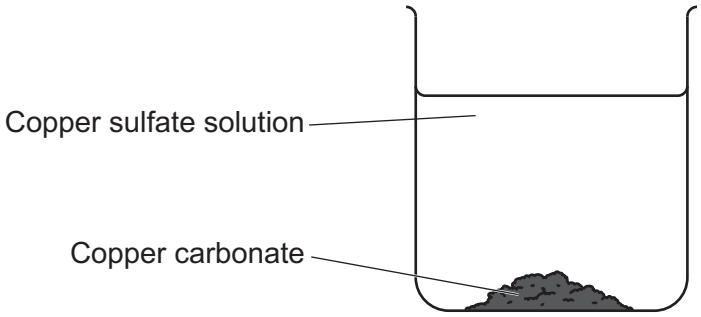
Tick (✓) **two** boxes.



[2]

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4 A student makes some blue crystals of copper sulfate. They add copper carbonate to sulfuric acid in a beaker until there is unreacted solid at the bottom of the container.



(a) Why does the student add copper carbonate until there is unreacted solid?

Tick (✓) **one** box.

So that all the acid is used up. ☐

So that all the carbonate is used up. ☐

So that no product is left in the solution. ☐

So the solid is the main product. ☐

[1]

(b) How can the student speed up the reaction?

Tick (✓) **two** boxes.

Add water to the beaker. ☐

Heat the solution in the beaker. ☐

Use a bigger volume of acid. ☐

Use a more concentrated acid. ☐

Use bigger pieces of copper carbonate. ☐

[2]

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(c) Which stages of the method to produce blue crystals of copper sulfate are **true** and which are **false**?

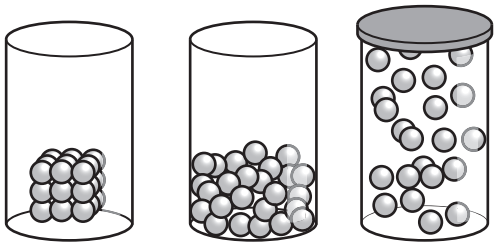
Tick (✓) **one** box in each row.

Stage	True	False
Filter and collect solid residue.		
Filter and collect solution.		
Evaporate the solution to dryness using a Bunsen burner.		
Leave solution to cool slowly and collect crystals.		

[3]

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5 The arrangements of particles in solids, liquids and gases are shown.



(a)

(i) Which descriptions about the states of matter are **true** and which are **false**?

Tick (✓) **one** box in each row.

	True	**False**
The particles in a gas are randomly arranged.		
The particles in a liquid are far apart.		
The particles in a solid vibrate about a fixed position.		

[2]

(ii) Describe what happens to the movement and arrangement of the particles when a solid is heated until it melts.

Movement .....

.....

Arrangement .....

.....

[2]

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(b) Mercury has a melting point of –39 °C and a boiling point of 357 °C.

What is the state of mercury at 20 °C?

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

(c) The melting point of a substance can be used to check its purity.

(i) What does a scientist mean by a pure substance?

Tick (✓) **one** box.

It contains only **one** element or compound. ☐

It contains only **one** type of atom. ☐

It does **not** contain harmful chemicals. ☐

[1]

(ii) How does the melting point of a substance show if it is pure?

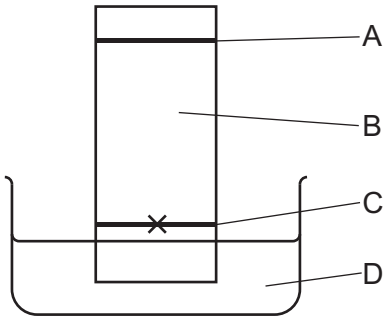
.....

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

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(d) Chromatography can also be used to test for purity.

The diagram shows the apparatus used.



(i) Draw lines to connect each **letter** with its correct **label**.

Letter	Label
A	Chromatography Paper
B	Solvent
C	Solvent Front
D	Starting Line

[3]

(ii) How would the results of this experiment show that a substance was pure?

.....

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

(iii) What step is needed if the substance being tested is colourless?

Tick (✓) **one** box.

Use a locating agent at the end. ☐

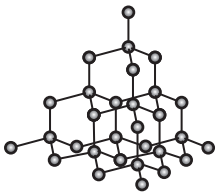
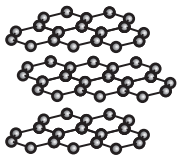
Use a second piece of paper. ☐

Use an extra solvent. ☐

[1]

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6* The table shows the structure, properties and uses of two carbon allotropes.

	Allotropes	
	Diamond	**Graphite**
Structure		
Melting Point (°C)	3550	3550
Hardness (1 = softest, 10 = hardest)	10	1–2
Electrical Conductivity	Low	High
Uses	drills (used for making holes)	electrodes, lubricants

Explain why diamond and graphite are suitable for the uses that are stated in the table.

Use ideas about the structure and bonding of diamond and graphite in your answer.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

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

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7 Crude oil is mainly a mixture of hydrocarbons.

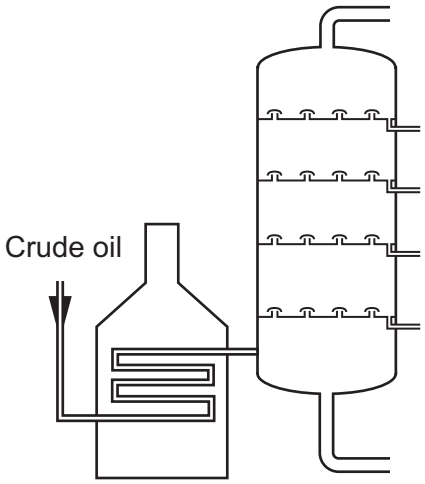
(a) Define a hydrocarbon.

.....

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

(b) The hydrocarbons in crude oil are separated using fractional distillation.

The diagram shows a fractionating column.



(i) Which property is used to separate hydrocarbons by fractional distillation?

Put a (ring) around the correct option.

Boiling point **Hardness** **Reactivity** **Solubility**

[1]

(ii) Complete the sentences to explain how separation occurs in the fractionating column.

Use words from the list.

Atoms	**Cooler**	**Condense**	**Hotter**	**Less**
Molecules	**More**	**Vapourise**		

The mixture of hydrocarbons is heated before entering the column which causes the hydrocarbons to ..... .

Smaller hydrocarbons reach the top of the column where it is ..... .

The smaller hydrocarbons have weaker forces between ..... .

This means they need ..... energy to separate.

[4]

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(c) The hydrocarbons in crude oil are mostly alkanes. Alkanes all have the general formula:

C_nH_{2n+2}.

Larger hydrocarbon molecules are broken down into smaller hydrocarbon molecules using cracking.

(i) Complete the equation to show the formula of the second product.

$C_{12}H_{26} \longrightarrow C_6H_{12}$ + ...

[1]

(ii) Explain why C_6H_{12} is **not** an alkane.

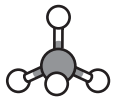
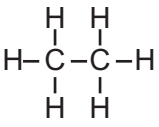
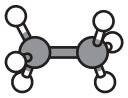
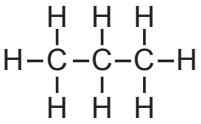
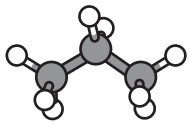
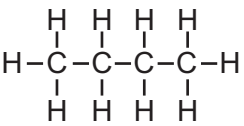
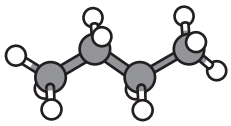
.....

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

(d) Other types of formula can be used to show hydrocarbon molecules.

The table shows examples of these formulae.

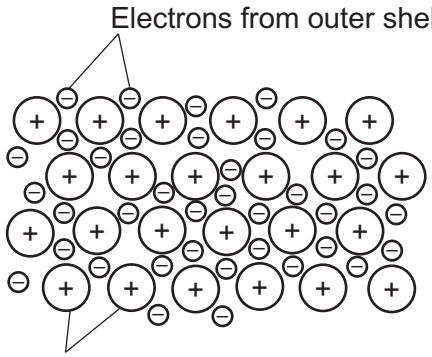
Complete the table.

Alkane	**Molecular Formula**	**Empirical Formula**	**Displayed Formula**	**3D Structure**
.....	CH_4	CH_4	.....	
Ethane	.....	CH_3		
Propane	C_3H_8	.....		
Butane	C_4H_{10}	.....		

[5]

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8 The diagram shows the structure of a metal.



(a) The properties of a metal depend on its structure.

Complete the sentences to explain the properties of metals.

Use words from the list.

Atoms	**Electrons**	**Ions**

Metals conduct electricity when solid because the ..... can move.

Metals are malleable because the ..... can slide over each other.

Metals have high melting points because there is a strong attraction between the

..... and the ..... .

[3]

(b) A student does some experiments to find the reactivities of some metals.

(i) In one experiment, they add a piece of zinc to a blue aqueous solution of copper ions.
They see a reddish metal formed and the blue solution fades to colourless.

$Zn(s) + Cu^{2+}(aq) \longrightarrow Cu(s) + Zn^{2+}(aq)$

Complete the sentence to explain how this reaction shows that zinc is more reactive than copper.

Put a (ring) around the correct option.

Zinc is more reactive than copper because it **gains / loses / shares** electrons more easily than copper.

[1]

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(ii) The table shows the student's results from the other experiments:

	$Cu^{2+}(aq)$	$Fe^{2+}(aq)$	$Mg^{2+}(aq)$	$Ag^{+}(aq)$
Cu(s)		No change	No change	Change
Fe(s)	Change		No change	Change
Mg(s)	Change	Change		Change
Ag(s)	No change	No change	No change	

Write down the metals in order of reactivity.

Most reactive .....

.....

.....

Least reactive .....

[2]

(c) Another student plans an experiment to find the order of reactivity of some metals by adding dilute acid to the metals. The general equation for the reaction between a metal and an acid is:

Metal + acid $\longrightarrow$ salt + hydrogen

(i) How will the results of their experiment show the order of reactivity of the metals?

.....

.....

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

(ii) Suggest why this method of adding metals to acid is not suitable for finding the reactivity of all metals.

.....

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

(iii) What is the test for hydrogen gas?

Tick (✓) **one** box.

Bleaches damp litmus paper. ☐

Pops a lighted splint. ☐

Relights a glowing splint. ☐

Turns limewater milky. ☐

[1]

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9

(a) **Table 9.1** shows the diameters of some particles.

Table 9.1

Particle	Diameter (m)
Carbon atom	1.54×10^{-10}
Fullerene molecule	1.10×10^{-9}
Silver atom	2.88×10^{-10}
Platinum nanoparticle	1.00×10^{-8}

(i) Which **two** particles have diameters with the same order of magnitude?

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

(ii) Write down the particles in order of diameter.



[2]

(b) Nanoparticles make effective catalysts because they have a high surface area to volume ratio.

Table 9.2 shows the surface area to volume ratio of some different sized particles.

Table 9.2

	Nanoparticle	Particle of Fine Powder	Particle of Coarse Powder
Size of Particle (nm)	60	600	6000
Surface Area to Volume Ratio	0.1	0.01	0.001

Describe the relationship between the size of a particle and its surface area to volume ratio.

.....

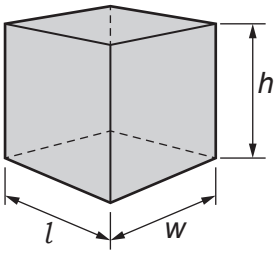
.....

.....

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

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(c) The nanoparticle shown is a cube. This nanoparticle has a volume of 1000 nm^3.



NOT TO SCALE

Calculate the surface area of the nanoparticle.

Use the formula: surface area = 6 × (h × w)

Surface area = ... nm^2

[3]

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10 A student is investigating the reaction between calcium hydroxide and hydrochloric acid.

$Ca(OH)_2(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + 2H_2O(l)$

(a) They want to find the temperature change during the reaction.

1 g masses of solid calcium hydroxide are added one by one to 50 cm^3 of dilute hydrochloric acid in a plastic cup.

Describe **two** measurements the student needs to make **and** the apparatus needed to make the measurements.

1. .....

.....

2. .....

.....

[2]

(b) The table shows the student's results:

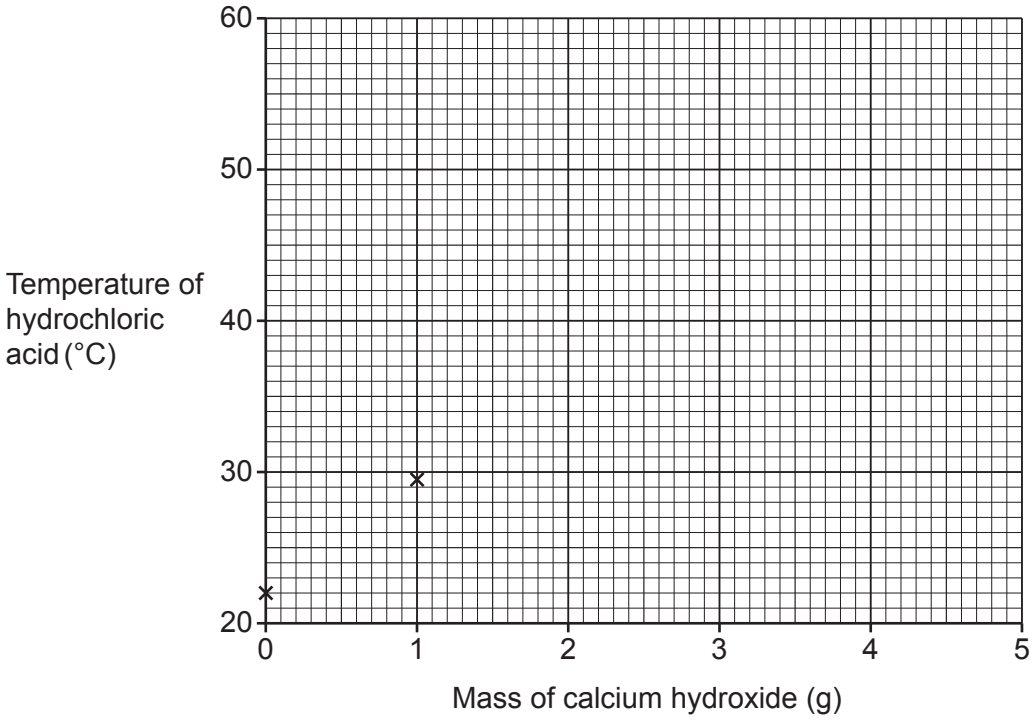
Mass of calcium hydroxide (g)	Temperature of hydrochloric acid (°C)
0	22.0
1	29.5
2	37.0
3	44.5
4	52.0
5	59.5

Plot the results from the table on the graph.

Two points have already been plotted. **[2]**

(c) Draw a line of best fit. **[1]**

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(d) Which relationship describes the graph?

Put a (ring) around the correct option.

y = mx **y = mx^2** **y = mx + c** **y = mx – c** **[1]**

(e) Calculate the **change** in temperature if 3.8 g of calcium hydroxide is added to the hydrochloric acid.

Use the graph.

Temperature change = ... °C **[2]**

(f) Calculate the change in thermal energy when 3.8 g of calcium hydroxide is added to 50 cm^3 of hydrochloric acid.

Use the formula:

Change in thermal energy (J) = 4.2 × temperature change (°C) × mass of hydrochloric acid (g)

1 cm^3 hydrochloric acid = 1.02 g

Change in thermal energy = ...J **[3]**

END OF QUESTION PAPER

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EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.

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