OCR
Oxford Cambridge and RSA

Monday 22 May 2023 – Morning

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

J248/01 Paper 1 (Foundation Tier)

Time allowed: 1 hour 45 minutes

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

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

F

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 the answer is wrong.

INFORMATION
- The total mark for this paper is **90**.
- 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.

Section A

You should spend a **maximum** of **30 minutes** on this section.

Write your answer to each question in the box provided.

1 Where is most of the mass found in an atom?

A Electrons

B Neutrons

C Nucleus

D Protons

Your answer ☐ **[1]**

2 Sodium fluoride has the formula NaF. The formula of the sodium ion is Na^+.

What is the formula of the fluoride ion?

A F^+

B F^-

C F^{2+}

D F^{2-}

Your answer ☐ **[1]**

3 Which row of results shows that the pH of a solution is **acidic**?

	pH	**Universal indicator colour**
A	3	orange
B	10	blue
C	3	blue
D	10	orange

Your answer ☐ **[1]**

4 Thomson discovered the first sub-atomic particle.

Which sub-atomic particle did Thomson discover?

A Atom

B Electron

C Neutron

D Proton

Your answer ☐ **[1]**

5 What is the relative formula mass of iron chloride, $FeCl_3$?

Relative atomic mass (A_r): Cl = 35.5 Fe = 55.8.

A 91.3

B 126.8

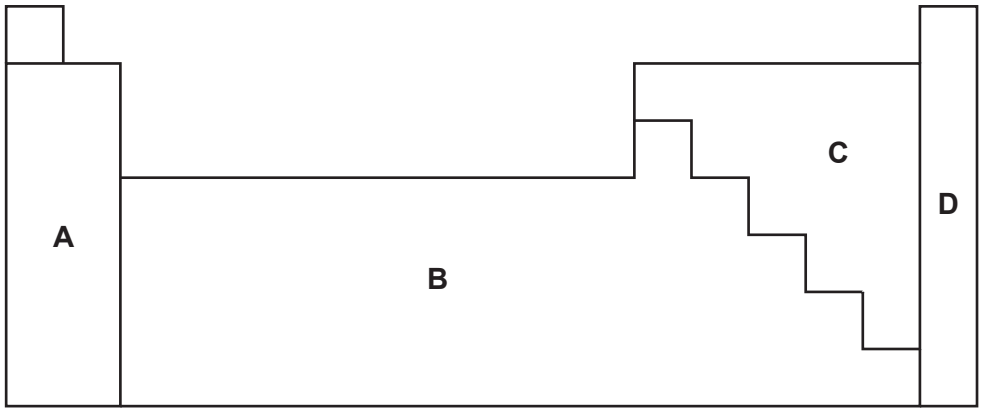
C 162.3

D 202.9

Your answer ☐ **[1]**

6 An element **gains** electrons to form a full outer shell.

Which part of the Periodic Table will the element be from?



Your answer ☐ **[1]**

7 Why can the mass of a reaction in an open conical flask decrease?

A One of the products is a gas.

B One of the products is a solid.

C One of the reactants is a liquid.

D One of the reactants is a solid.

Your answer ☐ **[1]**

8 When the model of the atom was developed, scientists reviewed the work of other scientists.

Why is it important for scientists to review each other's work?

A They will copy the experiments to complete the research first.

B They will evaluate the data and suggest improvements.

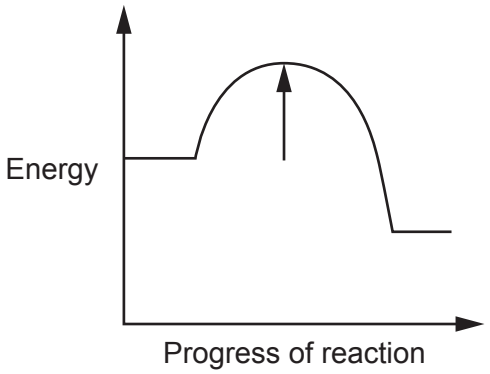
C They will make sure that personal protective equipment is worn.

D They will start an argument about who is correct.

Your answer ☐ **[1]**

9 Which reaction profile has an arrow showing the **activation energy**?

A



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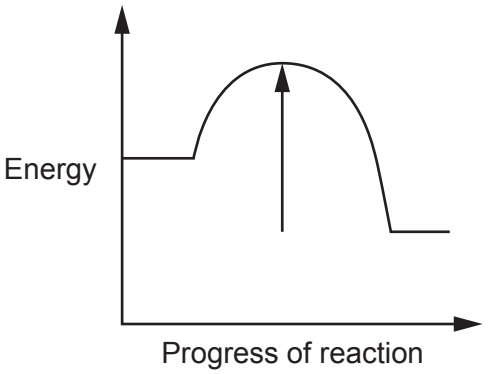

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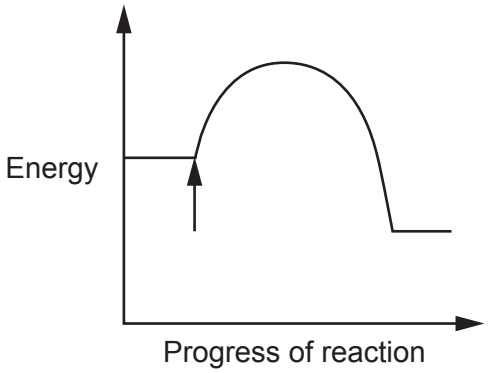
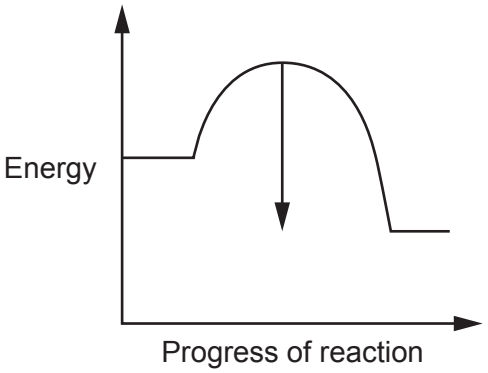


D



Your answer ☐ **[1]**

10 63.5 g of copper reacts to make 134.5 g of copper chloride, $CuCl_2$.

$Cu + Cl_2 \rightarrow CuCl_2$

How much copper chloride will be made from 0.635 g of copper?

A 0.01345 g

B 0.1345 g

C 1.345 g

D 13.45 g

Your answer ☐ **[1]**

11 Why are nanoparticles useful as catalysts in chemical reactions?

A Nanoparticles are a new technology.

B Nanoparticles have a high surface area to volume ratio.

C Nanoparticles have a large particle size.

D Nanoparticles have a low surface area to volume ratio.

Your answer ☐ **[1]**

12 The melting point of magnesium chloride is 714 °C.

Which state symbols are used for magnesium chloride at these temperatures?

	State symbol at 25 °C	**State symbol at 110 °C**
A	g	g
B	s	s
C	s	g
D	g	s

Your answer ☐ **[1]**

13 What changes did Mendeleev make to improve his Periodic Table?

A He arranged elements by mass number.

B He arranged elements by the number of neutrons.

C He put elements with low melting points on the left and high melting points on the right.

D He realised some elements had not yet been discovered so left spaces for them.

Your answer ☐ **[1]**

14 Nitrogen monoxide, NO, can be oxidised to form nitrogen dioxide, NO_2.

$2NO + O_2 \rightarrow 2NO_2$

What is the oxidising agent in this reaction?

A Nitrogen

B Nitrogen dioxide

C Nitrogen monoxide

D Oxygen

Your answer ☐ **[1]**

15 Hydrochloric acid, HC*l*, reacts with magnesium, Mg.

Magnesium chloride and hydrogen are made.

What is the balanced symbol equation for this reaction?

A $2HCl + Mg \rightarrow MgCl + H_2$

B $2HCl + Mg \rightarrow MgCl + H$

C $2HCl + Mg \rightarrow MgCl_2 + H_2$

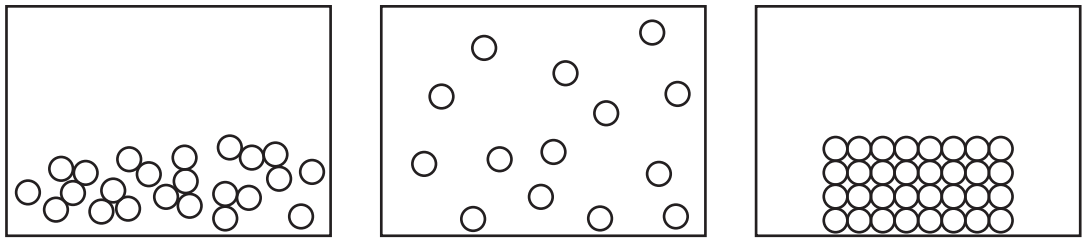
D $2HCl + Mg \rightarrow MgCl_2 + H$

Your answer ☐ **[1]**

Section B

16 (a) Oxygen is a gas at room temperature.

(i) The diagrams show three different particle models.



A **B** **C**

Which particle model represents a **gas**?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **[1]**

(ii) Oxygen has a melting point of –219 °C and a boiling point of –183 °C.

State a temperature at which oxygen will be a **liquid**.

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

(iii) Complete the sentences about the particle models.

Use words from the list.

condensing	**freezing**	**less**	**melting**	**more**

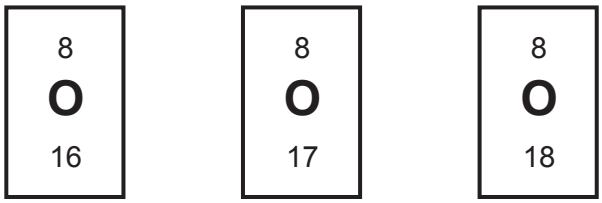
A liquid becoming a solid is called ..... . In a solid, the particles move ..... than in a liquid. In a solid, the arrangement of particles is ..... random than in a liquid. **[3]**

(b) Draw lines to connect each **particle** with its correct **description**.

Particle	Description
proton	relative mass of 0.0005
electron	positively charged and relative mass of 1
neutron	no charge

[2]

(c) The element oxygen has three different isotopes.



Isotope **1** Isotope **2** Isotope **3**

(i) Which isotope has the **highest** mass?

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

(ii) Which isotope has the **same number** of protons and neutrons?

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

(iii) Atoms of each isotope have the same number of electrons.

How many electrons do these atoms have?

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

(d) A sample of air contains all three isotopes of oxygen.
It contains 99.759% of isotope **1** and 0.037% of isotope **2**.

Calculate the percentage of isotope **3** in the sample of air.

Percentage of isotope **3** = ... % **[2]**

17 A scientist measures the melting points of three painkillers.

Painkiller	Melting point (°C)
A	136
B	169
C	76

(a) All of the painkillers are **pure** substances.

(i) Explain what is meant by a pure substance.

.....

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

(ii) How can you tell that the three painkillers are pure from their melting points?

.....

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

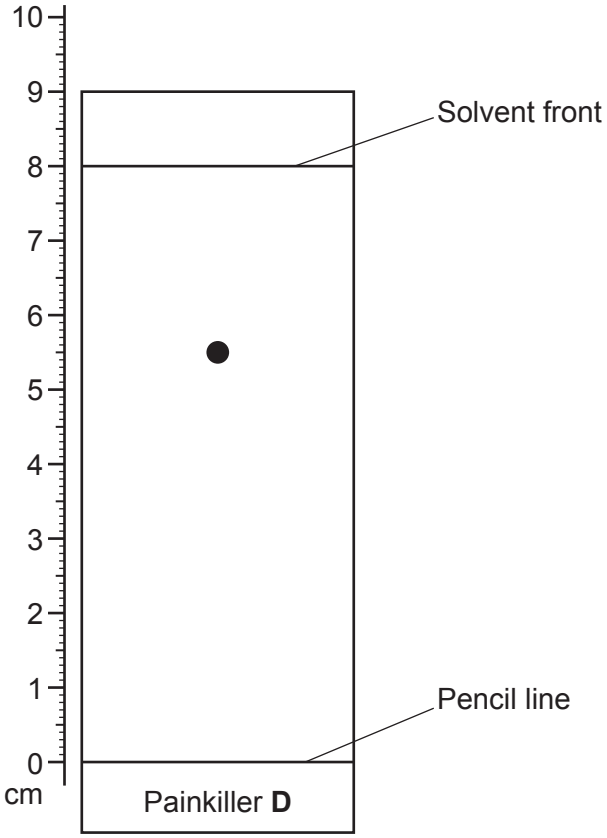
(b) The scientist uses gas chromatography to investigate a **mixture** of painkiller **A** and painkiller **B**.

How many peaks will the scientist see in the gas chromatogram?

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

(c) The scientist then analyses painkiller **D** using thin layer chromatography.

The chromatogram is shown in the diagram.



(i) Calculate the R_f value of painkiller **D**.

Use the formula: $R_f = \frac{\text{distance travelled by substance}}{\text{distance travelled by solvent}}$

Give your answer to **2** decimal places.

R_f of painkiller **D** = ... **[3]**

(ii) Which components are needed for thin layer chromatography?

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

balance	**Bunsen burner**	**mobile phase**
paper	**stationary phase**	**thermometer**

[2]

(d) The scientist thinks that an impure painkiller will **only** have **two** spots on the thin layer chromatogram.

Give **two** reasons why the scientist is **incorrect**.

1 .....

.....

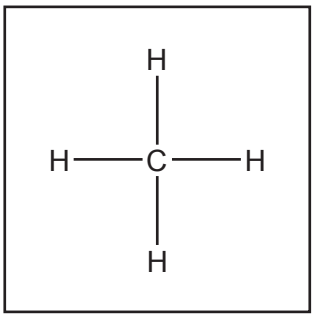
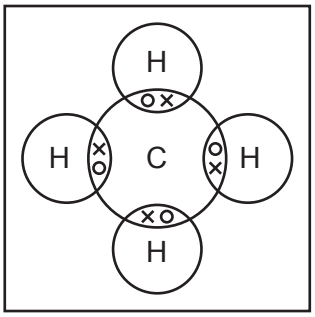
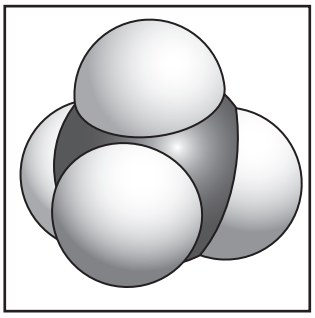
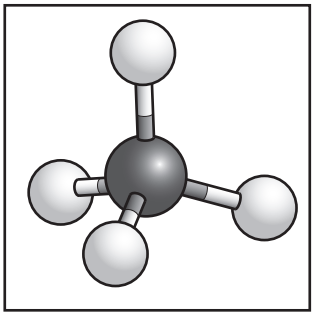
2 .....

.....

[2]

18 Molecules can be shown by different models.

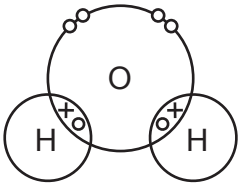
(a) Draw **three** lines to connect each **name** to its correct **model**.

Name	Model
Ball and stick model	
Dot and cross diagram	
3D Space-filling model	
	

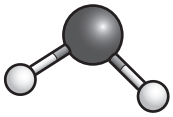
[3]

(b) A student wants to use a model to show the **location of the electrons** in a water molecule as shown in **Fig. 18.1**.

Fig. 18.1



Model **1**



Model **2**

Explain why the student uses model **1** instead of model **2**.

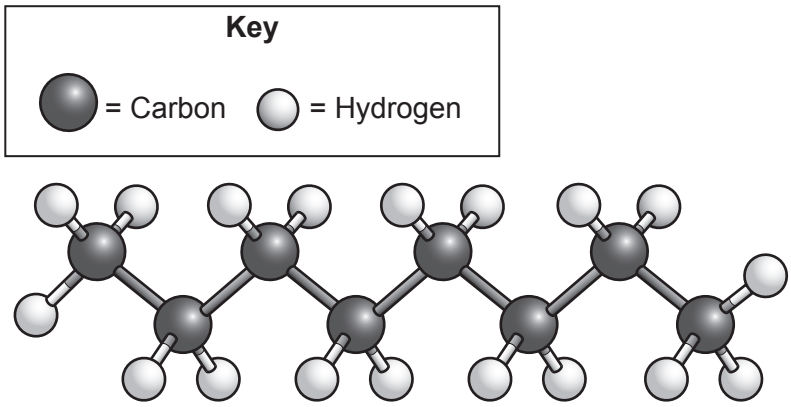
.....

.....

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

(c) **Fig. 18.2** shows a model of octane.

Fig. 18.2



(i) What is the **empirical formula** of octane?

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

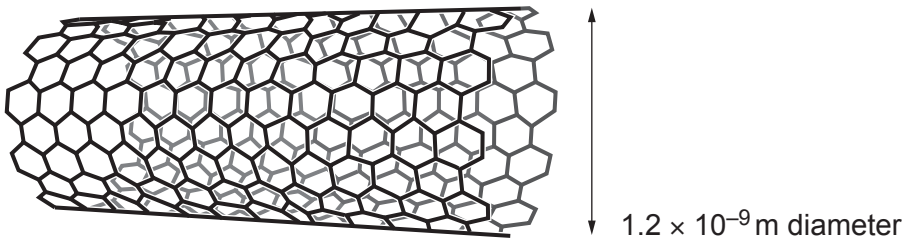
(ii) Calculate the **relative formula mass** of octane.

Relative atomic mass (A_r): C = 12.0 H = 1.0.

Relative formula mass = ... **[3]**

(d) **Fig. 18.3** shows a model of a carbon nanotube.

Fig. 18.3

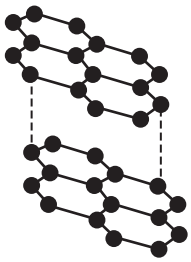


(i) What is the diameter of the carbon nanotube in **nanometres**?

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

(ii) **Fig. 18.4** shows a model of the structure and bonding in graphite.

Fig. 18.4



Explain why the carbon nanotube is stronger than graphite.

Use **Fig. 18.3** and **Fig. 18.4**.

.....

.....

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

(iii) A hydrogen atom has a diameter of 2.4×10^{-10} m.

Calculate how many times larger the carbon nanotube is than the hydrogen atom.

Number of times larger = ... **[2]**

19 The table shows the type of bonding in three substances.

Substance	Type of bonding
Bromine, Br_2	simple molecular (covalent)
Sodium chloride, NaCl	ionic
Diamond, C	giant covalent

(a)* Describe and compare the types of bonding in these three substances.

Predict which substance will have the lowest melting point.

.....

.....

.....

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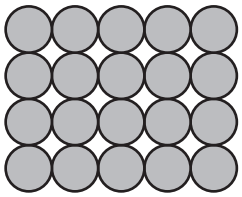
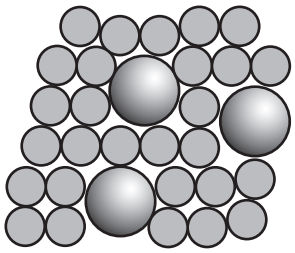
.....

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

(b) Titanium is a metal element. Metal **elements** can be mixed with other elements to form metal **alloys**.



Metal element



Metal alloy

(i) Explain why a metal alloy is harder than a metal element.

.....

.....

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

(ii) In medicine, titanium alloys are used in hip replacements.

The table shows some properties of alloys. Tensile strength is the amount of load a material can take before it breaks.

Alloy	Density (g/cm^3)	Tensile strength (MPa)	Does it contain any toxic elements?
1	4.43	950	yes
2	4.52	950	no
3	5.70	546	no

Which alloy would be best to use in a hip replacement?
Explain your answer.

Alloy .....

Reason .....

.....

.....

[3]

20 A teacher wants to make hydrogen and chlorine using electrolysis.

(a) Some **possible** steps they can use in the electrolysis experiment are listed.

1. Put test tubes over the electrodes to collect gases.
2. Weigh each electrode.
3. Put the electrodes into a solution of sodium chloride.
4. Put on safety goggles.
5. Connect the battery.
6. Put the electrodes into solid sodium chloride.

Put the **four** steps that the teacher should use in the correct order.

[3]

(b) Chlorine is in Period 3 and Group 7 of the Periodic Table.

Which statements about chlorine are **correct**?

Tick (✓) **two** boxes.

- Chlorine forms negative ions. ☐
- Chlorine has 3 electrons in its outer shell. ☐
- Chlorine has 7 electron shells. ☐
- Chlorine has 7 electrons. ☐
- Chlorine is a metal. ☐
- Chlorine is a non-metal. ☐

[2]

(c) The teacher sets up another electrolysis experiment using copper sulfate solution, $CuSO_4$.

The table shows their results.

Experiment	Mass of copper made (mg)	Volume of oxygen made (cm^3)
1	7.9	2.8
2	21.1	7.5
3	28.2	10.0
4	35.3	
5	42.4	14.9

(i) Estimate how much oxygen will be made in experiment **4**.

Volume of oxygen made = ... cm^3 **[1]**

(ii) Describe the relationship between the amount of copper made and the amount of oxygen made.

.....

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

(d) Copper sulfate solution is an electrolyte.

What type of compound is an electrolyte?

Tick (✓) **one** box.

Covalent ☐

Ionic ☐

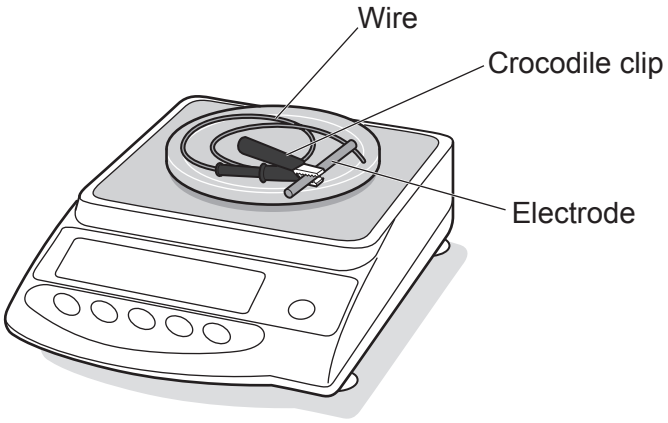
Molecular ☐

[1]

(e) Another teacher repeats the electrolysis experiment.

They record the mass of the electrode at the start of the experiment.

At the end of the experiment, they remove the electrode from the solution and record the mass **immediately** as shown in the diagram.



They notice that the mass is **higher** than they expect.

Suggest **two** changes the teacher could make to get a more accurate mass.

1 .....

.....

2 .....

.....

[2]

21 A scientist is studying acids and alkalis.

(a) Which statement about acids and alkalis is **correct**?

Tick (✓) **one** box.

A reaction between an acid and an alkali is neutralisation. ☐

Acids form OH^- ions in solution. ☐

Alkalis have a pH of less than 7. ☐

Sodium hydroxide, NaOH, is an example of an acid. ☐

[1]

(b) The scientist reacts sulfuric acid with insoluble magnesium carbonate, $MgCO_3$.

They repeat the experiment two more times.

The table shows their results.

	Experiment 1	**Experiment 2**	**Experiment 3**
Mass of magnesium sulfate, $MgSO_4$, produced (g)	4.37	4.31	4.38
Mass of magnesium carbonate, $MgCO_3$, remaining (g)	1.33	1.38	1.32

(i) Calculate the mean mass of magnesium sulfate, $MgSO_4$, made.

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

Mean mass of magnesium sulfate = ... g **[3]**

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

Include state symbols.

H_2SO_4 (aq) + $MgCO_3$(s) → $MgSO_4$(aq) + ... (.....) + ... (.....)

[2]

(iii) How does the scientist remove the unreacted solid magnesium carbonate, $MgCO_3(s)$?

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

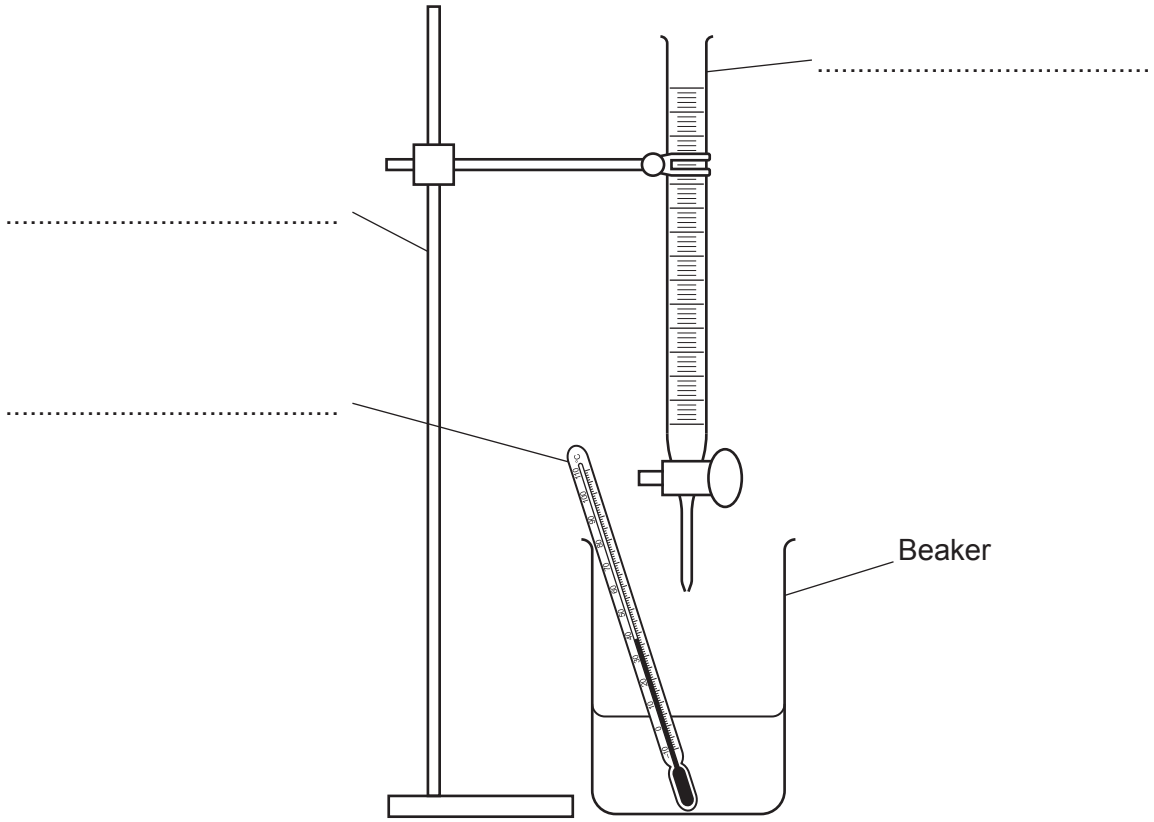
(iv) How does the scientist obtain **pure dry** magnesium sulfate crystals from magnesium sulfate solution?

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

22 **(a)** A student does an experiment to find out the temperature change of the reaction between an acid and an alkali.

The diagram shows the student's experiment.

(i) Label the equipment in the diagram.



[3]

(ii) Suggest **one** change the student can make so that the temperature change is measured more accurately. Use the diagram.

.....

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

(b) The student adds the acid, 5 cm^3 at a time, to the alkali in the beaker.

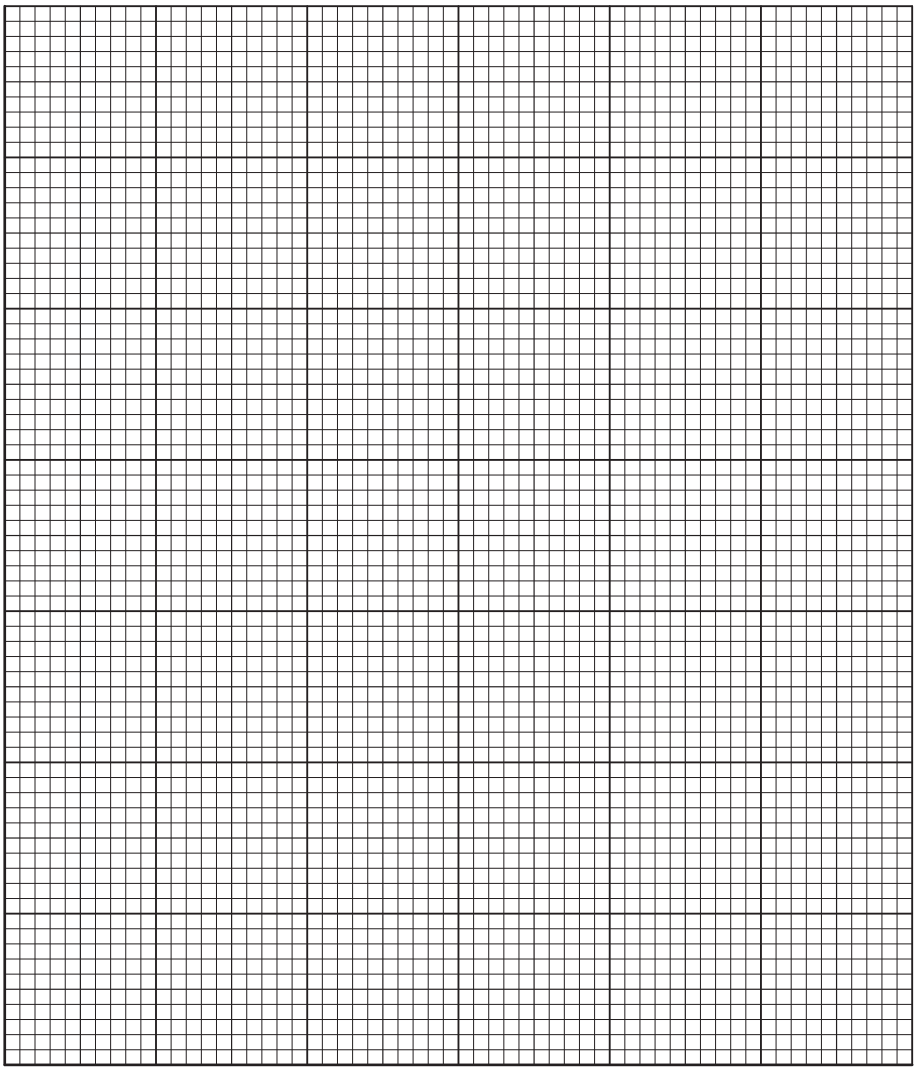
The student records the temperature of the solution after each addition of acid.

The table shows their results.

Volume of acid (cm^3)	Temperature (°C)
0	18
5	20
10	23
15	26
20	27
25	26
30	24

(i) Plot the results from the table on the grid.

Temperature (°C)



Volume of acid (cm^3)

[2]

(ii) Describe what happens to the temperature measured as the acid is added.

.....

.....

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

(iii) The reaction is exothermic.

Explain how you can tell this from the student's results.

.....

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

(c) The activation energy for the student's reaction is 132 kJ / mol.

Complete the sentence to state the meaning of activation energy.

Activation energy is the minimum .....

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

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).