OCR
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Tuesday 10 November 2020 – Morning

GCSE (9−1) Chemistry B (Twenty First Century Science)

J258/01 Breadth in Chemistry (Foundation Tier)

Time allowed: 1 hour 45 minutes

You must have:
- a ruler (cm/mm)
- the Data Sheet for GCSE (9–1) 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 **90**.
- The marks for each question are shown in brackets **[ ]**.
- This document has **28** pages.

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

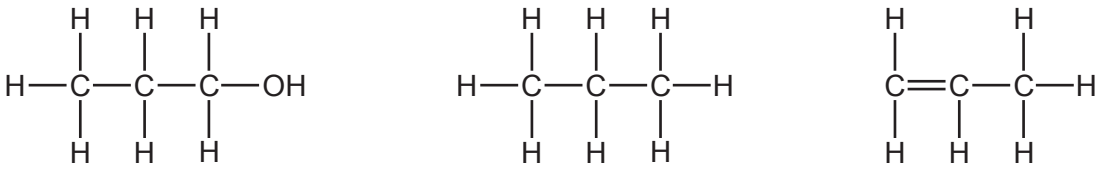
Answer **all** the questions.

1 Drinking cups can be made from poly(propene) or aluminium.

(a) Poly(propene) is made from propene. Propene has the structural formula $CH_3CH=CH_2$.

(i) Which is the correct displayed formula for propene?

Put a (ring) around the correct answer.



[1]

(ii) Complete **Fig. 1.1** to show the repeating unit of poly(propene).

Use **one** term from the list.

H **CH_3** **C_3H_6**

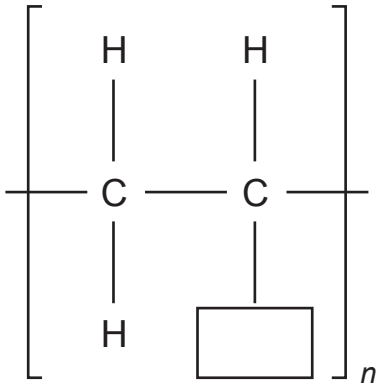


Fig. 1.1

[1]

(b) Aluminium has a metallic structure.

(i) Label the metallic structure shown in **Fig. 1.2** by completing the boxes.

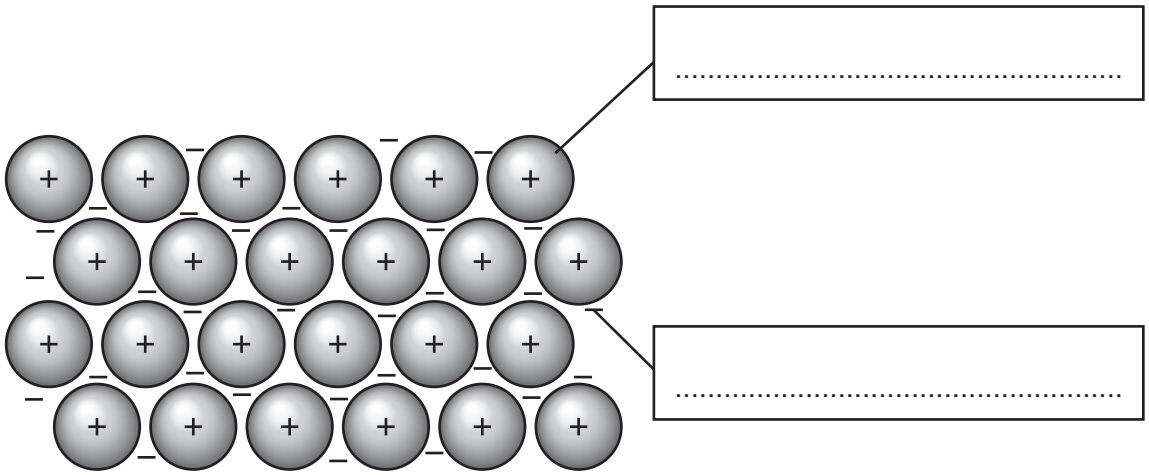


Fig. 1.2

[2]

(ii) Complete the sentence to explain why aluminium conducts electricity.

Aluminium conducts electricity because it contains ..... which can move. **[1]**

(c) Apart from cost, suggest **one** advantage of poly(propene) plastic drinking cups instead of aluminium metal drinking cups.

.....

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

2 **Fig. 2.1** shows how the average world temperature has changed since 1880.

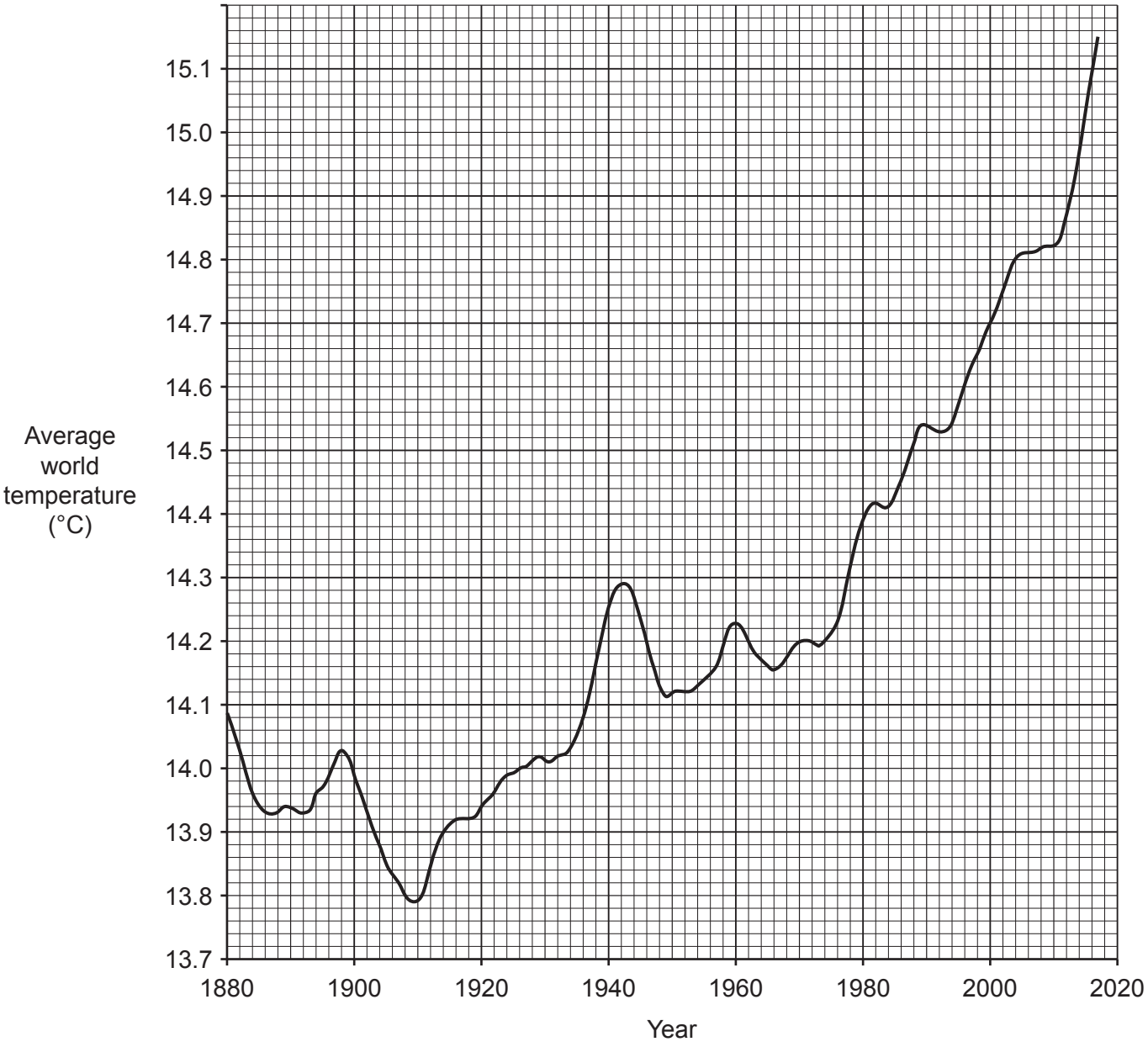


Fig. 2.1

(a) **(i)** Using **Fig. 2.1**, what was the temperature in 1910?

Temperature = ...°C **[1]**

(ii) Using **Fig. 2.1**, calculate the temperature rise between 1980 and 2000.

Temperature rise = ...°C **[2]**

(iii) Using **Fig. 2.1**, which **two** time periods show the **greatest** temperature rises?

Tick (✓) **two** boxes.

1890–1900 ☐

1910–1920 ☐

1920–1940 ☐

1980–2000 ☐

[2]

(b) Some scientists believe that world temperatures have increased due to increased amounts of greenhouse gases in the air.

(i) How do greenhouse gases increase world temperatures?

Tick (✓) **one** box.

They block out visible light from the Sun. ☐

They form a cover around the Earth. ☐

They absorb infrared radiation and re-emit it. ☐

They absorb visible light from the Earth. ☐

[1]

(ii) Carbon dioxide is a greenhouse gas.

Draw lines to connect **each** question with **one** correct answer.

Question	Answer
	People burning more fossil fuels.
What can directly increase the amount of carbon dioxide in the air?	People recycling less.
What can reduce the amount of carbon dioxide emissions into the air?	People changing to electric cars.
	People throwing away plastics.

[2]

3 Ethene is a gas.

The formula of ethene is C_2H_4.

(a) Name the **two** elements in ethene.

1 .....

2 ..... **[1]**

(b) What is the **empirical** formula of ethene?

Put a ring around the correct answer.

CH **CH_2** **C_2H_2** **C_2H_4**

[1]

(c) Which homologous series does ethene belong to?

Put a ring around the correct answer.

acids **alcohols** **alkanes** **alkenes**

[1]

(d) Ethene reacts with bromine water to make dibromoethane.

$C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$

Complete the sentences below to describe this reaction.

Use words from the list.

Each word can be used once, more than once or not at all.

addition **colourless** **single**

displacement **oxidised** **double**

This type of reaction is called ..... .

The bromine water becomes ..... .

Ethene reacts because it contains a ..... bond.

[3]

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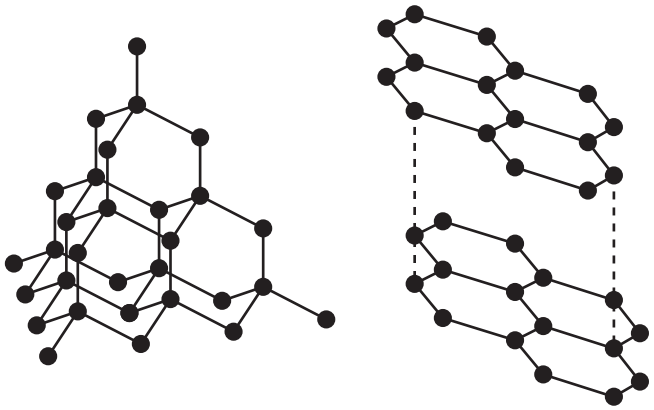
Turn over for the next question

4 Diamond and graphite are allotropes of carbon. They are both giant structures.

Fig. 4.1 shows models of diamond and graphite:



Diamond **Graphite**

Fig. 4.1

(a) (i) What do the black dots in **Fig. 4.1** represent?

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

(ii) Name the type of bond that is represented by the solid black lines in **Fig. 4.1**.

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

(b) **Fig. 4.2** shows a model of sodium chloride, which has a giant ionic lattice structure.

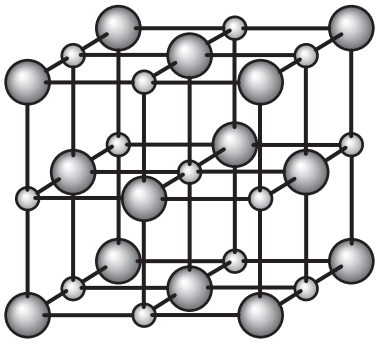


Fig. 4.2

Describe **one** similarity and **one** difference between the properties of sodium chloride and graphite.

Similarity .....

.....

Difference .....

.....

[2]

5 Lithium-ion batteries are used in phones, tablets and electric cars.

(a) Lithium reacts with chlorine and with bromine.

(i) Lithium is in Group 1. Chlorine and bromine are in Group 17.

Draw lines to connect each element with **one** correct property.

Element	Property
	Conducts electricity
Lithium (Group 1)	Unreactive
Chlorine (Group 17)	Colourless gas
	Green gas

[2]

(ii) 14 g of lithium reacts with 71 g of chlorine.

What mass of chlorine reacts with 5.6 g of lithium?

Mass of chlorine = ... g **[2]**

(iii) Jack reacts lithium with chlorine. He then reacts lithium with bromine.

Describe how the rates of these two reactions are different.

.....

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

(b) Lithium is made by the electrolysis of molten lithium chloride.

Which substance is formed at each electrode?

Put a ring around each correct answer.

Anode (positive electrode): **chloride** **chlorine** **hydride** **hydrogen**

Cathode (negative electrode): **oxide** **oxygen** **lithium**

[2]

(c) Lithium-ion batteries contain chemical cells.

Which statement is the correct definition for a chemical cell?

Tick (✓) **one** box.

A chemical cell produces its full potential difference but the potential difference then quickly decreases. ☐

A chemical cell takes a long time to get to its full potential difference. ☐

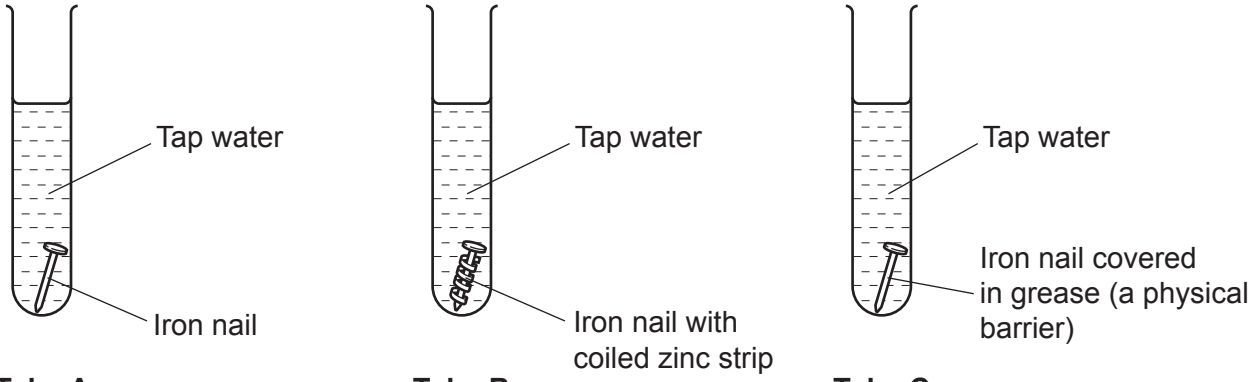
A chemical cell produces a potential difference that lasts for a short time. ☐

A chemical cell produces a potential difference until the reactants are used up. ☐

[1]

6 Iron is an important metal in the construction industry. The main disadvantage of iron is that it rusts.

Mia investigates the rusting of iron, using iron nails. She has three test tubes, **Tube A**, **Tube B** and **Tube C**.



Tube A **Tube B** **Tube C**

(a) (i) The iron nail in **Tube B** rusts much more slowly than the iron nail in **Tube A**.

Explain why.

.....

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

(ii) Mia compares **Tube A** with **Tube C**.

Complete the sentence using **one** of the phrases below.

faster than **more slowly than** **at the same rate as**

The iron nail in **Tube C** rusts .....the iron nail in **Tube A**. **[1]**

(iii) Explain your answer to **(a)(ii)**.

.....

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

(b) Mia collects the rust. She dissolves the rust in hydrochloric acid and adds some sodium hydroxide solution.

She sees a brown precipitate.

What is the name of this brown precipitate?

Tick (✓) **one** box.

Iron(III) chloride ☐

Iron(II) hydroxide ☐

Iron(III) hydroxide ☐

Sodium chloride ☐

[1]

(c) Mia now reacts an iron nail with hydrochloric acid.

Write a **word** equation for this reaction.

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

7 Amir has a sample of a salt, **Salt A**, that is used as a fertiliser.

He does some tests to find out which elements are in the salt.

(a) (i) Amir finds that **Salt A** contains positive potassium ions.

Which colour flame does Amir see when he does a flame test?

Put a (ring) around the correct answer.

green **lilac** **red** **yellow**

[1]

(ii) Potassium is an element. It is an essential nutrient for plants.

Name **one** other element that is an essential nutrient for plants.

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

(b) Amir thinks **Salt A** is potassium sulfate.

Potassium sulfate contains K^+ ions and SO_4^{2-} ions.

What is the chemical formula of potassium sulfate?

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

(c) Amir tests **Salt A** to check it is potassium sulfate.

He dissolves some of **Salt A** in water and adds barium chloride solution.

Barium sulfate is formed.

(i) Describe the **colour** and **state** of the barium sulfate formed.

.....

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

(ii) Complete the word equation for the reaction.

potassium sulfate + barium chloride $\longrightarrow$ barium sulfate + ...

[1]

(d) Amir tests another unknown salt, **Salt B**, by looking at its emission spectrum.

Some emission spectra are shown in **Fig. 7.1**:

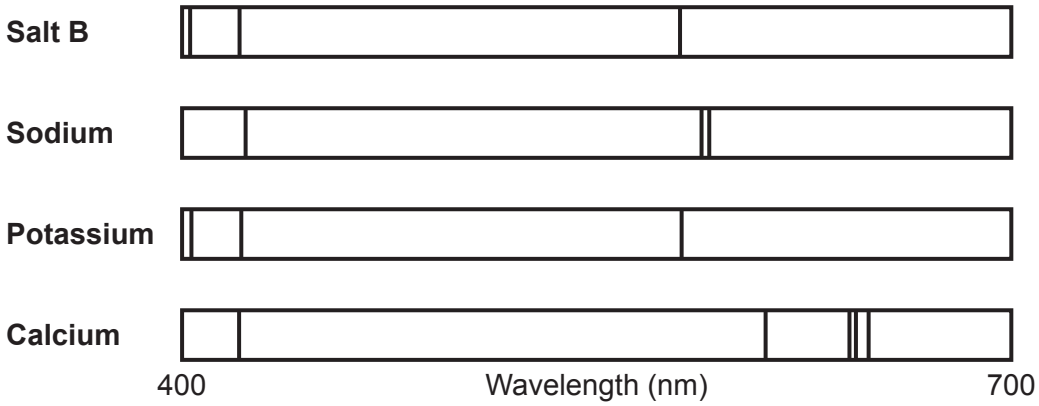


Fig. 7.1

(i) Using **Fig. 7.1**, name the metal ion in **Salt B**.

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

(ii) Convert 400 nm to metres.

Give your answer in **standard form**.

1 nm = 1×10^{-9} m

400 nm = ... m **[1]**

(e) Elements can be identified using flame tests or by comparing emission spectra.

Amir uses the internet to compare each method:

	Flame test	**Emission spectra**
Equipment cost	£10.15	£11 500
Sensitivity	Low	High
Speed	High	High
Accuracy	Low	High

Amir is given 0.01 g of a compound to analyse.

Amir decides to use a flame test rather than comparing emission spectra.

Give **one** advantage and **one** disadvantage of using a flame test rather than comparing emission spectra.

Advantage .....

.....

Disadvantage .....

.....

[2]

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Turn over for the next question

8 Titanium is used for hip replacements.

(a) Which term describes titanium?

Put a ring around the correct answer.

Group 1 metal **Group 7 element** **alloy** **transition metal**

[1]

(b) Titanium, Ti, can be made from titanium oxide by **two** methods.

Method 1 uses magnesium which reacts with titanium oxide:

$$2Mg + TiO_2 \longrightarrow Ti + 2MgO$$

Complete the sentences below, by putting a ring around the correct answers.

Use the symbol equation in **Method 1** to help you.

Magnesium is more reactive than **titanium oxide** / **titanium** / **magnesium oxide** .

Magnesium reduces **titanium oxide** / **titanium** / **magnesium oxide**

to **titanium oxide** / **titanium** / **magnesium oxide** .

[3]

(c) Calculate the relative formula mass of magnesium oxide (MgO).

Use the Periodic Table.

Relative formula mass = ... **[1]**

(d) Calculate the percentage of magnesium in magnesium oxide (MgO).

Use relative formula mass of magnesium = 24.

Percentage of magnesium = ... % **[2]**

(e) **Method 2** uses electrolysis to make titanium:

$$TiO_2 \rightarrow Ti + O_2$$

Method 2 has a higher atom economy than **Method 1**.

(i) Some relative formula masses are given in the table.

Formula	Ti	O_2	TiO_2
Relative formula mass	47.9	32.0	79.9

Calculate the atom economy for **Method 2**.

Use the data from the table.

Use the formula: atom economy = $\frac{\text{mass of atoms in desired product}}{\text{total mass of atoms in reactants}} \times 100\%$

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

Atom economy = ... % **[3]**

(ii) Look at the equations again for **Method 1** and **Method 2**.

Method 1: $2Mg + TiO_2 \rightarrow Ti + 2MgO$

Method 2: $TiO_2 \rightarrow Ti + O_2$

Explain why **Method 2** has a higher atom economy than **Method 1**.

.....

.....

.....

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

(f) Magnesium oxide (MgO) is formed in **Method 1**.

(i) **Fig. 8.1** shows the 'dot and cross' diagrams for a magnesium (Mg) atom and an oxygen (O) atom.

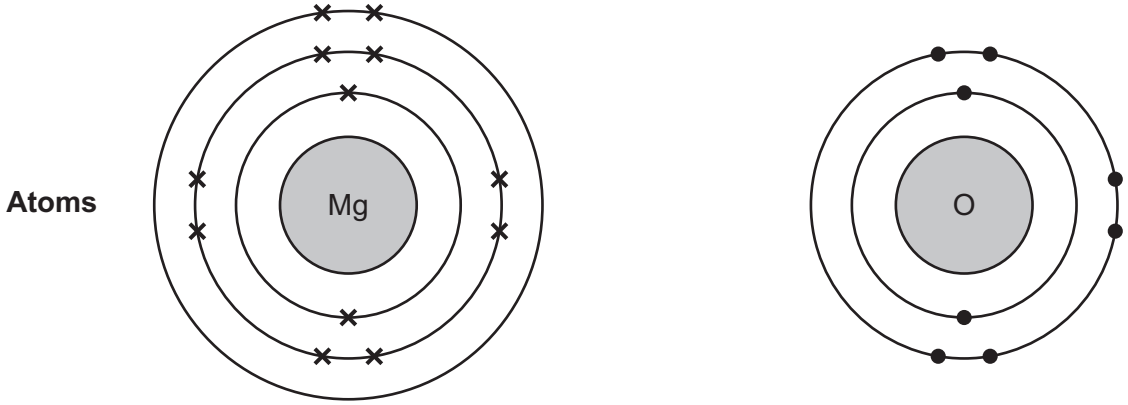

Fig. 8.1

Complete **Fig. 8.2** to show the 'dot and cross' diagrams for an Mg^{2+} ion and an O^{2-} ion.

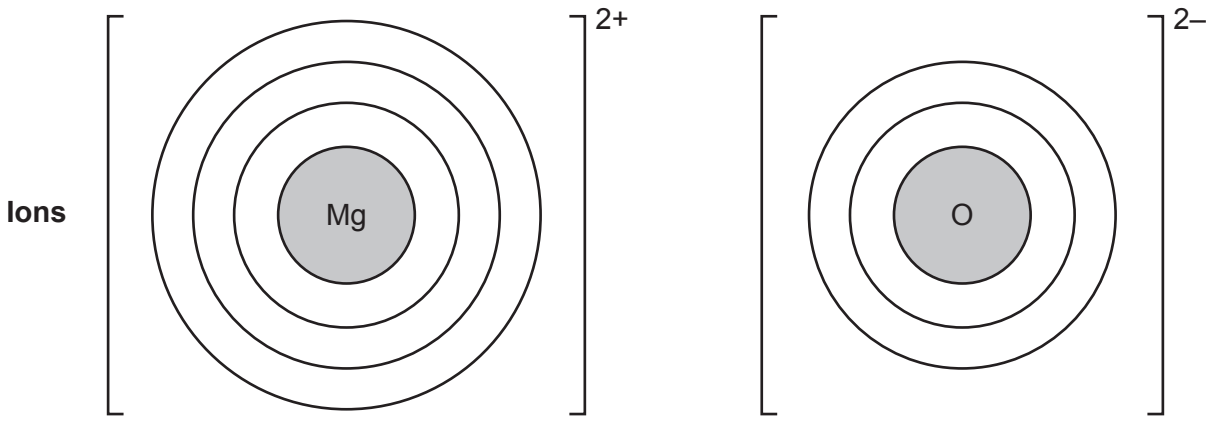

Fig. 8.2

[2]

(ii) Magnesium oxide can be formed by burning magnesium in oxygen.

Complete the balanced symbol equation for this reaction.

…… Mg + O_2 → …… MgO

[1]

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Turn over for the next question

9 Ammonia is used to make synthetic fertilisers.

(a) Ammonia is manufactured in the Haber process.

$N_2 + 3H_2 \rightleftharpoons 2NH_3$

Which statements about this reaction are **true** and which are **false**?

Tick (✓) **one** box in each row.

	True	**False**
2 moles of nitrogen react with 3 moles of hydrogen.		
The reaction reaches a 100% yield.		
At equilibrium, the forward reaction is faster than the backward reaction.		

[3]

(b) Sundip makes ammonium sulfate from a solution of ammonia in the laboratory.
The method is shown below but is **not** in the correct order.

Write a number from **1–6** in each box to give the correct order for the steps of the method.

Step	**Method**
	Wait for the crystals to form after the solution has cooled down.
	Slowly evaporate the solution until most of the solution has gone.
	Wash and dry the crystals.
	Put some sulfuric acid in a beaker.
	Add ammonia until the solution is alkaline.
	Filter the solution.

[2]

(c) Sundip makes 9.9 g of ammonium sulfate.

The maximum mass of ammonium sulfate she could have made is 13.2 g.

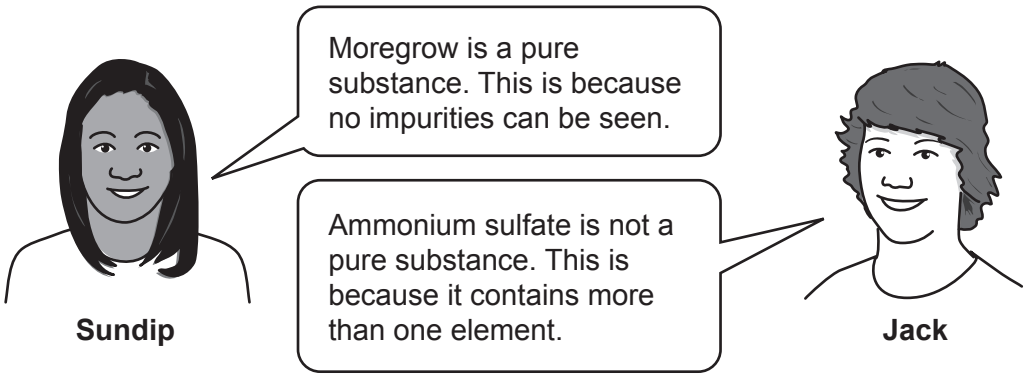
Calculate the percentage yield.

Use the formula: percentage yield = $\frac{\text{mass made}}{\text{maximum mass}} \times 100\%$

Percentage yield = ... % **[2]**

(d) Ammonium sulfate is mixed with other compounds to make the fertiliser Moregrow. Moregrow is a white powder.

Sundip and **Jack** talk about the compounds in Moregrow:



Do you agree with each person's comments?

Give **one** reason for each of your answers.

Sundip .....

.....

.....

Jack .....

.....

.....

[2]

10 Layla does a titration to find out the concentration of some sodium hydroxide solution. She reacts hydrochloric acid with the sodium hydroxide solution.

(a) Layla says, 'The titration uses a **neutralisation** reaction.'

Define a neutralisation reaction.

.....

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

(b) This is Layla's **incomplete** method for the titration:

- Put the hydrochloric acid in a burette.
- Put the sodium hydroxide solution in a flask.
- Add the hydrochloric acid to the sodium hydroxide solution.
- Stop adding the hydrochloric acid when the sodium hydroxide solution is neutralised.

(i) Layla needs to add another substance to the flask so that she knows when to stop adding the hydrochloric acid.

Which substance does Layla need to add, **and** what will she see?

Layla needs to add .....

Layla will see ..... **[2]**

(ii) Layla titrates the hydrochloric acid into a flask from a burette. She wants to make sure her final burette reading is as **accurate** as possible.

Describe **one** thing Layla can do to make her reading as accurate as possible.

.....

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

(c) (i) Layla's results for her rough titration are shown in **Table 10.1.**

Complete **Table 10.1** by calculating the volume for the rough titration.

	Rough titration
Initial burette reading (cm^3)	0.90
Final burette reading (cm^3)	25.80
Volume for the rough titration (cm^3)	.....

Table 10.1

[1]

(ii) Layla's repeat readings for her careful titrations are shown in **Table 10.2**.

	First titration	Second titration	Third titration	Fourth titration
Volume (cm^3)	24.55	24.95	24.65	24.60

Table 10.2

Layla calculates that the mean titration volume is 24.60 cm^3.

Explain why Layla is correct.

Use the information in **Table 10.2** and a calculation in your answer.

.....

.....

.....

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

(iii) Calculate the mass of acid in 1 cm^3 of hydrochloric acid.

Use the formula: mean titration volume = $\frac{0.0908}{\text{mass of acid in 1 cm}^3 \text{ of hydrochloric acid}}$

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

Mass of acid in 1 cm^3 of hydrochloric acid = ... g **[4]**

11 Beth has some tablets that react by fizzing, and then dissolving, when water is added.

Beth puts a whole tablet into **Tube A**, and a broken-up tablet into **Tube B**.

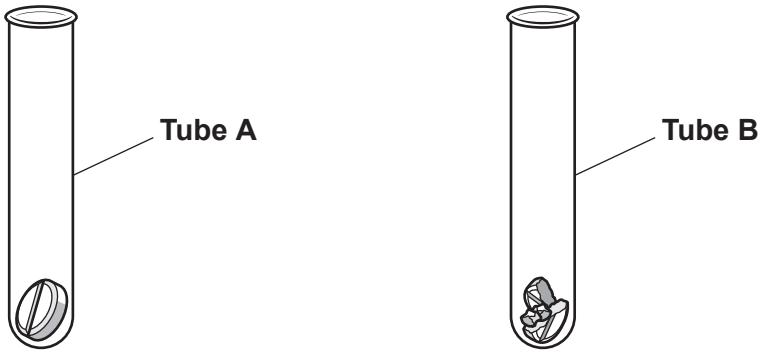


Fig. 11.1

(a) Beth wants to measure the rate of the two reactions. This is Beth's method:

- Add the same volume of **cold** water to each test tube at the same time.
- Start a stopwatch.

(i) When should Beth stop the stopwatch?

Tick (✓) **one** box.

When the bubbles start to appear. ☐

When the fizzing starts. ☐

When the fizzing stops. ☐

When only a small amount of tablet is left. ☐

[1]

(ii) Which type of tablet, whole or broken-up, will dissolve more quickly?

Whole tablet ☐

Broken-up tablet ☐

Explain your answer.

Use ideas from the particle model in your answer.

.....

.....

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

(b) Suggest **one** reason why the reactions are much faster using **hot** water.

.....

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

(c) **Fig. 11.2** shows how the mass of **Tube A** and its contents changes over time when cold water is added.

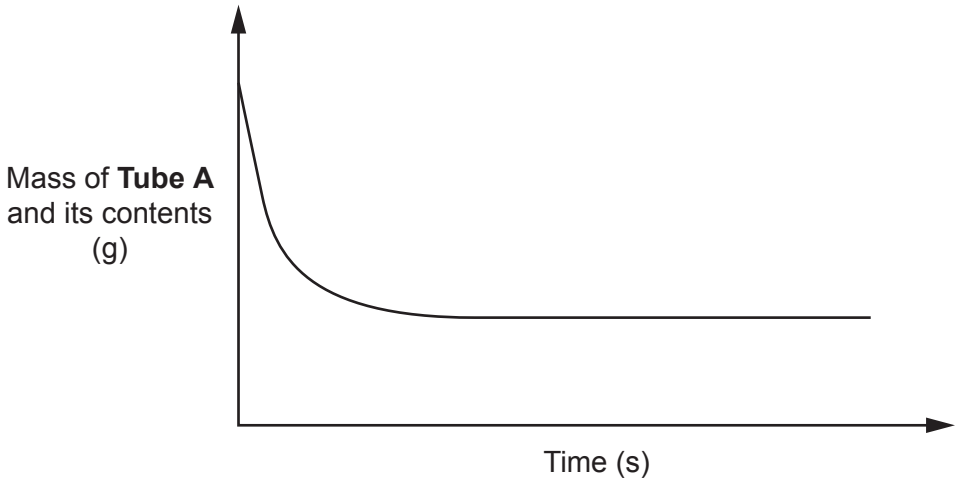


Fig. 11.2

(i) Using **Fig. 11.2**, explain why the mass of **Tube A** and its contents decreases during the reaction.

.....

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

(ii) The rate of the reaction decreases with time.

Describe how **Fig. 11.2** shows this.

.....

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

(iii) Explain why the rate of reaction decreases with time.

.....

..... **[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).