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Friday 20 November 2020 – Morning

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

J258/02 Depth 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:
- a scientific or graphical calculator
- an HB pencil

J258/02

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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 **[ ]**.
- 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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Answer **all** the questions.

1 **Fig. 1.1** shows the dot and cross diagrams for some molecules.

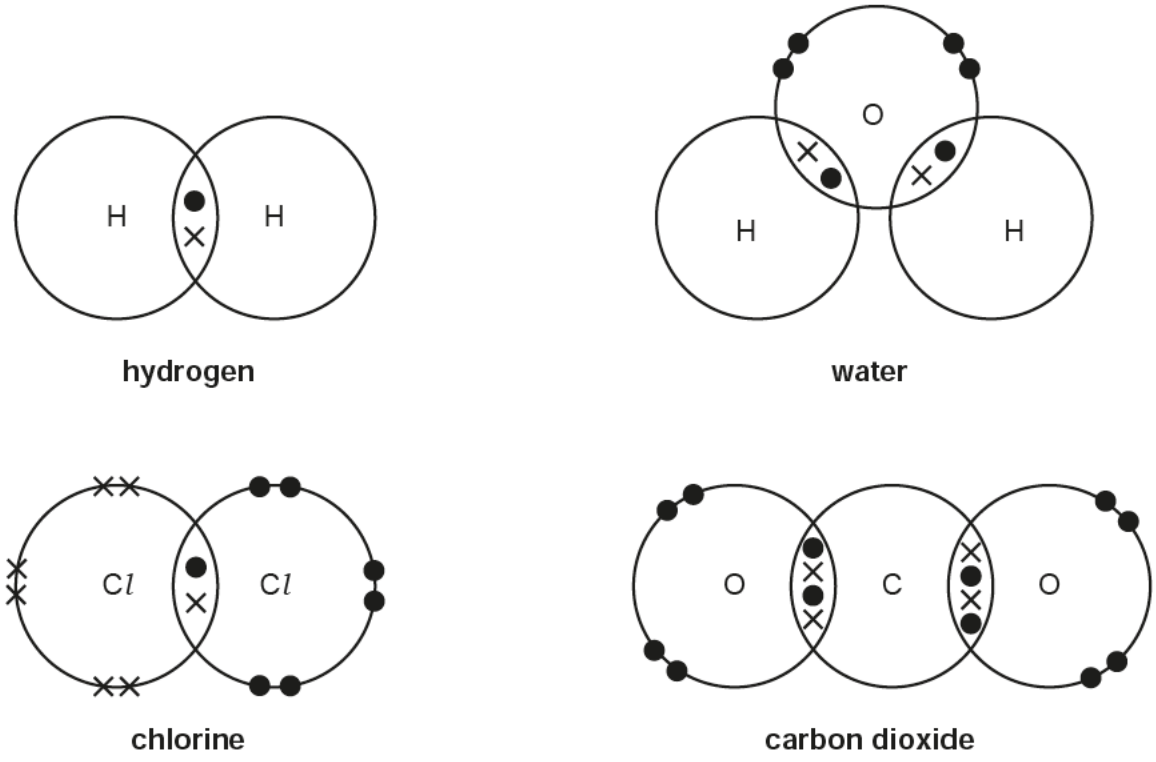

Fig. 1.1

(a) Which molecules are elements and which are compounds?

Tick (✓) **one** box in each row.

	Element (✓)	**Compound (✓)**
carbon dioxide		
chlorine		
hydrogen		
water		

[2]

(b) How do the dot and cross diagrams in **Fig. 1.1** show that all of these molecules are simple covalent?

Tick (✓) **two** boxes.

- They are all gases. ☐
- They bond by sharing electrons. ☐
- They contain only a few atoms. ☐
- They have electrons in their outer shells. ☐

[2]

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(c) How does the dot and cross diagram in **Fig. 1.1** show that carbon dioxide has double bonds?

.....

.....

.....

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

(d) Using **Fig. 1.1**, complete the table to show how many bonds each atom forms.

Atom	Number of bonds
hydrogen	.....
oxygen	2
carbon	.....
chlorine	.....

[2]

(e) Argon is a gas. The arrangement of electrons in the outer shell of argon is shown in **Fig. 1.2**.

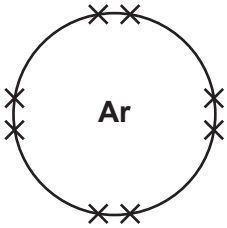

Fig. 1.2

Explain **how** and **why** argon is different to the simple covalent molecules shown in **Fig. 1.1**.

.....

.....

.....

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

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2 Nina works for a company that makes pH meters.

She makes up four solutions **A**, **B**, **C** and **D**. Each solution has a different, known pH.

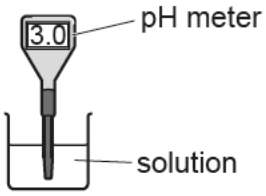
Table 2.1 shows the pH of each solution.

Solution	pH
A	3.0
B	9.0
C	1.0
D	7.0

Table 2.1

(a) Nina tests three pH meters to find out if they measure pH accurately.

She uses the three pH meters to measure the pH of solutions **A**, **B**, **C** and **D**. She dips each pH meter into each solution and takes a reading.



(i) Nina washes each pH meter between readings.

Explain why it is important that she does this.

.....

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

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(ii) **Table 2.2** shows Nina's results.

Solution	actual pH	pH meter 1 reading	pH meter 2 reading	pH meter 3 reading
A	3.0	3.1	3.0	3.3
B	9.0	9.1	9.0	9.1
C	1.0	0.9	1.0	1.1
D	7.0	6.8	7.0	6.7

Table 2.2

Nina decides that the pH meter gives accurate readings if all of its pH readings are within **+/−0.2** of the actual pH.

Tick (✓) **one** box in each column to show whether each pH meter gives **accurate** or **inaccurate** readings.

	pH meter 1 (✓)	pH meter 2 (✓)	pH meter 3 (✓)
Accurate			
Inaccurate			

[2]

(b) **(i)** Nina wants to use another method to measure pH.

What other method could she use to measure pH?

Tick (✓) **one** box.

Do a titration. ☐

Test with litmus paper. ☐

Test any gases given off with lime water. ☐

Use Universal Indicator. ☐

[1]

(ii) Explain why scientists often use more than one method to collect results when they do experiments.

.....

.....

.....

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

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3 Crude oil is a mixture of mainly alkanes.

All alkanes have this general formula:

$$C_nH_{2n+2}$$

(a) Explain how this formula shows that alkanes are **hydrocarbons**.

.....

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

(b) Crude oil also contains a small amount of other molecules that are **not** alkanes.

The table shows the formulae of three molecules in crude oil.

Formula of molecule
C_8H_{18}
C_3H_8S
C_6H_{12}

Put a (ring) around the correct answer to show whether each molecule **is** or **is not** an alkane.

Explain your answers.

Use the general formula for alkanes to help you.

C_8H_{18} **is** / **is not** an alkane

because .....

.....

C_3H_8S **is** / **is not** an alkane

because .....

.....

C_6H_{12} **is** / **is not** an alkane

because .....

.....

[3]

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4 Beth does an experiment to measure the rate of reaction between zinc pieces and dilute hydrochloric acid.

(a) When dilute hydrochloric acid reacts with zinc a gas is made.

This is the word and symbol equation for the reaction between zinc and dilute hydrochloric acid.

zinc + hydrochloric acid → zinc chloride + a **gas**

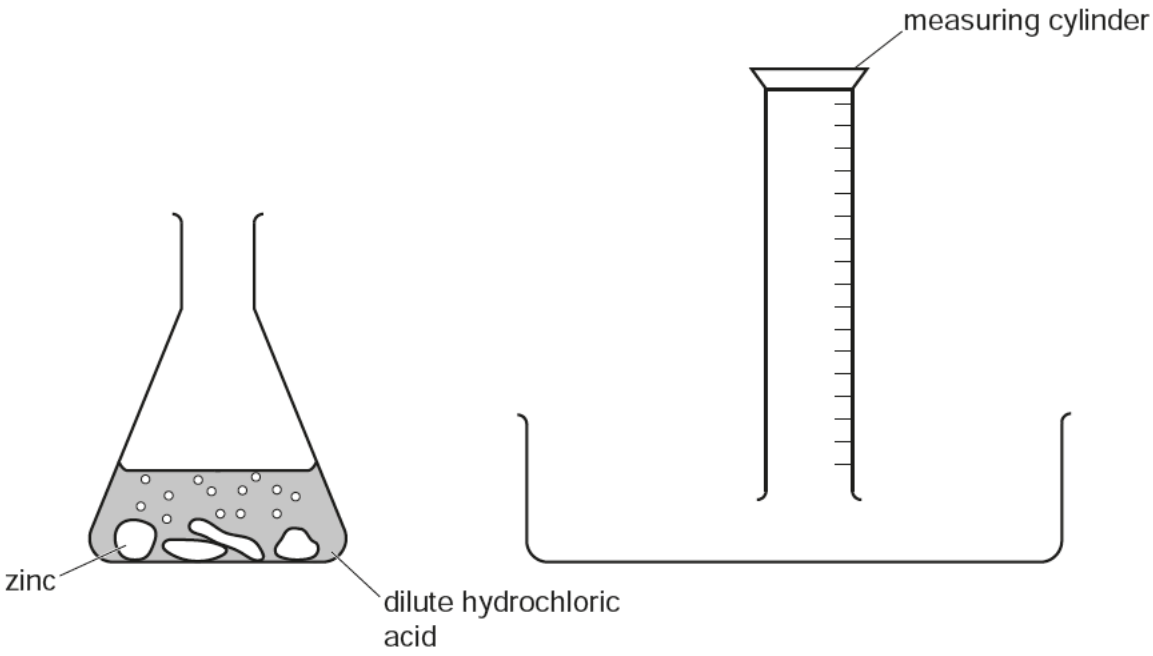
$Zn + 2HCl \rightarrow ZnCl_2 +$ a **gas**

What is the name of the **gas** that is made in this reaction?

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

(b) Beth uses this apparatus to collect and measure the amount of gas that is made.

Complete the diagram to show how the gas is collected.



[2]

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(c) Beth does a control experiment first. She then repeats her experiment three times.

For each experiment, she measures the time taken for 50.0 cm^3 of gas to be made.
She changes one variable for each experiment.

Table 4.1 shows her results.

Experiment	What variable has changed?	How has the variable changed?	Time taken for 50.0 cm^3 gas to be made (s)
1 (control)			75
2	Concentration of Acid	higher concentration of acid (2.0 mol/dm^3)	34
3	Temperature	higher temperature (40 °C)	10
4	Surface Area	greater surface area (small pieces of zinc)	23

Table 4.1

(i) What conclusions can you make about the effects of changing **each** variable on the rate of the reaction?

Use the data in **Table 4.1** to explain your reasons.

Concentration of Acid .....

.....

Temperature .....

.....

Surface Area .....

.....

[3]

(ii) What conditions did Beth use for her **control** experiment?

Put a (ring) around **one** condition in **each** row.

Use the data in **Table 4.1** to help you.

Concentration of Acid:	**1.0 mol/dm^3**	**2.0 mol/dm^3**	**3.0 mol/dm^3**
Temperature:	**20 °C**	**40 °C**	**60 °C**
Surface Area:	**powdered zinc**	**small pieces of zinc**	**large pieces of zinc**

[3]

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(d) Beth repeats her control experiment, but now adds a small amount of catalyst to the reaction mixture.

How does adding a catalyst affect the reaction?

Tick (✓) **two** boxes.

The time taken to collect the gas will be….

- >75 s. ☐
- <75 s. ☐
- $=75$ s. ☐

The activation energy for the reaction will….

- increase. ☐
- stay the same. ☐
- decrease. ☐

[2]

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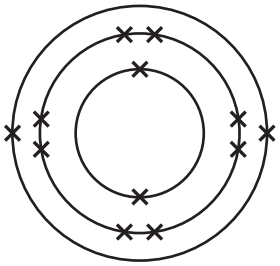
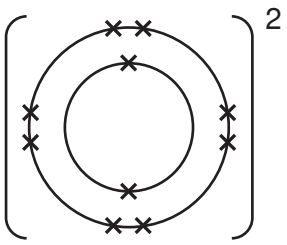
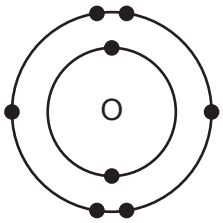
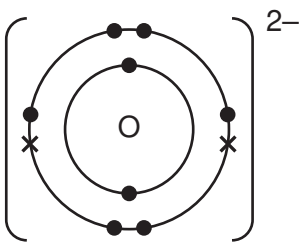
5 Magnesium oxide has ionic bonding. When ionic bonds form, electrons pass from one atom to another to form ions.

The diagrams show the arrangement of electrons in the **atoms** and **ions** of magnesium oxide.

Magnesium oxide MgO	
Atoms (before bonding)	**Ions (after bonding)**
magnesium atom 	magnesium ion 
oxygen atom 	oxygen ion 

(a)* Describe how magnesium and oxygen atoms form ions, and explain the charges on each ion.

Use ideas about electrons and electron shells in your answer.

.....

.....

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.....

.....

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

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(b) The table shows the melting point and boiling point of magnesium oxide and some other oxides.

	Melting point (°C)	**Boiling point** (°C)
Magnesium oxide	2852	3600
Carbon monoxide	−205	−192
Water	0	100

(i) Room temperature is 20 °C.

Draw lines to connect each **oxide** with its correct **state** and **state symbol** (at room temperature).

Oxide	**State**	**State symbol**
magnesium oxide	gas	(s)
carbon monoxide	liquid	(l)
water	solid	(g)

[2]

(ii) Complete the sentences to explain the differences between the melting points of the three oxides.

Use words from the list.

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

magnesium oxide	**strong**
carbon monoxide	**covalent**
water	**ionic**
weak	**intermolecular**

The oxide with the highest boiling point is .....

The oxide with the lowest melting point is .....

The melting point is low because the forces between molecules are very .....

These forces are called ..... forces.

The type of bonding between atoms in carbon monoxide and water is

..... .

[3]

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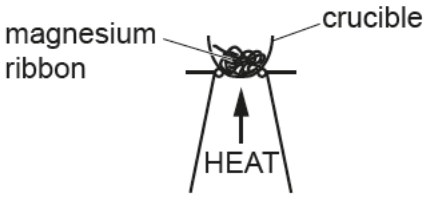
6 Eve heats magnesium ribbon in a crucible.



(a) Complete the word equation and balance the symbol equation for the reaction that happens in the crucible.

magnesium + ... → magnesium oxide

.....Mg + O_2 → .....MgO

[2]

(b) Eve writes down the mass of the empty crucible, and the mass of the crucible and magnesium oxide at the end of the experiment.

She also works out how much magnesium oxide she expects to make (her **theoretical yield**).

Mass of empty crucible (g)	17.9
Mass of crucible and magnesium oxide at the end of the experiment (g)	21.6
Mass of magnesium oxide formed (g)	.....
Theoretical yield of magnesium oxide (g)	4.0

Table 6.1

(i) Complete **Table 6.1** by calculating the mass of magnesium oxide formed in Eve's experiment.

[1]

(ii) Eve works out her percentage yield, using the equation:

$$\textbf{percentage yield} = \frac{\textbf{mass of magnesium oxide formed}}{\textbf{theoretical yield of magnesium oxide}} \times 100\ \%$$

Calculate the percentage yield in Eve's experiment.

Use the data in **Table 6.1**, and the equation provided.

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

Percentage yield = ... % **[3]**

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(c) Eve does some more experiments.

She measures the mass of magnesium oxide formed when different masses of magnesium are heated.

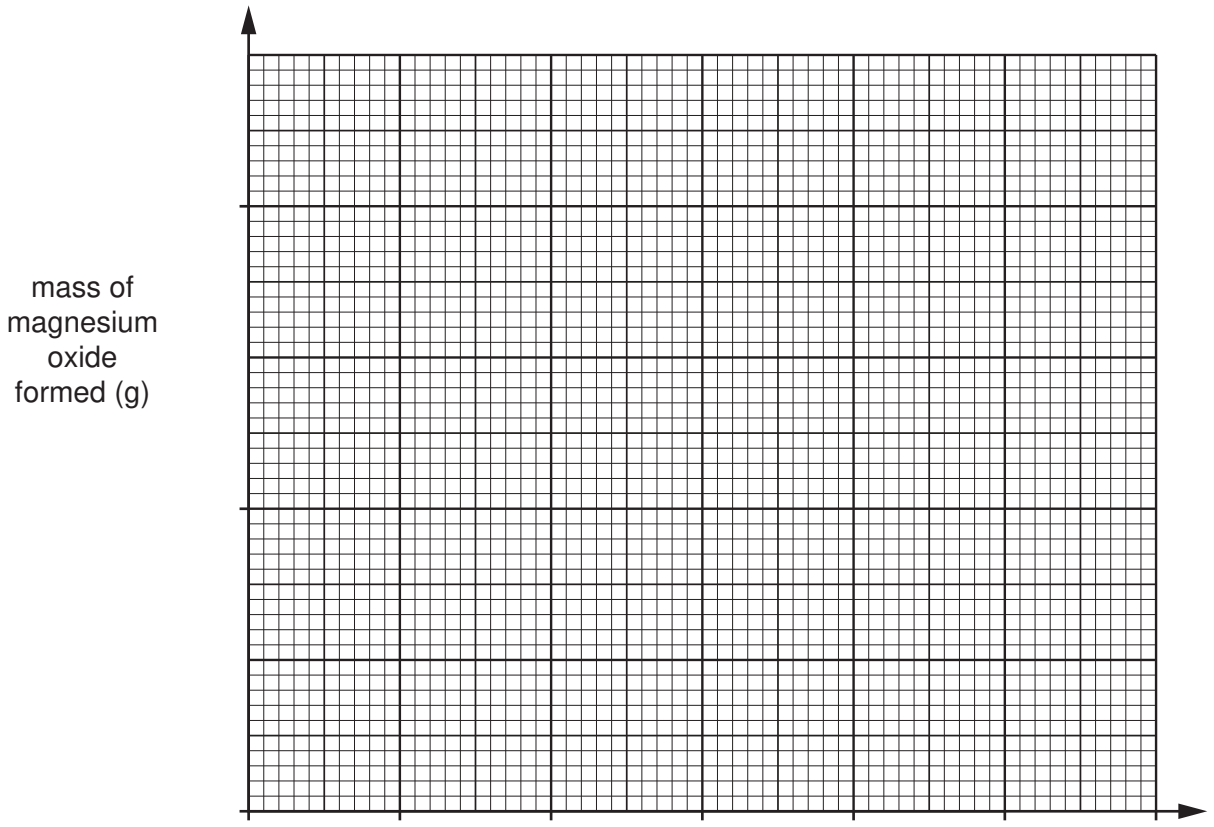
Experiment	Mass of magnesium heated (g)	Mass of magnesium oxide formed (g)
1	0.5	0.8
2	1.0	1.3
3	1.5	2.4
4	2.0	3.2
5	2.5	4.0

Table 6.2

(i) Plot a graph of magnesium oxide formed against mass of magnesium heated.

Use the data in **Table 6.2**.

You should include on your graph:
- an appropriate scale for your axes
- a line of best fit.



[4]

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(ii) Eve thinks that she wrote down the results for one of her experiments before the reaction had fully finished.

Suggest which reaction had not fully finished.

Use your graph to explain your answer.

Reaction .....

Explanation .....

.....

[2]

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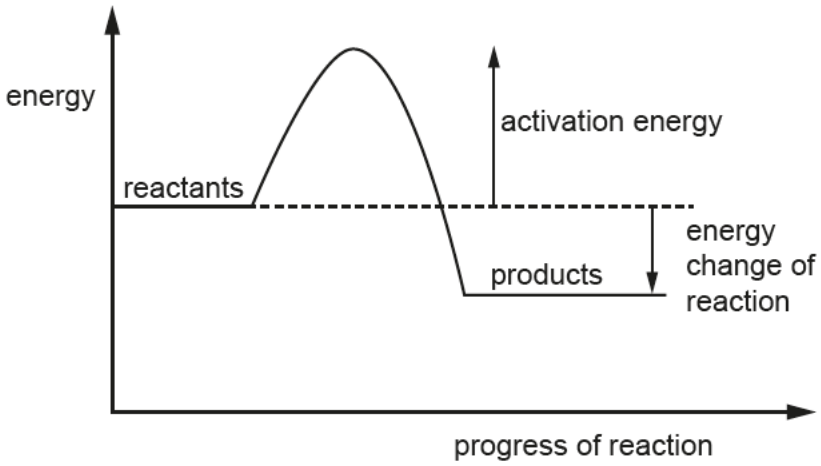
7 Drain cleaner removes blockages in shower drains.

Drain cleaner contains solid sodium hydroxide.

An exothermic reaction happens when the solid sodium hydroxide dissolves in water in the drain. This helps to clear the blockage.

The diagram shows the energy change of the reaction when solid sodium hydroxide dissolves in water.



(a) How does the diagram show that this reaction is **exothermic**?

Tick (✓) **two** boxes.

Energy is taken in at the start of the reaction. ☐

The activation energy is very large. ☐

The energy change of the reaction is negative. ☐

The energy change of the reaction is small. ☐

The reactants have more energy than the products. ☐

[2]

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(b) (i) Kai does an experiment to prove that when solid sodium hydroxide dissolves in water, an **exothermic** reaction happens.

Write an outline plan for Kai's experiment.

The plan should include:
- what Kai should **do**
- what **measurements** he should make
- what **results** he should expect.

.....

.....

.....

.....

.....

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

(ii) This is the hazard warning symbol for solid sodium hydroxide.

Kai wears gloves and goggles when he does his experiment.

Explain why these are necessary.

.....

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

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8 A company sets up three monitoring stations to measure the concentration of sulfur dioxide in the air around a coal-fired power station.

(a) Why does the company set up three monitoring stations rather than only one?

.....

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

(b) There is a motorway with a lot of traffic near the power station.

The company makes sure that the monitoring stations are **not** set up near the motorway.

(i) Explain **one** reason why this is important.

.....

.....

.....

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

(ii) Suggest **one other** factor the company should consider when deciding where to set up the monitoring stations.

.....

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

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(c)* The power station burns the same amount of coal every day.

The table shows the mean concentration of sulfur dioxide in the air and the weather conditions near the power station over 6 days.

Day	Mean concentration of sulfur dioxide in the air (g/m^3)	Weather conditions
Monday	24	dry, sunny, no wind
Tuesday	24	dry, cloudy, no wind
Wednesday	13	dry, windy
Thursday	15	light rain, no wind
Friday	9	light rain, windy
Saturday	3	heavy rain

Describe how the concentration of sulfur dioxide in the air changes over the week, and suggest reasons for the changes.

Use the information in the table to support your answer.

.....

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.....

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

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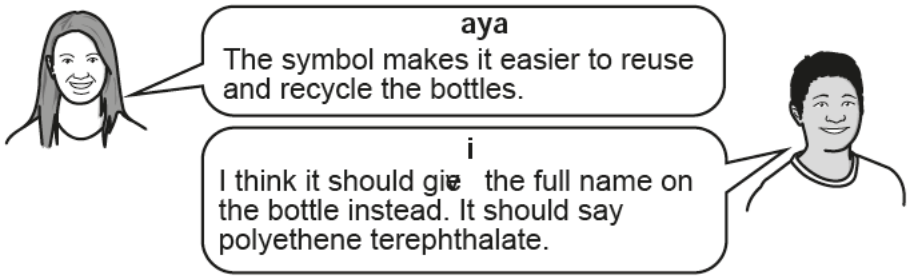
9 Mixed plastic waste contains drinks bottles made from a polymer known as PET (polyethene terephthalate).

Bottles made from PET have this symbol on the bottle.

(a) Amaya and Li discuss the PET symbol.



Do you agree with each person's comments?

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

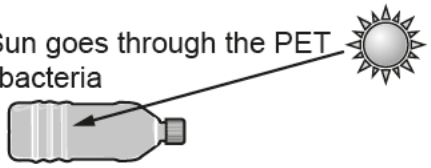
Amaya .....

.....

Li .....

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

(b) In some countries, waste PET bottles are used to treat water to make it safe for drinking. They are washed and dried first, and then filled with water and left in the Sun.



(i) If glass bottles are used instead of PET bottles, the bacteria are not killed.

Suggest why bacteria in water in a glass bottle are not killed.

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

(ii) In the UK, bacteria in drinking water are killed by adding a substance to the water.

Name this substance.

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

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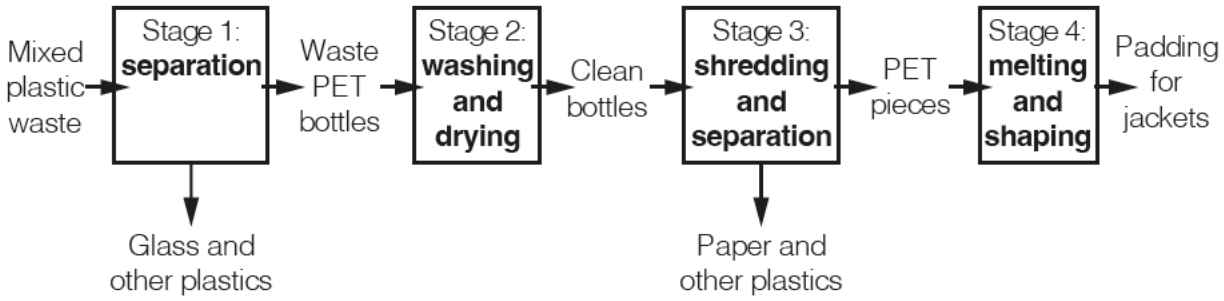
(c) Waste PET bottles can also be processed to be remade into polymers for new products.

The flowchart shows how mixed plastic waste is processed to produce padding for jackets.



(i) Which stage of the flowchart produces pure PET?

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

(ii) Waste PET bottles that are used to treat water are removed from the process before the end.

After which stage should bottles that are used to treat water be removed?

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

(d) Using waste PET bottles to treat water or to make padding for jackets are two examples of ways to reduce mixed plastic waste.

Explain the difference between **reusing** and **recycling** PET bottles, using these two examples.

.....

.....

.....

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

(e) Waste PET bottles used to treat water and to make padding for jackets have different Life Cycle Assessments.

Give **two** reasons why their Life Cycle Assessments are different.

1. .....

.....

2. .....

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

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10 Sundip passes electricity through solutions of some ionic compounds and finds out what products are formed at the positive and negative electrodes.

(a) Here are Sundip's results.

Solution	Product at positive electrode	Product at negative electrode
concentrated sodium chloride	chlorine gas	hydrogen gas
dilute sodium chloride	oxygen gas	hydrogen gas
dilute copper chloride	chlorine gas	copper metal
concentrated copper sulfate	oxygen gas	copper metal
concentrated copper chloride	.....	.....
dilute sodium sulfate	.....	.....

(i) Complete the table by predicting the products formed at each electrode when electricity is passed through concentrated copper chloride and dilute sodium sulfate. **[3]**

(ii) Sundip uses tests to identify the gases formed in her experiments.

Draw lines to connect each **gas** to its correct **test and result**.

Gas	Test and result
	relights a glowing splint
chlorine	makes a lighted splint go 'pop'
oxygen	turns lime water milky
hydrogen	turns blue litmus red and then bleaches it
	turns red litmus blue and then bleaches it

[2]

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(iii) Explain why, at the negative electrode:

- **copper** metal is formed when electricity is passed through dilute copper chloride, **but**
- **hydrogen** gas is formed when electricity is passed through dilute sodium chloride.

.....

.....

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

(b) This is a list of apparatus Sundip uses to pass electricity through the solution of dilute sodium chloride:

- electrodes
- leads and clips
- a battery
- a beaker
- the solution of sodium chloride.

Draw a labelled diagram in the **box** to show how Sundip sets up her experiment to pass electricity through the solution of dilute sodium chloride.

[2]

END OF QUESTION PAPER

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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).

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