OCR
Oxford Cambridge and RSA

Friday 13 June 2025 – Morning

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

J248/04 (Higher 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

H

J248804

1859522846

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 page 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 **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.

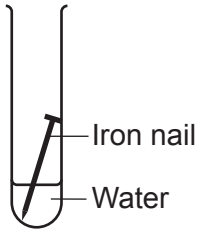
Write your answer to each question in the box provided.

1 Which row in the table shows the change in the percentage of each gas in the **Earth's atmosphere today** compared to the Earth's early atmosphere?

	Carbon dioxide	**Oxygen**
A	decreased	decreased
B	decreased	increased
C	increased	decreased
D	increased	increased

Your answer ☐ **[1]**

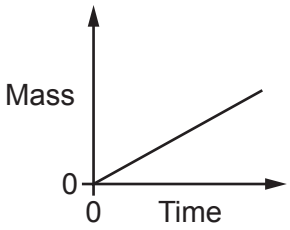
2 An iron nail is left in a test tube containing water.



The iron nail rusts.

Which graph shows how the mass of the iron nail changes?

A



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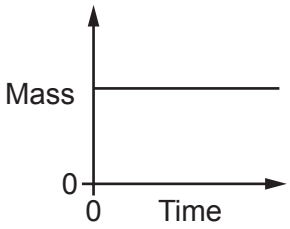

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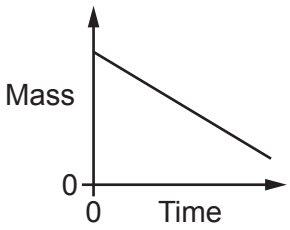

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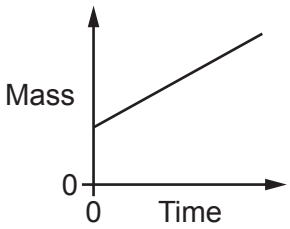


Your answer ☐ **[1]**

3 The alkanes are a homologous series of molecules.

Which statement about different alkane molecules is **correct**?

A The molecular formula of the molecules differs by CH_3.

B The molecules all contain a double bond.

C The molecules all have the same general formula.

D The molecules all have the same physical properties.

Your answer ☐ **[1]**

4 Which row in the table shows a property of a Group 1 metal and of a transition metal?

	Group 1 metal	**Transition metal**
A	forms white compounds	low density
B	high melting point	conducts electricity
C	low density	forms coloured compounds
D	very reactive	low density

Your answer ☐ **[1]**

5 The theoretical yield of a product in a reaction is 71 g.

The actual yield is 60 g.

What is the **percentage yield**?

A 15.5%

B 18.3%

C 84.5%

D 118.3%

Your answer ☐ **[1]**

6 Which type of bond is found in butene?

A Covalent

B Electrostatic

C Ionic

D Metallic

Your answer ☐ **[1]**

7 Which equation shows the relationship between:

- the mass of a solute
- the volume of a solution
- the concentration of the solution?

A $\text{mass of solute} = \frac{\text{concentration of solution}}{\text{volume of solution}}$

B $\text{concentration of solution} = \frac{\text{mass of solute}}{\text{volume of solution}}$

C $\text{volume of solution} = \frac{\text{concentration of solution}}{\text{mass of solute}}$

D $\text{concentration of solution} = \frac{\text{volume of solution}}{\text{mass of solute}}$

Your answer ☐ **[1]**

8 What is a **disadvantage** of a hydrogen/oxygen fuel cell?

A Electricity is generated directly from the reaction.

B Greenhouse gases are not produced.

C Hydrogen gas is produced from hydrocarbons.

D There are no moving parts.

Your answer ☐ **[1]**

9 Nitrogen reacts with hydrogen to make ammonia.

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

What is the volume of ammonia made from 366 cm^3 of hydrogen?

A 183 cm^3

B 244 cm^3

C 549 cm^3

D 732 cm^3

Your answer ☐ **[1]**

10 What is the correct equation for the **complete** combustion of butane?

A $C_4H_{10} + 2\frac{1}{2}O_2 \rightarrow 4C + 5H_2O$

B $C_4H_{10} + 4\frac{1}{2}O_2 \rightarrow 4CO + 5H_2O$

C $C_4H_{10} + 6\frac{1}{2}O_2 \rightarrow 4CO_2 + 5H_2O$

D $C_4H_{10} + 5O_2 \rightarrow 2CO_2 + CO + C + 5H_2O$

Your answer ☐ **[1]**

11 Why do Group 1 metals become more reactive **down** the group?

A There is a stronger attraction between the outer electron and the nucleus.

B There is less shielding.

C The outer electron gets closer to the nucleus.

D The outer electron is lost more easily.

Your answer ☐ **[1]**

12 Potash alum, $KAl(SO_4)_2$, is a chemical compound.

What is the test to identify the Group 1 metal in potash alum?

A A flame test gives a lilac flame.

B A white precipitate is made when barium chloride solution is added.

C A white precipitate is made when a few drops of sodium hydroxide solution are added.

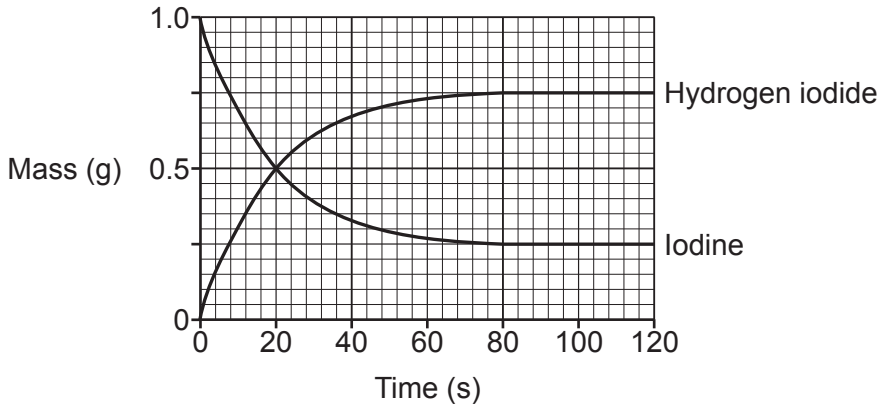
D Damp red litmus paper turns blue.

Your answer ☐ **[1]**

13 The reaction between iodine gas and hydrogen gas reaches equilibrium in a sealed container.

Hydrogen iodide is made.

The graph shows how the mass of iodine and the mass of hydrogen iodide change over time.



At what time is equilibrium reached?

A 0 s

B 20 s

C 80 s

D 120 s

Your answer ☐ **[1]**

14 The equation shows one stage in the extraction of the metal titanium, Ti.

$TiCl_2 + Mg \rightarrow MgCl_2 + Ti$

Which row in the table shows what is oxidised and what is reduced?

	Oxidised	**Reduced**
A	Mg	Ti^{2+}
B	Mg^{2+}	Ti^{2+}
C	Ti	Mg
D	Ti^{2+}	Mg

Your answer ☐ **[1]**

15 The reaction between sulfur dioxide gas and oxygen gas reaches equilibrium in a sealed container.

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

The reaction is exothermic.

Which conditions will move the position of equilibrium to the **left**?

A	high pressure	catalyst
B	high pressure	low temperature
C	low pressure	high temperature
D	low temperature	catalyst

Your answer ☐ **[1]**

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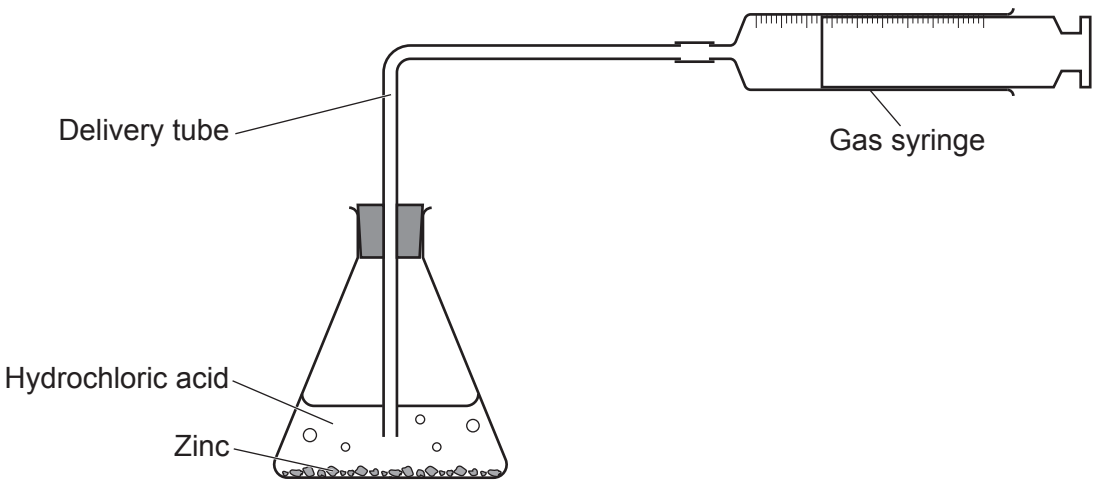
Section B

16 A student investigates the rate of the reaction between zinc and an excess of hydrochloric acid.

The diagram shows the equipment the student uses.



(a) The student has made a mistake setting up the delivery tube in their experiment.

Describe the mistake and the problem this will cause.

Mistake .....

.....

Problem .....

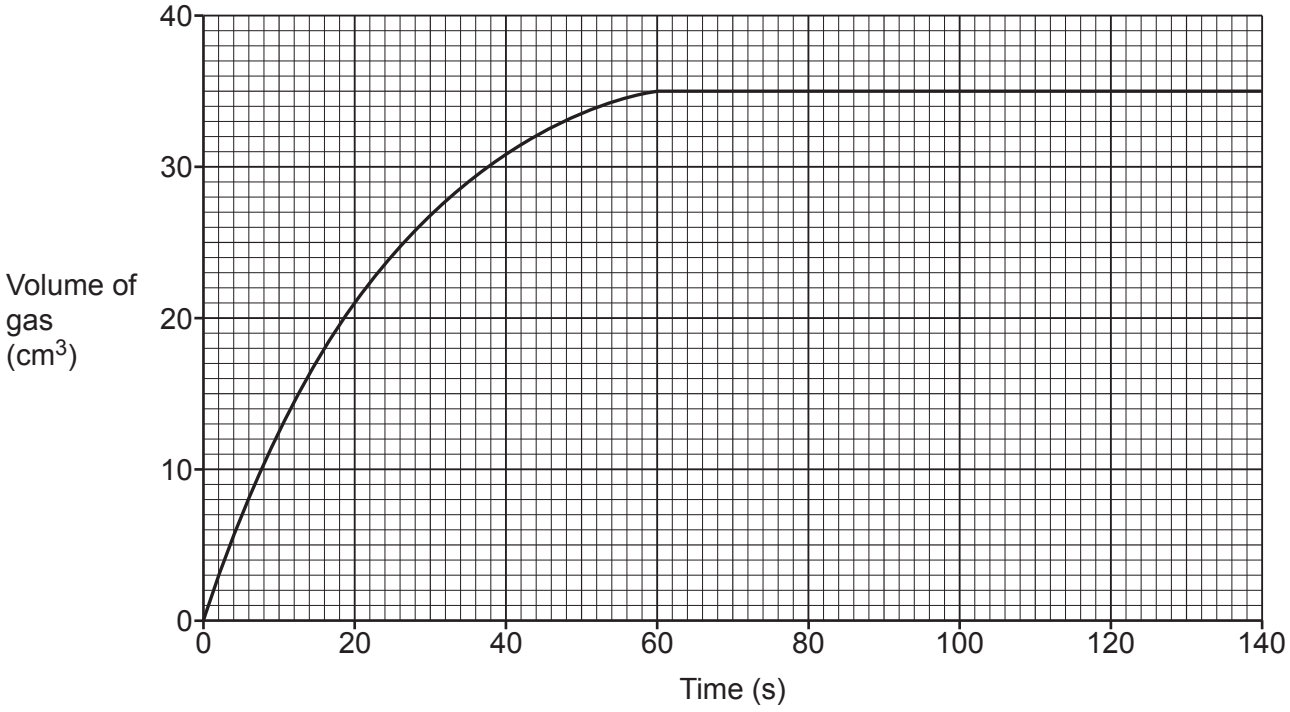
.....

[2]

(b) The student sets up the experiment correctly.

They measure the volume of gas every 20 seconds.

The graph shows their results.



(i) Calculate the mean rate of reaction between 0 seconds and 60 seconds.

Use the graph and the equation:

$$\text{mean rate of reaction} = \frac{\text{volume of gas}}{\text{time}}$$

Give the units for your answer.

Mean rate of reaction = ... Units ..... **[4]**

(ii) The student repeats the experiment.

They use the same mass of zinc, but in **smaller** pieces.

Draw a line on the graph to show the student's results. **[2]**

(c) The reaction is faster when **more concentrated** hydrochloric acid is used.

Explain why.

.....

.....

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

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17 Ammonia is made from nitrogen and hydrogen in the Haber process.

The word equation for the reaction is:

nitrogen + hydrogen $\rightleftharpoons$ ammonia

(a) What does the symbol $\rightleftharpoons$ tell you about the reaction?

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

(b) A catalyst is used in the Haber process.

(i) What is the catalyst used?

Tick (✓) **one** box.

Iron	☐
Manganese(IV) oxide	☐
Nickel	☐
Platinum	☐

[1]

(ii) Explain how the catalyst speeds up the reaction.

.....

.....

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

(c) Ammonia is used in the manufacture of fertilisers.

NPK fertilisers contain the essential elements nitrogen, phosphorus, and potassium.

The table shows the percentages of nitrogen, phosphorus, and potassium in four different fertilisers.

Fertiliser	Percentage (%) of essential element		
	Nitrogen	Phosphorus	Potassium
A	12	6	36
B	8	8	30
C	12	12	17
D	15	5	12

Plants do **not** grow well if they get too little of these essential elements because:

- too little nitrogen can cause yellow leaves
- too little phosphorus can cause poor root growth
- too little potassium can cause poor fruit growth.

(i) Which fertiliser is best at preventing yellow leaves **and** poor fruit growth?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

[1]

(ii) A farmer buys a 25 kg bag of fertiliser **C**.

Calculate the mass of **potassium** in the bag of fertiliser.

Mass of potassium = ... kg **[2]**

(iii) Fertilisers are made in industry using a continuous process.

Fertilisers can be made in a school laboratory using a batch process.

State **one advantage** of using a continuous process.

.....

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

18 A life-cycle assessment is an analysis of the overall environmental impact that a product may have throughout its lifetime.

(a) The life-cycle assessment is broken down into four main stages.

The first stage is looking at obtaining the **raw materials**.

State **two** other stages in a life-cycle assessment.

1 .....

2 .....

[2]

(b) A company does a life-cycle assessment to investigate three possible materials for making a single-use takeaway food container.

The table gives some of the information the company uses.

	Aluminium	**Poly(propene)**	**Polystyrene**
Mass of raw materials (g)	8	31.5	8
Energy used (MJ / kg)	61	73	40
Percentage recycled (%)	54	11	12
Cost per kg (£)	1.40	0.98	0.62

Suggest which material the company should use to make the food container.

Explain your answer using information from the table.

Material .....

Explanation .....

.....

.....

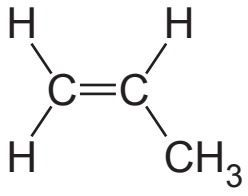
.....

.....

.....

[4]

(c) Poly(propene) is a polymer made from the monomer propene.



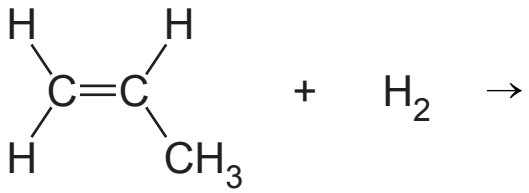
Propene

Draw the structure of the **polymer** poly(propene).

[2]

(d) Propene reacts with hydrogen.

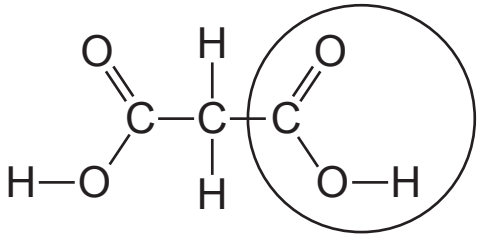
Complete the equation for this reaction.



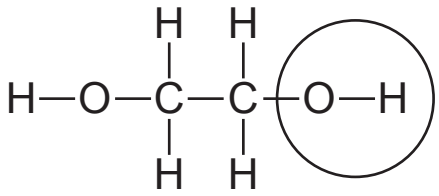
[2]

19 The displayed formulae of molecules **X** and **Y** are shown in **Fig. 19.1**.

Fig. 19.1



Molecule **X**



Molecule **Y**

The functional group of each molecule is shown in a ring.

(a) State the name of the functional group in molecule **X** and molecule **Y**.

Molecule **X** .....

Molecule **Y** .....

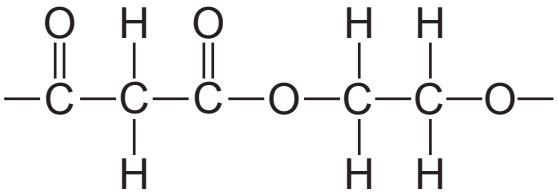
[2]

(b) Molecule **X** reacts with molecule **Y** to form polymer **Z**.

Polymer **Z** is a polyester because it contains an **ester functional group**.

Polymer **Z** is shown in **Fig. 19.2**.

Fig. 19.2



Draw a ring around the ester functional group in **Fig. 19.2**. **[1]**

(c) Polyester is a condensation polymer.

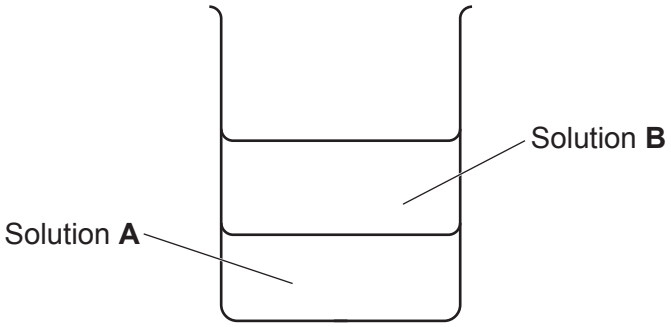
Nylon is also a condensation polymer.

Nylon can be made in the laboratory using two solutions, **A** and **B**, as shown in **Fig. 19.3**.

Solution **A** is poured into a beaker.

Solution **B** is carefully poured on top of solution **A** to minimise mixing.

Fig. 19.3



State where the nylon forms and describe how the nylon is removed from the beaker.

The nylon forms .....

The nylon is removed from the beaker by .....

.....

.....

[3]

(d) The monomer in solution **A** contains two NH_2 groups.

The monomer in solution **B** contains two COC*l* groups.

State the formula of the small molecule made as well as the nylon.

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

(e) A naturally occurring polymer is made by combining monomers called nucleotides.

State the name of this natural polymer.

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

20 A student plans a titration experiment to find the concentration of a solution of sulfuric acid.

This is their method:

- Fill the burette with dilute sulfuric acid.
- Add 25.0 cm^3 of 0.50 mol/dm^3 sodium hydroxide solution to a conical flask.
- Add 5 drops of indicator to the sodium hydroxide solution.
- Add the dilute sulfuric acid to the sodium hydroxide solution until the indicator changes colour.
- Repeat the titration.

(a)

(i) State the piece of apparatus the student should use to accurately measure the 25.0 cm^3 of sodium hydroxide solution.

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

(ii) State a suitable indicator for the student to use in the titration.

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

(iii) Suggest an improvement to the student's method.

.....

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

(b) The reading at the start of the rough titration is 0.0 cm^3.

At the end of the rough titration the student reads the volume of dilute sulfuric acid added from the burette.

What is the volume of dilute sulfuric acid added?

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

Volume = ... cm^3 **[1]**

(c) After the rough titration the student repeats the experiment five more times.

The table shows their results.

Titration number	1	2	3	4	5
Volume of dilute sulfuric acid added (cm^3)	24.80	24.45	24.50	24.55	24.50

The student calculated that the mean of these results was 24.50 cm^3.

Explain why.

Use data from the table.

.....

.....

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

(d) The equation for the reaction in the student's titration is

$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

They used 25.0 cm^3 of 0.40 mol / dm^3 sodium hydroxide solution and 24.50 cm^3 of dilute sulfuric acid.

Calculate the concentration of the dilute sulfuric acid in mol / dm^3.

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

Concentration of dilute sulfuric acid = ... mol / dm^3 **[4]**

21

(a)* A teacher finds an unlabelled beaker containing a white solid.

They know that the solid is one of the following:

- lithium bromide
- lithium iodide
- sodium bromide
- sodium carbonate.

Plan a series of experiments the teacher can do to identify the white solid.

Include the reactants and apparatus used and the results of each experiment.

.....

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

(b) Instrumental methods of analysis can be used to analyse chemical substances.

State **two advantages** of instrumental methods of analysis.

1 .....

2 .....

[2]

(c) Chlorine, Cl_2, reacts with lithium bromide, LiBr.

(i) Write the **balanced symbol equation** for the reaction.

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

(ii) Iodine, I_2, does **not** react with lithium bromide.

Explain why.

.....

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

22 Copper ore can be obtained by quarrying.

Copper metal is then extracted by heating the copper ore in a furnace.

(a) One type of copper ore contains copper oxide.

The copper oxide is heated with carbon.

Write the **balanced symbol equation** for this reaction.

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

(b) Scientists have developed methods of extracting copper from ores that contain a **low percentage** of copper compounds.

(i) Suggest **two** reasons why scientists have developed these methods.

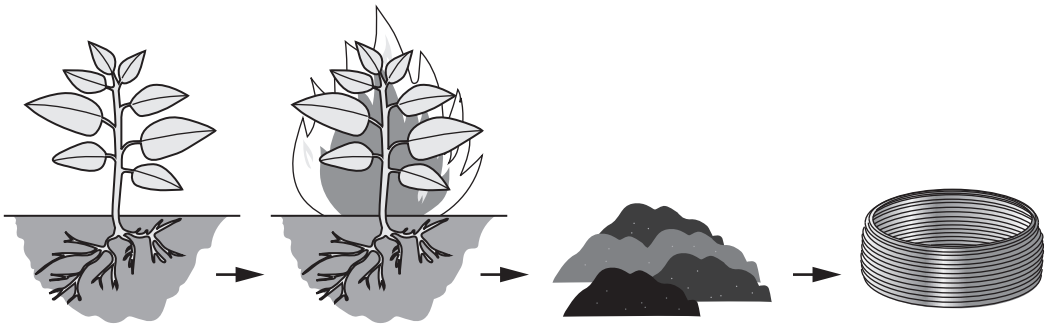
1 .....

2 .....

[2]

(ii) Phytoextraction is a method used to obtain copper from ores that contain a low percentage of copper compounds.

The diagram shows the stages in phytoextraction.



Evaluate phytoextraction as a method of obtaining copper compared to quarrying and heating the copper ore in a furnace.

Use the information in the diagram and your own knowledge of how metals are extracted.

.....

.....

.....

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.....

.....

..... **[4]**

(c) Metals can also be extracted from their metal oxide by reduction with hydrogen.

Element **X** is a metal.

$\mathbf{X}O_3 + 3H_2 \rightarrow \mathbf{X} + 3H_2O$

(i) Explain how the equation shows that the metal oxide is **reduced**.

.....

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

(ii) The sum of the relative formula masses (M_r) of the reactants is 149.9.

Identify element **X**.

Use the Periodic Table.

Relative atomic mass (A_r): H = 1.0 O = 16.0

X = ... **[3]**

23 In the last 75 years there has been an increase in both:

- the world population
- the concentration of carbon dioxide in the atmosphere.

(a) Why may the increase in the world population have caused the increase in the concentration of carbon dioxide in the atmosphere?

.....

.....

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

(b) State **one** possible problem associated with an increase in the concentration of carbon dioxide in the atmosphere.

.....

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

(c) A household gas central heating boiler produces 42 460 g of carbon dioxide in a week.

Calculate the **volume** of carbon dioxide, in dm^3, produced at room temperature and pressure in a week.

Relative atomic mass (A_r): C = 12.0 O = 16.0

Volume of carbon dioxide = ... dm^3 **[2]**

END OF QUESTION PAPER

EXTRA ANSWER SPACE

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