

## Friday 20 November 2020 – Morning

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

#### J248/02 Paper 2 (Foundation Tier)

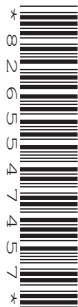
**Time allowed: 1 hour 45 minutes**

**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



Please write clearly in black ink. **Do not write in the barcodes.**

Centre number

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Candidate number

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First name(s)

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Last name

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### 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 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 **32** pages.

### ADVICE

- Read each question carefully before you start your answer.

**2**  
**SECTION A**

Answer **all** the questions.

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

**Write your answer to each question in the box provided.**

- 1** Iron is a metal that rusts.

What conditions are needed for the rusting of iron?

- A** Air and an acid
- B** Air and salt
- C** Air and water
- D** Water and salt

Your answer

[1]

- 2** A student adds a few drops of sodium hydroxide solution to an unknown solution and a blue precipitate is made.

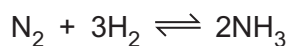
Which metal ion is present in the original solution?

- A** Calcium
- B** Copper(II)
- C** Iron(II)
- D** Iron(III)

Your answer

[1]

3 Look at the equation for the Haber process.



What is meant by the symbol  $\rightleftharpoons$  in the equation?

- A A reaction that involves a catalyst.
- B A reaction that is exothermic.
- C A reaction with 100% atom economy.
- D A reversible reaction.

Your answer

[1]

4 Brass is an alloy.

What are the main metals in brass?

- A Aluminium and copper
- B Copper and iron
- C Copper and tin
- D Copper and zinc

Your answer

[1]

5 Which of the following are three of the **essential elements** needed by plants?

- A Carbon, nitrogen, oxygen
- B Hydrogen, potassium, phosphorus
- C Nitrogen, oxygen, potassium
- D Nitrogen, phosphorus, potassium

Your answer

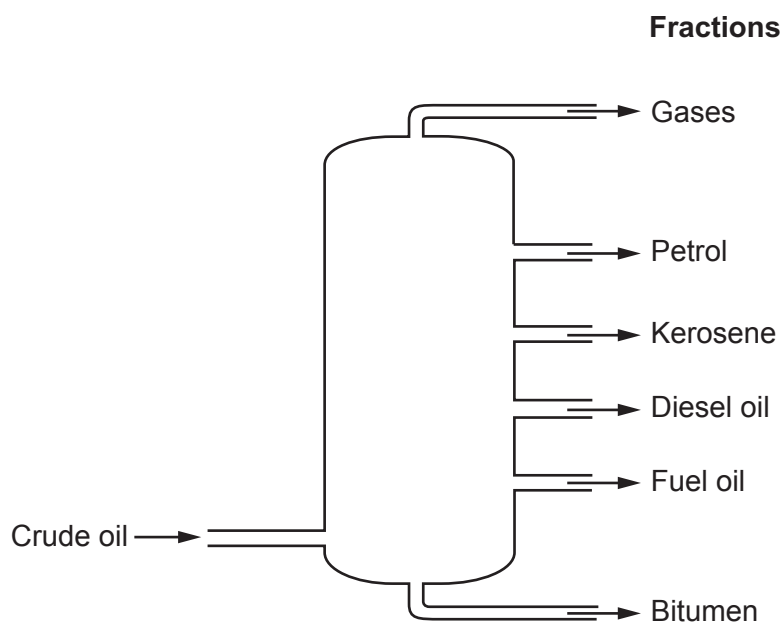
[1]

- 6 What happens to the potential difference of a chemical cell once the reactants are used up?
- A It decreases
  - B It increases
  - C It starts and finishes at 0V
  - D It stays the same

Your answer

[1]

- 7 Crude oil is separated into fractions by fractional distillation.  
Look at the diagram of the fractions made in fractional distillation.



Which of these fractions has the **lowest** boiling point?

- A Bitumen
- B Diesel oil
- C Gases
- D Petrol

Your answer

[1]

8 DNA molecules are polymers.

What is the name of the **monomers** that make up DNA molecules?

- A Amino acids
- B Carbohydrates
- C Nucleotides
- D Proteins

Your answer

[1]

9 The table shows the stages in a flame test.

Stage	Process
1	Dip a nichrome wire loop into the test solution.
2	Observe and record the flame colour.
3	Clean a nichrome wire loop with hydrochloric acid, then rinse with distilled water.
4	Hold the nichrome wire loop in the edge of a roaring blue flame.

Which is the correct order for the stages in a flame test?

- A 1, 4, 2, 3
- B 1, 4, 3, 2
- C 3, 1, 4, 2
- D 3, 4, 1, 2

Your answer

[1]

10 Which of the following are the first four members of the homologous series of **alcohols**?

- A  $\text{CH}_4, \text{C}_2\text{H}_6, \text{C}_3\text{H}_8, \text{C}_4\text{H}_{10}$   
 B  $\text{CH}_3\text{OH}, \text{C}_2\text{H}_5\text{OH}, \text{C}_3\text{H}_7\text{OH}, \text{C}_4\text{H}_9\text{OH}$   
 C  $\text{HCOOH}, \text{CH}_3\text{COOH}, \text{C}_2\text{H}_5\text{COOH}, \text{C}_3\text{H}_7\text{COOH}$   
 D  $\text{C}_2\text{H}_4, \text{C}_3\text{H}_6, \text{C}_4\text{H}_8, \text{C}_5\text{H}_{10}$

Your answer

[1]

11 A student investigates the reaction between zinc and dilute sulfuric acid.

He measures the time taken to collect  $50 \text{ cm}^3$  of hydrogen gas. This time is 65 seconds.

The student investigates four substances which are possible **catalysts** for the reaction.

Substance	Appearance of substance	Time to collect $50 \text{ cm}^3$ of hydrogen (g)	Other observations
A	red-brown powder	19	red-brown powder remains
B	blue solid	15	colourless solution formed
C	red-brown lumps	65	red-brown lumps remain
D	white solid	65	colourless solution formed

Which substance, **A**, **B**, **C** or **D**, is a catalyst for the reaction?

Your answer

[1]

12 Ethene,  $\text{C}_2\text{H}_4$ , reacts with bromine,  $\text{Br}_2$ , in an addition reaction.

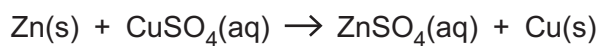
Which is the balanced symbol equation for this reaction?

- A  $\text{C}_2\text{H}_4 + \text{Br}_2 \rightarrow \text{C}_2\text{H}_3\text{Br} + \text{HBr}$   
 B  $\text{C}_2\text{H}_4 + \text{Br}_2 \rightarrow \text{C}_2\text{H}_4\text{Br}_2$   
 C  $\text{C}_2\text{H}_4 + 2\text{Br}_2 \rightarrow \text{C}_2\text{Br}_4 + 2\text{H}_2$   
 D  $\text{C}_2\text{H}_4 + 2\text{Br}_2 \rightarrow \text{C}_2\text{H}_4\text{Br}_4$

Your answer

[1]

13 Zinc, Zn, reacts with copper sulfate solution,  $\text{CuSO}_4$ .



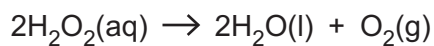
What type of reaction is this?

- A Combustion
- B Displacement
- C Neutralisation
- D Thermal decomposition

Your answer

[1]

14 A student investigates the decomposition of hydrogen peroxide.



0.2g of oxygen gas is produced in the reaction.

The student uses 0.5g of manganese(IV) oxide as a catalyst in the reaction.

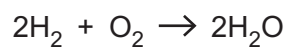
How much manganese(IV) oxide remains at the end of the reaction?

- A 0.2g
- B 0.3g
- C 0.5g
- D 0.7g

Your answer

[1]

15 Hydrogen gas,  $\text{H}_2$ , reacts with oxygen gas,  $\text{O}_2$ , to make water,  $\text{H}_2\text{O}$ .



What is the **atom economy** for this reaction?

$M_r$ :  $\text{H}_2 = 2$ ,  $\text{O}_2 = 32$ ,  $\text{H}_2\text{O} = 18$ .

- A 50%
- B 53%
- C 89%
- D 100%

Your answer

[1]




9  
SECTION B

Answer **all** the questions.

16 This question is about elements in the Periodic Table.

Look at the table. It shows some properties of Group 7 elements.

Element	Molecular formula	State at room temperature	Radius of an atom (nm)	Order of reactivity
Fluorine	F <sub>2</sub>	.....	0.072	most reactive  least reactive
Chlorine	Cl <sub>2</sub>	gas	0.099	
Bromine	Br <sub>2</sub>	liquid	0.114	
Iodine	I <sub>2</sub>	solid	0.133	
Astatine	At <sub>2</sub>	solid	.....	

(a) Complete the table. Use ideas about trends down a Group to help you. [2]

(b) In the table, the Group 7 elements are listed in order of reactivity.

The equations show a displacement reaction of Group 7 elements.

chlorine + sodium bromide → sodium chloride + bromine



(i) Complete the word equation.

bromine + sodium iodide → ..... + ..... [1]

(ii) There is no reaction between iodine and sodium bromide.

Explain why.

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

(iii) Chlorine reacts with sodium iodide. Sodium chloride and iodine are made.

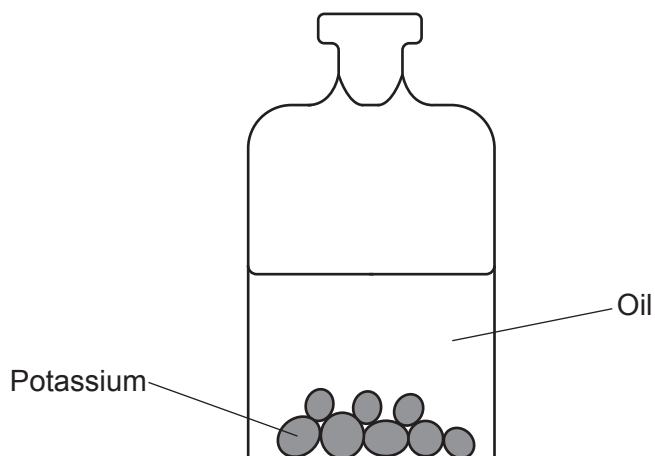
Write the **balanced symbol** equation for this reaction.

..... [2]

(c) Group 1 is another group of elements in the Periodic Table.

(i) Potassium is a Group 1 metal.

Potassium is stored under oil because it is very reactive.



What does the oil stop the potassium reacting with?

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

(ii) Sodium is another Group 1 metal.

Sodium reacts in a similar way to potassium.

Explain why.

Use ideas about atomic structure in your answer.

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

11  
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17 A student investigates a white solid.

**Table 17.1** shows some of the results of the tests that the student does.

	Test	Results
<b>Test 1</b>	flame test	a lilac flame
<b>Test 2</b>	dilute hydrochloric acid added gas given off passed into limewater	effervescence ?

**Table 17.1**

(a) Which **ion** is shown to be in the white solid by the result of **Test 1**?

..... [1]

(b) (i) Which **ion** is shown to be in the white solid by the result of **Test 2**?

..... [1]

(ii) The **gas** given off in **Test 2** is carbon dioxide,  $\text{CO}_2$ .

What is the expected result with limewater?

..... [1]

(c) The student reacts some metals with different salt solutions.

**Table 17.2** shows her results.

	Magnesium	Zinc	Iron	Copper
<b>Copper sulfate</b>	blue solution becomes colourless	blue solution becomes colourless	blue solution becomes green	no reaction
<b>Iron sulfate</b>	green solution becomes colourless	green solution becomes colourless	no reaction	no reaction
<b>Magnesium sulfate</b>	no reaction	no reaction	no reaction	no reaction
<b>Zinc sulfate</b>	black coating on magnesium	no reaction	no reaction	no reaction

**Table 17.2**

(i) What colour is **iron sulfate** solution?

..... [1]

- (ii) Write down the order of reactivity of the four metals copper, iron, magnesium and zinc.

Use **Table 17.2** to help you.

..... **most reactive**

.....

.....

..... **least reactive**

[2]

- (iii) Magnesium reacts with copper sulfate,  $\text{CuSO}_4$ .

Magnesium sulfate,  $\text{MgSO}_4$ , and copper are made.

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

..... [1]

- 18 A student investigates the rate of reaction between dilute hydrochloric acid and magnesium carbonate.

She wants to find out how the concentration of the acid changes the rate of reaction.

Fig. 18.1 shows the apparatus she uses.

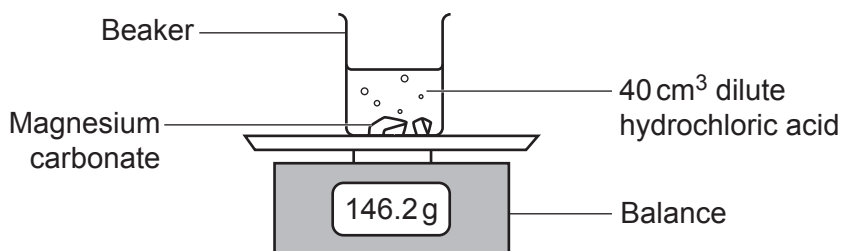


Fig. 18.1

Carbon dioxide gas is given off in the reaction.

The student measures the loss in mass every 30 seconds for 5 minutes.

- (a) Another student also investigates the rate of reaction between dilute hydrochloric acid and magnesium carbonate.

Fig. 18.2 shows diagrams of some of the apparatus he uses.

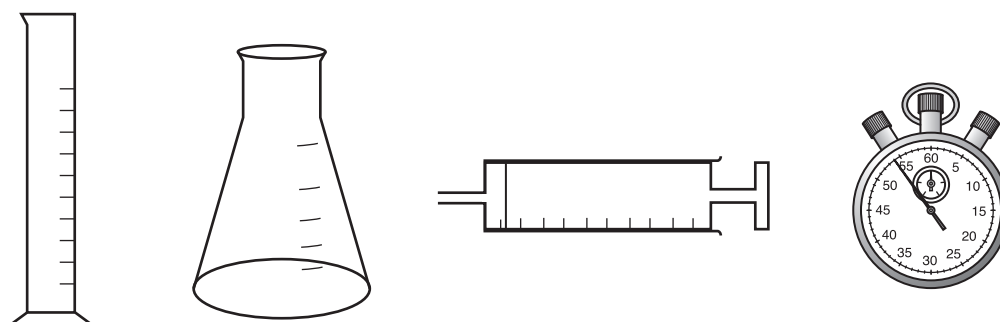


Fig. 18.2

The student also wants to find out how the **concentration** of the acid changes the rate of reaction.

Describe the **method** he follows using the apparatus in **Fig. 18.2**.

Include a **labelled diagram** of the set-up of the apparatus he uses.

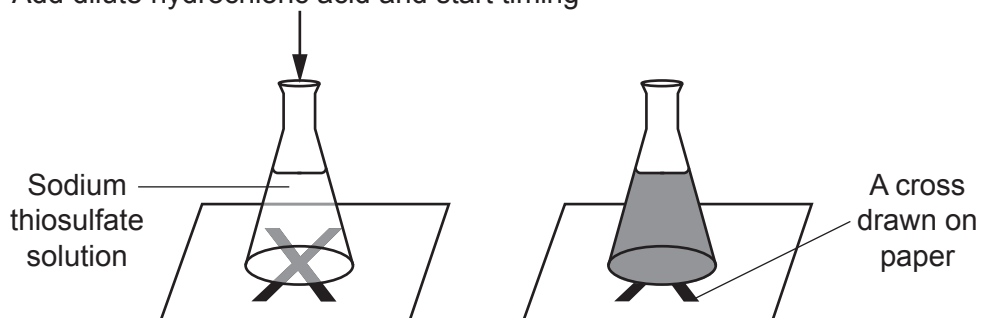
.....  
.....  
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.....  
.....  
.....  
.....  
.....  
..... [4]

- (b) The students now investigate the reaction between sodium thiosulfate and dilute hydrochloric acid.

They want to find out how **temperature** changes the rate of reaction.

**Fig. 18.3** is a diagram of their experiment.

Add dilute hydrochloric acid and start timing



**Fig. 18.3**

A yellow solid is made during the reaction.

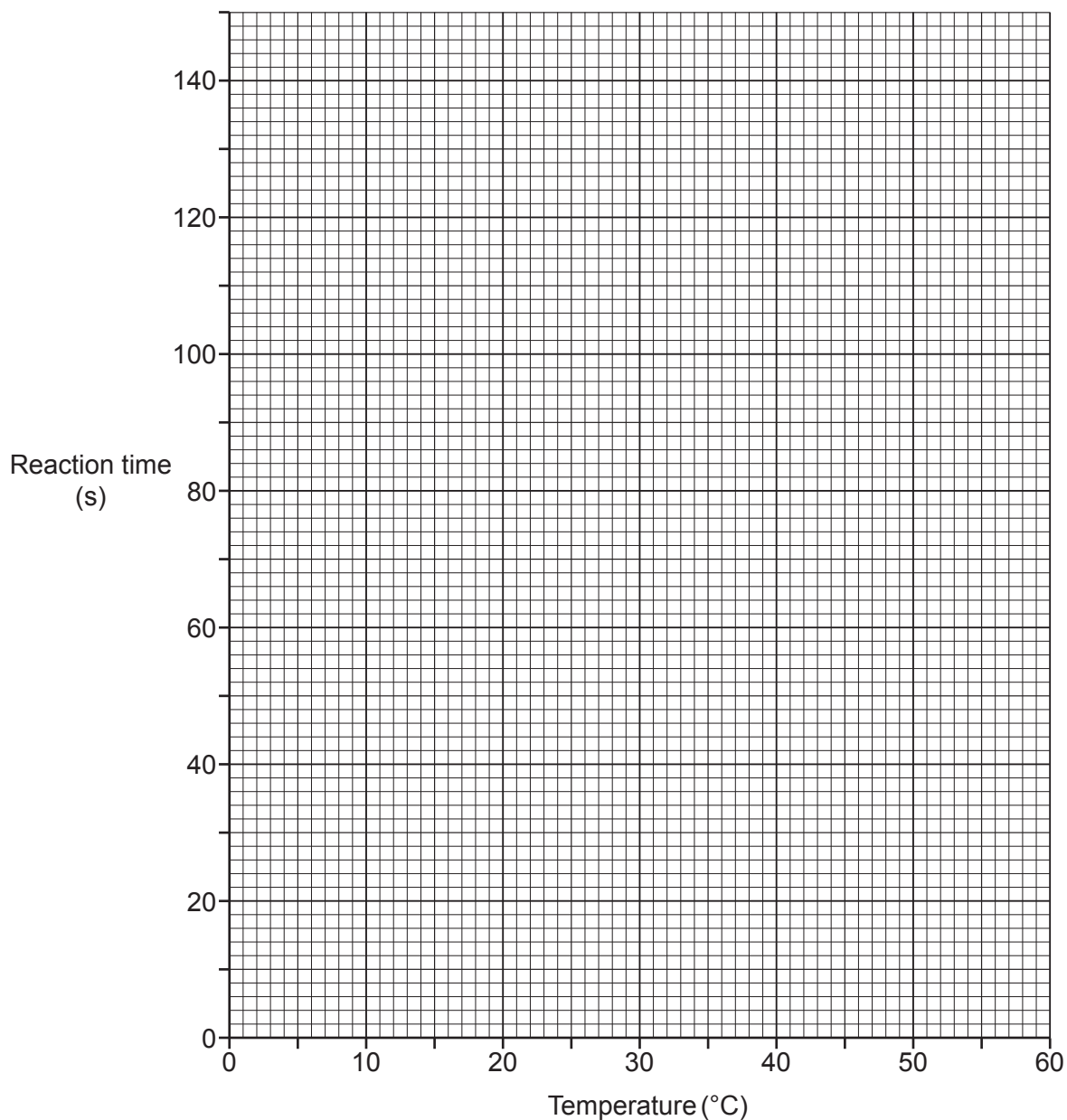
The students time how long it takes for the cross to disappear. This is the reaction time.

Look at their results.

Temperature (°C)	Reaction Time (s)
10	140
20	56
30	34
40	26
50	22



(i) Plot a graph of the results on the grid. Draw a line of best fit.



[3]

(ii) What is the reaction time at **25°C**?

Reaction time = ..... s [1]

(iii) What happens to the **rate of reaction** as the temperature increases?

..... [1]

(iv) Explain your answer to (b)(iii). Include ideas about collisions between particles in your answer.

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

19 Fractional distillation separates crude oil into useful fractions.

Look at the table.

It shows the percentage of each fraction made from crude oil. It also shows the percentage of each fraction needed for everyday uses.

Fraction	Percentage made by fractional distillation	Percentage needed for everyday uses
Gases	4	11
Petrol	11	22
Naphtha	10	18
Paraffin	12	20
Fuel oil	22	10
Waxes and tar	23	4

(a) (i) Which fraction is **made** in the **greatest** percentage?

Tick (✓) **one** box.

Gases	<input type="checkbox"/>
Petrol	<input type="checkbox"/>
Naphtha	<input type="checkbox"/>
Paraffin	<input type="checkbox"/>
Fuel oil	<input type="checkbox"/>
Waxes and tar	<input type="checkbox"/>

[1]

(ii) Which fraction is **needed** in the **smallest** percentage?

Tick (✓) **one** box.

Gases	<input type="checkbox"/>
Petrol	<input type="checkbox"/>
Naphtha	<input type="checkbox"/>
Paraffin	<input type="checkbox"/>
Fuel oil	<input type="checkbox"/>
Waxes and tar	<input type="checkbox"/>

[1]

(b) Cracking changes large hydrocarbon molecules into smaller hydrocarbon molecules.

(i) One of the conditions needed for cracking is a high pressure.

Write down **one** other condition needed.

..... [1]

(ii) Cracking is a very useful reaction.

Explain why.

Use information from the table in your answer.

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

(c) In 2008 the USA produced 4 900 000 barrels of crude oil per day. In 2019 this had increased to 11 000 000 barrels of crude oil per day.

Calculate the percentage increase in the number of barrels of crude oil produced per day from 2008 to 2019.

Use the formula: percentage increase =  $\frac{\text{increase}}{\text{original}} \times 100$

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

Percentage increase = ..... % [3]

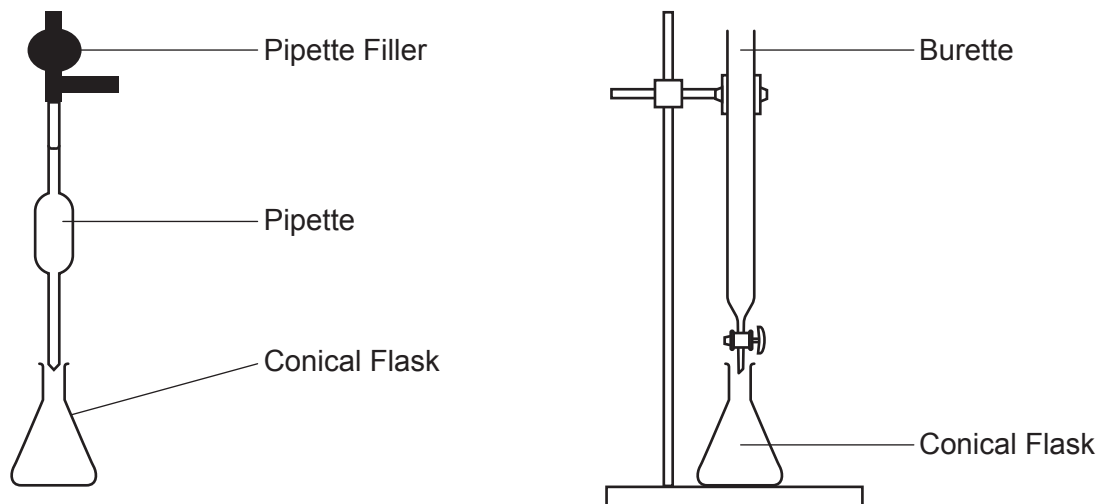
20 A student neutralises an alkali with an acid in a titration experiment.

(a) Complete the word equation for the reaction of an acid with an alkali.

acid + alkali  $\rightarrow$  ..... + .....

[2]

(b) Look at the student's method for her experiment.



- Measure 25.0 cm<sup>3</sup> of alkali solution into a conical flask using a pipette.
- Add a few drops of universal indicator to the alkali solution.
- Fill the burette to above the 0.0 cm<sup>3</sup> line with acid.
- Quickly add the acid to alkali until the indicator changes colour.
- Repeat the experiment until consistent results are obtained.

Describe and explain **one** improvement the student should make to her method to get a more accurate titration result.

.....

.....

.....

..... [2]

- (c) The student repeats the experiment three times.

Look at the student's results.

<b>Titration number</b>	1	2	3
<b>Volume of acid (cm<sup>3</sup>)</b>	25.75	23.60	23.70

Calculate the **accurate** volume of the acid that reacts with the alkali.

Accurate volume of acid = ..... cm<sup>3</sup> [2]

21 This question is about the Earth's atmosphere.

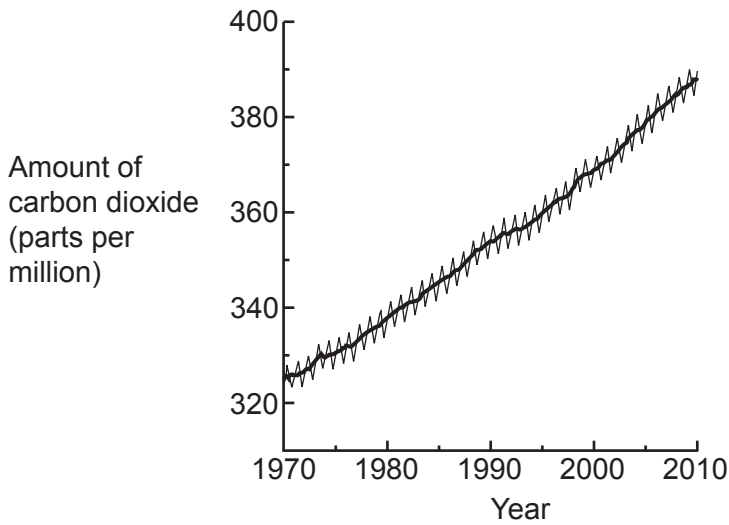
The Earth's early atmosphere contained mostly carbon dioxide gas.

The Earth's atmosphere today contains about 0.04% carbon dioxide.

(a) Explain why the amount of carbon dioxide in the atmosphere today has decreased from the early atmosphere.

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

(b) The graph shows the amount of carbon dioxide in the Earth's atmosphere from 1970 to 2010.



Describe the trend in the amount of carbon dioxide in the Earth's atmosphere from 1970 to 2010.

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

(c) Many scientists believe that increasing amounts of carbon dioxide in the Earth's atmosphere are causing global warming.

(i) Write down **one** way that carbon dioxide is **released** into the atmosphere.

..... [1]

(ii) Write down **one** way to **reduce** the amount of carbon dioxide that is released into the atmosphere.

..... [1]

(d) Sulfur dioxide is a pollutant found in many large cities.

Sulfur dioxide is an **acidic** gas.

(i) Suggest a value for the pH of sulfur dioxide.

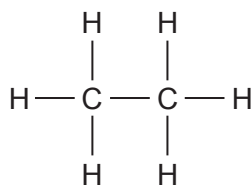
..... [1]

(ii) Describe **one** problem caused by sulfur dioxide.

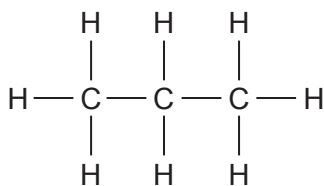
..... [1]

22 This question is about compounds of carbon.

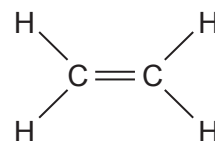
Look at the displayed formulae of ethane, propane and ethene.



**Ethane**



**Propane**



**Ethene**

(a) Ethane and propane are both members of the **homologous series** called the alkanes.

Write down **two** reasons why ethane and propane are members of the same homologous series.

1 .....

2 .....

[2]

(b) Many ethene molecules react together to form the polymer poly(ethene).

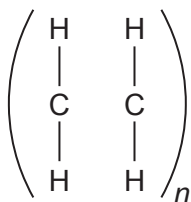
This reaction is called **polymerisation**.

(i) Why do ethene molecules undergo polymerisation but ethane molecules do not?

.....

..... [1]

(ii) Complete the diagram to show the displayed formula of poly(ethene).



[2]



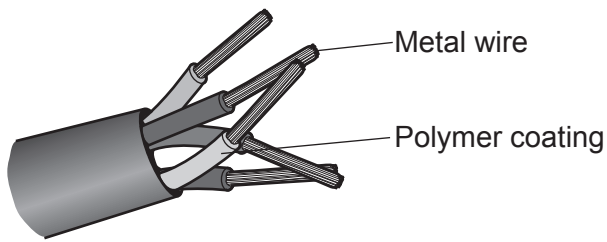


23 This question is about the properties of materials.

(a) Look at the table. It shows information about two materials.

	<b>Polymer</b>	<b>Metal</b>
<b>Melting Point (°C)</b>	100–260	1100
<b>Density (kg/m<sup>3</sup>)</b>	940	8940
<b>Relative electrical conductivity (10 = good, 1 = poor)</b>	2	10
<b>Flexibility</b>	high	high

Electrical cables are made of metal wires surrounded by a polymer coating.



Explain why

- the wire is made of metal
- the metal wire is coated with a polymer.

Use information from the table in your answer.

.....

.....

.....

.....

.....

.....

.....

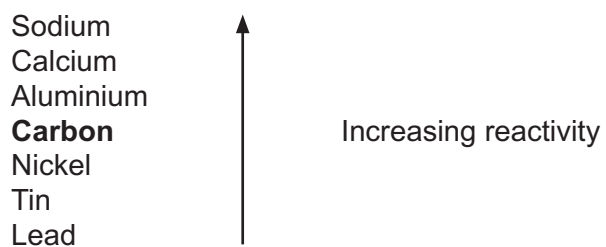
..... [3]

(b) Aluminium is a metal.

Aluminium is extracted from an ore called bauxite.

Electrolysis is used to extract the aluminium.

Use the reactivity series to explain why aluminium cannot be extracted from bauxite by heating the bauxite with carbon.



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

(c) Drinks cans are often made from aluminium.

4.0 kg of bauxite makes 1.0 kg of aluminium.

285 000 kJ of energy is needed to make 1.0 kg of aluminium from bauxite.

Aluminium can be **recycled**.

4.0 kg of recycled aluminium makes 3.8 kg of aluminium.

14 250 kJ of energy is needed to produce 1.0 kg of aluminium from recycled aluminium.

(i) Describe how aluminium is recycled.

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

(ii) Describe and explain **two** advantages of recycling aluminium.

Use the information in the question in your answer.

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

29  
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24 The Haber process is used to manufacture ammonia,  $\text{NH}_3$ .

Ammonia is used to make fertilisers, which farmers use on their crops.

(a) Explain why fertilisers are so important in the agricultural production of crops.

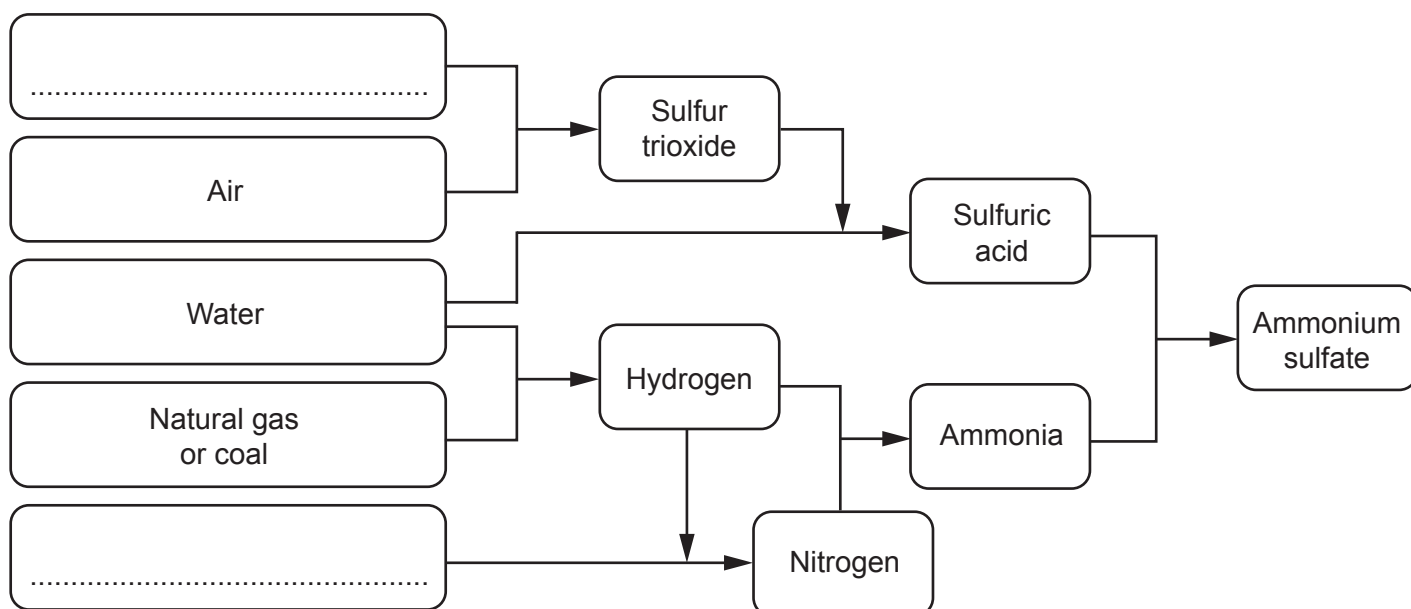
.....  
 ..... [2]

(b) Ammonium sulfate is a fertiliser made from ammonia and sulfuric acid.

The diagram shows the stages in the industrial production of ammonium sulfate.

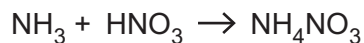
Complete the diagram to show the **raw materials** in the production of ammonium sulfate. [2]

### Raw Materials



- (c) Ammonium nitrate,  $\text{NH}_4\text{NO}_3$ , is another fertiliser made from ammonia.

Ammonium nitrate is made by reacting ammonia with nitric acid.



- (i) Calculate the mass of **ammonium nitrate** that could be made from 25.5 tonnes of ammonia.

$$A_r: \text{H} = 1.0, \text{N} = 14.0, \text{O} = 16.0$$

Mass of ammonium nitrate = ..... tonnes [3]

- (ii) A student makes some ammonium nitrate in the laboratory.

He predicts that he should make 12.5g of ammonium nitrate.

His percentage yield is 80%.

Calculate the **actual mass** of ammonium nitrate that the student makes.

Actual mass of ammonium nitrate = ..... g [2]

**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).

A large rectangular area with a solid vertical line on the left side and horizontal dotted lines across the rest of the page, providing space for writing answers.



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