OCR
Oxford Cambridge and RSA

H

Friday 20 November 2020 – Morning

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

J248/04 Paper 4 (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

J248/04

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 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.

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 A student investigates the decomposition of hydrogen peroxide.

$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$

0.2 g of oxygen gas is produced in the reaction.

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

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

A 0.2 g

B 0.3 g

C 0.5 g

D 0.7 g

Your answer ☐ **[1]**

2 Hydrogen gas, H_2, reacts with oxygen gas, O_2, to make water, H_2O.

$2H_2 + O_2 \rightarrow 2H_2O$

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

M_r: $H_2 = 2$, $O_2 = 32$, $H_2O = 18$

A 50%

B 53%

C 89%

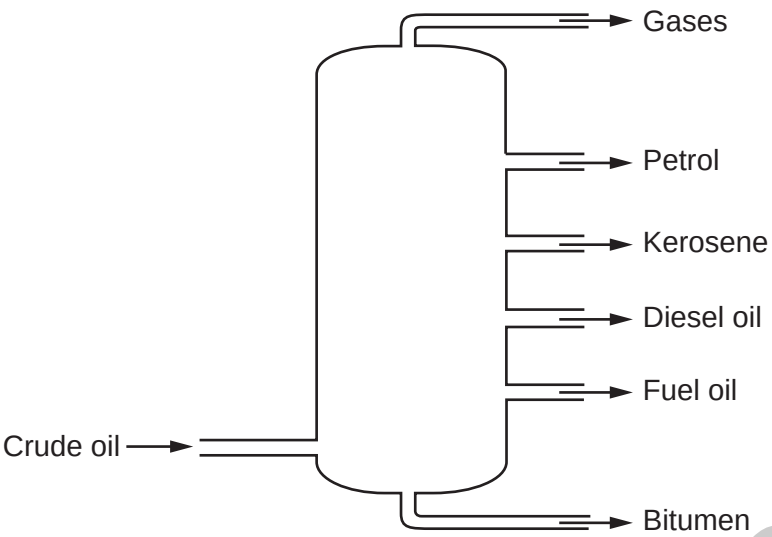
D 100%

Your answer ☐ **[1]**

3 Crude oil is separated into fractions by fractional distillation.

Look at the diagram of the fractions made in fractional distillation.

Fractions



Which of these fractions has the **strongest** intermolecular forces?

A Bitumen

B Diesel oil

C Gases

D Kerosene

Your answer ☐ **[1]**

4 What is the **general formula** of the fractions produced by the fractional distillation of crude oil?

A C_nH_{2n}

B C_nH_{2n+2}

C $C_2H_{2n+1}OH$

D $C_{2n+2}H_2$

Your answer ☐ **[1]**

5 The table shows some information about four alloys.

	Alloy	Main metals	Typical Uses
A	brass	copper and tin	musical instruments
B	bronze	copper and zinc	bells
C	duralumin	aluminium and copper	aircraft parts
D	solder	iron and tin	bridges

Which row of the table gives correct information about an alloy?

Your answer ☐ **[1]**

6 Enzymes are a type of catalyst.

Which of the following catalysts is an example of an enzyme?

A Amylase – a catalyst found in human saliva.

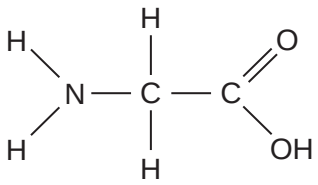
B Iron – a catalyst used in the Haber process.

C Manganese(IV) oxide – a catalyst used in the decomposition of hydrogen peroxide.

D Vanadium(V) oxide – a catalyst used in the Contact process.

Your answer ☐ **[1]**

7 Look at the structure of glycine.



Glycine is a monomer that reacts to form proteins.

Glycine contains **two** different functional groups that allow it to undergo polymerisation.

What are the two functional groups?

A $-NH_2$ and $-C=O$

B $-NH_2$ and $-CH_2-$

C $-NH_2$ and $-OH$

D $-NH_2$ and $-COOH$

Your answer ☐ **[1]**

8 In the Haber process, nitrogen reacts with hydrogen to make ammonia.

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

What is the maximum volume of ammonia, NH_3, that can be made from 150 cm^3 of hydrogen, H_2?

A 50 cm^3

B 100 cm^3

C 225 cm^3

D 450 cm^3

Your answer ☐ **[1]**

9 The Contact process produces sulfur trioxide, SO_3, in an **exothermic** reaction.

$2SO_2 + O_2 \rightleftharpoons 2SO_3$

The temperature in the reaction vessel is usually 450 °C.

What happens as the temperature is increased to 600 °C?

A Higher rate of reaction and increased yield of sulfur trioxide.

B Higher rate of reaction and decreased yield of sulfur trioxide.

C Higher rate of reaction and no change in yield of sulfur trioxide.

D Lower rate of reaction and decreased yield of sulfur trioxide.

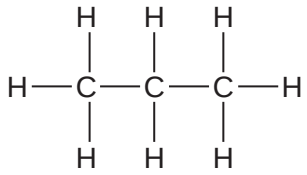
Your answer ☐ **[1]**

10 A student reacts a hydrocarbon with bromine water.

The formula of the product is $C_3H_6Br_2$.

Which is the displayed formula of the hydrocarbon?

A



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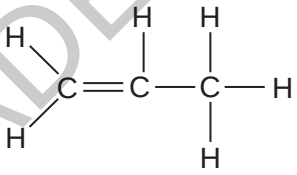

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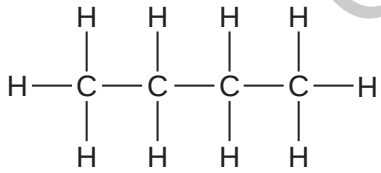

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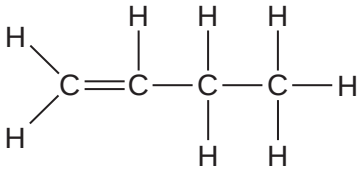

Your answer ☐ **[1]**

11 Which of these homologous series can react together to form addition polymers?

A Alcohols and carboxylic acids

B Alkenes only

C Alkenes and alkanes

D Carboxylic acids only

Your answer ☐ **[1]**

12 Which is the correct expression for calculating the concentration of a solution in g / dm^3?

A $\text{Concentration} = \frac{\text{volume of solution in dm}^3}{\text{mass of solute in g}}$

B $\text{Concentration} = \frac{\text{amount of solute in mol}}{\text{mass of solute in g}}$

C $\text{Concentration} = \frac{\text{mass of solute in g}}{\text{volume of solution in cm}^3 \times 1000}$

D $\text{Concentration} = \frac{\text{mass of solute in g}}{\text{volume of solution in dm}^3}$

Your answer ☐ **[1]**

13 Chemists often have a choice of reaction pathway when making a new product.

Which factor do chemists consider when choosing a reaction pathway?

A Disposal of product

B Price they can charge for the product

C Rate of reaction

D Usefulness of waste reactants

Your answer ☐ **[1]**

14 What is the formula of the functional group in **alcohols**?

A $-CH_3$

B $-COOH$

C $-CO_2$

D $-OH$

Your answer ☐ **[1]**

15 The rate of reaction of marble chips with dilute hydrochloric acid depends on the surface area of the marble chips.

Which surface area of the marble chips gives the **highest** rate of reaction?

A $0.673\,mm^2$

B $1030\,mm^2$

C $2.18 \times 10^3\,mm^2$

D $4.98 \times 10^{-2}\,mm^2$

Your answer ☐ **[1]**

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SECTION B

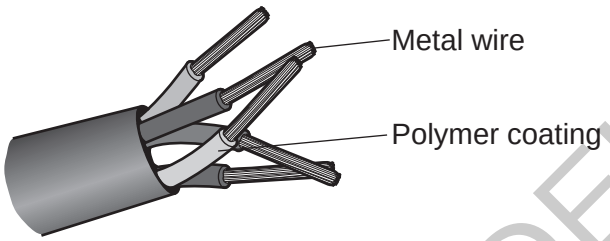
Answer **all** the questions.

16 This question is about the properties of materials.

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

	Polymer	**Metal**
Melting Point (°C)	100–260	1100
Density (kg / m^3)	940	8940
Relative electrical conductivity (10 = good, 1 = poor)	2	10
Flexibility	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.

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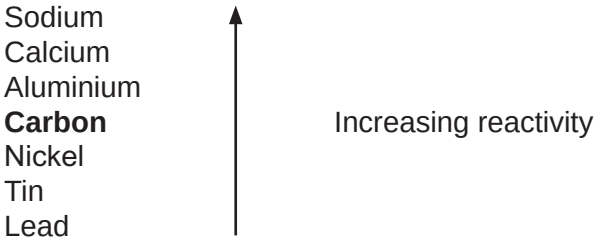
..... **[3]**

(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 kg of aluminium from recycled aluminium.

(i) Describe how aluminium is recycled.

.....

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

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

Use the information in the question in your answer.

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

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17 The Haber process is used to manufacture ammonia, 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.

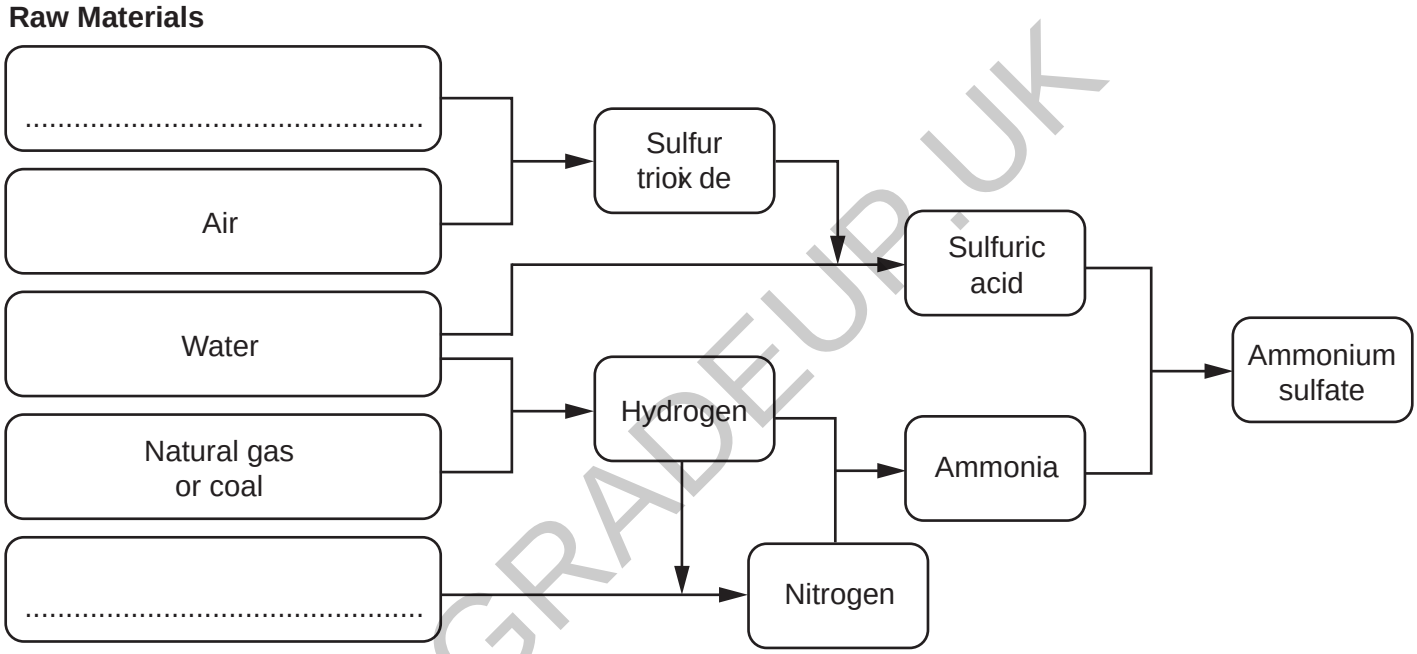
.....

..... **[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]**



(c) Ammonium nitrate, NH_4NO_3, is another fertiliser made from ammonia.

Ammonium nitrate is made by reacting ammonia with nitric acid.

$NH_3 + HNO_3 \rightarrow NH_4NO_3$

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

A_r: H = 1.0, N = 14.0, 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 12.5 g 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]**

18 Sodium is in Group 1 of the Periodic Table.

(a) Sodium reacts with water to make sodium hydroxide, NaOH, and hydrogen.

Write the **balanced symbol** equation for the reaction between sodium and water.

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

(b) Sodium ions, Na^+, are formed when sodium reacts with water.

Look at the equation. It shows how a sodium ion is formed from a sodium atom.

$Na - e^- \longrightarrow Na^+$

The symbol e^- means an electron.

The formation of a sodium ion from a sodium atom is an example of **oxidation**.

Explain why.

.....

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

(c) Rubidium is another element in Group 1.

Rubidium reacts much faster than sodium does.

Explain why.

Use ideas about electrons in your answer.

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

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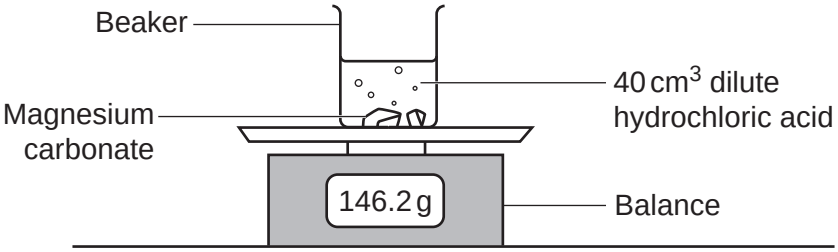
19 A student investigates the rate of reaction between dilute hydrochloric acid and magnesium carbonate.

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

Look at the apparatus she uses.



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.

He also wants to find out how the **concentration** of the acid changes the rate of reaction. He uses a **different** method.

Describe the **method** he uses.

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

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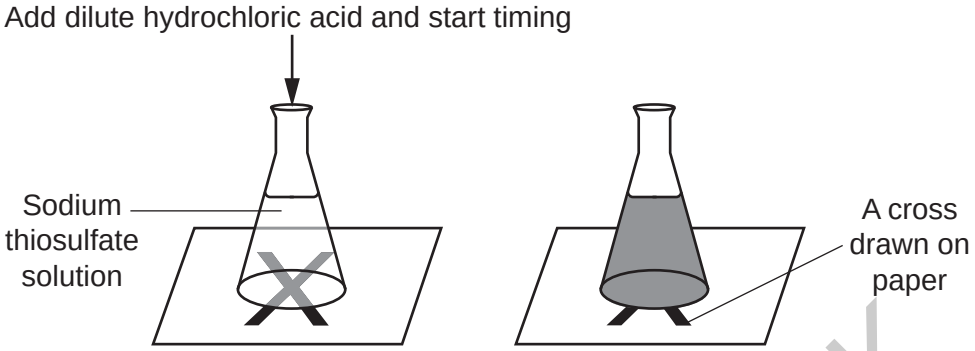
..... **[5]**

(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.

Look at the diagram of their experiment.



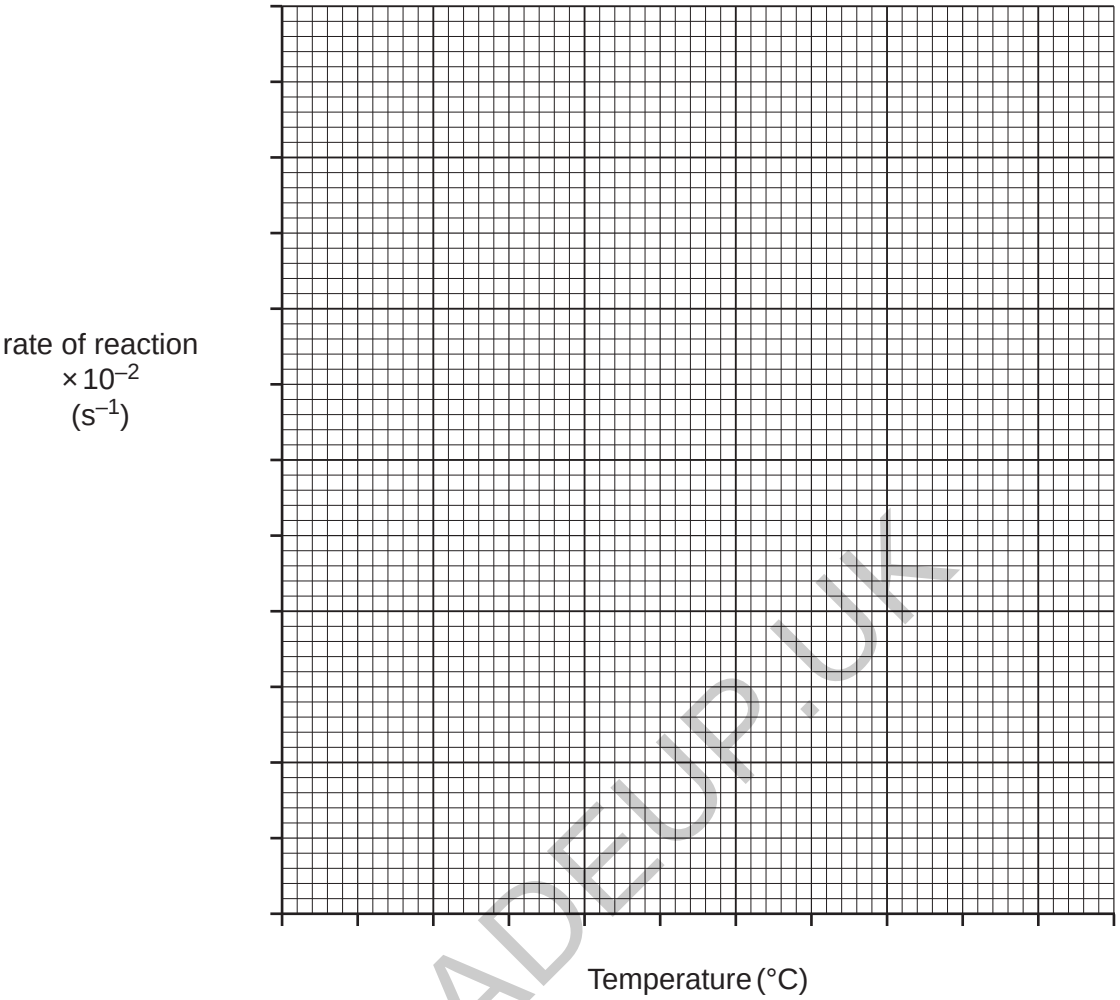
A yellow solid is made during the reaction.

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)	Rate of reaction (s^{-1})
10	140	7×10^{-3}
20	56	2×10^{-2}
30	34	3×10^{-2}
40	26	4×10^{-2}
50	22	5×10^{-2}

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



[4]

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

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

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

Use ideas about collisions between particles in your answer.

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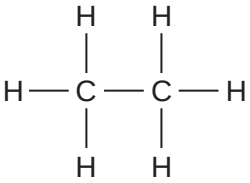
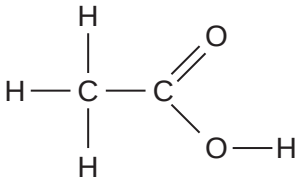
..... **[3]**

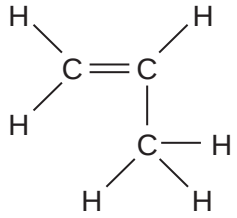
20 Look at the displayed formulae of some compounds.



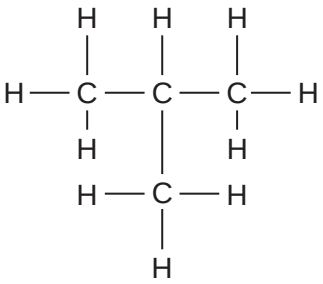
Compound **A**



Compound **B**



Compound **C**



Compound **D**

(a) **(i)** Which **two** compounds are members of the same **homologous series**?

..... and .....

(ii) Write down **two** reasons for your answer in **(a)(i)**.

1 .....

2 .....

[3]

(b) Many molecules of compound **C** react together to form a polymer.

This reaction is called **addition polymerisation**.

(i) Draw the **displayed formula** of the polymer formed by compound **C**.

[2]

(ii) Another type of polymerisation is **condensation polymerisation**.

Describe one **difference** between addition polymerisation and condensation polymerisation.

.....

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

(c)* A student has unlabelled samples of three liquids.

The student knows that the three liquids are:

- pentane, C_5H_{12}
- pentene, C_5H_{10}
- ethanoic acid, CH_3COOH.

Describe tests that the student should do to identify each of the three liquids.

Include **balanced symbol** equations for the reactions described.

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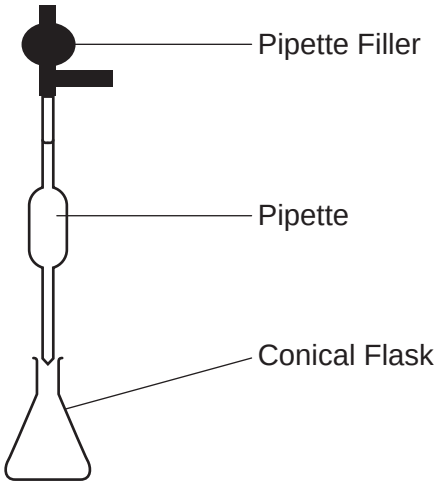
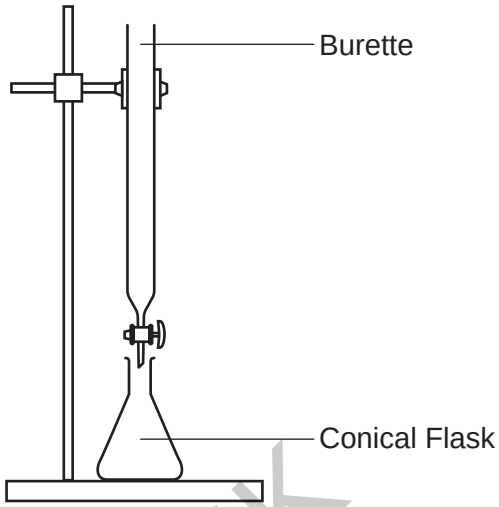
..... **[6]**

21 A student neutralises potassium hydroxide with dilute sulfuric acid in a titration experiment.

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





- Measure 25.0 cm^3 of 0.200 mol/dm^3 potassium hydroxide into a conical flask using a pipette.
- Add a few drops of universal indicator to the potassium hydroxide.
- Fill the burette to above the 0.00 cm^3 line with dilute sulfuric acid.
- Quickly add the dilute sulfuric acid to the potassium hydroxide until the indicator changes colour.
- Repeat the experiment.

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

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

(b) The student repeats the experiment four times.

Look at the student's results.

Titration number	1	2	3	4
Volume of acid (cm^3)	25.75	23.60	23.70	23.65

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

Accurate volume of acid = ... cm^3 **[2]**

(ii) Look at the equation for the reaction between sulfuric acid and potassium hydroxide.

$$H_2SO_4 + 2KOH \rightarrow K_2SO_4 + 2H_2O$$

Use your answer from part **(b)(i)** to calculate the concentration of the dilute sulfuric acid, H_2SO_4, that reacted with the 25.0 cm^3 of 0.200 mol/dm^3 potassium hydroxide.

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

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

22 A student investigates the reactivity of four metals, **A**, **B**, **C** and **D**.

He adds a small piece of each metal to cold water.

He then adds a small piece of each metal to dilute hydrochloric acid.

Look at his results.

Metal	Observations in water	Observations in dilute hydrochloric acid
A	slow bubbling	very fast bubbling
B	no reaction	no reaction
C	fast bubbling	very fast bubbling
D	no change	slow bubbling

(a) Write down the order of reactivity of the four metals **A**, **B**, **C** and **D**.

..... **most reactive**

.....

.....

..... **least reactive** **[2]**

(b) The piece of metal **C** used by the student produces 30 cm^3 of hydrogen gas when it reacts with the dilute hydrochloric acid at room temperature and pressure.

(i) Calculate the number of **moles** of hydrogen gas produced.

One mole of any gas occupies 24 dm^3 at room temperature and pressure.

Moles of hydrogen gas = ... **[2]**

(ii) Use your answer from **(b)(i)** to calculate the **mass** of hydrogen gas produced.

Mass of hydrogen gas = ... g **[1]**

(c) Chromium metal, Cr, reacts with nickel sulfate solution, $NiSO_4$. Solid nickel is made.

Two possible equations for this reaction are:

Equation 1 $Cr + NiSO_4 \rightarrow CrSO_4 + Ni$

Equation 2 $2Cr + 3NiSO_4 \rightarrow Cr_2(SO_4)_3 + 3Ni$

10.40 g of chromium metal reacts with excess nickel sulfate solution to make 17.61 g of nickel.

Deduce which equation, **1** or **2**, represents the reaction which takes place.

A_r: Cr = 52.0, Ni = 58.7

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

(d) Bioleaching is one method used to extract copper from ores.

Reactions involving bacteria slowly convert copper sulfide to a mixture of copper sulfate solution and sulfuric acid.

(i) Describe **two advantages** of extracting copper using bioleaching instead of traditional mining.

1 .....

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2 .....

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[2]

(ii) Suggest **one** reason why the sulfuric acid produced during bioleaching may be harmful to the environment.

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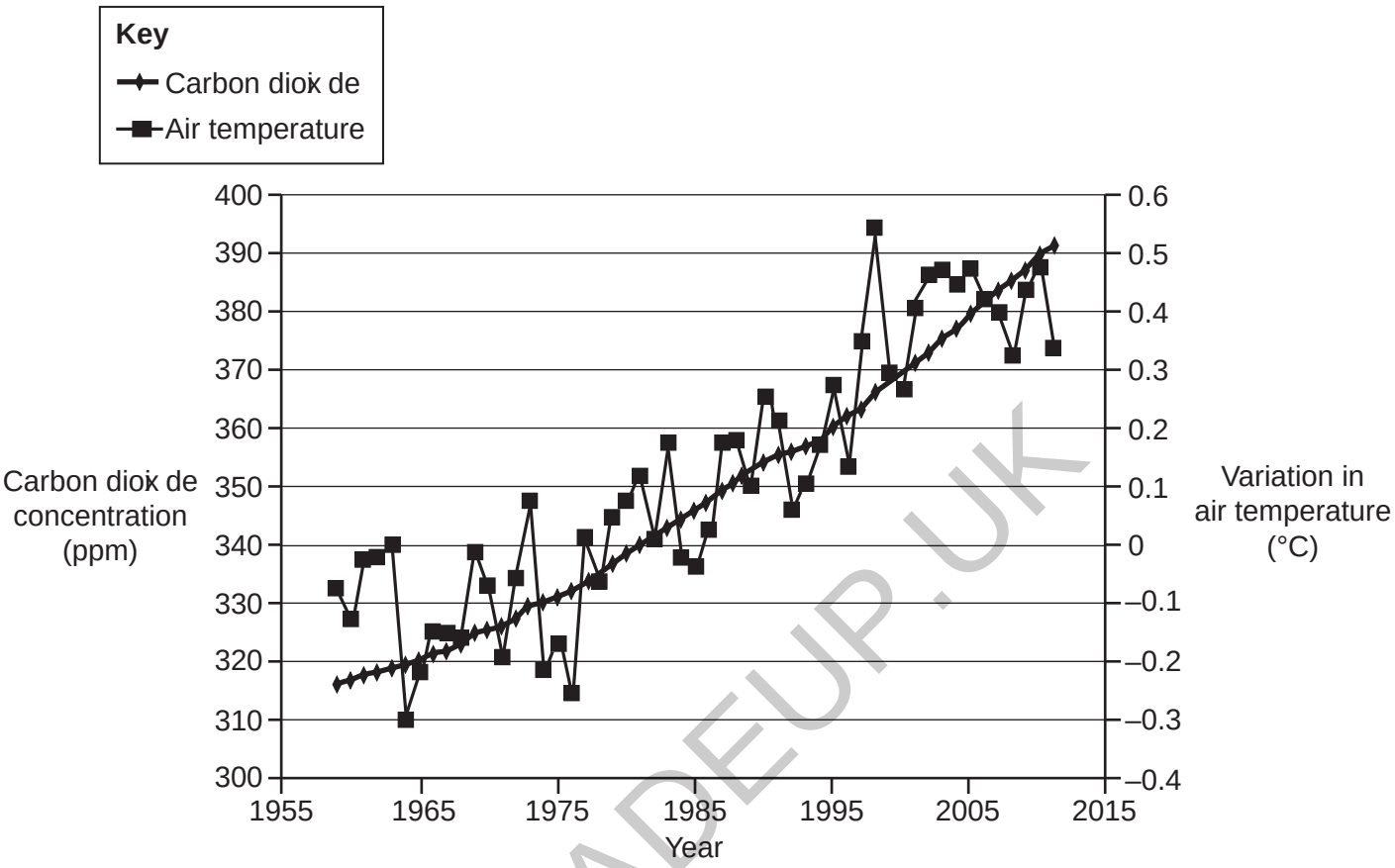
..... **[1]**

23 This question is about the Earth's atmosphere.

The graph shows how carbon dioxide concentration and air temperature have changed between 1955 and 2015.



(a) Evaluate the information shown in the graph.

To what extent does the graph support a link between carbon dioxide levels and global warming?

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

(b) Describe and explain what is meant by the **greenhouse effect**.

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

(c) Many scientists believe an **enhanced greenhouse effect** is caused by human activities.

(i) State a **human activity** that can cause an enhanced greenhouse effect.

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

(ii) State **two** environmental effects of an enhanced greenhouse effect.

1 .....

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2 .....

..... **[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).