AQA Style

GCSE
COMBINED SCIENCE: TRILOGY

H

Higher Tier   Chemistry Paper 1

Time allowed: 1 hour 15 minutes

Materials

• A ruler

• A pen and pencil

• A calculator

• Periodic Table of Elements

Instructions and Information

• Answer all the questions using a black pen.

• Answer the questions in the space available and cross out any work you do not want to be marked.

• In any calculations make sure you show your working out.

• The marks for each question are shown in brackets.

• The maximum mark for the paper is 70.

• You must make your work as neat as possible and use good English in your answers.

• You should make sure you leave time to check your answers.

Question	Mark
1	
2	
3	
4	
5	
6	
7	
Total	

Name _____

Date _____

BEYOND
SCIENCE

0 1   **Table 1** shows the melting and boiling points of the halogens.

Table 1

Halogen	Melting Point	Boiling Point
fluorine	-220	-188
chlorine	-101	-35
bromine	-7	59
iodine	114	184

0 1 . 1   Determine the state of chlorine at room temperature.

[1 mark]

_____

0 1 . 2   **Table 2** describes how the halogens react with hydrogen.

Table 2

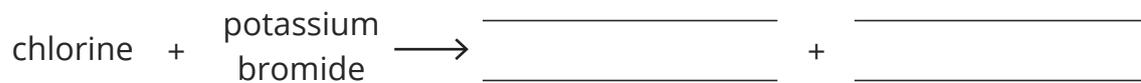| Halogen	Melting Point
fluorine	explosive
chlorine	explosive in light, reacts slowly in the dark
bromine	only reacts at temperatures over 300°C in the presence of a catalyst

Explain the trend in reactivity.

[4 marks]

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10

0 1 . 3 Chlorine reacts with potassium bromide.

Complete the word equation to show the products of the reaction.

[2 marks]

chlorine   +   potassium bromide $\longrightarrow$ _____   +   _____

0 1 . 4 What is the name of the type of reaction shown by the equation in **01.3?**

[1 mark]

_____

0 1 . 5 A student adds iodine to potassium bromide.

Explain what will happen.

[2 marks]

_____

_____

10

Turn over for the next question

BEYOND
SCIENCE

0 2   The discovery of the electron led to the plum pudding model of the atom.

Twelve years later, new experimental evidence caused the plum pudding model to be replaced with the nuclear model.

0 2 . 1   Describe the difference between the plum pudding model and the nuclear model of the atom and explain why the new evidence led to the plum pudding model being replaced.

[6 marks]

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BEYOND
SCIENCE

0 2 . 2 We now know that atoms contain protons, neutrons and electrons.

A boron atom has the symbol $^{11}_{5}B$

Determine the number of neutrons in an atom of boron.

[1 mark]

_____

_____

number of neutrons = _____

0 2 . 3 There are two isotopes of boron.

$$^{10}_{5}B \qquad ^{11}_{5}B$$

Give **one** similarity and **one** difference between the two isotopes of boron.

[2 marks]

Similarity _____

_____

Difference _____

_____

0 2 . 4 The abundance of $^{10}_{5}B$ is 20%.

The abundance of $^{11}_{5}B$ is 80%.

Calculate the relative atomic mass of boron.

[2 marks]

_____

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_____

relative atomic mass = _____

11

BEYOND
SCIENCE

0 3   **Table 3** describes the reactions of some metals with water and with acid at room temperature.

Table 3

Metal	Reaction with Water	Reaction with Dilute Acid
A	very slow reaction	fizzes
B	no reaction	no reaction
C	fizzes	violent reaction

0 3 . 1   Identify each metal.

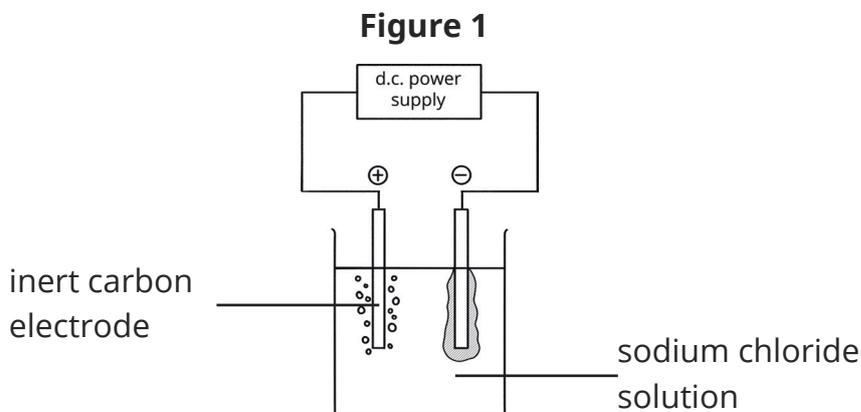Draw **one** line from each box.

[2 marks]

Metal   **Name**

A   copper

B   lithium

C   zinc

0 3 . 2   **Figure 1** shows the apparatus used for the electrolysis of $100cm^3$ sodium chloride.

Figure 1

inert carbon electrode

d.c. power supply

sodium chloride solution

The sodium chloride solution has a concentration of 300 grams per dm^3.

Calculate the mass of sodium chloride used in the experiment.

[3 marks]

_____

_____

_____

_____

mass of sodium chloride = _____ g

0 3 . 3   An extra 10g of solid sodium chloride is added to the solution.

Describe how this will affect the concentration of the solution.

[1 mark]

_____

0 3 . 4   Name the gas produced at the positive electrode (anode).

[1 mark]

_____

0 3 . 5   Hydrogen is produced at the negative electrode (cathode).

Complete the half equation for the reaction at the cathode.

[1 mark]

$2H^+$ _____ $\longrightarrow$ _____

0 3 . 6   Aluminium is extracted from aluminium oxide by electrolysis.

Aluminium oxide is not electrolysed in its pure form.

Explain why a molten mixture is used as the electrolyte.

You should name the other ionic compound in the mixture in your answer.

[4 marks]

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12

BEYOND
SCIENCE

0 4   This question is about carbon.

Methane is formed when a carbon atom forms bonds with four hydrogen atoms.

Complete the dot and cross diagram in **Figure 2** to show the bonds in methane.

You should only show the electrons in the outer shells.

[1 mark]

0 4 . 1   **Figure 2**
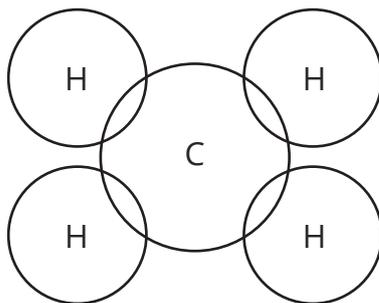
0 4 . 2   Calculate the percentage by mass of hydrogen in methane (CH_4).

Relative atomic masses (A_r): C = 12, H = 1

[3 marks]

_____

_____

_____

percentage by mass of hydrogen = _____%

0 4 . 3   Explain why methane is a gas at room temperature.

[3 marks]

_____

_____

_____

_____

0 4 . 4   Carbon can bond to other carbon atoms to form graphite and diamond.

A scientist set up an electrical circuit as shown in **Figure 3**.

Figure 3
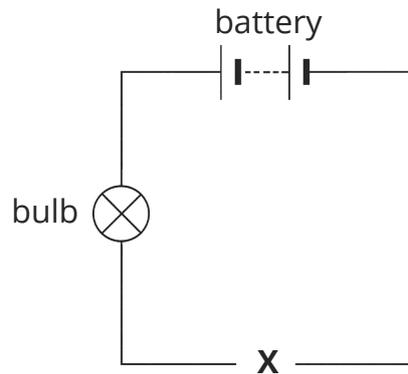
The scientist placed the graphite core of a pencil in position **X** to complete the circuit. The bulb lit up.

They then placed a diamond in position **X**. The bulb did not light up.
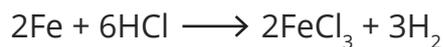
Explain the scientist's observations.

[4 marks]

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11

Turn over for the next question

BEYOND
SCIENCE

0 5   Iron (III) chloride ($FeCl_3$) is used to purify water.

0 5 . 1   Name the type of bonding in iron (III) chloride.

[1 mark]

_____

0 5 . 2   Iron chloride can be made by reacting iron with hydrochloric acid.

The balanced equation for the reaction is:

$$2Fe + 6HCl \longrightarrow 2FeCl_3 + 3H_2$$

A student uses 112g of iron in a reaction with 182.5g hydrochloric acid.
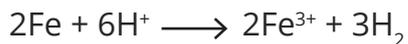
Relative atomic masses (A_r): Cl = 35.5, Fe = 56, H = 1
Relative formula mass (M_r): HCl = 36.5

Explain which reactant is the limiting reactant.

You must show your working.

[4 marks]

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BEYOND
SCIENCE

$\boxed{0}\boxed{5}.\boxed{3}$ The ionic equation for the reaction is:

$$2Fe + 6H^+ \longrightarrow 2Fe^{3+} + 3H_2$$

Which statement about the reaction between iron and hydrochloric acid is correct?

Tick **one** box.

[1 mark]

Hydrogen has been oxidised because the hydrogen atoms have gained electrons. ☐

Hydrogen has been oxidised because the hydrogen atoms have lost electrons. ☐

Iron has been oxidised because the iron atoms have gained electrons. ☐

Iron has been oxidised because the iron atoms have lost electrons. ☐

$\boxed{}$
$\boxed{6}$

Turn over for the next question

BEYOND
SCIENCE

| 0 | 6 |

Magnesium chloride is used in medicine as a source of magnesium ions.

| 0 | 6 | . | 1 |

Magnesium chloride can be made by reacting magnesium carbonate ($MgCO_3$) with hydrochloric acid.

The balanced equation for the reaction is

$$2HCl + MgCO_3 \longrightarrow MgCl_2 + H_2O + CO_2$$
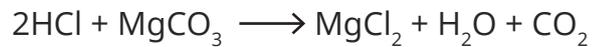
A chemist uses 210g of magnesium carbonate in the reaction.

Relative atomic masses (A_r): C = 12, Cl = 35.5, H = 1, Mg = 24, O = 16

Relative formula mass (M_r): HCl = 36.5, $MgCO_3$ = 84

Calculate the mass of hydrochloric acid needed for the magnesium carbonate to react completely.

[4 marks]

_____

_____

_____

_____

_____

_____

mass = _____ g

0 6 . 2   When the reaction was complete, the chemist measured the mass of the products. The equipment they used is shown in **Figure 4**.

Figure 4

The chemist's measurement of mass was 282.5g.

Explain why the mass was different to what the chemist expected.

[2 marks]

_____

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6

Turn over for the next question

0 7   Sulfuric acid and sodium hydroxide react in a neutralisation reaction.

Some students investigated how the temperature change of the reaction mixture was affected by the volume of sodium hydroxide added.

They used the following method:

1. Pour 30cm³ of dilute sulfuric acid into a polystyrene cup.

2. Measure the temperature of the acid using a thermometer.

3. Add 5cm³ sodium hydroxide to the polystyrene cup and stir gently.

4. When the reading on the thermometer stops changing, record the maximum temperature reached.

5. Rinse out the polystyrene cup with water.

6. Repeat the experiment 5 more times, increasing the volume of the sodium hydroxide by 5cm³ each time.

A diagram of the equipment is shown in **Figure 5**.

Figure 5

thermometer

polystyrene cup

reaction mixture

beaker
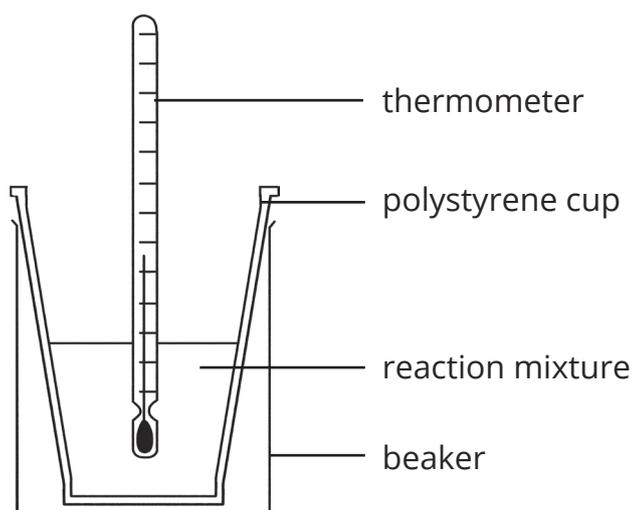
0 7 . 1   Explain why the students used a polystyrene cup.

[2 marks]

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_____

_____

0 7 . 2   Suggest **one** improvement the students could make to their method.

[1 mark]

_____

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_____

0 7 . 3   **Table 4** shows the students' results.

Table 4

Volume of Sodium Hydroxide Added (cm³)	Start Temperature (°C)	Mean Maximum Temperature (°C)
5	19	22
10	19	23
15	19	24
20	20	26
25	20	27
30	20	28

Figure 6 shows part of the reaction profile for the reaction between sulfuric acid and sodium hydroxide.

[2 marks]

Complete the reaction profile in **Figure 6**.

Figure 6

BEYOND SCIENCE
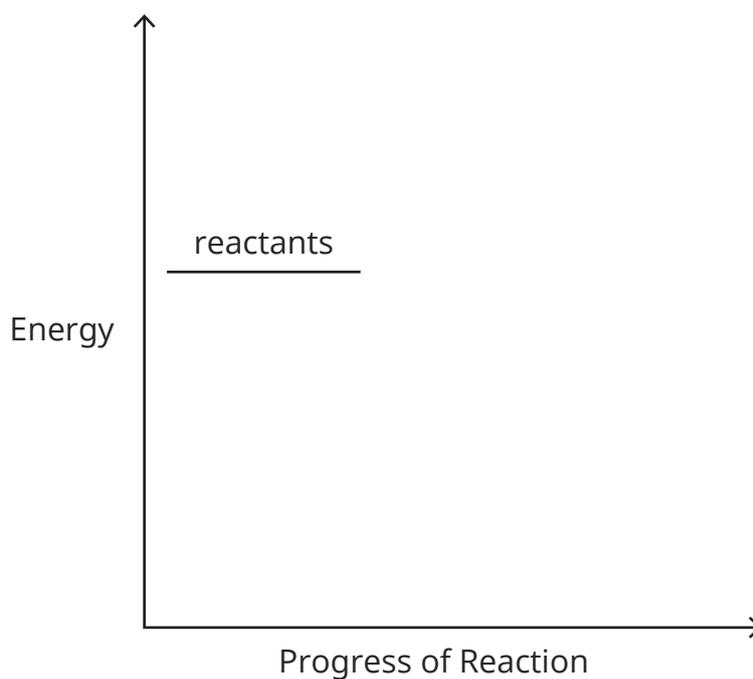
0 7 . 4   Complete the balanced symbol equation for the reaction.

The SO_4 ion has a charge of 2−.

[2 marks]

____H_2SO_4 + ____ NaOH $\longrightarrow$ _____ + ____ H_2O

0 7 . 5   Sulfuric acid is made in three stages.

In the final stage, sulfur trioxide reacts with water to make sulfuric acid.
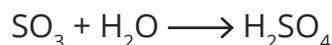
The equation for the reaction is:

$$SO_3 + H_2O \longrightarrow H_2SO_4$$

Figure 7 shows the displayed formulae for the reaction.

Figure 7
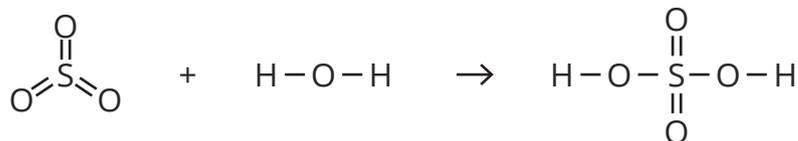
Table 5 shows the bond energies.

Table 5

Bond	Bond Energy (kJ/mol)
S=O	522
S–O	265
O–H	460

Calculate the overall energy change for the reaction.

Use **Figure 7** and **Table 5**.

[3 marks]

_____

_____

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_____

overall energy change = _____ kJ/mol

0 7 . 6   Sulfuric acid is a strong acid.

Citric acid is a weak acid.

Explain why, for a given concentration, strong acids have a lower pH than weak acids.

[2 marks]

_____

_____

_____

_____

0 7 . 7   A $0.1 mol/dm^3$ solution of sulfuric acid has a pH of 1.

Distilled water is added to the solution until the concentration is $0.001 mol/dm^3$.

Determine the pH after the distilled water is added.

[2 marks]

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pH = _____

14

END OF QUESTIONS

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