AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE
COMBINED SCIENCE: TRILOGY

H

Higher Tier
Chemistry Paper 1H

Thursday 14 May 2020 Morning Time allowed: 1 hour 15 minutes

Materials

For this paper you must have:
- a ruler
- a scientific calculator
- the periodic table (enclosed).

Instructions
- Use black ink or black ball-point pen.
- Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
TOTAL	

Information
- The maximum mark for this paper is 70.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

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0 1 This question is about the extraction of aluminium.

0 1 . 1 An aluminium atom is represented as:

$$^{27}_{13}Al$$

Give the number of electrons and neutrons in the aluminium atom.

[2 marks]

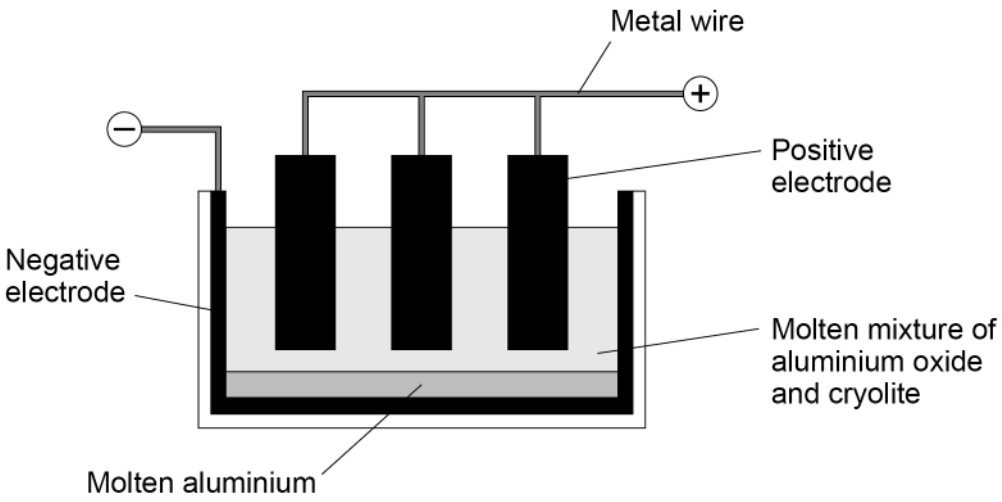
Number of electrons 13

Number of neutrons 14

Aluminium is extracted by the electrolysis of a molten mixture of aluminium oxide and cryolite.

Figure 1 shows the cell used for the electrolysis.

Figure 1



0 1 . 2 Aluminium is produced by the reduction of aluminium oxide (Al_2O_3).

What is meant by the term reduction?

[1 mark]

loss of oxygen

Do not write outside the box

0 1 . 3 Oxygen is formed at the positive carbon electrodes.

Explain why the positive carbon electrodes must be continually replaced.

[3 marks]

(at high temperature) oxygen reacts with carbon / electrode

(so the positive) electrode burns / wears away

to produce carbon dioxide

0 1 . 4 A substance conducts electricity because of free moving, charged particles.

What are the free moving, charged particles in a:

- carbon electrode (made from graphite)
- molten mixture of aluminium oxide and cryolite
- metal wire?

[3 marks]

Carbon electrode (made from graphite) (delocalised) electron(s)

Molten mixture of aluminium oxide and cryolite ion(s)

Metal wire (delocalised) electron(s)

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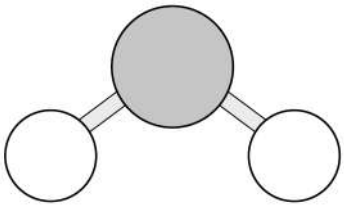
Turn over for the next question

Do not write outside the box

0 2 This question is about substances with covalent bonding.

0 2 . 1 **Figure 2** shows a ball and stick model of a water molecule (H_2O).

Figure 2



Suggest **one** limitation of using a ball and stick model for a water molecule.

[1 mark]

any one from:
• not to scale
• not 3 dimensional / D
• incorrect arrangement in space
• electrons / shells not shown

0 2 . 2 Ice has a low melting point.

Water molecules in ice are held together by intermolecular forces.

Complete the sentence.

[1 mark]

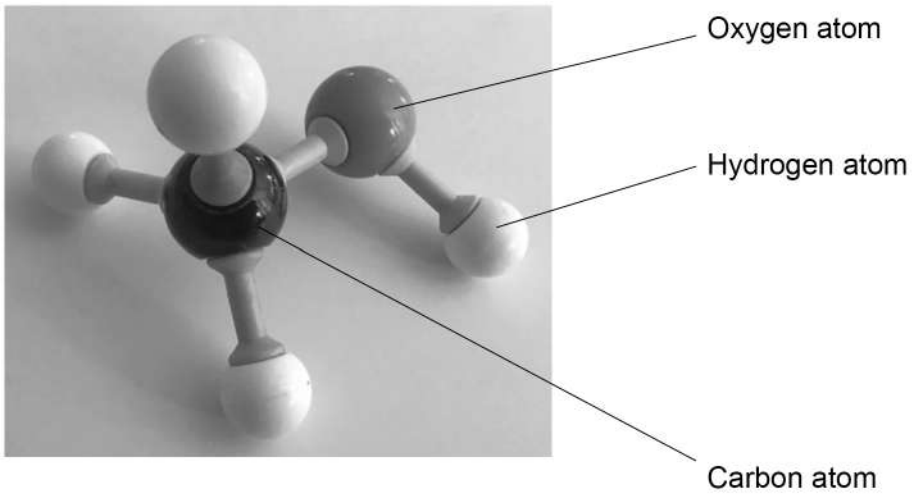
Ice has a low melting point because the

intermolecular forces are Weak .

Do not write outside the box

0 2 . 3 **Figure 3** shows the structure of a molecule.

Figure 3



What is the molecular formula of the molecule in **Figure 3**?

[1 mark]

CH4O

Question 2 continues on the next page

Do not write outside the box

Diamond has a giant covalent structure.

0 2 . 4 What is the number of bonds formed by each carbon atom in diamond?

[1 mark]

Tick (✓) **one** box.

2 ☐ 3 ☐ 4 ☑ 8 ☐

0 2 . 5 Give **two** physical properties of diamond.

[2 marks]

1 • (very) hard

2 • (very) high melting point

0 2 . 6 Name **two** other substances with giant covalent structures.

[2 marks]

1 graphite

2 silicon dioxide

8

Do not write outside the box

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 3 Some students investigated the thermal decomposition of metal carbonates.

The word equation for the reaction is:

metal carbonate → metal oxide + carbon dioxide

The students made the following hypothesis:

'When heated the same mass of any metal carbonate produces the same mass of carbon dioxide.'

The students heated a test tube containing copper carbonate.

Table 1 shows their results.

Table 1

Time the test tube containing copper carbonate was heated in mins	0	2	4	6
Mass of test tube and contents in g	17.7	17.1	17.0	17.0

Do not write outside the box

Plan a method the students could use to test their hypothesis.

You should show how the students use their results to test the hypothesis.

You do **not** need to write about safety precautions.

[6 marks]

Indicative content:

- weigh test tube
- add metal carbonate
- weigh test tube and metal carbonate

- heat
- allow to cool
- weigh test tube and metal oxide
- repeat (heat, cool and weigh) until no change in mass

- determine mass of metal carbonate used
- determine mass of carbon dioxide produced

- repeat with different metal carbonate(s)

an alternative method can be based on any mass of metal carbonates and at end divide by this mass to find mass carbon dioxide per gram metal carbonate

6

Turn over for the next question

Do not write outside the box

0 4 This question is about acids, alkalis and bases.

A student reacted zinc oxide powder with hydrochloric acid to produce zinc chloride solution.

0 4 . 1 Complete the equation for the reaction by writing the state symbols.

[2 marks]

$$ZnO(\ (s)\ ) + 2\,HCl(\ (aq)\ ) \rightarrow ZnCl_2(\ (aq)\ ) + H_2O(\ (l)\ )$$

0 4 . 2 Give **one** way that the student could speed up the reaction between zinc oxide powder and hydrochloric acid.

[1 mark]

any one from:
- warm / heat the mixture
- increase the concentration of the (hydrochloric) acid

Hydrochloric acid was the limiting reactant.

0 4 . 3 How could the student know when all the hydrochloric acid has reacted?

[1 mark]

zinc oxide remains or
solid remains

0 4 . 4 How could the student obtain zinc chloride solution from the reaction mixture when all the hydrochloric acid has reacted?

[1 mark]

filtration / filter

Do not write outside the box

0 4 . 5 Describe how zinc chloride crystals are produced from zinc chloride solution.

[2 marks]

heat

leave to crystallise / cool

Sulfuric acid and sodium hydroxide react to produce sodium sulfate.

0 4 . 6 Sulfuric acid is gradually added to sodium hydroxide solution.

The pH of the mixture changes as the sulfuric acid is added until in excess.

Suggest the pH at:

- the start before sulfuric acid is added
- the end when sulfuric acid is in excess.

[2 marks]

pH at start = (at start) value in range 12–14

pH at end = (at end) value in range 0–3

0 4 . 7 Complete the symbol equation for the preparation of sodium sulfate.

You should balance the equation.

[2 marks]

$$2\ NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2\ H2O$$

Question 4 continues on the next page

Do not write outside the box

0 4 . 8 A solution of hydrochloric acid had a hydrogen ion concentration of 1.0 mol/dm^3

Water was added to the hydrochloric acid until the pH increased by 1

What was the hydrogen ion concentration of the hydrochloric acid after water had been added?

[1 mark]

Tick (✓) **one** box.

100 mol/dm^3 ☐

10 mol/dm^3 ☐

0.10 mol/dm^3 ☑

0.010 mol/dm^3 ☐

12

Do not write outside the box

0 5 A student investigated the temperature change when magnesium was added to copper sulfate solution.

This is the method used.

1. Pour 30 cm^3 of copper sulfate solution into a polystyrene cup.

2. Measure the temperature of copper sulfate solution every minute for 3 minutes.

3. Add magnesium on the fourth minute.

4. Measure the temperature of the mixture at 5 minutes and then every minute up to 14 minutes.

0 5 . 1 What is the dependent variable in this investigation?

[1 mark]

temperature (change)

Question 5 continues on the next page

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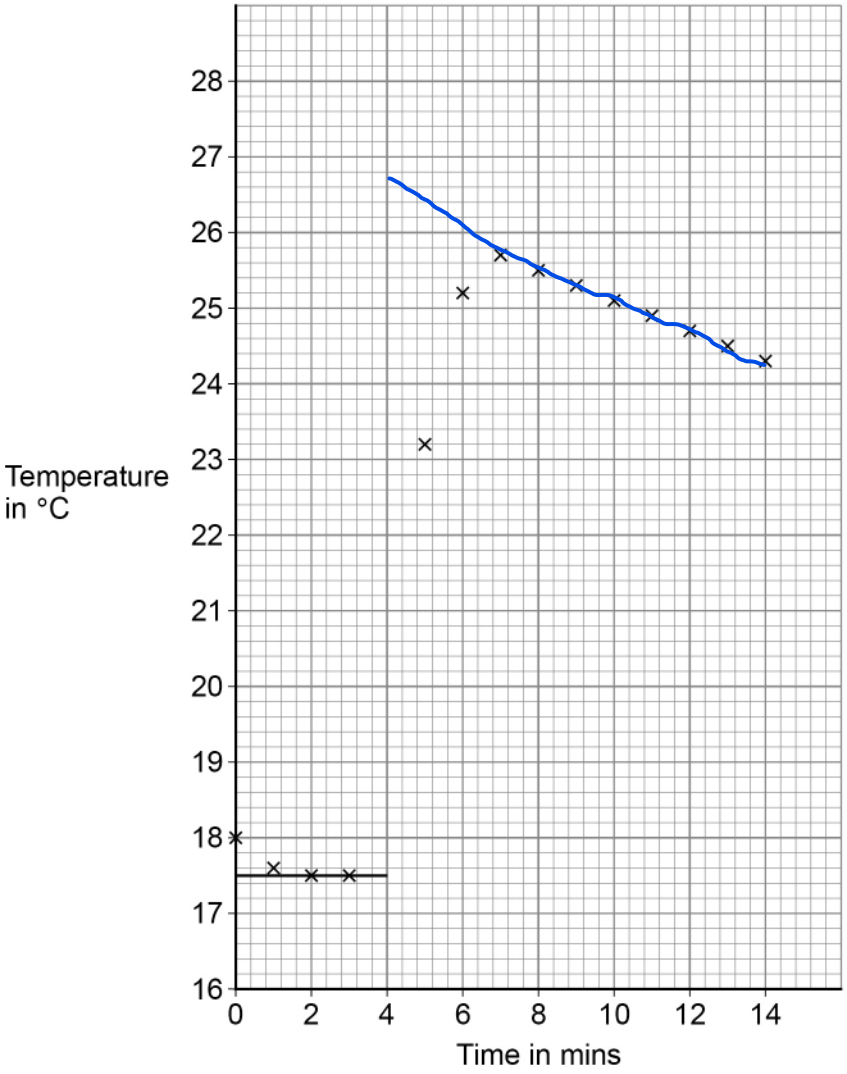
The student used the results to plot a graph.

Figure 4 shows the graph.

Figure 4



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0 5 . 2 Suggest why the copper sulfate solution was left for four minutes before adding the magnesium.

[1 mark]

to reach a constant temperature

0 5 . 3 Complete **Figure 4** by:

- drawing a line of best fit through all the points after 7 minutes
- extending the line back to 4 minutes.

[2 marks]

0 5 . 4 The temperature change for the reaction is the temperature difference between the two graph lines at 4 minutes.

Determine the temperature change for the reaction.

Use **Figure 4**.

[2 marks]

(maximum and minimum values at 4 minutes)
26.3 (°C) and 17.5 (°C)

(temperature change at 4 minutes)
= 8.8 °C)

Temperature change = 8.8 °C

0 5 . 5 Explain why the temperature of the mixture decreases after 7 minutes.

[2 marks]

the reaction finished / stopped

so) energy is lost to surroundings / atmosphere

or

(so the) solution cools (back to room temperature)

Do not write outside the box

0 5 . 6 The student repeated the experiment with an unknown metal **Q** instead of magnesium.

All the other variables were kept the same.

The student recorded a smaller temperature change.

Suggest the identity of metal **Q**.

Give **one** reason for your answer.

[2 marks]

Metal **Q** aluminium / zinc / iron / beryllium

Reason metal Q is less reactive (than magnesium)

0 5 . 7 A copper sulfate solution contained 0.100 moles of copper sulfate dissolved in 0.500 dm^3 of water.

Calculate the mass of copper sulfate in 30.0 cm^3 of this solution.

Relative formula mass (M_r): $CuSO_4$ = 159.5

[4 marks]

(unit conversion) 30.0 cm3 = 0.030 dm3

(moles = $\frac{30}{500} \times 0.1$ =) 0.006

mass = 0.006 × 159.5

Mass = 0.957 g

14

Do not write outside the box

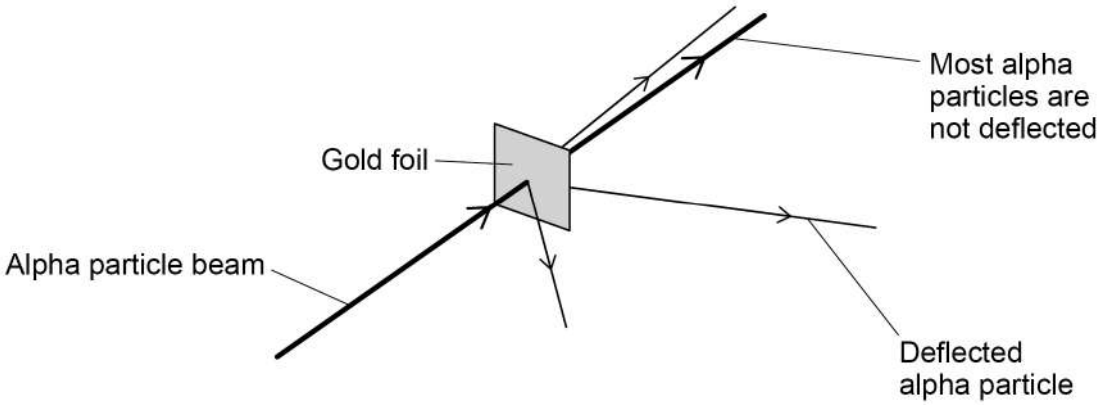
0 6 This question is about gold and compounds of gold.

0 6 . 1 In the alpha particle scattering experiment alpha particles are fired at gold foil.

Alpha particles are positively charged.

Figure 5 shows the results.

Figure 5



What **two** conclusions can be made from the results?

[2 marks]

Tick (✓) **two** boxes.

- Atoms are balls of positive charge with embedded electrons. ☐
- Atoms are tiny spheres that cannot be divided. ☐
- Atoms have a positively charged nucleus. ☑
- Mass is concentrated in the nucleus in the centre of atoms. ☑
- Neutrons exist within the nucleus. ☐

Question 6 continues on the next page

Do not write outside the box

0 6 . 2 The gold foil is:

- 4.00×10^{-7} metres thick
- 2400 atoms thick.

What is the diameter of one gold atom in metres?

Give your answer to 3 significant figures.

[3 marks]

$\frac{4 \times 10^{-7}}{2400}$

$= 1.66666 \times 10^{-10}$

$= 1.67 \times 10^{-10}$ (m)

Diameter of one gold atom (3 significant figures) = $= 1.67 \times 10^{-10}$ (m) m

Do not write outside the box

0 6 . 3 Gold reacts with the elements in Group 7 of the periodic table.

0.175 g of gold reacts with chlorine.

The equation for the reaction is:

$$2\ Au + 3\ Cl_2 \rightarrow 2\ AuCl_3$$

Calculate the mass of chlorine needed to react with 0.175 g of gold.

Give your answer in mg

Relative atomic masses (A_r): Cl = 35.5 Au = 197

[5 marks]

(moles Au = $\frac{0.175}{197}$ =) 0.000888

(moles Cl2 = 0.000888 × $\frac{3}{2}$ =) 0.000888

(mass Cl2 =) 0.00133 × 71

= 0.0946 (g)

Mass of chlorine = 94.6 mg

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Turn over for the next question

Do not write outside the box

0 7 This question is about elements.

Caesium is in Group 1 of the periodic table.

0 7 . 1 Explain what happens to caesium atoms and to oxygen atoms when caesium reacts with oxygen to produce caesium oxide.

You should answer in terms of electrons.

[4 marks]

caesium atom loses one electron

(and) oxygen atom gains two electrons

(so) two caesium atoms react with one oxygen atom

any one from:

• (to form) Cs+ and O2-

0 7 . 2 Explain why caesium is more reactive than sodium.

You should answer in terms of electrons.

[4 marks]

(caesium has) more energy levels or

(caesium has) more shells

(so the) outer electron / shell is further from nucleus

or

outer electron / shell is more shielded

(so) weaker attraction between nucleus and outer electron / shell

(so) outer electron is more easily lost

Do not write outside the box

0 7 . 3 **Figure 6** shows part of Mendeleev's periodic table.

Figure 6

16 **O**	19 **F**
32 **S**	35.5 **Cl**
79 **Se**	80 **Br**
128 **Te**	127 **I**

Explain why the early periodic tables placed iodine (I) before tellurium (Te), but then Mendeleev placed tellurium before iodine.

[3 marks]

early periodic tables were arranged with elements in order

of their atomic weights

iodine has a lower atomic weight than tellurium

(so) Mendeleev placed iodine with elements with same / similar properties

or

(so) Mendeleev placed tellurium with elements with same / similar properties

11

END OF QUESTIONS

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Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**

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