AQA

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

GCSE
COMBINED SCIENCE: TRILOGY

H

Higher Tier
Chemistry Paper 1H

Thursday 17 May 2018 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.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided.
- 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.

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.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
TOTAL	

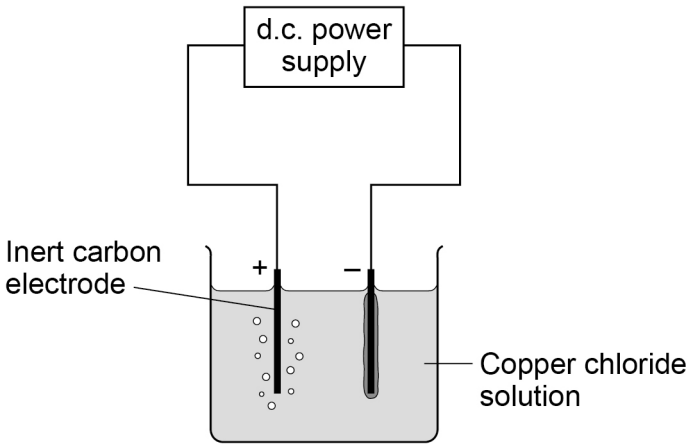
0 1 This question is about electrolysis.

A student investigates the mass of copper produced during electrolysis of copper chloride solution.

Cu^{2+} Cl^- H^+ OH^- H_2O → H^+ OH^-

Figure 1 shows the apparatus.

Figure 1



attract negative ions

0 1 . 1 Which gas is produced at the positive electrode (anode)?

[1 mark]

Tick **one** box.

- carbon dioxide ☐
- chlorine ☑
- hydrogen ☐
- oxygen ☐

At the anode, a halide ion always takes priority.

Do not write outside the box

0 1 . 2 Copper is produced at the negative electrode (cathode).

What does this tell you about the reactivity of copper?

[1 mark]

Tick **one** box.

- Copper is less reactive than hydrogen ☑
- Copper is less reactive than oxygen ☐
- Copper is more reactive than carbon ☐
- Copper is more reactive than chlorine ☐

Cu^{2+} Cl^- H^+ OH^-

At the cathode the less reactive element is formed.

Table 1 shows the student's results.

Table 1

	Total mass of copper produced in mg			
Time in mins	**Experiment 1**	**Experiment 2**	**Experiment 3**	**Mean**
1	0.60	0.58	0.62	0.60
2	1.17	1.22	1.21	1.20
4	2.40	2.41	2.39	2.40
5	3.02	**X**	3.01	3.06

+0.60

0 1 . 3 Determine the **mean** mass of copper produced after 3 minutes.

no calculation "needed" (however, useful in this Q)

[1 mark]

2 mins = 1.20 } +0.60

3 mins = 1.80 } +0.60

4 mins = 2.40

Allow 1.7 – 1.9

Mass = 1.80 mg

Question 1 continues on the next page

0 1 . 4 Calculate the mass **X** of copper produced in **Experiment 2** after 5 minutes.

Use **Table 1** on page 3

[2 marks]

$\frac{3.02 + x + 3.01}{3} = 3.06$ (x3) ✓ (1)

$3.02 + 3.01 + x = 9.18$

Simplify... $6.03 + x = 9.18$

$x = 9.18 - 6.03$

Mass **X** = 3.15 ✓ (1) mg

0 1 . 5 The copper chloride solution used in the investigation contained 300 grams per dm^3 of solid $CuCl_2$ dissolved in 1 dm^3 of water.

The student used 50 cm^3 of copper chloride solution in each experiment.

Calculate the mass of solid copper chloride used in each experiment.

$1000\ cm^3 = 1\ dm^3$

[3 marks]

300 g per $1\ dm^3$

÷20 ↓ 300 g per $1000\ cm^3$ ↓ ÷20

15 g per $50\ cm^3$ ✓ ✓ (2)

Mass = 15 ✓ g (1)

Alternate Method 1

0.05×300

$= 15g$

Alternate Method 2

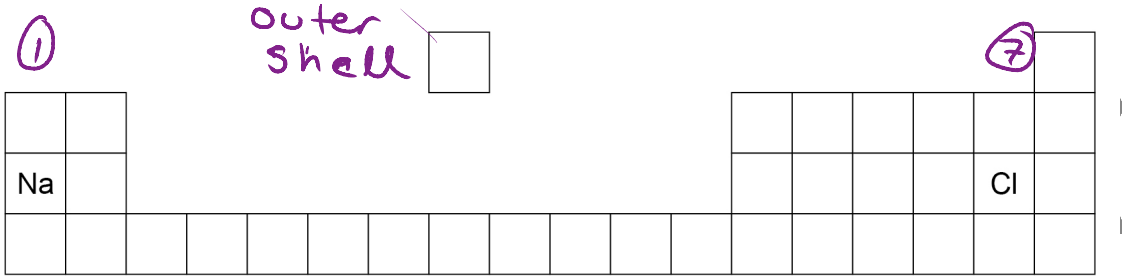
0.3×50

$= 15g$

0 2 This question is about sodium and chlorine.

Figure 2 shows the positions of sodium and chlorine in the periodic table.

Figure 2



0 2 . 1 State **one** difference and **one** similarity in the electronic structure of sodium and of chlorine.

[2 marks]

Difference They have different numbers of electrons in their outer shells.

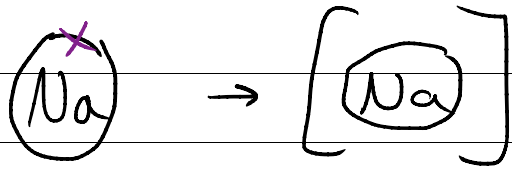
Similarity They have the same number of electron shells.

0 2 . 2 Sodium atoms react with chlorine atoms to produce sodium chloride (NaCl).

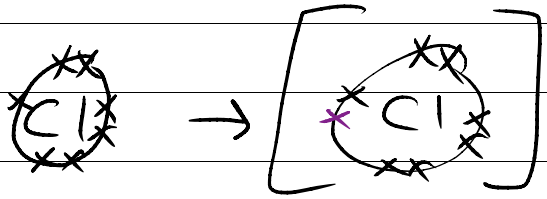
Describe what happens when a sodium atom reacts with a chlorine atom.

Write about electron transfer in your answer.

[4 marks]



Na lost 1 electron



Cl gained 1 electron

The electron lost from Na was transfered to Cl.

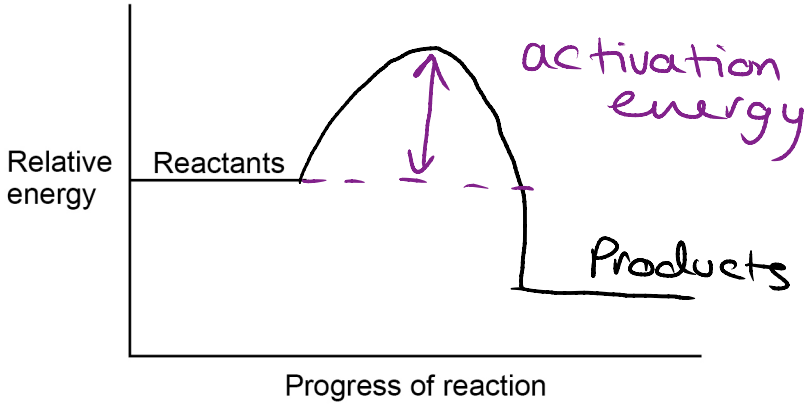
0 2 . 3 The reaction between sodium and chlorine is an exothermic reaction.

heat energy released

Complete the reaction profile for the reaction between sodium and chlorine.

[2 marks]

Figure 3



0 3 A student plans a method to prepare pure crystals of copper sulfate.

The student's method is:

1. Add one spatula of calcium carbonate to dilute hydrochloric acid in a beaker.
2. When the fizzing stops, heat the solution with a Bunsen burner until all the liquid is gone.

The method contains several errors and does not produce copper sulfate crystals.

Explain the improvements the student should make to the method so that pure crystals of copper sulfate are produced.

[6 marks]

- The student should use sulfuric acid instead of hydrochloric acid, to produce a sulfate rather than a chloride.

- Use copper carbonate instead of calcium carbonate.

- Add the carbonate in excess, to ensure the acid fully reacts.

- Filter to remove the excess carbonate.

- Heat gently and leave to crystallise.

- Relevant points identified
- Given in detail
- Logically linked
- Clear account.

0 4 This question is about the halogens.

0 4 . 1 Write the state symbol for chlorine at room temperature.

[1 mark]

Cl_2 (g)

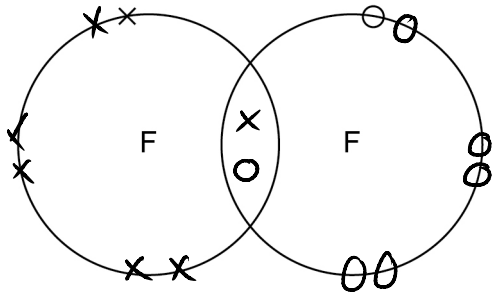
Simple Molecular → low boiling point

0 4 . 2 **Figure 4** represents one molecule of fluorine. F_2

Complete the dot and cross diagram on **Figure 4**

[2 marks]

Figure 4



0 4 . 3 A fluorine atom can be represented as $^{19}_{9}F$

mass number, atomic number, no of protons / electrons

What is the total number of electrons in a fluorine molecule (F_2)?

[1 mark]

Tick **one** box.

9 ☐ 14 ☐ 18 ☑ 38 ☐

9 × 2 = 18

0 4 . 4 Aluminium reacts with bromine to produce aluminium bromide.

ionic

Complete the balanced chemical equation for this reaction.

2 Al + 3 Br_2 → 2 $AlBr_3$

Al 3+ Br 1-

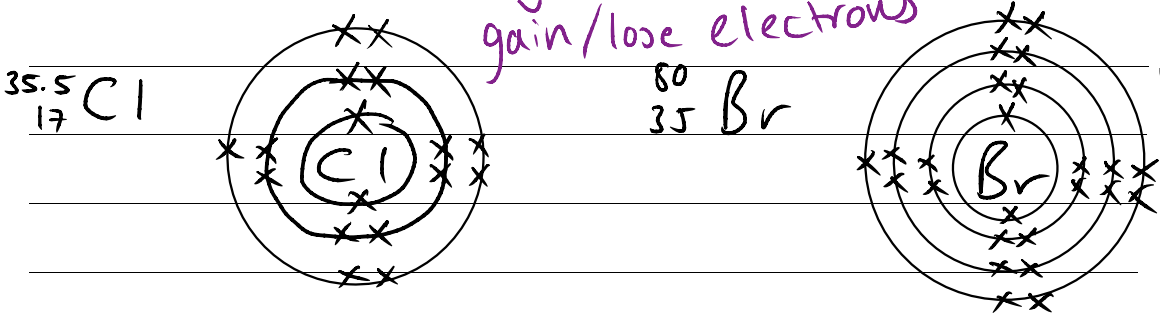
$AlBr_3$

0 4 . 5 When chlorine reacts with potassium bromide, chlorine displaces bromine.

$$Cl_2 + 2\,KBr \rightarrow Br_2 + 2\,KCl$$

Explain why chlorine is more reactive than bromine.

[3 marks]



- Cl is a smaller atom / has fewer shells. ✓ (1)

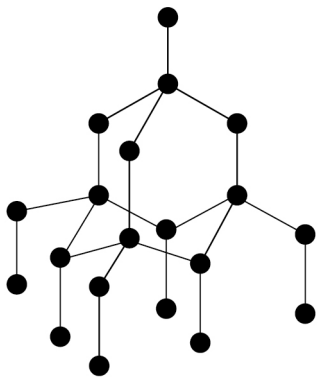
- Cl has shell shielding / greater attraction between nucleus and the outer shell. ✓ (1)

- Easier for Cl to gain an electron ✓ (1)

0 5 This question is about structure and bonding.

Figure 5 shows part of the structure and bonding in diamond.

Figure 5



carbon atoms

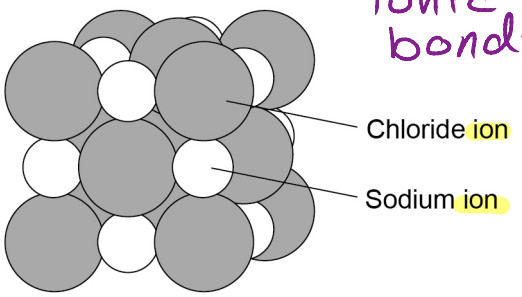
Explain why diamond has a high melting point.

[3 marks]

- Lots of strong covalent bonds. ✓1
- Giant Covalent Structure ✓1
- Lots of energy to break/overcome. ✓1

0 5 . 2 **Figure 6** shows part of the structure and bonding in sodium chloride (NaCl).

Figure 6



ionic bonding

giant ionic lattice

Explain the conditions needed for sodium chloride to conduct electricity.

flow of charged particles

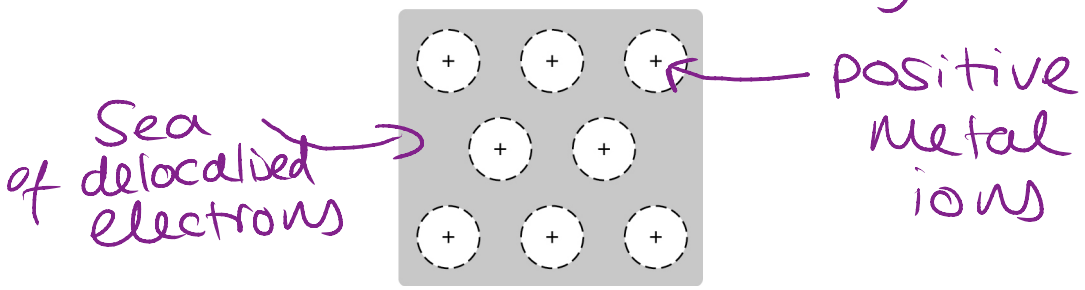
[3 marks]

- Molten / liquid ✓ (1)
- Dissolved (in water) / aq ✓ (1)
- Ions are mobile ✓ (1) (moving around structure, carrying charge)

0 5 . 3 **Figure 7** shows the structure of sodium.

metallic bonding

Figure 7



Describe how sodium conducts thermal energy.

[3 marks]

- Delocalised electrons ✓ (1)
- free to move around the structure ✓ (1)
- free to transfer energy through structure ✓ (1)

0 6 Group 2 metal carbonates thermally decompose to produce a metal oxide and a gas.

Ca^{2+} O^{2-}

0 6 . 1 Give the formula of each product when calcium carbonate ($CaCO_3$) is heated.

[2 marks]

CaO and CO_2

X → a group 2 metal

0 6 . 2 The relative formula mass (M_r) of a Group 2 metal carbonate is 197

Relative atomic masses (A_r): C = 12 O = 16 X^{2+} CO_3^{2-}

Calculate the relative atomic mass (A_r) of the Group 2 metal in the metal carbonate.

Name the Group 2 metal.

[3 marks]

$XCO_3 = 197$

$X + 12 + 3(16) = 197$

$X + 60 = 197$

$X = 197 - 60$

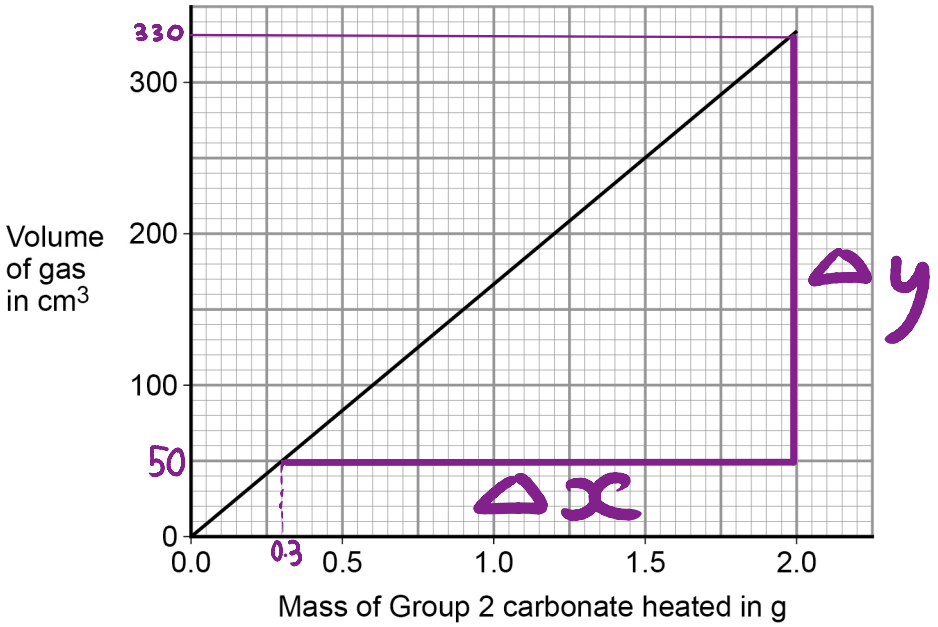
$X = 137$

Relative atomic mass (A_r) = 137

Metal Barium

Figure 8 shows the volume of gas produced when a different Group 2 carbonate, **W**, is heated.

Figure 8



0 6 . 3 Calculate the gradient of the line in **Figure 8**

Give the unit.

[3 marks]

Gradient $= \frac{\Delta y}{\Delta x} = \frac{330 - 50}{2.0 - 0.3}$

$= 165$

Allow 160 - 174

Gradient 165

Unit cm^3 / g

0 6 . 4 24 dm^3 of gas is produced when one mole of a Group 2 carbonate is heated.

Determine the relative formula mass of the Group 2 carbonate **W**.

Use **Figure 8**

[4 marks]

240 cm^3 = mass

240 cm^3 = 1.45 g (reading off the graph)

x 100 ↓ x 100 ↓

24,000 cm^3 = 145

24 dm^3 = 24,000 cm^3

Relative formula mass (M_r) = 145

0 7 A scientist does two tests on four white solids. The solids are labelled **A**, **B**, **C** and **D**.

Test 1 Adds the sample of the solid to distilled water and stirs.

Test 2 Measures the pH of the solution after **Test 1**

Table 2 shows the results.

Table 2

Solid	Appearance after stirring	pH
A	colourless solution, no solid	14
B	colourless solution, no solid	3
C	colourless solution, solid remains	9
D	colourless liquid, solid remains	7

These four solids are:

- magnesium oxide
- phosphorus oxide
- silicon dioxide
- sodium oxide.

Table 3 shows the solubility of these four solids in water.

Table 3

Solid	Solubility in grams per 100 cm^3 of water
Magnesium oxide	0.01
Phosphorus oxide	52
Silicon dioxide	0
Sodium oxide	109

- relevant points
- given in detail
- logically linked
- clear account

0 7 . 1 Identify the solids **A**, **B**, **C** and **D**.

Explain your answers.

[6 marks]

Table 2	Table 3
A: no solid (pH = 14)	Magnesium oxide = 0.01
B: no solid (pH = 3)	Phosphorus oxide (acid) = 52
C: Solid remains (pH = 9)	Silicon dioxide = 0
D: Solid remains (pH = 7)	Sodium oxide (base) = 109

D is silicon dioxide. This is because the pH is unchanged from that of distilled water, therefore no solid dissolved, and silicon dioxide is completely insoluble.

C is Magnesium Oxide. This is because it is insoluble (slightly), yet some dissolved in the water, hence the pH increase.

A is Sodium Oxide because it is a base (hence has high pH) and is very soluble.

B is Phosphorus oxide as it is acidic (low pH) and soluble.

0 7 . 2 10 cm^3 of solution **B** is added to a beaker.

Distilled water is added to the beaker until the final volume in the beaker is 1000 cm^3

The pH of the solution is measured before and after distilled water is added.

Table 4 shows the results.

Table 4

Volume of solution in beaker	pH of solution B
10 cm^3 ×100 ↓	3
1000 cm^3	**X**

100 = 10 × 10

Calculate the value of **X**.

[2 marks]

- Dilution by a factor of 100.

∴ 3 + 1 + 1 = 5

When diluting by a factor of 10, there will be a pH change of 1. As there are 2 dilutions by a factor of 10, the pH will change by 2.

X = 5

0 8 This question is about iron.

Iron reacts with dilute hydrochloric acid to produce iron chloride solution and one other product.

$Fe + 2HCl \rightarrow FeCl_2 + H_2$

0 8 . 1 Name the other product.

[1 mark]

H_2 (hydrogen)

0 8 . 2 Suggest how any unreacted iron can be separated from the mixture.

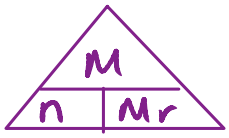
[1 mark]

filtration (or magnet)

Magnesium reacts with iron chloride solution.

$$3\ Mg + 2\ FeCl_3 \rightarrow 2\ Fe + 3\ MgCl_2$$

0 8 . 3 0.120 g of magnesium reacts with excess iron chloride solution.



Relative atomic masses (A_r): Mg = 24 Fe = 56

Calculate the mass of iron produced, in mg

[5 marks]

$3Mg + 2FeCl_3 \rightarrow 2Fe + 3MgCl_2$

0.120 g

$n = \frac{M}{Mr} = \frac{0.120}{24} = 0.005$ moles (of Mg) ✓ (1)

n of Fe : $\frac{2}{3} \times 0.005 = 0.0033$ moles (1)

$M = n \times Mr = 0.0033 \times 56 = 0.1866$ g (of Fe) ✓ (1) ✓ (1)

Mass of iron = 187 ✓ (1) mg

$0.1866\ g \times 1000 = 186.6$ mg

0 8 . 4 Explain which species is reduced in the reaction between magnesium and iron chloride.

$$\overset{0}{3\,Mg} + 2\,\overset{+3\ -1}{FeCl_3} \rightarrow \overset{0}{2\,Fe} + 3\,\overset{+2\ -1}{MgCl_2}$$

Oxidation is Loss
Reduction is Gain

Your answer should include the half equation for the reduction. **[3 marks]**

(Mg has been oxidised)
(Cl^- is a spectator ion)

Fe^{3+} ✓ has been reduced because it has gained electrons. ✓ (1)

$Fe^{3+} + 3e^- \rightarrow Fe$ ✓ (1)

END OF QUESTIONS