



Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

Forename(s)

Candidate signature

GCSE COMBINED SCIENCE: TRILOGY

F

Foundation Tier
Chemistry Paper 1F

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	
TOTAL	



J U N 1 8 8 4 6 4 C 1 F 0 1

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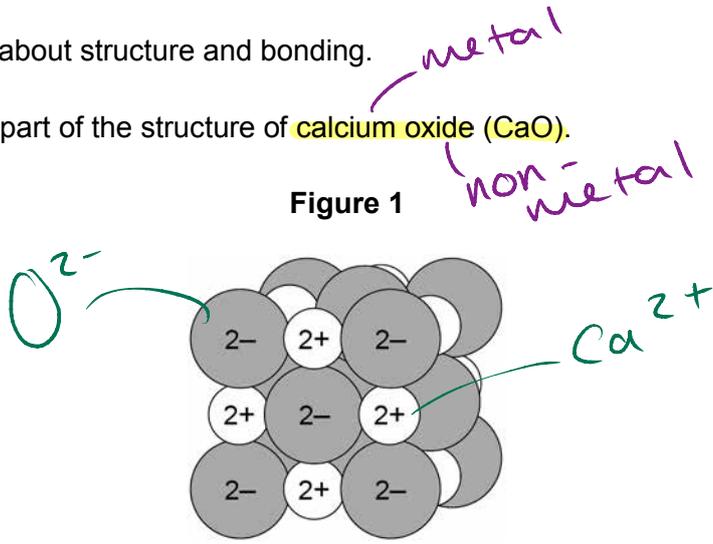
0 1

This question is about structure and bonding.

0 1 . 1

Figure 1 shows part of the structure of calcium oxide (CaO).

Figure 1



What type of bonding is present in calcium oxide?

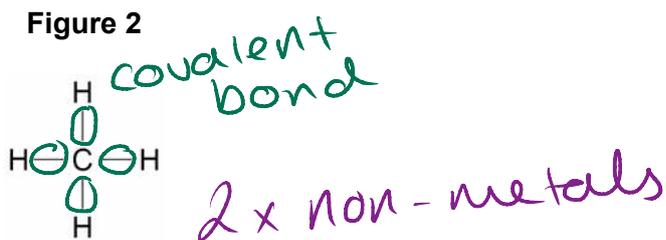
[1 mark]

Tick **one** box.

- Covalent
- Ionic
- Macromolecular
- Metallic



0 1 2 Figure 2 shows a particle of methane (CH₄).



What type of **particle** is present in Figure 2?

[1 mark]

Tick **one** box.

An ion

A lattice

A molecule

A polymer

Covalently bonded atoms

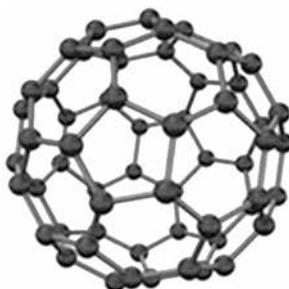
charged particles

See Figure 1 (alternating arrangement of + and - ions)

"many"

0 1 3 Figure 3 shows the structure of C₆₀

Figure 3



Complete the sentence.

Choose the answer from the box.

[1 mark]

two atoms → diatomic *charges* → giant ionic *metals* → giant metallic

a fullerene

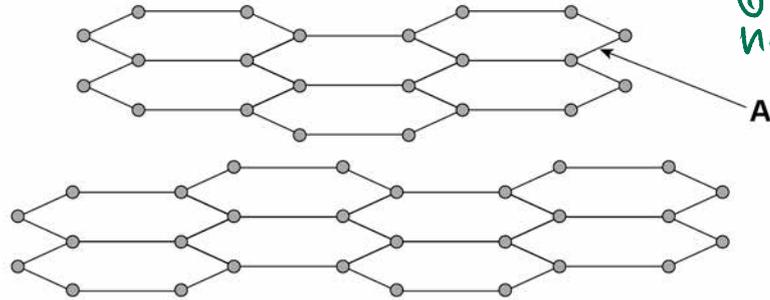
The structure of C₆₀ is a fullerene.



Figure 4 shows the structure of graphite.

allotrope of carbon

Figure 4



non-metal

C - C

0 1 . 4

What type of bond is labelled **A** in Figure 4?

[1 mark]

Tick **one** box.

covalent

double

ionic

metallic

two non-metals bonded together ⇒ covalent bond!

0 1 . 5

In graphite, each carbon atom forms bonds with other carbon atoms as shown in Figure 4

How many electrons does **one** carbon atom use to form **one** bond?

[1 mark]

Tick **one** box.

1

2

3

4

*Carbon is in group 4
has 4 electrons in outer shell.*

(all 4 electrons in carbon are unpaired, therefore they could all form covalent bonds)

forming covalent bonds.



*4 covalent bonds
4 electrons*

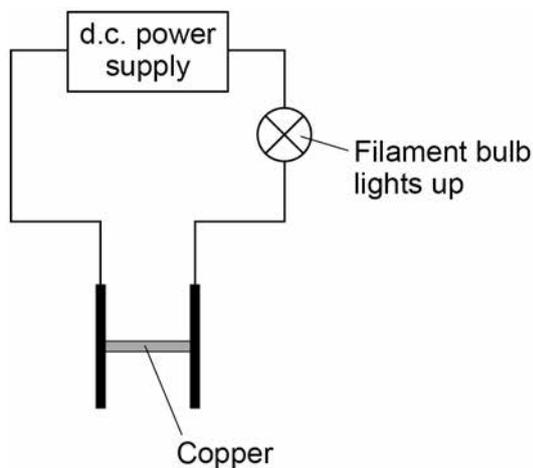
Therefore C gives 1 electron to form 1 covalent bond.



An **electric current** is passed through **copper**.

Figure 5 shows the apparatus used.

Figure 5



0 1 . 6

Complete the sentence.

Choose the answer from the box.

dissolved

[1 mark]

gas	liquid	solid	solution
----------------	-------------------	-------	---------------------

Figure 5 shows that copper conducts electricity as a solid.

0 1 . 7

Complete the sentence.

Choose the answer from the box.

fixed *no charge*

[1 mark]

atoms	<i>no charge</i>	electrons	<i>fixed</i>	ions	<i>no charge</i>	molecules
------------------	------------------	-----------	--------------	------	------------------	----------------------

Copper conducts electricity because of the movement of delocalised electrons.

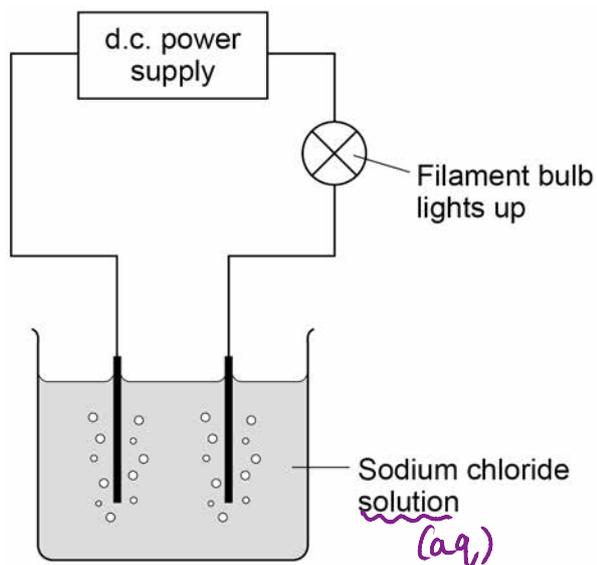


0 1 . 8

Figure 6 shows the apparatus used to investigate the effect of electricity on sodium chloride solution.

(aq)

Figure 6



Complete the sentence.

Choose the answer from the box.

gas → *melted*

[1 mark]

dissolved	<i>gas</i> → gaseous	<i>melted</i> → molten
-----------	----------------------	------------------------

Figure 6 shows that sodium chloride conducts electricity when dissolved



0 1 . 9

Sodium chloride is made up of **ions**.

movement of charged particles

Figure 7 shows the apparatus used to investigate the effect of **electricity** on **solid** sodium chloride and **molten** sodium chloride.

Figure 7

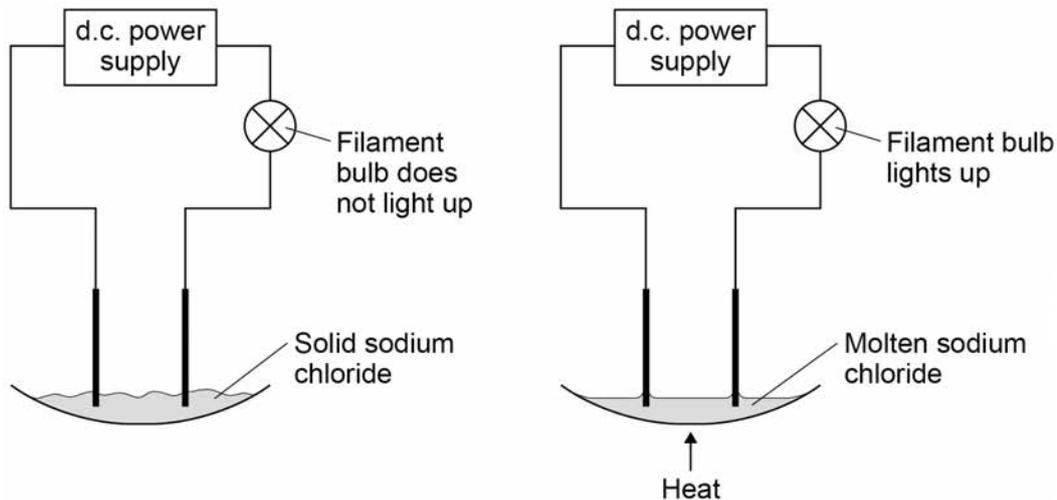


Table 1 shows the results.

Table 1

	Solid sodium chloride	Molten sodium chloride
Observation	The filament bulb does not light up	The filament bulb lights up
Deduction	Does not conduct electricity	Does conduct electricity

Draw **one** line from each statement to the correct reason.

[2 marks]

Statement

Reason

Solid

Solid sodium chloride does not conduct electricity.

Molten sodium chloride conducts electricity.

The ions are fixed.

The ions are mobile.

The ions are neutral.

The ions are vibrating.

hence can move around the structure and carry charge.



0 2

This question is about the **halogens**.

0 2 . 1

Which **group** in the **periodic table** is known as the **halogens**?

"Salt former"

[1 mark]

Tick **one** box.

- Group 1 *alkali metals*
- Group 2 *alkaline earth metals*
- Group 7
- Group 0 *noble gases*

If unsure, read ahead!
The later parts of this question mention fluorine and chlorine!

These can both be found in Group 7!

0 2 . 2

A fluorine atom has **7 electrons** in the **outer shell**.

Figure 8 shows part of a dot and cross diagram to represent a molecule of fluorine (F_2).

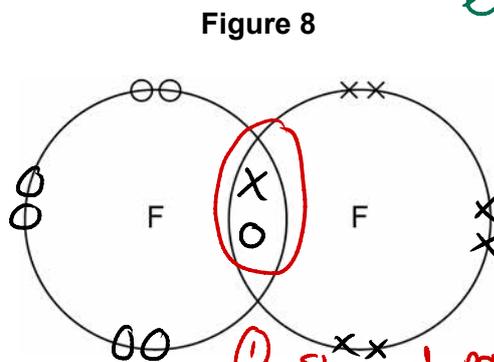
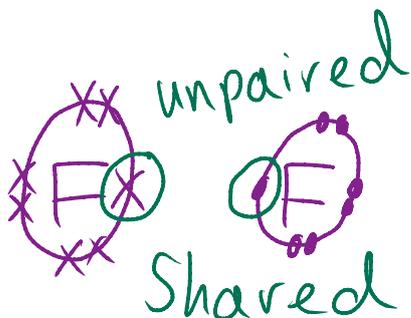
Complete the dot and cross diagram.

You should show only the electrons in the outer shells.

Covalently bonded

Sharing electrons

[2 marks]



1 6 other electrons in each atom

1 shared pair of electrons

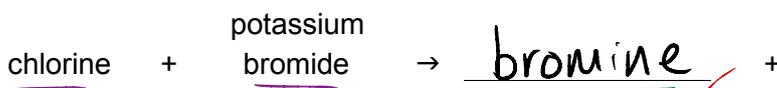
0 2 . 3

Chlorine reacts with **potassium bromide** solution.

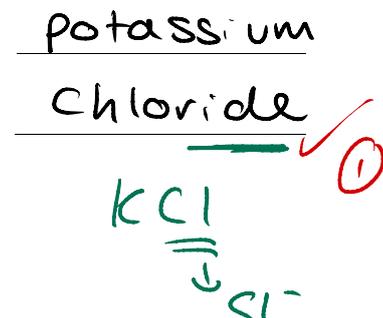
Complete the word equation.

Displacement

[2 marks]



Cl is more reactive than Br



0 2 . 4 What type of reaction happens when chlorine reacts with potassium bromide solution? [1 mark]

Tick **one** box.

- decomposition
- displacement
- neutralisation
- precipitation
- a more reactive halogen displaces a less reactive halogen in a compound.*

0 2 . 5 Complete the sentence.

Choose the answer from the box.

[1 mark]

~~an atom~~ an electron ~~a neutron~~ ~~a proton~~

Chlorine is **more reactive** than bromine.

This is because chlorine gains an electron more easily.

0 2 . 6 How does the **size** of a **chlorine atom** compare with the **size** of a **bromine atom**?

Complete the sentence.

Choose the answer from the box.

[1 mark]

bigger than **the same size as** **smaller than**

A chlorine atom is smaller than a bromine atom.



0 2 7 Give a reason for your answer to question 02.6

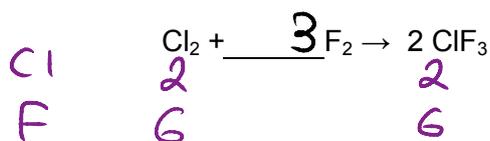
[1 mark]

Reason Chlorine has fewer shells than Bromine.
 - Cl has fewer electrons.
 - Cl has 3 shells and Br has 4 shells.

0 2 8 Fluorine reacts with chlorine to produce ClF_3

Balance the chemical equation for the reaction.

[1 mark]



0 2 9 Explain why fluorine is a gas at room temperature.

Use the following words in your answer:

energy

forces

molecules

weak

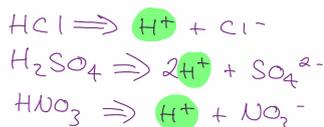
[3 marks]

Fluorine is a simple covalent molecule. This means that although the covalent bonds between the atoms is strong, there are weak intermolecular forces between the molecules, which require little energy to overcome.



0 3 This question is about **acids** and **bases**.

Examples of Acids



0 3. **1** Which **ion** is found in all **acids**?

[1 mark]

Tick **one** box.

Cl^-

H^+

Na^+

OH^-

0 3. **2** **Zinc nitrate** can be produced by reacting **an acid** and **a metal oxide**.

Name the **acid** and the **metal oxide** used to produce **zinc nitrate**.

[2 marks]

Acid nitric acid (HNO_3)

Metal oxide zinc oxide

0 3. **3** In an equation, zinc nitrate is written as $Zn(NO_3)_2(aq)$.

What does (aq) mean?

State Symbol

[1 mark]

Tick **one** box.

Dissolved in water

Insoluble

Not all reacted

Reactant

aqueous solution

0 3. **4** The pH of a solution is **8**.

Some hydrochloric **acid** is added to the solution.

Suggest the pH of the solution after mixing.

[1 mark]

pH = 5

more acidic

0 - less than 8



0 3 . 5 Table 2 shows the solubility of three solids in water at room temperature.

Table 2

Solid	The mass of the solid that dissolves in 100 cm ³ of water
Phosphorus oxide	50 g
Silicon dioxide	0 g <i>insoluble</i>
Sodium hydroxide	100 g



A teacher labelled these three solids A, B and C.

She gave a student the information shown in Table 3

Table 3

Solid	Observation when added to water	pH of the solid in water
A	colourless solution	14 <i>alkali</i>
B	colourless solution	2 <i>acid</i>
C	solid does not dissolve	7

Phosphorus oxide

Sodium hydroxide

Silicon dioxide

alkali

Describe a method that could be used to identify each of the three solids A, B and C.

You must use an indicator in the method.

Use information in Table 2 and Table 3

- valid outcome
- key steps outlined
- logical sequence [4 marks]

- ① Dissolve solid A, B, C in water.
- ② As silicon dioxide is insoluble, solid C is silicon dioxide.
- ③ Add universal indicator to solutions A and B.
- ④ For A, the indicator will turn purple/blue as it's an alkali. Therefore A is sodium hydroxide.
- ⑤ For B, the indicator will turn red as it's an acid. Therefore B is phosphorus oxide

9



Group 2 metal carbonates break down when heated to produce a metal oxide and a gas.

metal carbonate → metal oxide + gas



0 4 . 2

Name the two products when calcium carbonate (CaCO_3) is heated.

[2 marks]

Calcium oxide and Carbon dioxide

0 4 . 3

What type of reaction happens when a compound breaks down?

[1 mark]

Tick **one** box.

burning → combustion.

decomposition ✓ → acid + base → Salt + water

neutralisation →

reduction → gain of electrons.

decomposing

0 4 . 4

The metal carbonate takes **in** energy from the surroundings **to break down**.

What type of reaction **takes in energy** from the surroundings?

[1 mark]

Tick **one** box.

combustion X → burning in oxygen (releases heat energy)

electrolysis X → splitting a compound using electricity.

endothermic ✓

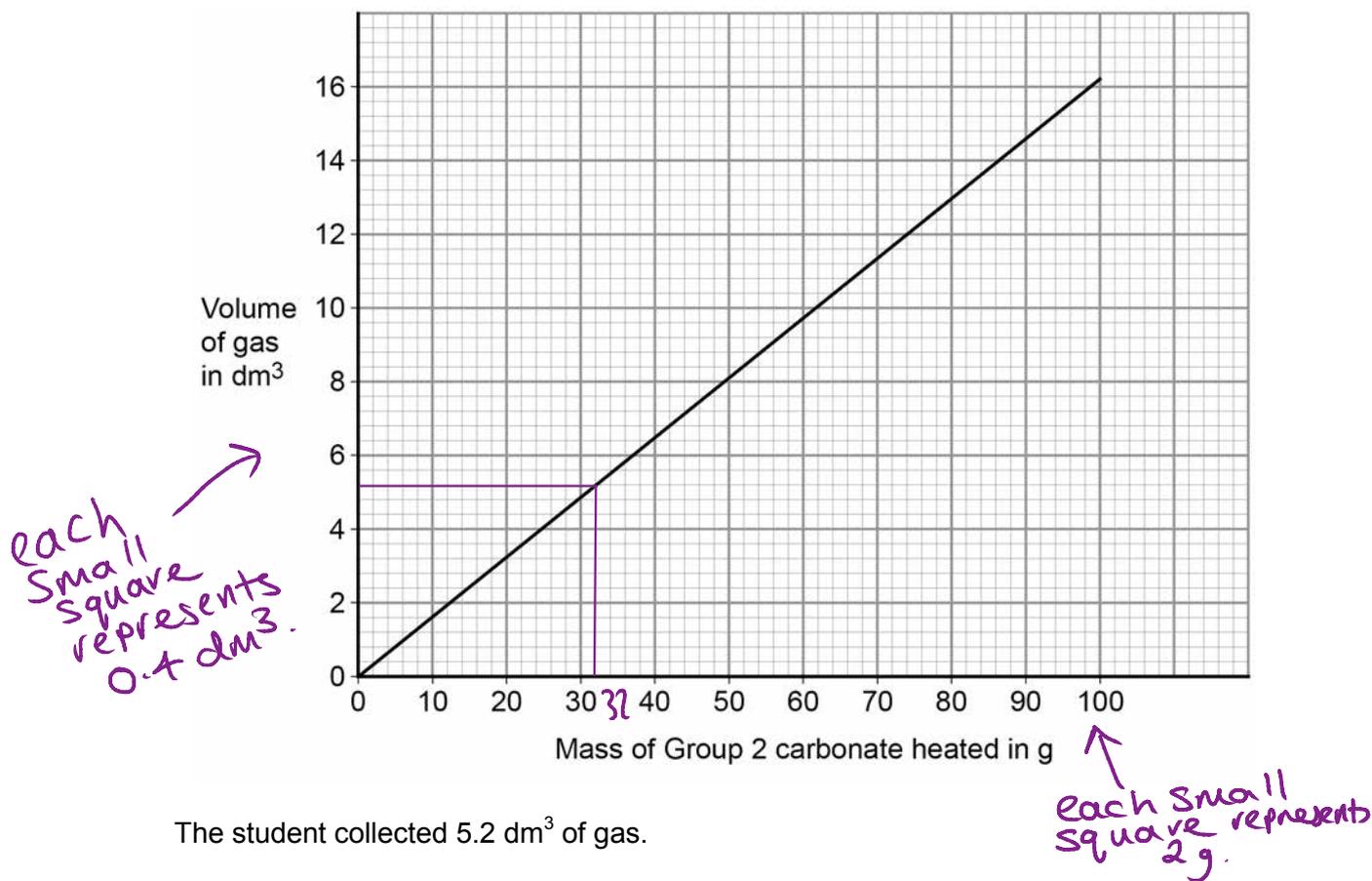
exothermic X → heat energy is given off.

"exit" "heat"



0 4 . 5 Figure 10 shows the volume of gas produced when a Group 2 metal carbonate is heated.

Figure 10



The student collected 5.2 dm³ of gas.

What mass of the Group 2 metal carbonate is heated?

[1 mark]

Allow 31-33g

Mass = 32 g

0 4 . 6 Calculate the mass of the Group 2 carbonate needed to produce 24 dm³ of gas.

Use your answer from question 04.5 to help you.

[2 marks]

$$\begin{array}{l} \times 4.62 \quad 5.2 \text{ dm}^3 \\ \hline 24 \text{ dm}^3 \end{array} \Rightarrow \begin{array}{l} 32 \text{ g} \\ \hline 148 \text{ g} \end{array} \times 4.62 \quad \textcircled{1}$$

$$\begin{array}{l} 24 = 4.62 \\ \hline 5.2 \end{array} \quad \text{OR} \quad \begin{array}{l} 32 \times 24 = 148 \\ \hline 5.2 \end{array} \quad \text{Mass} = \underline{148} \text{ g} \quad \textcircled{1}$$

143 - 153g



0 4 . 7

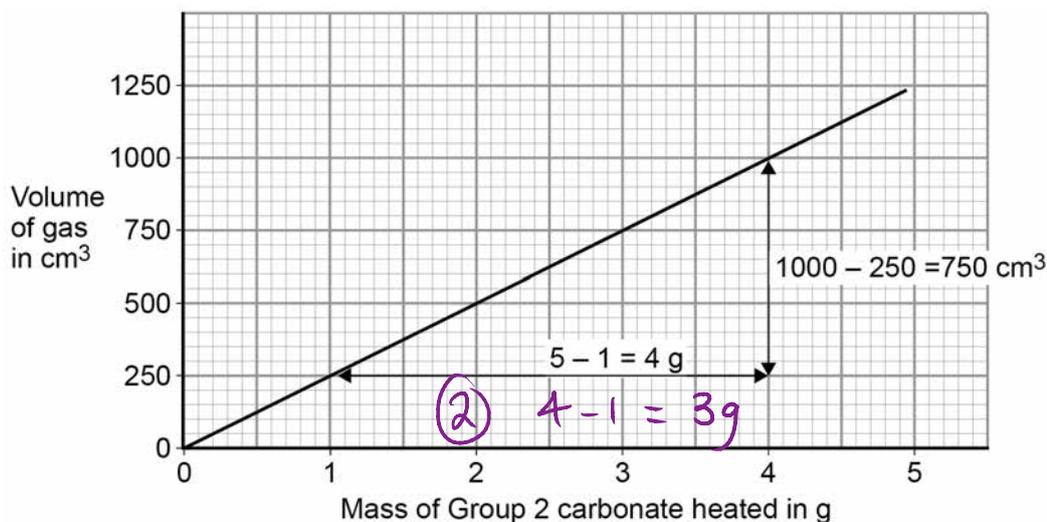
A student heated different masses of a Group 2 carbonate. The student measured the volume of gas produced.

Figure 11 shows a graph of the student's results.

The student calculates the gradient of the line in Figure 11

The student makes two mistakes.

Figure 11



Correct formula for gradient = $\frac{\text{Increase in volume of gas}}{\text{Increase in mass of Group 2 metal carbonate heated}}$

Student's calculation = $\frac{4}{750} = 0.00533 \text{ cm}^3 \text{ per g}$

① wrong way round

Identify the two mistakes the student makes.

Calculate the correct gradient of the line.

[4 marks]

Mistake 1 Inserted numbers inversely into the formula. ✓ ①

Mistake 2 Increase in mass is not 4g, it is 3g (as 4 - 1 = 3g) ✓ ①

Calculation $\frac{750}{3} = 250$ ✓ ①

Gradient = 250 ✓ ① $\text{cm}^3 \text{ per g}$



0 4 . 8

A student repeated the experiment with a different Group 2 metal carbonate (XCO_3).

The relative formula mass (M_r) of XCO_3 is 84

Relative atomic masses (A_r): C = 12 O = 16

Calculate the relative atomic mass (A_r) of X.

Name metal X.

Use the periodic table.

[4 marks]

$$\begin{aligned} M_r \text{ of } \text{XCO}_3 &= 84 && \textcircled{1} \\ M_r \text{ of } \text{CO}_3 &= 12 + 3(16) = 60 && \textcircled{1} \\ A_r \text{ of } \text{X} &= 84 - 60 = 24 \end{aligned}$$

1	2		3	4	5	6	7	0									
		1 H Hydrogen 1						4 He Helium 2									
7 Li Lithium 3	9 Be Beryllium 4																
23 Na Sodium 11	24 Mg Magnesium 12																
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	59 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	63.5 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	98 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Cesium 55	137 Ba Barium 56	139 La* Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	188 Os Osmium 76	192 Ir Iridium 77	197 Pt Platinum 78	201 Au Gold 79	204 Hg Mercury 80	207 Tl Thallium 81	209 Pb Lead 82	209 Bi Bismuth 83	[209] Po Polonium 84	[210] At Astatine 85	[222] Rn Radon 86
[223] Fr Francium 87	[226] Ra Radium 88	[227] Ac* Actinium 89	[261] Rf Rutherfordium 104	[262] Db Dubnium 105	[266] Sg Seaborgium 106	[271] Bh Bohrium 107	[277] Hs Hassium 108	[285] Mt Meitnerium 109	[288] Ds Darmstadtium 110	[293] Rg Roentgenium 111	[295] Cn Copernicium 112	[297] Nh Nihonium 113	[298] Fl Flerovium 114	[299] Mc Moscovium 115	[299] Lv Livermorium 116	[294] Ts Tennessine 117	[294] Og Oganesson 118

Relative atomic mass (A_r) = 24 $\textcircled{1}$
 Metal X is Magnesium $\textcircled{1}$

16

Turn over for the next question



0 5 . 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

$\underline{\text{Cu}^{2+}}$ Cl^- $\underline{\text{H}^+}$ OH^-
At the cathode,
the less reactive
element is formed.

Table 4 shows the student's results.

Table 4

Time in mins	Total mass of copper produced in mg			
	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

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

0 5 . 3 Determine the **mean** mass of copper produced after 3 minutes.

[1 mark]

2 mins = 1.20
3 mins = 1.80
4 mins = 2.40

Mass = 1.80 mg

Handwritten notes: +0.60, +0.60, Allow 1.7 - 1.9

Question 5 continues on the next page



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

Use Table 4 on page 19

[2 marks]

$$\frac{3.02 + x + 3.01}{3} = 3.06 \quad \checkmark \quad \textcircled{1} \quad (\times 3)$$

$$3.02 + 3.01 + x = 9.18$$

Simplify... $6.03 + x = 9.18$

$$x = 9.18 - 6.03 \quad \text{Mass X} = \underline{3.15} \quad \checkmark \quad \textcircled{1} \quad \text{mg}$$

0 5 . 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 students used 50 cm^3 of copper chloride solution in each experiment.

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

$1000 \text{ cm}^3 = 1 \text{ dm}^3$

[3 marks]

$$\begin{array}{l} 300 \text{ g per } 1 \text{ dm}^3 \\ \div 20 \downarrow \quad \underline{300 \text{ g per } 1000 \text{ cm}^3} \quad \downarrow \div 20 \\ \underline{15 \text{ g per } 50 \text{ cm}^3} \quad \checkmark \checkmark \quad \textcircled{2} \end{array}$$

Alternate Method 1

$$0.05 \times 300 = \underline{15 \text{ g}}$$

Alternate Method 2

$$0.3 \times 50 = \underline{15 \text{ g}}$$

Mass = 15 g $\checkmark \quad \textcircled{1}$

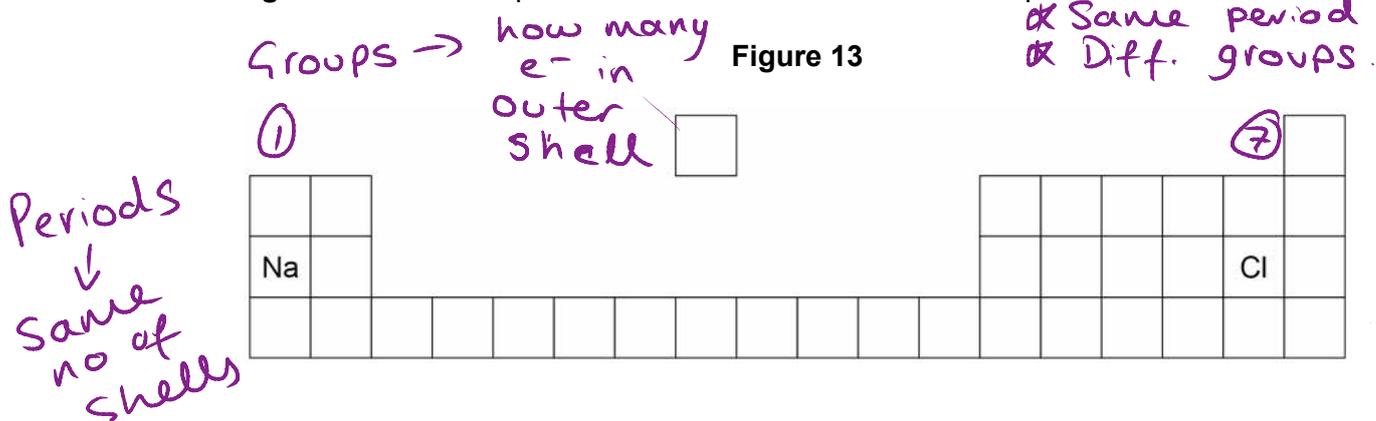
8



0 6

This question is about **sodium** and **chlorine**.

Figure 13 shows the positions of sodium and chlorine in the periodic table.



0 6 . 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.

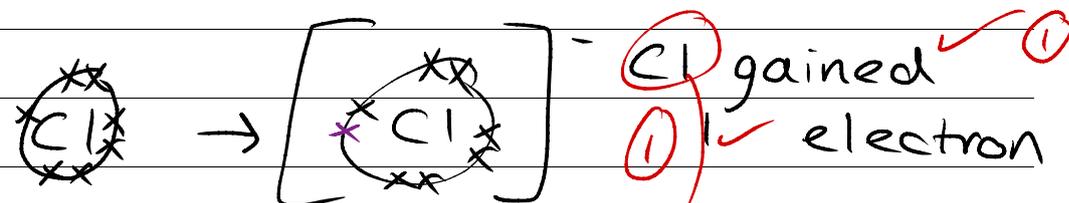
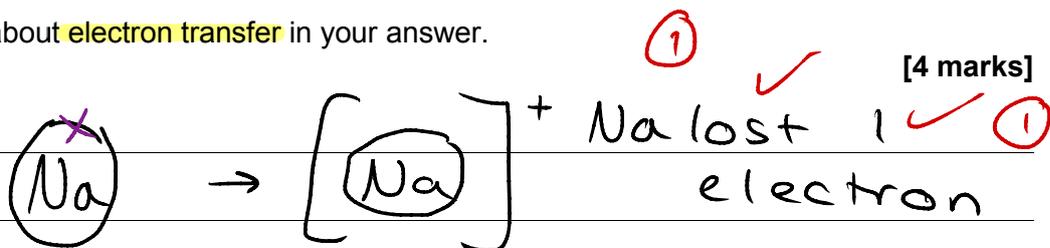
0 6 . 2

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]



The electron lost from Na was transferred to Cl.

Chlorine NOT Chloride



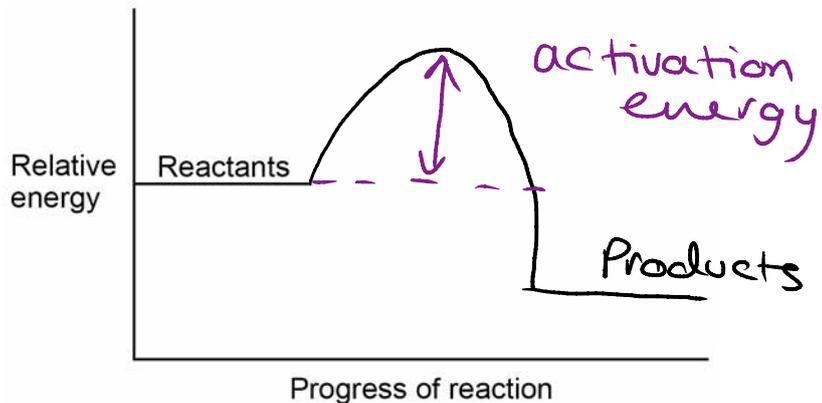
0 6 . 3

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 14



8



0 7

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
- Mark Scheme

6



There are no questions printed on this page

*Do not write
outside the
box*

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ANSWER IN THE SPACES PROVIDED**

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