Separate Science (Chemistry)   Unit 3 Quantitative chemistry

Foundation

Question number	Description	Marks	Page number
4.3.1 Chemical measurements, conservation of mass and the quantitative interpretation of chemical equations			
4	(Mixed multiple choice questions), reading value from a graph, extrapolation of graph calculation, describing mistakes in a gradient calculation example and doing the correct calculation, Calculating Ar of an unknown element in a compound and then using periodic table to name element	16	2
4.3.3 Yield and atom economy of chemical reactions			
6	Calculating atom economy, calculating 38% of 40kg, calculating Mr of a compound, calculating percentage yield, (4.4.3 explain why aluminium is extracted from aluminium oxide by electrolysis rather than reduction)	11	7

0 4   This question is about the elements in Group 2 of the periodic table.

0 4 . 1   **Figure 9** shows the positions of four elements, **A**, **B**, **C**, and **D**, in the periodic table.

Figure 9

Which element is in Group 2?

[1 mark]

Tick **one** box.

A ☐   B ☐   C ☐   D ☐

Question 4 continues on the next page

Turn over ▶

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

metal carbonate → metal oxide + gas
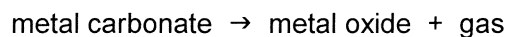
0 4 . 2 Name the two products when calcium carbonate ($CaCO_3$) is heated.

[2 marks]

_____ and _____

0 4 . 3 What type of reaction happens when a compound breaks down?

[1 mark]

Tick **one** box.

burning ☐

decomposition ☐

neutralisation ☐

reduction ☐

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 ☐
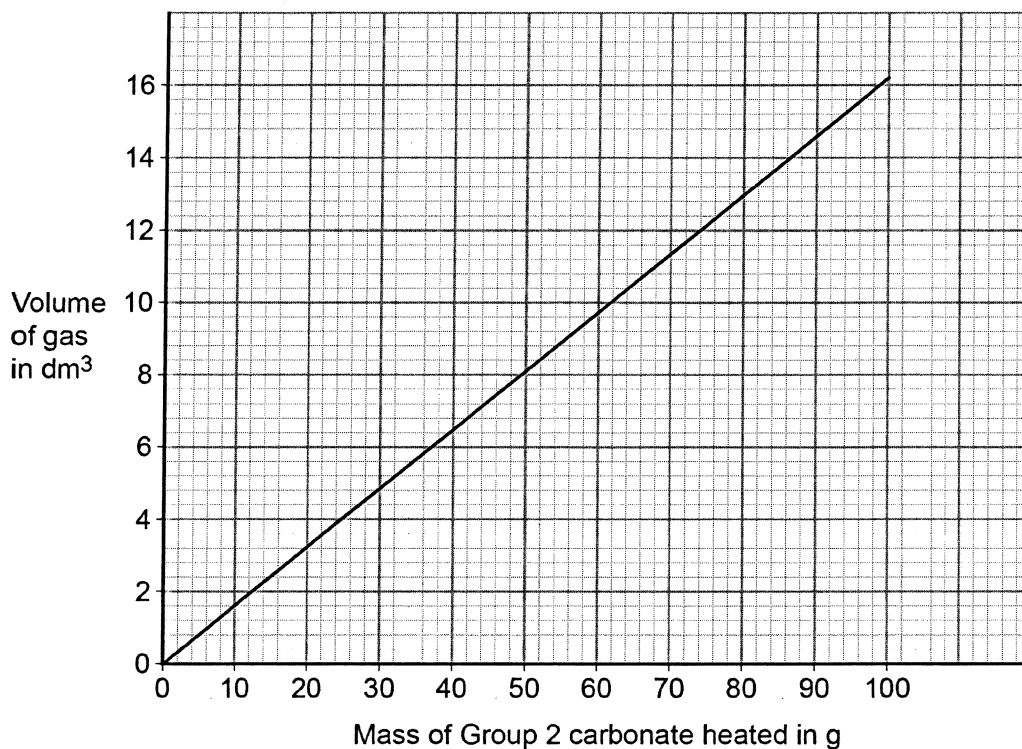
electrolysis ☐

endothermic ☐

exothermic ☐

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

Figure 10

Volume of gas in dm^3 (y-axis, 0 to 16)

Mass of Group 2 carbonate heated in g (x-axis, 0 to 100)

The student collected 5.2 dm^3 of gas.

What mass of the Group 2 metal carbonate is heated?

[1 mark]

Mass = _____ g

0 4 . 6 Calculate the mass of the Group 2 carbonate needed to produce 24 dm^3 of gas.

Use your answer from question **04.5** to help you.

[2 marks]

_____

_____

_____

_____
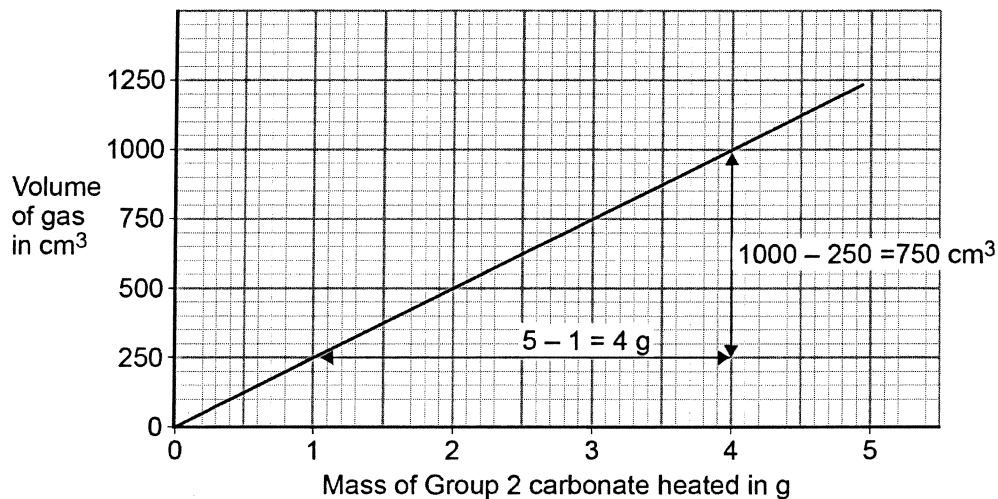
Mass = _____ g

Turn over ▶

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

Volume of gas in cm³

Mass of Group 2 carbonate heated in g

$1000 - 250 = 750 \text{ cm}^3$

$5 - 1 = 4 \text{ g}$

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

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

Identify the **two** mistakes the student makes.

Calculate the correct gradient of the line.

[4 marks]

Mistake 1 _____

_____

Mistake 2 _____

_____

Calculation _____

_____

Gradient = _____ cm³ per g

0 4 . **8** A student repeated the experiment with a different Group 2 metal carbonate (**X**CO$_3$).

The relative formula mass (M_r) of **X**CO$_3$ 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]

_____

_____

_____

_____

Relative atomic mass (A_r) = _____

Metal **X** is _____

16

Turn over for the next question

Turn over ▶

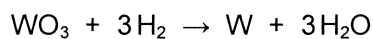**0 6** This question is about the extraction of metals.

0 6 . 1 Tungsten is a metal.

The symbol of tungsten is W

Tungsten is produced from tungsten oxide by reaction with hydrogen.

The equation for the reaction is:

$$WO_3 + 3H_2 \rightarrow W + 3H_2O$$

Calculate the percentage atom economy when tungsten is produced in this reaction.

Use the equation:

$$\text{percentage atom economy} = \frac{184}{(M_r\ WO_3) + (3 \times M_r\ H_2)} \times 100$$

Relative formula masses (M_r): $WO_3 = 232$ $H_2 = 2$

[2 marks]

_____

_____

_____

_____

Percentage atom economy = _____ %

Aluminium is extracted from aluminium oxide.

0 6 . 2 38% of a rock sample is aluminium oxide.

Calculate the mass of aluminium oxide in 40 kg of the rock sample.

[2 marks]

_____

_____

_____

_____

Mass of aluminium oxide = _____ kg

0 6 . 3 The formula of aluminium oxide is Al_2O_3

Calculate the relative formula mass (M_r) of aluminium oxide.

Relative atomic masses (A_r):   O = 16   Al = 27

[2 marks]

_____

_____

_____

_____

Relative formula mass (M_r) = _____

Question 6 continues on the next page

Turn over ▶

0 6 . 4 60.0 kg of aluminium oxide produces a maximum of 31.8 kg of aluminium.

In an extraction process only 28.4 kg of aluminium is produced from 60.0 kg of aluminium oxide.

Calculate the percentage yield.

Give your answer to 3 significant figures.

Use the equation:

$$\text{percentage yield} = \frac{\text{mass of product actually made}}{\text{maximum theoretical mass of product}} \times 100$$

[3 marks]

_____

_____

_____

_____

_____

_____

Percentage yield = _____ %

0 6 . 5 Extracting metals by electrolysis is a very expensive process.

Explain why aluminium is extracted using electrolysis and not by reduction with carbon.

[2 marks]

_____

_____

_____

_____

11