AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.3.1.2

# Relative formula mass

## Past-paper questions

| | |
|---|---|
| Tier | **Higher** |
| Question groups | **13** |
| Available paper years | **2018–2025** |

## Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

**Name:** _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

### 5.3.1.2 Relative formula mass

**Question 01**

June 2018 | 8464/C/1H | Original Q6

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

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

**[2 marks]**

_____ and _____

**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

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

Name the Group 2 metal.

**[3 marks]**

Relative atomic mass ($A_r$) = _____

Metal _____

**Question 6 continues on the next page**

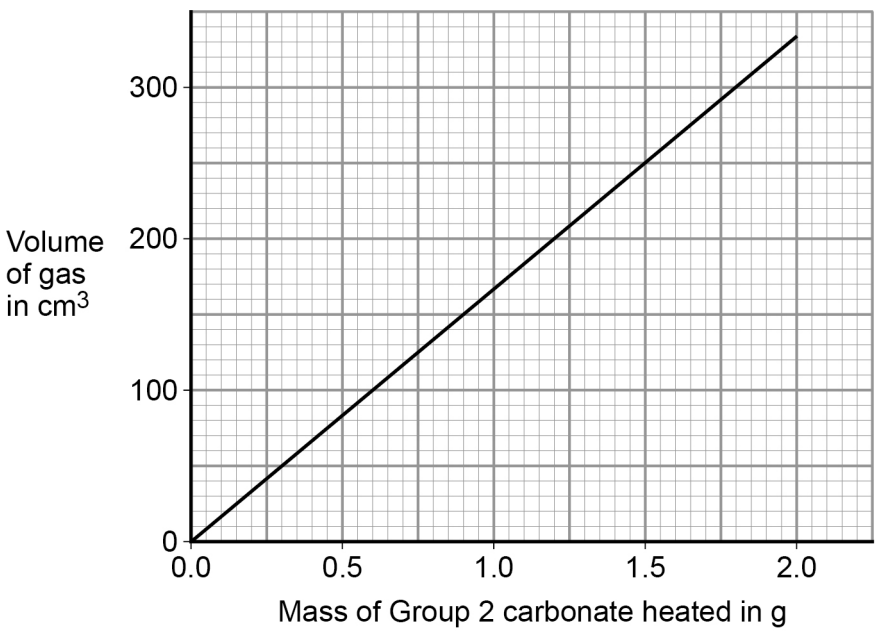
5.3.1.2 Relative formula mass

Question 01 · continued



**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 _____

Unit _____

5.3.1.2 Relative formula mass

Question 01 · continued



**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]**

Relative formula mass ($M_r$) = _____

12

5.3.1.2 Relative formula mass

Question 02



**0 3** A student investigated the mass of dissolved solids in 5 $cm^3$ samples of water.

**Figure 3** shows the apparatus.

**Figure 3**

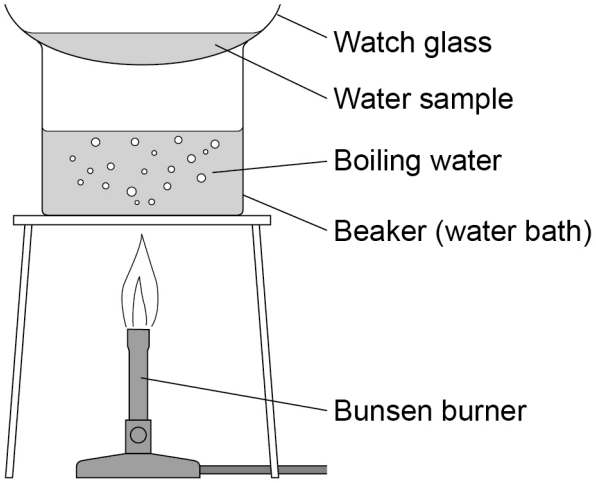



**Table 2** shows the student's results.

**Table 2**

| Type of water | Mass in g | | | |
|---|---|---|---|---|
| | Watch glass | Watch glass and dissolved solids | Dissolved solids in 5 $cm^3$ of water | Dissolved solids in 1000 $cm^3$ of water |
| Sea water | 9.34 | 9.48 | 0.14 | 28.00 |
| River water | 9.15 | 9.23 | 0.08 | **X** |
| Rainwater | 8.93 | 8.93 | 0.00 | 0.00 |

**0 3 . 1** Calculate mass **X** in **Table 2**

**[1 mark]**

Mass **X** = _____ g

5.3.1.2 Relative formula mass

Question 02 · continued



**0 3 . 2** 5 $cm^3$ is a small volume of water for each experiment.

Give **one** advantage and **one** disadvantage of using a larger volume.

**[2 marks]**

Advantage _____

_____

Disadvantage _____

_____

**0 3 . 3** Potable water is **not** pure water.

Describe the difference between potable water and pure water.

**[1 mark]**

_____

_____

_____

**0 3 . 4** Potable water is obtained from both groundwater **and** from sea water.

Describe how groundwater and sea water are treated to produce potable water.

**[3 marks]**

_____

_____

_____

_____

_____

_____

**Question 3 continues on the next page**

5.3.1.2 Relative formula mass

Question 02 · continued



0 3 . 5 The percentage by mass of dissolved solids in a 6.50 g sample is 2.2%

Calculate the mass of the dissolved solids.

**[2 marks]**

Mass of dissolved solids = _____ g

9

### 5.3.1.2 Relative formula mass

**Question 03**

June 2018 | 8464/C/2H | Original Q4

**0 4** Fertilisers are formulations.

**0 4 . 1** What is a formulation?

**[1 mark]**

**0 4 . 2** A bag of fertiliser contains 14.52 kg of ammonium nitrate ($NH_4NO_3$).

Relative formula mass ($M_r$): $NH_4NO_3$ = 80

Calculate the number of moles of ammonium nitrate in the bag of fertiliser.

Give your answer in standard form to 2 significant figures.

**[4 marks]**

Moles of ammonium nitrate = _____ mol

**Question 4 continues on the next page**

5.3.1.2 Relative formula mass

Question 03 · continued



**0 4 . 3** The fertiliser also contains potassium chloride.

Explain why potassium chloride has a high melting point.

**[4 marks]**

9

5.3.1.2 Relative formula mass

Question 04

June 2019 | 8464/C/1H | Original Q2

**0 2** This question is about salts.

Ammonium nitrate solution is produced when ammonia gas reacts with nitric acid.

**0 2 . 1** Give the state symbol for ammonium nitrate solution.

**[1 mark]**

_____

**0 2 . 2** What is the formula of nitric acid?

**[1 mark]**

Tick (✓) **one** box.

HCl ☐

$HNO_3$ ☐

$H_2SO_4$ ☐

$NH_4OH$ ☐

**0 2 . 3** Ammonia gas dissolves in water to produce ammonia solution.

Ammonia solution contains hydroxide ions, $OH^-$

A student adds universal indicator to solutions of nitric acid and ammonia.

What colour is observed in each solution?

**[2 marks]**

Colour in nitric acid _____

Colour in ammonia solution _____

5.3.1.2 Relative formula mass

Question 04 · continued



**0 2 . 4** The student gradually added nitric acid to ammonia solution.

Which row, **A**, **B**, **C** or **D**, shows the change in pH as the nitric acid is added until in excess?

**[1 mark]**

Tick (✓) **one** box.

| | pH of ammonia solution at start | pH after addition of excess nitric acid | |
|---|---|---|---|
| **A** | 10 | 7 | ☐ |
| **B** | 2 | 10 | ☐ |
| **C** | 7 | 1 | ☐ |
| **D** | 10 | 2 | ☐ |

**0 2 . 5** Calculate the percentage by mass of oxygen in ammonium nitrate ($NH_4NO_3$).

Relative atomic masses ($A_r$): H = 1 N = 14 O = 16

Relative formula mass ($M_r$): $NH_4NO_3$ = 80

**[3 marks]**

Percentage by mass of oxygen = _____ %

**Question 2 continues on the next page**

**5.3.1.2 Relative formula mass**

**Question 04 · continued**



**0 2 . 6** Describe a method to investigate how the temperature changes when different masses of ammonium nitrate are dissolved in water.

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

**[6 marks]**

**14**

### 5.3.1.2 Relative formula mass

**Question 05**

November 2020 | 8464/C/1H | Original Q5

**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]**

**Question 5 continues on the next page**

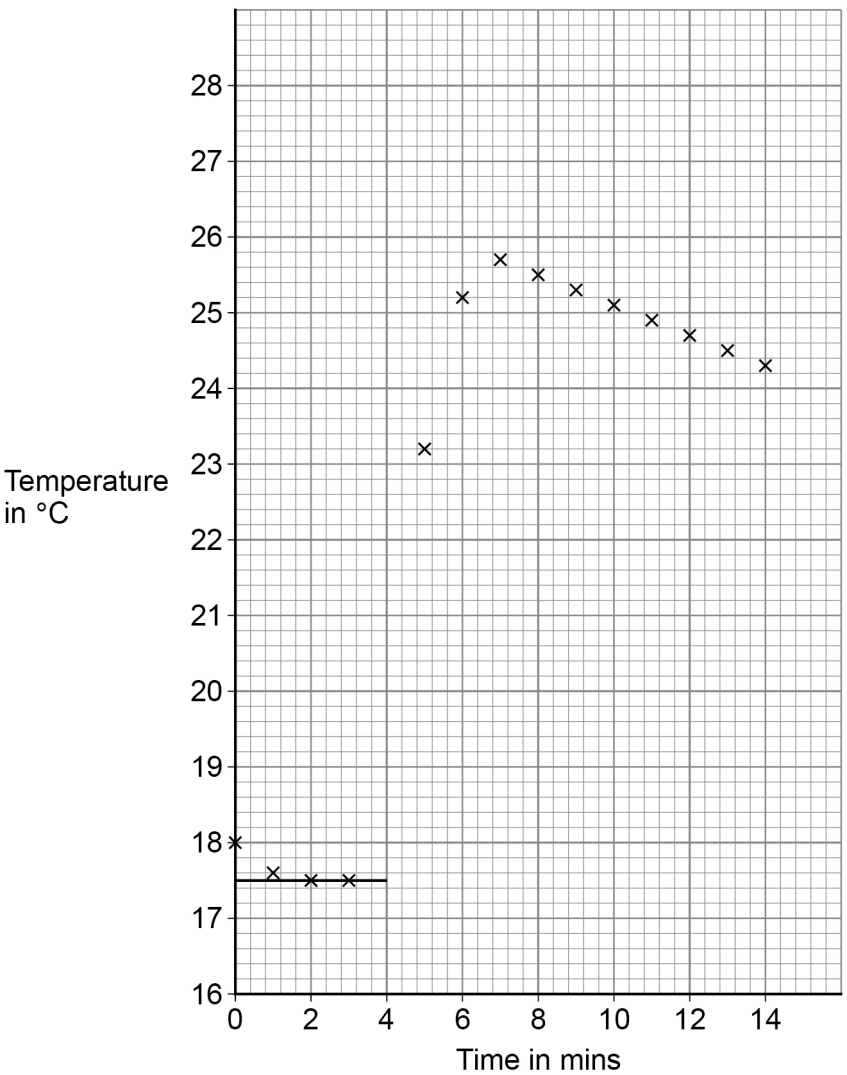
**Question 05 · continued**



The student used the results to plot a graph.

**Figure 4** shows the graph.

**Figure 4**



5.3.1.2 Relative formula mass

Question 05 · continued



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

**[1 mark]**

**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]**

Temperature change = _____ °C

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

**[2 marks]**

5.3.1.2 Relative formula mass

Question 05 · continued



**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** _____

Reason _____

_____

**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]**

_____

_____

_____

_____

_____

_____

Mass = _____ g

14

5.3.1.2 Relative formula mass

Question 06

November 2020 | 8464/C/2H | Original Q6

**0 6** This question is about the Earth's atmosphere.

**0 6 . 1** Carbon dioxide is a greenhouse gas.

The greenhouse effect happens in four stages.

The four stages are:

Stage **A** Carbon dioxide stops longer wavelength radiation escaping

Stage **B** Radiation is absorbed by the Earth

Stage **C** Longer wavelength radiation is emitted

Stage **D** Shorter wavelength radiation enters the atmosphere

What is the correct order of stages **A**, **B**, **C** and **D**?

**[1 mark]**

Tick (✓) **one** box.

**C**, **A**, **B**, **D** ☐

**C**, **D**, **B**, **A** ☐

**D**, **B**, **C**, **A** ☐

**D**, **C**, **B**, **A** ☐

**Question 6 continues on the next page**

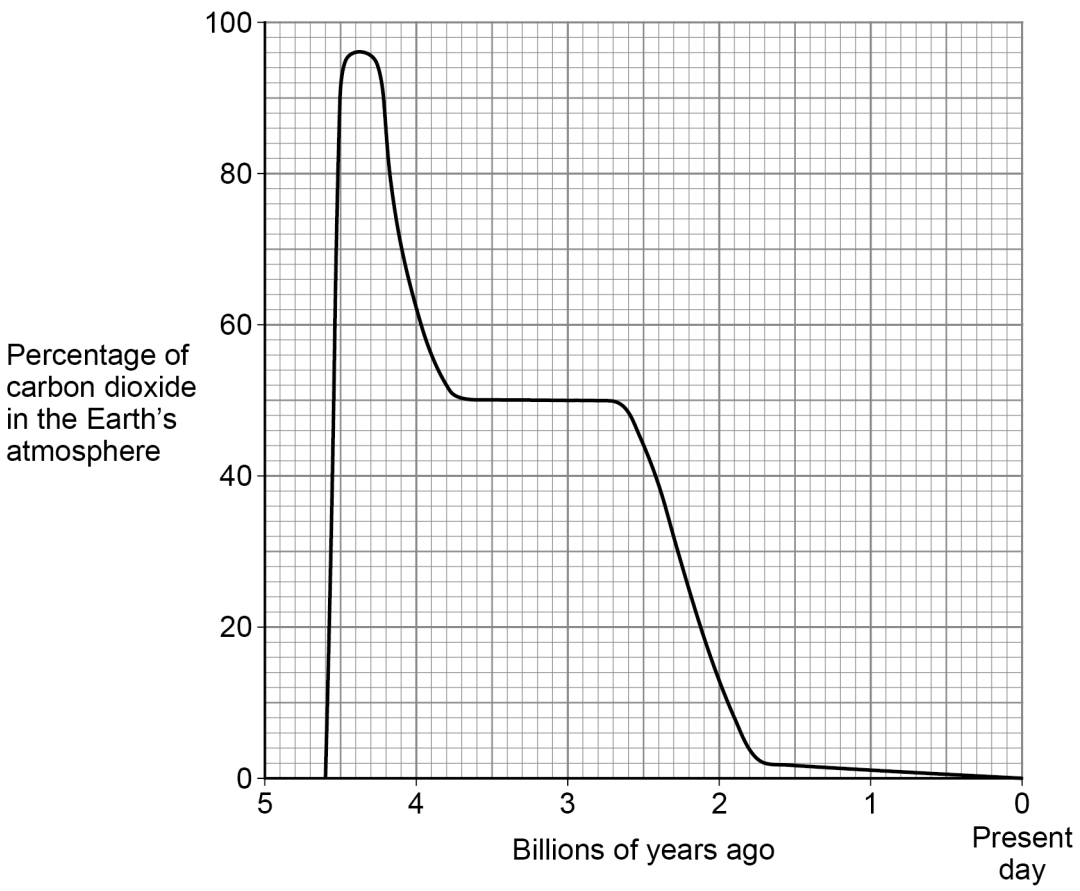
5.3.1.2 Relative formula mass

Question 06 · continued



**Figure 6** shows how the percentage of carbon dioxide in the Earth's atmosphere has changed over 4.6 billion years.

**Figure 6**




**0 6 . 2** The mass of gas in Earth's atmosphere remains constant at $5.15 \times 10^{18}$ kg

Determine the maximum mass of carbon dioxide that was in the Earth's atmosphere.

Use **Figure 6**.

**[3 marks]**

Mass of carbon dioxide = _____ kg

5.3.1.2 Relative formula mass

Question 06 · continued



**0 6 . 3** Describe the processes that have caused the main **changes** in the percentage of carbon dioxide in the Earth's atmosphere over the last 4.6 billion years.

Use **Figure 6**.

**[6 marks]**

10

### 5.3.1.2 Relative formula mass

**Question 07**



**0 7** This question is about equilibrium.

**0 7 . 1** Describe how a reaction reaches equilibrium.

**[2 marks]**

Nitrogen dioxide gas reacts to form dinitrogen tetraoxide gas.

The reaction is reversible.

The equation for the reaction is:

$$2\ NO_2(g) \rightleftharpoons N_2O_4(g)$$

**0 7 . 2** Explain the effect on the equilibrium position of increasing the pressure.

**[2 marks]**

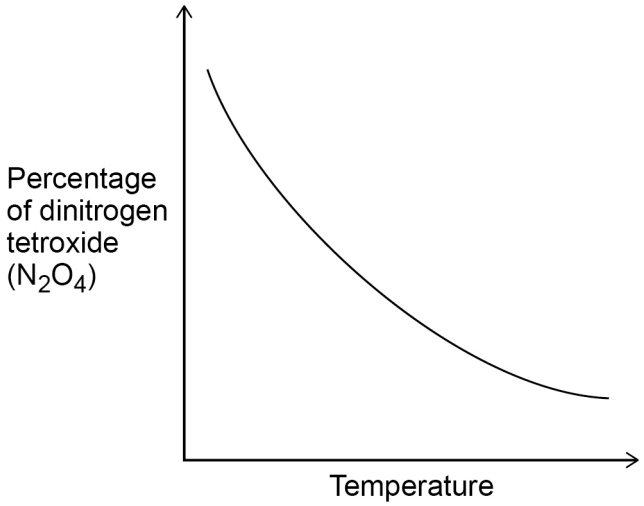
5.3.1.2 Relative formula mass

Question 07 · continued



**0 7 . 3** **Figure 7** shows the change in the percentage of dinitrogen tetroxide ($N_2O_4$) in the equilibrium mixture as the temperature of the equilibrium mixture is changed.

**Figure 7**




Explain the effect on the equilibrium position of increasing the temperature.

Use **Figure 7**.

**[3 marks]**

7

5.3.1.2 Relative formula mass

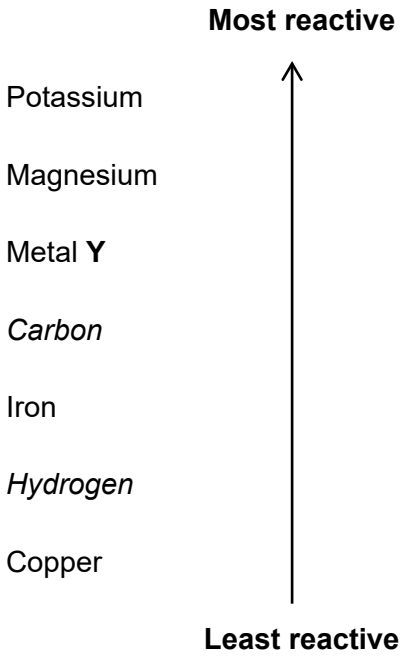
Question 08

June 2022 | 8464/C/1H | Original Q7

**0 7** This question is about elements and compounds.

**0 7 . 1** **Figure 8** shows a reactivity series.

**Figure 8**




Give the method and conditions used to extract metal **Y** from a compound of metal **Y**.

**[2 marks]**

**Question 7 continues on the next page**

**5.3.1.2 Relative formula mass**

**Question 08 · continued**



Sodium reacts with titanium chloride ($TiCl_4$) to produce titanium.

**0 7 . 2** Complete the equation.

You should balance the equation.

**[2 marks]**

____ Na + $TiCl_4$ → _____ + _____

**0 7 . 3** The reaction between sodium and titanium chloride is a redox reaction.

Write a half-equation to show that sodium is oxidised in this reaction.

**[2 marks]**

_____

**5.3.1.2 Relative formula mass**

**Question 08 · continued**



**0 7 . 4** 108 g of aluminum reacts with 1.21 kg of copper chloride to produce copper.

The equation for the reaction is:

$$2\,Al + 3\,CuCl_2 \rightarrow 3\,Cu + 2\,AlCl_3$$

Calculate the maximum mass of copper produced in grams (g).

You should determine the limiting reactant.

Relative atomic masses ($A_r$): Al = 27 Cu = 63.5

Relative formula masses ($M_r$): $CuCl_2$ = 134.5 $AlCl_3$ = 133.5

**[6 marks]**

Limiting reactant is _____

Mass of copper = _____ g

**Question 7 continues on the next page**

5.3.1.2 Relative formula mass

**Question 08 · continued**



Sodium metal and sodium chloride are both able to conduct electricity.

**0 7 . 5** Describe how sodium metal conducts electricity.

**[2 marks]**

**0 7 . 6** Explain how sodium chloride can conduct electricity.

**[3 marks]**

17

### 5.3.1.2 Relative formula mass

**Question 09**



**0 2** Lithium hydroxide reacts with sulfuric acid to produce lithium sulfate.

The equation for the reaction is:

$$2\,LiOH + H_2SO_4 \longrightarrow Li_2SO_4 + 2\,H_2O$$

**0 2 . 1** What type of reaction is this?

**[1 mark]**

**0 2 . 2** Calculate the relative formula mass ($M_r$) of sulfuric acid ($H_2SO_4$).

Relative atomic masses ($A_r$): H = 1 O = 16 S = 32

**[2 marks]**

Relative formula mass ($M_r$) = _____

5.3.1.2 Relative formula mass

Question 09 · continued



**0 2 . 3** Calculate the percentage by mass of oxygen in lithium sulfate ($Li_2SO_4$).

Relative atomic mass ($A_r$): O = 16

Relative formula mass ($M_r$): $Li_2SO_4$ = 110

Give your answer to 2 significant figures.

**[4 marks]**

Percentage by mass of oxygen (2 significant figures) = _____ %

**0 2 . 4** A solution of lithium sulfate contains 0.30 g of lithium sulfate in 25 $cm^3$.

Calculate the concentration of lithium sulfate in $g/dm^3$.

**[3 marks]**

Concentration = _____ $g/dm^3$

10

### 5.3.1.2 Relative formula mass

**Question 10**

June 2023 | 8464/C/1H | Original Q6

**0 6** Acids react with some metals to produce soluble salts.

A student adds magnesium to hydrochloric acid until no more acid reacts and excess magnesium remains.

The equation for the reaction is:

$$Mg(s) + 2\,HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

**0 6 . 1** Describe how solid magnesium chloride is obtained from the reaction mixture.

**[2 marks]**

**0 6 . 2** The reaction between magnesium and hydrochloric acid is a redox reaction.

Explain what happens to the magnesium atoms in this reaction.

**[2 marks]**

5.3.1.2 Relative formula mass

Question 10 · continued



**0 6 . 3** 0.72 g of magnesium is added to 100 $cm^3$ of hydrochloric acid.

The hydrochloric acid is in excess.

Calculate the concentration of the magnesium chloride ($MgCl_2$) solution produced in $g/dm^3$.

Relative atomic mass ($A_r$): Mg = 24

Relative formula mass ($M_r$): $MgCl_2$ = 95

**[6 marks]**

Concentration = _____ $g/dm^3$

10

### 5.3.1.2 Relative formula mass

**Question 11**

June 2024 | 8464/C/1H | Original Q7

**0 7** Halogens are elements in Group 7 of the periodic table.

**0 7 . 1** Calcium reacts with chlorine to produce calcium chloride.

Explain what happens to calcium atoms and to chlorine atoms when calcium reacts with chlorine to produce calcium chloride.

**[4 marks]**

**0 7 . 2** Explain why chlorine is more reactive than bromine.

**[4 marks]**

5.3.1.2 Relative formula mass

Question 11 · continued



**0 7 . 3** **Table 4** shows the boiling points of four hydrogen halides.

**Table 4**

| Hydrogen halide | Boiling point in °C |
|---|---|
| HF | 20 |
| HCl | –85 |
| HBr | –67 |
| HI | –35 |

Describe how the boiling points of the hydrogen halides change as the relative formula mass changes.

**[2 marks]**

10

**5.3.1.2 Relative formula mass**

**Question 12**

June 2025 | 8464/C/1H | Original Q2

**0 2** A student investigated an exothermic reaction.

The student reacted solid calcium oxide with water to produce calcium hydroxide.

**0 2 . 1** What is meant by an 'exothermic' reaction?

**[1 mark]**

**0 2 . 2** The formula of calcium hydroxide is $Ca(OH)_2$

Calculate the percentage by mass of oxygen in calcium hydroxide.

Relative atomic mass ($A_r$): O = 16

Relative formula mass ($M_r$): $Ca(OH)_2$ = 74

**[3 marks]**

Percentage = _____ %

**Question 2 continues on the next page**

5.3.1.2 Relative formula mass

Question 12 · continued



**0 2 . 3** When solid calcium oxide is added to water, the temperature of the reaction mixture changes.

Plan a method to investigate how changing the mass of calcium oxide affects the temperature change of the reaction mixture.

**[6 marks]**

Extra space

10

5.3.1.2 Relative formula mass

Question 13



**0 2** The proportions of most gases in the Earth's atmosphere have not changed much for the past 200 million years.

**0 2 . 1** About one-fifth of the atmosphere is oxygen.

Describe the test for oxygen gas.

Give the result of the test.

**[2 marks]**

Test _____

_____

Result _____

_____

**0 2 . 2** **Table 1** shows the percentages of some gases in the Earth's early atmosphere and in the Earth's atmosphere today.

**Table 1**

| | Percentage (%) of gas in the atmosphere | |
|---|---|---|
| **Gas** | **Earth's early atmosphere** | **Earth's atmosphere today** |
| Carbon dioxide | 95 | 0.04 |
| Nitrogen | 3 | 78.0 |
| Oxygen | Less than 1 | 21.0 |

5.3.1.2 Relative formula mass

Question 13 · continued



Explain how the percentages of gases have changed from Earth's early atmosphere to Earth's atmosphere today.

You should refer to all three gases in **Table 1**.

**[6 marks]**

Extra space

**0 2 . 3** Methane is a greenhouse gas.

Give **two** ways to reduce methane emissions into the atmosphere.

**[2 marks]**

1

2

**5.3.1.2 Relative formula mass**

**Question 13 · continued**



The percentage of sulfur dioxide in the Earth's atmosphere increased between 1850 and 1980.

**0 2 . 4** Describe how sulfur dioxide emissions are produced.

**[2 marks]**

**0 2 . 5** Give **one** harmful effect of sulfur dioxide emissions.

**[1 mark]**

**0 2 . 6** Suggest **one** reason why the percentage of sulfur dioxide in the Earth's atmosphere has decreased since 1980.

**[1 mark]**

**14**