Quantitative Chemistry 2

Name: _____

Class: _____

Date: _____

Time: **49 minutes**

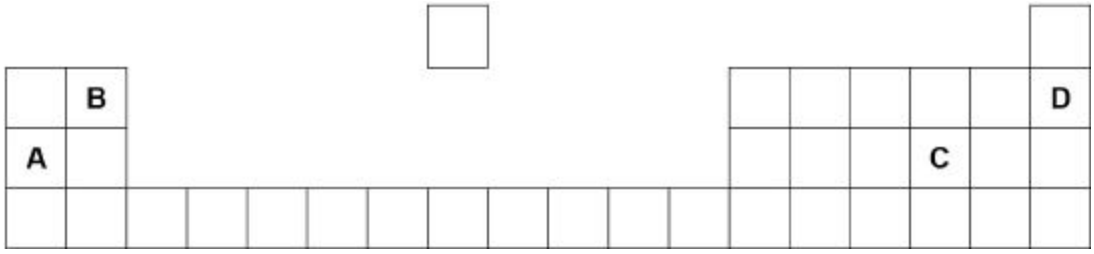
Marks: **47 marks**

Comments:

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

(a) **Figure 1** shows the positions of four elements, **A**, **B**, **C**, and **D**, in the periodic table.

Figure 1



Which element is in Group 2?

Tick **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

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

metal carbonate ⟶ metal oxide + gas

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

_____ and _____

(2)

(c) What type of reaction happens when a compound breaks down?

Tick **one** box.

burning ☐

decomposition ☐

neutralisation ☐

reduction ☐

(1)

(d) The metal carbonate takes in energy from the surroundings to break down.

What type of reaction takes in energy from the surroundings?

Tick **one** box.

combustion ☐

electrolysis ☐

endothermic ☐

exothermic ☐

(1)

(e) **Figure 2** shows the volume of gas produced when a Group 2 metal carbonate is heated.

Figure 2

The student collected 5.2 dm^3 of gas.

What mass of the Group 2 metal carbonate is heated?

Mass = _____ g

(1)

(f) Calculate the mass of the Group 2 carbonate needed to produce 24 dm^3 of gas.

Use your answer from part **(e)** to help you.

_____

_____

_____

_____

Mass = _____ g

(2)

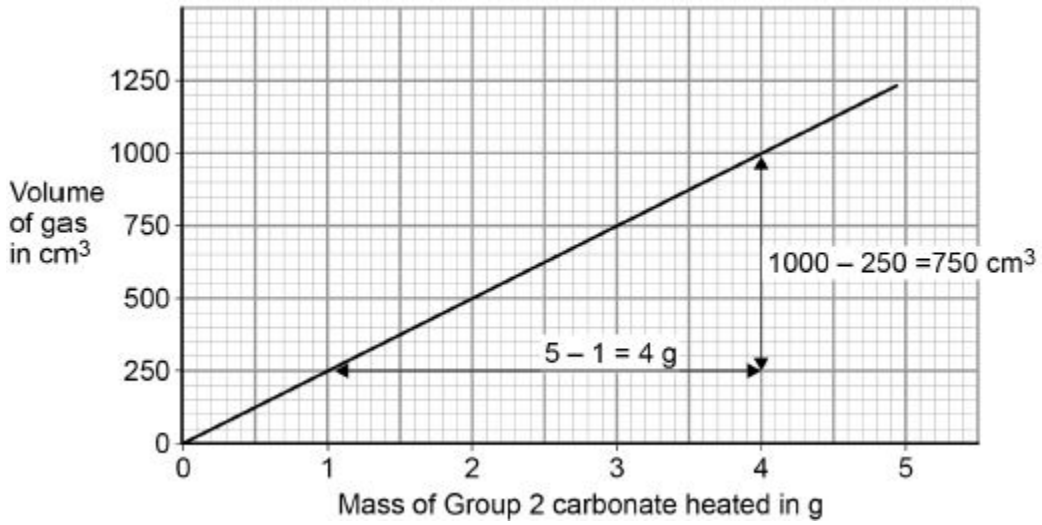
(g) A student heated different masses of a Group 2 carbonate. The student measured the volume of gas produced.

Figure 3 shows a graph of the student's results.

The student calculates the gradient of the line in **Figure 3**

The student makes **two** mistakes.

Figure 3



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

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

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

Calculate the correct gradient of the line.

Mistake 1 _____

_____

Mistake 2 _____

_____

Calculation _____

_____

Gradient = _____ cm^3 per g

(4)

(h) 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.

_____

_____

_____

_____

Relative atomic mass (A_r) = _____

Metal **X** is _____

(4)

(Total 16 marks)

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

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

_____ and _____

(2)

(b) 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.

_____

_____

_____

_____

_____

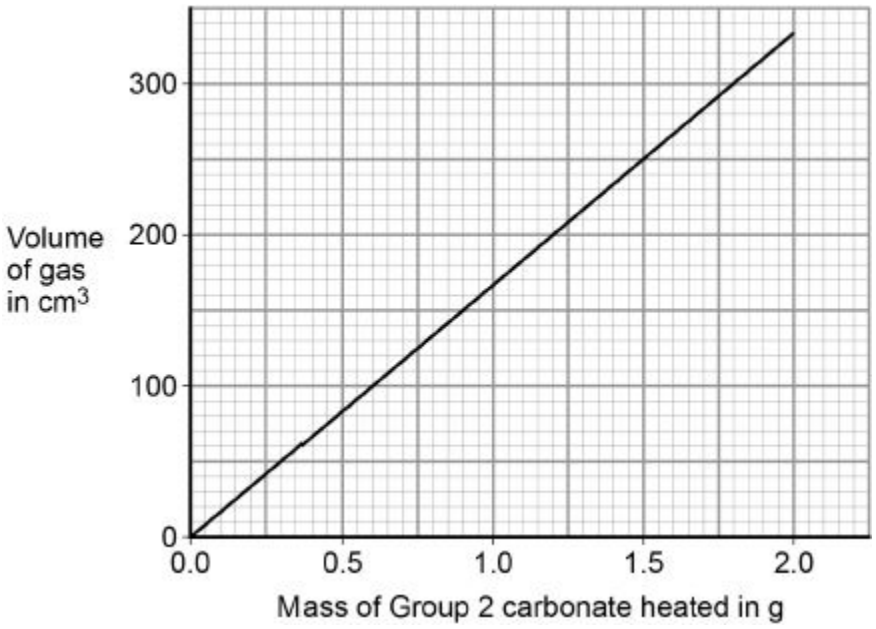
_____

Relative atomic mass (A_r) = _____

Metal _____

(3)

The graph below shows the volume of gas produced when a different Group 2 carbonate, **W**, is heated.



(c) Calculate the gradient of the line in the graph above.

Give the unit.

Gradient _____

Unit _____

(3)

(d) 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 the graph above.

Relative formula mass (M_r) = _____

(4)

(Total 12 marks)

3. This question is about iron.

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

(a) Name the other product.

(1)

(b) Suggest how any unreacted iron can be separated from the mixture.

(1)

Magnesium reacts with iron chloride solution.

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

(c) 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

Mass of iron = _____ mg

(5)

(d) Explain which species is reduced in the reaction between magnesium and iron chloride.

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

Your answer should include the half equation for the reduction.

(3)

(Total 10 marks)

4. Aqamed is a medicine for children.

(a) The medicine is a formulation.

What is meant by a formulation?

(1)

(b) Children often do not like taking medicine.

Suggest a substance that could be added to Aqamed to increase the desire for children to take it.

Give a reason for your suggestion.

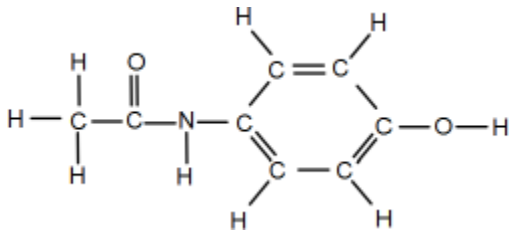
Substance _____

Reason _____

(2)

(c) The main ingredient in Aqamed is a painkiller called paracetamol.

The figure below represents a molecule of paracetamol.



Give the molecular formula of paracetamol.

Calculate its relative formula mass (M_r).

Relative atomic masses (A_r): H = 1; C = 12; N = 14; O = 16

Molecular formula _____

Relative formula mass _____

_____

M_r = _____

(2)

(d) Aspirin is a medicine for use by adults.

An aspirin tablet contains 300 mg of acetylsalicylic acid.

Calculate the number of moles of acetylsalicylic acid in one aspirin tablet.

Give your answer in standard form to three significant figures.

Relative formula mass (M_r) of aspirin = 180

_____

_____

_____

_____

_____

_____

Number of moles = _____

(4)

(Total 9 marks)

Mark schemes

1.

(a) B

1

(b) calcium oxide **or** CaO

1

carbon dioxide **or** CO_2

1

either order

(c) decomposition

1

(d) endothermic

1

(e) 32 (g)

allow 31−33 (g)

1

(f) $\frac{32}{5.2} \times 24$

1

148 (g)

allow a range 143−153 (g)

or

uses graph e.g. 12 dm^3 gives 74 (g) (1)

(then factors up so that 24 dm^3 gives) 148 (g) (1)

allow a range 143−153 (g)

1

*an answer of 148 (g) scores **2** marks*

*allow ecf from part **(e)***

(g) (mistakes)
increase in mass = 3 (not 4)

allow mistakes in either order

1

inserted numbers inversely into formula

allow numbers wrong way round

1

(calculation)

*an answer of 250 scores the **2** calculation marks*

1

$$\text{gradient} = \frac{750}{3}$$

allow $\frac{1000}{4}$

250 (cm^3 per g)

if no calculation marks awarded

allow $\frac{750}{4}$ ***or*** *187.5* ***or*** $\frac{3}{750}$

***or** 0.004 for **1** mark*

1

(h) 3 × 16 or 48

1

(48) + 12 or 60

allow their mass of oxygen + 12

1

84 − (60) **or** 24

allow 84 − their mass of carbonate

1

magnesium **or** Mg

*magnesium **or** Mg without working scores this mark*

1

*an answer of 24 scores the **3** calculation marks*

[16]

2. (a) CaO

1

CO_2

1

either order
ignore names

(b) [12 + (3 × 16)]
or 60

1

(197 − 60 =) 137

1

barium **or** Ba

*barium **or** Ba without working scores this mark*

1

*an answer of 137 scores the **2** calculation marks*

(c) (working) Y increase and X increase measured from graph and substitution into $\frac{\Delta Y}{\Delta X}$

y-axis	*80−85*	*162−170*	*248−252*	*330−335*
x-axis	*0.5*	*1.0*	*1.5*	*2.0*
=	*160−170*	*162−170*	*165−168*	*165−168*

1

(answer) 167

allow answer in range 160−174

1

(units) cm^3/g

allow $cm^3\ g^{-1}$

1

*if no other mark awarded allow **1** mark for the inverse ($\frac{\Delta X}{\Delta Y}$)*
***or** 0.006*

*an answer of 160−174 scores the **2** calculation marks*

(d) (from graph)
volume to 240 cm^3 mass
= 1.45 g

allow answer based on any reading from the graph
(e.g. 250 cm^3 = 1.5 g)

1

ratio is $\frac{1}{100}$ (ie $\frac{24\,000}{240}$)

allow ratio from their volume
eg $\frac{24\,000}{250}$

1

100 × 1.45

$\left(\frac{24\,000}{250}\right) \times 1.5$

1

145

allow range 140−150

1

or

allow method using answer from part **(c)**

$x = \frac{y}{m}(1)$

(rearrangement of y = mx where m = answer from part ***(c)****)*

24 (dm^3) to 24 000 (cm^3) (1)

$\frac{24\,000}{\text{answer from part } \mathbf{(c)}}(1)$

144 (1)

allow range 140−150

[12]

3. (a) hydrogen **or** H_2

allow hydrogen gas
ignore H without the 2 subscript

1

(b) filtration / filter

*allow magnet **or** decant*
ignore heating

1

(c) (Mg) $\frac{0.12}{24}$ or 0.005 (moles)

mark is for ÷ by 24

1

(Fe) $\frac{2}{3} \times 0.005 = 0.00333$ (moles)

mark is for $\times \frac{2}{3}$

1

(mass Fe) = 0.00333 × 56

mark is for × 56

1

= 0.1866 (g)

1

= 187 (mg)

1

*an answer of 280 (mg) scores **4** marks*

*an answer of 0.280 scores **3** marks (no ratio from equation)*

*184 scores **0** [= (3 × 24) + (2 × 56)]*

OR

$(Mg) = \frac{0.12}{(3 \times 24 =)72}$ (1)

$= 0.00166$ **or** $\frac{1}{600}$ (moles) (1)

(mass of Fe) = 0.00166

or $\frac{1}{600} \times 112(2 \times 56)$ (1)

= 0.1866 (g) (1)

187 (mg) (1)

OR

72 g Mg ⟶ 112g Fe (1)

$1\ g\ Mg \rightarrow \frac{112}{72}$ **or** 1.56 g Fe (1)

$0.12\ g\ Mg \rightarrow \frac{112}{72} \times 0.12$ (1)

= 0.1866 (g) (1)

= 187 (mg) (1)

*an answer of 185−190 (mg) scores **5** marks*

*an answer of 0.185−0.19 scores **4** marks*

(d) Fe^{3+}

1

(because) reduction is gain <u>of electrons</u>

allow change in oxidation state / (+)3 to 0

1

$Fe^{3+} + 3e^{(-)} \longrightarrow Fe$

1

[10]

4. (a) (medicine is) a mixture **and**

(designed as) a useful product

1

(b) sugar / flavouring

1

to make it taste better

or

colouring

to make it look more attractive

1

(c) $C_8H_9NO_2$

any order of elements

1

151

1

(d) mass of acetylsalicylic acid = 0.3 g

1

$= \frac{0.3}{100}$ (mol)

method mark – divide mass by M_r

1

= 0.00167 (mol)

allow 0.0016666(66)

1

1.67×10^{-3} (mol)

*correct answer with or without working scores **4** marks*

allow ecf from steps1, 2 and 3

1

[9]