

# Atoms, Amount, Equations & Reactions

## AS & A Level

### Question Paper 1

Level	A Level
Subject	Chemistry
Exam Board	OCR
Module	Foundations in Chemistry
Topic	Atoms, Amount, Equations & Reactions
Paper	AS & A Level
Booklet	Question Paper 1

**Time allowed:** 73 minutes

**Score:** /54

**Percentage:** /100

**Grade Boundaries:**

A*	A	B	C	D	E
>85%	73%	60%	47%	34%	21%

## Question 1

This question is about the elements with atomic numbers between 58 and 70.

- (a) Cerium, atomic number 58, is a metal.

Complete the table to show the relative charge of each particle and the number of each particle found in a  $^{140}\text{Ce}^{2+}$  ion.

Particle	Relative charge of each particle	Number of each particle present in a $^{140}\text{Ce}^{2+}$ ion
proton		
neutron		
electron		

[2]

- (b) Cerium behaves as a typical metal when it reacts with dilute sulfuric acid to form the salt cerium(III) sulfate and a second product.

- (i) Identify the second product.

[1]

- (ii) Write the formula of cerium(III) sulfate and, explain what has happened to the cerium in this reaction in terms of the number of electrons transferred.

Formula

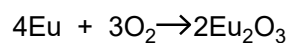
Explanation

[2]

- (iii) How has a salt been formed in this reaction?

[1]

(c) Europium, atomic number 63, reacts with oxygen at room temperature.



Calculate the volume of oxygen, in  $\text{cm}^3$ , required to fully react with 9.12 g of europium at room temperature and pressure.

[2]

(d) A compound of thulium, atomic number 69, has the following composition by mass:

O 30.7%      S 15.4%      Tm 53.9%

(i) State what is meant by the term *empirical formula*.

[1]

(ii) Determine the empirical formula of the compound.

Show your working.

[2]

(e) Ytterbium, atomic number 70, is the first element in the Periodic Table to have the first four shells full.

(i) State the number of electrons in the **fourth** shell of ytterbium.

[1]

(ii) How many orbitals are there in the **third** shell of ytterbium?

[1]

[Total 13 Marks]

## Question 2

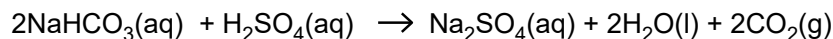
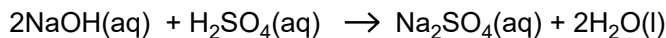
A student was given 200 cm<sup>3</sup> of solution **X** in which sodium hydroxide, NaOH, and sodium hydrogencarbonate, NaHCO<sub>3</sub>, had **both** been dissolved.

The student carried out **two different** titrations on samples of solution **X** using 0.100 mol dm<sup>-3</sup> sulfuric acid, H<sub>2</sub>SO<sub>4</sub>.

- In the first titration, **both** NaOH **and** NaHCO<sub>3</sub> were neutralised.
- In the second titration, **only** NaOH was neutralised.

The student's results for the titrations of 25.0 cm<sup>3</sup> samples of solution **X** are shown.

volume of H <sub>2</sub> SO <sub>4</sub> needed to neutralise <b>both</b> NaOH <b>and</b> NaHCO <sub>3</sub>	29.50 cm <sup>3</sup>
volume of H <sub>2</sub> SO <sub>4</sub> needed to neutralise <b>only</b> NaOH	18.00 cm <sup>3</sup>



- (a) (i) Calculate the amount, in mol, of H<sub>2</sub>SO<sub>4</sub> used to neutralise **only** the NaOH in 25.0 cm<sup>3</sup> of solution **X**.

[1]

- (ii) Calculate the concentration, in mol dm<sup>-3</sup>, of NaOH in solution **X**.

[1]

(b) (i) Calculate the amount, in mol, of  $\text{NaHCO}_3$  in the  $200 \text{ cm}^3$  of solution **X**.

[2]

(ii) Calculate the mass of  $\text{NaHCO}_3$  in the  $200 \text{ cm}^3$  of solution **X**.

Give your answer to **three** significant figures.

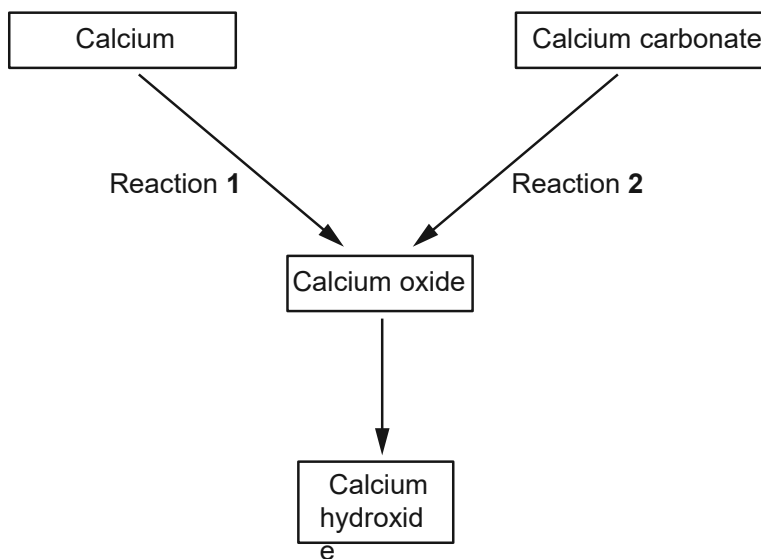
[1]

[Total 5 Marks]

### Question 3

Calcium is in Group 2 of the Periodic Table.

The diagram shows some reactions of calcium and its compounds.



(a) Reactions 1 and 2 both form calcium oxide.

(i) Write the equation for reaction 1.

[1]

(ii) What type of reaction is reaction 2?

[1]

(b) Calcium hydroxide is both a base and an alkali. Refer to any relevant ions in your answer.

Explain what is meant by the terms *base* and *alkali*.

Base

Alkali

[2]

- (c) A student prepared some calcium hydroxide by adding a small piece of calcium to a large excess of water.

Describe what the student would observe and write the equation for the reaction.

Observation

Equation

[2]

- (d) A student prepares a solution of calcium nitrate from calcium carbonate.

What reagent would the student need to use?

Write the equation for the reaction.

Reagent

Equation

[2]

[Total 8 Marks]



## Question 4

This question is about compounds used in fertilisers.

(a) A compound used as a fertiliser has the following composition by mass:

C, 20.00%; H, 6.67%; N, 46.67%; O, 26.66%.

Calculate the empirical formula of this compound. [2]

(b) A salt used as a fertiliser has the empirical formula  $\text{H}_4\text{N}_2\text{O}_3$ .

Suggest the formulae of the ions present in this salt. [2]

(c) Calcium phosphate(V),  $\text{Ca}_3(\text{PO}_4)_2$ , is another salt used in fertilisers.

Calcium phosphate(V) can be prepared by reacting together an acid and a base.

(i) Suggest the **formula** of the acid used to prepare  $\text{Ca}_3(\text{PO}_4)_2$ . [1]

(ii) **Name** a base which could be used to prepare  $\text{Ca}_3(\text{PO}_4)_2$ . [1]

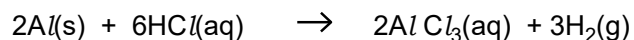
[Total 6 Marks]

## Question 5

An aqueous solution of aluminium chloride can be prepared by the redox reaction between aluminium metal and dilute hydrochloric acid.

A student reacts 0.0800 mol of aluminium completely with dilute hydrochloric acid to form an aqueous solution of aluminium chloride.

The equation for this reaction is shown below.



(a) In terms of electron transfer, explain whether aluminium is being oxidised or reduced. [1]

(a) Calculate the volume of hydrogen gas formed, in  $dm^3$ , at room temperature and pressure. [2]

(c) Calculate the mass of  $AlCl_3$  formed.

Give your answer to **three** significant figures.

[2]

(d) Calculate the volume, in  $cm^3$ , of  $1.20 \text{ mol dm}^{-3}$  hydrochloric acid needed to react completely with 0.0800 mol of aluminium.

[2]

[Total 7 Marks]

## Question 6

Magnesium is the eighth most abundant element in the Earth's crust and many rocks are a source of magnesium compounds.

Magnesium carbonate,  $\text{MgCO}_3$ , is present in dolomite, a rock found in the Dolomite mountains in Italy.

A student collected two equal-sized samples of dolomite. These samples were put into two labelled test-tubes, **A** and **B**. Tube **A** was heated until there was no further change in mass and was then allowed to cool. Tube **B** was left unheated.

(a) Write the equation for the action of heat on the magnesium carbonate present in tube **A**. [1]

(b) The student wanted to make magnesium chloride crystals. The student added an excess of warm dilute hydrochloric acid to tube **A** and to tube **B**.

(i) Write the equation for the reaction of magnesium carbonate in tube **B** with dilute hydrochloric acid.

Include state symbols. [2]

(ii) State **one** similarity and **one** difference the student would see between the reactions in the two tubes. [1]

(iii) From the solution in each tube, the student obtained crystals with the formula  $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$ .

Calculate the relative formula mass of  $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$ . [2]  
Give your answer to **one** decimal place.

(iv) Draw a 'dot-and-cross' diagram to show the bonding in  $\text{MgCl}_2$ .

Show **outer** electrons only. [2]

- (c) A compound containing magnesium, silicon and oxygen is also present in rock types in Italy. A sample of this compound weighing 5.27 g was found to have the following composition by mass:

Mg, 1.82g; Si, 1.05g; O, 2.40g.

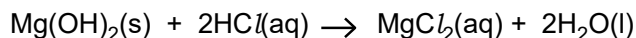
Calculate the empirical formula of the compound.

Show your working.

[2]

- (d) Pharmacists sell tablets containing magnesium hydroxide,  $\text{Mg}(\text{OH})_2$ , to combat indigestion.

A student carried out an investigation to find the percentage by mass of  $\text{Mg}(\text{OH})_2$  in an indigestion tablet. The student reacted the tablet with dilute hydrochloric acid.



The student found that  $32.00 \text{ cm}^3$  of  $0.500 \text{ mol dm}^{-3} \text{ HCl}$  was needed to react with the  $\text{Mg}(\text{OH})_2$  in a 500 mg tablet. [1 g = 1000mg].

- (i) Calculate the amount, in mol, of  $\text{HCl}$  used. [1]

- (ii) Determine the amount, in mol, of  $\text{Mg}(\text{OH})_2$  present in the tablet. [1]

- (iii) Determine the percentage by mass of  $\text{Mg}(\text{OH})_2$  present in the tablet. [3]

**[Total: 15 Marks]**