

Atoms, Amount, Equations & Reactions

AS & A Level

Question Paper 2

Level	A Level
Subject	Chemistry
Exam Board	OCR
Module	Foundations in Chemistry
Topic	Atoms, Amount, Equations & Reactions
Paper	AS & A Level
Booklet	Question Paper 2

Time allowed: 73 minutes

Score: /54

Percentage: /100

Grade Boundaries:

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

Question 1

Hydrated aluminium sulfate, $Al_2(SO_4)_3 \cdot x H_2O$, and chlorine, Cl_2 , are used in water treatment.

(a) A student attempts to prepare hydrated aluminium sulfate by the following method.

- The student heats dilute sulfuric acid with an excess of solid aluminium oxide.
- The student filters off the excess aluminium oxide to obtain a colourless solution of $Al_2(SO_4)_3$.

(i) State the formulae of the two **main** ions present in the solution of $Al_2(SO_4)_3$. [2]

(ii) Write an equation for the reaction of aluminium oxide, Al_2O_3 , with sulfuric acid.
Include state symbols. [2]

(iii) What does ' $\cdot x H_2O$ ' represent in the formula $Al_2(SO_4)_3 \cdot x H_2O$? [1]

(iv) The student heats 12.606 g of $Al_2(SO_4)_3 \cdot x H_2O$ crystals to constant mass.
The anhydrous aluminium sulfate formed has a mass of 6.846 g.
Use the student's results to calculate the value of x .
The molar mass of $Al_2(SO_4)_3 = 342.3 \text{ g mol}^{-1}$. [3]

(b) A student tests chlorine gas with damp blue litmus paper. The litmus paper first turns a red colour and is then bleached. A reaction takes place between chlorine and water in the damp litmus paper.

(i) Write the equation for the reaction between chlorine and water.

Explain why the damp litmus paper turns a red colour as a result of this reaction. [2]

(ii) Bleach is made by reacting chlorine with cold dilute aqueous sodium hydroxide.

Suggest the formula of the **ion** responsible for bleaching. [1]

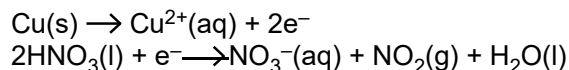
[Total 11 Marks]

Question 2

Brass is an alloy which contains copper.

The percentage of copper in brass can be determined using the steps below.

Step 1 2.80 g of brass is reacted with an excess of concentrated nitric acid, HNO_3 . The half-equations taking place are shown below.

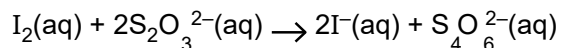


Step 2 Excess aqueous sodium carbonate is added to neutralise any acid. The mixture effervesces and a precipitate forms.

Step 3 The precipitate is reacted with ethanoic acid to form a solution which is made up to 250 cm^3 with water.

Step 4 A 25.0 cm^3 sample of the solution is pipetted into a conical flask and an excess of aqueous potassium iodide is added. A precipitate of copper(I) iodide and a solution of iodine, $\text{I}_2(\text{aq})$, forms.

Step 5 The resulting mixture is titrated with $0.100 \text{ mol dm}^{-3}$ sodium thiosulfate to estimate the iodine present:



Step 6 **Steps 4 and 5** are repeated to obtain an average titre of 29.8 cm^3 .

- For **steps 1, 2 and 4**, write ionic equations, including state symbols, for the reactions taking place.
- Determine the percentage, by mass, of copper in the brass. Give your answer to **one** decimal place. [9]

[Total 9 Marks]

Question 3

Tin mining was common practice on Dartmoor in pre-Roman times. Most of the tin extracted was mixed with copper to produce bronze.

(a) The table below shows the sub-atomic particles of an isotope of tin.

isotope	protons	neutrons	electrons
^{118}Sn			

(i) Complete the table. [1]

(i) In terms of sub-atomic particles, how would atoms of ^{120}Sn differ from atoms of ^{118}Sn ? [1]

(b) The relative atomic mass of tin is 118.7.

Define the term *relative atomic mass*. [3]

(c) A bronze-age shield found on Dartmoor contained 2.08 kg of tin.

Calculate the number of tin atoms in this bronze shield.
Give your answer to **three** significant figures. [2]

(d) Tin ore, known as cassiterite, contains an oxide of tin. This oxide contains 78.8% tin by mass.
Calculate the empirical formula of this oxide. You must show your working. [2]

[Total: 9 Marks]

Question 4

Chemicals called 'acids' have been known throughout history. The word acid comes from the Latin 'acidus' meaning sour. Dilute sulfuric acid, H_2SO_4 , is a common laboratory acid.

(a) (i) State the formulae of two ions released when sulfuric acid is in aqueous solution. [2]

(ii) A student adds a sample of solid potassium carbonate, K_2CO_3 , to an excess of dilute sulfuric acid.

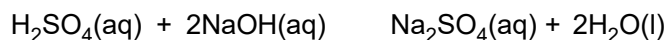
Describe what the student would see and write the equation for the reaction which takes place. [3]

(b) Dilute sulfuric acid reacts with alkalis such as sodium hydroxide.

Solid sodium hydroxide is known as caustic soda. It has a household use as a drain cleaner.

A student believes a box of caustic soda has been accidentally contaminated.

- To prove this, the student dissolves 2.00 g of the impure caustic soda in water and the solution is made up to 250 cm^3 .
- 25.0 cm^3 of this solution of caustic soda is neutralised by 24.60 cm^3 of 0.100 mol dm^{-3} dilute sulfuric acid.



(i) Calculate the amount, in moles, of H_2SO_4 used. [1]

(ii) Determine the amount, in moles, of NaOH in the 25.0 cm^3 used. [1]

(iii) Calculate the percentage, by mass, of NaOH in the impure caustic soda. [3]

[Total: 10 Marks]

Question 5

The Group 2 element magnesium was first isolated by Sir Humphry Davy in 1808.

(a) Magnesium has three stable isotopes, which are ^{24}Mg , ^{25}Mg and ^{26}Mg .

(i) Complete the table below to show the atomic structures of ^{24}Mg and ^{25}Mg . [2]

	protons	neutrons	electrons
^{24}Mg			
^{25}Mg			

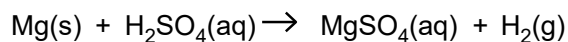
(ii) A sample of magnesium contained ^{24}Mg : 78.60%; ^{25}Mg : 10.11%; ^{26}Mg : 11.29%.

Calculate the relative atomic mass of this sample of Mg.

Give your answer to **four** significant figures. [2]

(iii) Define the term *relative atomic mass*. [3]

(b) The reaction between magnesium and sulfuric acid is a redox reaction.



(i) Use oxidation numbers to identify which element has been oxidised. [2]

Explain your answer.

element oxidized

(ii) Describe what you would **see** when magnesium reacts with an excess of sulfuric acid.

[2]

(c) Epsom salts can be used as bath salts to help relieve aches and pains.

Epsom salts are crystals of hydrated magnesium sulfate, $\text{MgSO}_4 \cdot x\text{H}_2\text{O}$.

A sample of Epsom salts was heated to remove the water. 1.57 g of water was removed leaving behind 1.51 g of anhydrous MgSO_4 .

- (i) Calculate the amount, in mol, of anhydrous MgSO_4 formed. [2]
- (ii) Calculate the amount, in mol, of H_2O removed. [1]
- (iii) Calculate the value of x in $\text{MgSO}_4 \cdot x\text{H}_2\text{O}$. [1]

[Total: 15 Marks]