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%

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 $g mol^{-1}$. [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.

$Cu(s) \longrightarrow Cu^{2+}(aq) + 2e^-$
$2HNO_3(l) + e^- \longrightarrow NO_3^-(aq) + NO_2(g) + H_2O(l)$

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, $I_2(aq)$, forms.

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

$I_2(aq) + 2S_2O_3^{2-}(aq) \longrightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$

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]

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]

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.

$$H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

(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]

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.

$$Mg(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2(g)$$

(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, $MgSO_4 \cdot \boldsymbol{x}H_2O$.

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 $\boldsymbol{x}$ in $MgSO_4 \cdot \boldsymbol{x}H_2O$. [1]

[Total: 15 Marks]