

Answer **all** the questions.

1 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 .

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

[2]

(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.

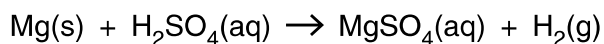
answer = [2]

(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.

Explain your answer.

element oxidised

explanation

.....

..... [2]

- (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.

amount = mol [2]

- (ii) Calculate the amount, in mol, of H_2O removed.

amount = mol [1]

- (iii) Calculate the value of x in $\text{MgSO}_4 \cdot x\text{H}_2\text{O}$.

x = [1]

[Total: 15]

2 A student carries out experiments using acids, bases and salts.

(a) Calcium nitrate, $\text{Ca}(\text{NO}_3)_2$, is an example of a salt.

The student prepares a solution of calcium nitrate by reacting dilute nitric acid, HNO_3 , with the base calcium hydroxide, $\text{Ca}(\text{OH})_2$.

(i) Why is calcium nitrate an example of a salt?

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..... **[1]**

(ii) Write the equation for the reaction between dilute nitric acid and calcium hydroxide. Include state symbols.

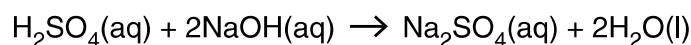
..... **[2]**

(iii) Explain how the hydroxide ion in aqueous calcium hydroxide acts as a base when it neutralises dilute nitric acid.

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.....
..... **[1]**

- (b) A student carries out a titration to find the concentration of some sulfuric acid.

The student finds that 25.00 cm^3 of $0.0880\text{ mol dm}^{-3}$ aqueous sodium hydroxide, NaOH, is neutralised by 17.60 cm^3 of dilute sulfuric acid, H_2SO_4 .



- (i) Calculate the amount, in moles, of NaOH used.

answer = mol [1]

- (ii) Determine the amount, in moles, of H_2SO_4 used.

answer = mol [1]

- (iii) Calculate the concentration, in mol dm^{-3} , of the sulfuric acid.

answer = mol dm^{-3} [1]

- (c) After carrying out the titration in (b), the student left the resulting solution to crystallise. White crystals were formed, with a formula of $\text{Na}_2\text{SO}_4 \cdot x\text{H}_2\text{O}$ and a molar mass of 322.1 g mol^{-1} .

- (i) What term is given to the ' $x\text{H}_2\text{O}$ ' part of the formula?

..... [1]

- (ii) Using the molar mass of the crystals, calculate the value of x .

answer = [2]

[Total: 10]

Turn over

- 3 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.

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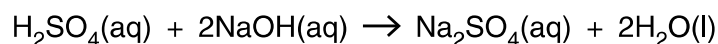
..... [3]

(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 cm³.
- 25.0 cm³ of this solution of caustic soda is neutralised by 24.60 cm³ of 0.100 mol dm⁻³ dilute sulfuric acid.



(i) Calculate the amount, in moles, of H₂SO₄ used.

answer = mol [1]

(ii) Determine the amount, in moles, of NaOH in the 25.0 cm³ used.

answer = mol [1]

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

answer = [3]

[Total: 10]