

# Stoichiometry

## Question Paper 1

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Level	IGCSE
Subject	Chemistry
ExamBoard	CIE
Topic	Stoichiometry
Sub-Topic	
Paper	(Extended) Theory
Booklet	Question Paper 1

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**TimeAllowed:** 83 minutes

**Score:** / 69

**Percentage:** /100

1 Dilute hydrochloric acid reacts with sodium carbonate solution.



(a) Explain why effervescence is seen during the reaction.

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

(b) Dilute hydrochloric acid was titrated with sodium carbonate solution.

- 10.0 cm<sup>3</sup> of 0.100 mol/dm<sup>3</sup> hydrochloric acid were placed in a conical flask.
- A few drops of methyl orange indicator were added to the dilute hydrochloric acid.
- The mixture was titrated with sodium carbonate solution.
- 16.2 cm<sup>3</sup> of sodium carbonate solution were required to react completely with the acid.

(i) What colour would the methyl orange indicator be in the hydrochloric acid?

..... [1]

(ii) Calculate how many moles of hydrochloric acid were used.

..... mol [1]

(iii) Use your answer to (b)(ii) and the equation for the reaction to calculate the number of moles of sodium carbonate that reacted.

..... mol [1]

(iv) Use your answer to (b)(iii) to calculate the concentration of the sodium carbonate solution in mol/dm<sup>3</sup>.

..... mol/dm<sup>3</sup> [2]

(c) In another experiment, 0.020 mol of sodium carbonate were reacted with excess hydrochloric acid.

Calculate the maximum volume (at r.t.p.) of carbon dioxide gas that could be made in this reaction.

..... dm<sup>3</sup> [3]

[Total: 9]

2 (a) Alkanes and alkenes are examples of hydrocarbons.

(i) What is meant by the term *hydrocarbon*?

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

(ii) Give the general formula of straight-chain

alkanes, .....

alkenes. .... [2]

(b) A compound X contains carbon, hydrogen and oxygen only.

X contains 54.54% of carbon by mass, 9.09% of hydrogen by mass and 36.37% of oxygen by mass.

(i) Calculate the empirical formula of compound X.

[2]

(ii) Compound X has a relative molecular mass of 88.

Deduce the molecular formula of compound X.

[2]

(c) An ester has the molecular formula  $C_3H_6O_2$ .

Name and give the structural formulae of **two** esters with the molecular formula  $C_3H_6O_2$ .

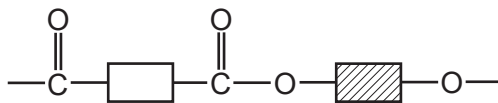
name of ester		
structural formula		

[4]

(d) Name the ester produced from the reaction of propanoic acid and methanol.

..... [1]

(e) A polyester is represented by the structure shown.



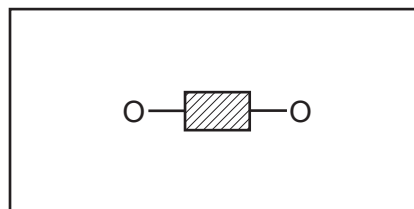
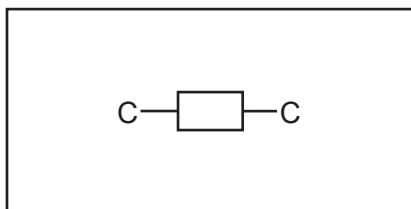
(i) What type of polymerisation is used for the production of polyesters?

..... [1]

(ii) Which simple molecule is removed when the polyester is formed?

..... [1]

(iii) Complete the diagrams below to show the structures of the monomers used to produce the polyester. Show all atoms and bonds.



[2]

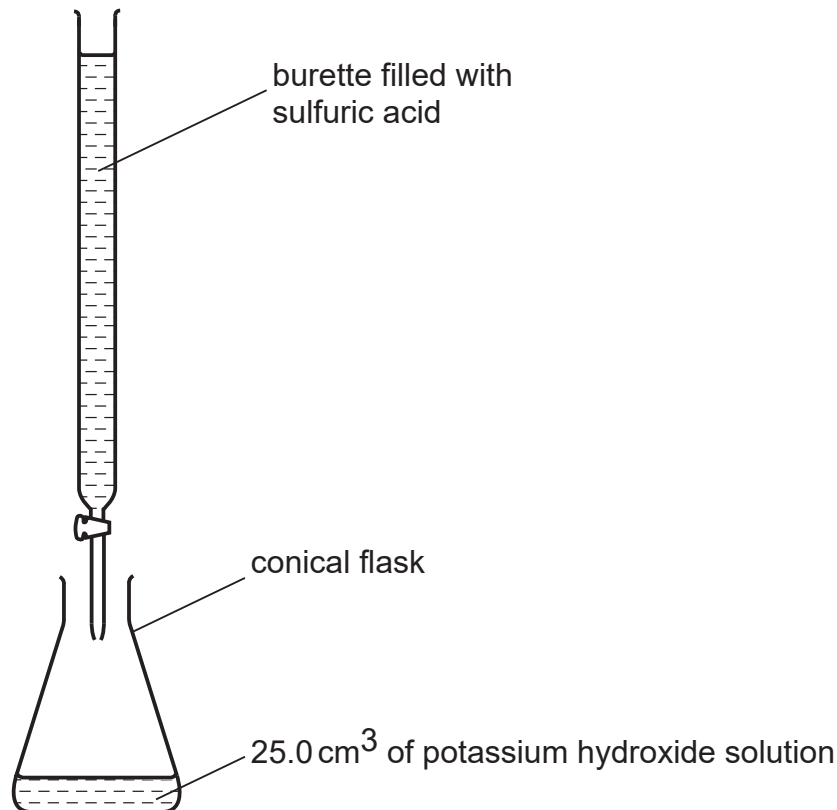
[Total: 16]

- 3 (a) A compound, **X**, contains 55.85% carbon, 6.97% hydrogen and 37.18% oxygen.
- (i) How does this prove that compound **X** contains only carbon, hydrogen and oxygen?  
..... [1]
- (ii) Use the above percentages to calculate the empirical formula of compound **X**.  
  
..... [2]
- (iii) The  $M_r$  of **X** is 86.  
What is its molecular formula?  
  
..... [2]
- (b) (i) Bromine water changes from brown to colourless when added to **X**.  
What does this tell you about the structure of **X**?  
..... [1]
- (ii) Magnesium powder reacts with an aqueous solution of **X**. Hydrogen is evolved.  
What does this tell you about the structure of **X**?  
..... [1]
- (iii) **X** contains two different functional groups.  
Draw a structural formula of **X**.

[1]

[Total: 8]

- 4 Two salts can be made from potassium hydroxide and sulfuric acid. They are potassium sulfate,  $K_2SO_4$ , and the acid salt potassium hydrogen sulfate,  $KHSO_4$ . They are both made by titration.



- (a) 25.0 cm<sup>3</sup> of potassium hydroxide, concentration 2.53 mol/dm<sup>3</sup>, was neutralised by 28.2 cm<sup>3</sup> of dilute sulfuric acid.



Calculate the concentration of the sulfuric acid.

number of moles of KOH used = .....

number of moles of H<sub>2</sub>SO<sub>4</sub> needed to neutralise the KOH = .....

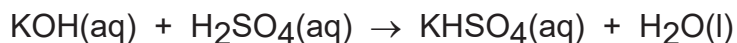
concentration of dilute sulfuric acid = ..... mol/dm<sup>3</sup>

(b) In the conical flask there is a neutral solution of potassium sulfate which still contains the indicator used in the titration.

(i) Describe how you could obtain a solution of potassium sulfate without the indicator.

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

(ii) Potassium hydrogen sulfate can be made by the following reaction.



Suggest how you could make a solution of potassium hydrogen sulfate without using an indicator.

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

(c) Describe a test which would distinguish between aqueous solutions of potassium sulfate and sulfuric acid

test .....

result .....

[2]

[Total: 9]

5 The Atacama desert in Chile has deposits of the salt sodium nitrate. Very large amounts of this salt were exported to Europe for use as a fertiliser. After the introduction of the Haber process in 1913, this trade rapidly diminished.

(a) Explain why the introduction of the Haber process reduced the demand for sodium nitrate.

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

(ii) Suggest why surface deposits of sodium nitrate only occur in areas with very low rainfall such as desert areas.

..... [1]

(iii) The desert has smaller surface deposits of potassium nitrate.

Suggest why potassium nitrate is a better fertiliser than the sodium salt.

..... [1]

(b) All nitrates decompose when heated. The extent to which a nitrate decomposes is determined by the metal in the salt.

(i) Sodium nitrate decomposes to form sodium nitrite,  $\text{NaNO}_2$ .

Write the equation for decomposition of sodium nitrate.

..... [2]

(ii) Sodium nitrite is a reducing agent.

What would be observed if an excess of sodium nitrite solution was added to a solution of acidified potassium manganate(VII)?

..... [2]

(iii) Copper(II) nitrate decomposes to form copper(II) oxide, nitrogen dioxide and oxygen.

What is the relationship between the extent of decomposition and the reactivity of the metal in the nitrate?

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



(c) The equation for the decomposition of copper(II) nitrate is given below.



(i) Predict what you would observe when copper(II) nitrate is heated.

.....  
.....  
..... [3]

(ii) Copper(II) nitrate forms a series of hydrates with the formula  $\text{Cu}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$ .  
All these hydrates decompose to form copper(II) oxide.  
1 mole of  $\text{Cu}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$  forms 1 mole of CuO.

What is meant by 1 mole of a substance?

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

(iii) 7.26 g of a hydrate,  $\text{Cu}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$ , formed 2.4 g copper(II) oxide.

number of moles of CuO formed = .....

number of moles of  $\text{Cu}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$  in 7.26 g = .....

mass of 1 mole of  $\text{Cu}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$  = .....g

mass of 1 mole of  $\text{Cu}(\text{NO}_3)_2$  is 188g

the value of x in this hydrate = .....

[4]

[Total: 18]

6 Use your copy of the Periodic Table to help you answer these questions.

(a) Predict the formula of each of the following compounds.

(i) aluminium fluoride ..... [1]

(ii) arsenic oxide .....

(iii) silicon bromide ..... [1]

(b) Deduce the formula of each of the following ions.

(i) phosphide ..... [1]

(ii) barium ion .....

(iii) francium ion ..... [1]

(c) Draw a diagram showing the arrangement of the valency electrons in one molecule of the covalent compound carbon dioxide.

Use x to represent an electron from a carbon atom. Use o to represent an electron from an oxygen atom.

[3]

[Total: 9]