Stoichiometry – 2022 IGCSE

1. June/2022/Paper_11/No.8

The relative atomic mass, A_r, of an element is determined by comparing the mass of one atom of the element with the mass of one atom of element Q.

What is Q?

A carbon

B chlorine

C hydrogen

D oxygen

2. June/2022/Paper_12/No.9

A compound of element X has the formula X_2O and a relative formula mass of 144.

What is element X?

A copper, Cu

B gadolinium, Gd

C sulfur, S

D tellurium, Te

3. June/2022/Paper_13/No.9

Compounds that contain nitrogen can be used as fertilisers.

Which compound contains the greatest proportion of nitrogen by mass?

A CH_4N_2O **B** NH_4Cl **C** NH_4NO_3 **D** $(NH_4)_2SO_4$

4. June/2022/Paper_21/No.7

The equation for the reaction between barium chloride and dilute sulfuric acid is shown.

$$BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + 2HCl$$

Which row shows the state symbols for this equation?

	$BaCl_2$	H_2SO_4	$BaSO_4$	$2HCl$
A	(aq)	(aq)	(s)	(aq)
B	(aq)	(l)	(s)	(aq)
C	(l)	(aq)	(s)	(l)
D	(aq)	(l)	(aq)	(l)

5. June/2022/Paper_21/No.8

The relative atomic mass, A_r, of an element is determined by comparing the mass of one atom of the element with the mass of one atom of element Q.

What is Q?

A carbon

B chlorine

C hydrogen

D oxygen

6. June/2022/Paper_21/No.9

The equation for the reaction between aqueous lead(II) nitrate and aqueous sodium chloride is shown.

$$Pb(NO_3)_2(aq) + 2NaCl(aq) \rightarrow PbCl_2(s) + 2NaNO_3(aq)$$

If 100 cm^3 of aqueous lead(II) nitrate of concentration 0.1 mol/dm^3 is reacted with an excess of aqueous sodium chloride, which mass of lead(II) chloride is obtained?

A 1.16 g **B** 2.42 g **C** 2.78 g **D** 3.31 g

7. June/2022/Paper_22/No.7

The equation for the reaction between barium chloride and dilute sulfuric acid is shown.

$$BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + 2HCl$$

Which row shows the state symbols for this equation?

	$BaCl_2$	H_2SO_4	$BaSO_4$	$2HCl$
A	(aq)	(aq)	(s)	(aq)
B	(aq)	(l)	(s)	(aq)
C	(l)	(aq)	(s)	(l)
D	(aq)	(l)	(aq)	(l)

8. June/2022/Paper_22/No.8

Methane and steam react in the presence of a catalyst.

$$CH_4(g) + H_2O(g) \rightarrow CO(g) + 3H_2(g)$$

0.5 mol of methane reacts completely with 0.5 mol of steam.

What is the volume of carbon monoxide and hydrogen produced, measured at room temperature and pressure?

	volume of CO / dm^3	volume of H_2 / dm^3
A	0.5	1.5
B	1.0	3.0
C	12.0	12.0
D	12.0	36.0

9. June/2022/Paper_22/No.9

A compound of element X has the formula X_2O and a relative formula mass of 144.

What is element X?

A copper, Cu

B gadolinium, Gd

C sulfur, S

D tellurium, Te

10. June/2022/Paper_23/No.7

The equation for the reaction between barium chloride and dilute sulfuric acid is shown.

$$BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + 2HCl$$

Which row shows the state symbols for this equation?

	$BaCl_2$	H_2SO_4	$BaSO_4$	$2HCl$
A	(aq)	(aq)	(s)	(aq)
B	(aq)	(l)	(s)	(aq)
C	(l)	(aq)	(s)	(l)
D	(aq)	(l)	(aq)	(l)

11. June/2022/Paper_23/No.8

A 0.5 g sample of calcium carbonate is reacted with excess dilute hydrochloric acid.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

Which volume of CO_2 is produced at r.t.p.?

A $0.12\,dm^3$ **B** $0.18\,dm^3$ **C** $0.24\,dm^3$ **D** $12\,dm^3$

12. June/2022/Paper_31/No.2(a, b)

The table shows the masses of some ions in a 1000 cm^3 sample of toothpaste.

name of ion	formula of ion	mass of ion in 1000 cm^3 of toothpaste / g
	NH_4^+	0.2
calcium	Ca^{2+}	1.2
	Cl^-	0.9
fluoride	F^-	1.4
magnesium	Mg^{2+}	2.0
phosphate	PO_4^{3-}	24.4
sodium	Na^+	28.1
sulfate	SO_4^{2-}	9.2
tin(II)	Sn^{2+}	0.2
zinc	Zn^{2+}	0.1

(a) Answer these questions using only the information in the table.

(i) State which negative ion has the lowest mass in 1000 cm^3 of toothpaste.

..... [1]

(ii) Name the compound that contains NH_4^+ and Cl^- ions.

..... [1]

(iii) Calculate the mass of phosphate ions in 250 cm^3 of toothpaste.

mass = ... g [1]

(b) Describe a test for sulfate ions.

test .....

observations .....

[2]

13. June/2022/Paper_31/No.8(d)

(d) When 0.2 g of copper(II) carbonate is used, 38 cm^3 of carbon dioxide gas is produced.

Calculate the volume of carbon dioxide gas produced when 0.50 g of copper(II) carbonate is used.

volume of carbon dioxide gas = ... cm^3 [1]

14. June/2022/Paper_32/No.2(a, b)

The table shows the masses of some ions in a 1000 cm^3 sample of toothpaste.

name of ion	formula of ion	mass of ion in 1000 cm^3 of toothpaste / g
ammonium	NH_4^+	0.5
calcium	Ca^{2+}	3.6
carbonate	CO_3^{2-}	2.5
chloride	Cl^-	0.9
fluoride	F^-	1.2
	Mg^{2+}	0.2
phosphate	PO_4^{3-}	28.0
sodium	Na^+	32.0
	SO_4^{2-}	10.4
tin(II)	Sn^{2+}	0.3

(a) Answer these questions using only the information in the table.

(i) State which positive ion has the lowest mass in 1000 cm^3 of toothpaste.

..... [1]

(ii) Name the compound that contains Mg^{2+} and SO_4^{2-} ions.

..... [1]

(iii) Calculate the mass of sodium ions in 200 cm^3 of toothpaste.

mass = ... g [1]

(b) Describe a test for chloride ions.

test .....

observations .....

[2]

15. June/2022/Paper_33/No.2(a _b)

The table shows the masses of some ions in a 1000 cm^3 sample of toothpaste.

name of ion	formula of ion	mass of ion in 1000 cm^3 of toothpaste / g
	NH_4^+	0.2
calcium	Ca^{2+}	0.8
	CO_3^{2-}	0.7
chloride	Cl^-	0.9
fluoride	F^-	2.2
magnesium	Mg^{2+}	2.0
phosphate	PO_4^{3-}	24.4
sodium	Na^+	34.2
sulfate	SO_4^{2-}	10.1
tin(II)	Sn^{2+}	0.4
zinc	Zn^{2+}	0.1

(a) Answer these questions using only the information in the table.

(i) State which negative ion has the highest mass in 1000 cm^3 of toothpaste.

..... [1]

(ii) Name the compound that contains NH_4^+ and CO_3^{2-} ions.

..... [1]

(iii) Calculate the mass of fluoride ions in 250 cm^3 of toothpaste.

mass = ... g [1]

(b) Describe the observations when aqueous ammonia is added drop by drop to a solution containing zinc ions until the ammonia is in excess.

observations with a few drops of ammonia

.....

observations with ammonia in excess

.....

[2]

16. June/2022/Paper_41/No.3(c)

(c) A student determines the concentration of a solution of dilute sulfuric acid, H_2SO_4, by titration with aqueous sodium hydroxide, NaOH.

step 1 25.0 cm^3 of 0.200 mol/dm^3 NaOH is transferred into a conical flask.

step 2 Three drops of methyl orange indicator are added to the conical flask.

step 3 A burette is filled with H_2SO_4.

step 4 The acid in the burette is added to the conical flask until the indicator changes colour. The volume of acid is recorded. This process is known as titration.

step 5 The titration is repeated several times until a suitable number of results is obtained.

(i) Name the piece of apparatus used to measure exactly 25.0 cm^3 of 0.200 mol/dm^3 NaOH in **step 1**.

..... [1]

(ii) State the colour change of the methyl orange indicator in **step 4**.

from ..... to ..... [1]

(iii) State how the student decides that a suitable number of results have been obtained.

.....

..... [1]

(iv) 20.0 cm^3 of H_2SO_4 reacts with 25.0 cm^3 of 0.200 mol/dm^3 NaOH.

The equation for the reaction is shown.

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

Calculate the concentration of H_2SO_4 using the following steps.

- Calculate the number of moles in 25.0 cm^3 of 0.200 mol/dm^3 NaOH.

..... mol

- Determine the number of moles of H_2SO_4 that react with the NaOH.

..... mol

- Calculate the concentration of H_2SO_4.

..... mol/dm^3
[3]

17. June/2022/Paper_41/No.5(h _i)

(h) Ester **Y** has the following composition by mass:

C, 48.65%; H, 8.11%; O, 43.24%.

Calculate the empirical formula of ester **Y**.

empirical formula = ... [3]

(i) Ester **Z** has the empirical formula C_2H_4O and a relative molecular mass of 88.

Determine the molecular formula of ester **Z**.

molecular formula = ... [1]

18. June/2022/Paper_42/No.2(d)

(d) A 25.0 cm^3 sample of limewater is placed in a conical flask. The concentration of $Ca(OH)_2$ in the limewater is determined by titration with dilute hydrochloric acid, HCl.

(i) Name the item of apparatus used to measure the volume of acid in this titration.

..... [1]

(ii) State the type of reaction which takes place.

..... [1]

(iii) As well as limewater and dilute hydrochloric acid, state what other type of substance must be added to the conical flask.

..... [1]

(iv) The equation for the reaction is shown.

$$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$$

20.0 cm^3 of 0.0500 mol/dm^3 HCl reacts with the 25.0 cm^3 of $Ca(OH)_2$.

Determine the concentration of $Ca(OH)_2$ in g/dm^3. Use the following steps.

- Calculate the number of moles in 20.0 cm^3 of 0.0500 mol/dm^3 HCl.

..... mol

- Determine the number of moles of $Ca(OH)_2$ in 25.0 cm^3 of the limewater.

..... mol

- Calculate the concentration of $Ca(OH)_2$ in mol/dm^3.

..... mol/dm^3

- Determine the concentration of $Ca(OH)_2$ in g/dm^3.

..... g/dm^3
[5]

19. June/2022/Paper_42/No.4(b)

(b) Fluorine reacts with sulfur to form a compound which has 25.2% sulfur by mass and a relative molecular mass of 254.

Determine the molecular formula of this compound.

molecular formula = ... [3]

20. June/2022/Paper_43/No.4(e _ f)

(e) Ester **Y** has the following composition by mass:

C, 58.82%; H, 9.80%; O, 31.37%.

Calculate the empirical formula of ester **Y**.

empirical formula = ... [3]

(f) Ester **Z** has the empirical formula C_3H_6O and a relative molecular mass of 116.

Calculate the molecular formula of ester **Z**.

molecular formula = ... [1]

21. June/2022/Paper_43/No.5(c _ i)

(c) The formula for crystals of hydrated copper(II) sulfate is $CuSO_4 \cdot 5H_2O$.

Hydrated copper(II) sulfate is made by reacting copper(II) oxide with dilute sulfuric acid.

The overall equation is shown.

$$CuO + H_2SO_4 + 4H_2O \rightarrow CuSO_4 \cdot 5H_2O$$

The crystals are made using the following steps:

step 1 50.0 cm^3 of 0.200 mol/dm^3 dilute sulfuric acid is heated in a beaker. Powdered copper(II) oxide is added until the copper(II) oxide is in excess. Aqueous copper(II) sulfate is formed.

step 2 The excess copper(II) oxide is separated from the aqueous copper(II) sulfate.

step 3 The aqueous copper(II) sulfate is heated until a saturated solution is formed.

step 4 The saturated solution is allowed to cool and crystallise.

step 5 The crystals are removed and dried.

Calculate the maximum mass of copper(II) sulfate crystals, $CuSO_4 \cdot 5H_2O$, that can form using the following steps.

- Calculate the number of moles of H_2SO_4 in 50.0 cm^3 of 0.200 mol/dm^3 H_2SO_4.

..... mol

- Deduce the number of moles of $CuSO_4 \cdot 5H_2O$ that can form.

..... mol

- The M_r of $CuSO_4 \cdot 5H_2O$ is 250.

  Calculate the maximum mass of $CuSO_4 \cdot 5H_2O$ that can form.

..... g
[3]

(d) State **one** observation that indicates the copper(II) oxide is in excess in **step 1**.

..... [1]

(e) **Step 1** is repeated without heating the dilute sulfuric acid.

All other conditions are kept the same.

The rate of reaction decreases.

Give a reason why the rate of reaction decreases. Explain your answer in terms of particles.

.....

.....

.....

.....

..... [3]

(f) Name a substance, other than copper(II) oxide, that can be added to dilute sulfuric acid to produce copper(II) sulfate in **step 1**.

..... [1]

(g) Name the process used to separate excess copper(II) oxide from aqueous copper(II) sulfate in **step 2**.

..... [1]

(h) Suggest what is meant by the term *saturated solution* in **step 3**.

.....

.....

..... [2]

(i) The phrase 'heating to dryness' means heating until no more water is given off.

Explain why aqueous copper(II) sulfate is **not** heated to dryness in **step 3**.

.....

..... [1]

22. March/2022/Paper_12/No.12

Calcium carbonate, $CaCO_3$, reacts with dilute hydrochloric acid to produce carbon dioxide.

The equation for the reaction is shown. The relative formula mass of calcium carbonate is 100.

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

10 g of calcium carbonate is reacted with an excess of dilute hydrochloric acid.

Which mass of carbon dioxide is produced?

A 2.2 g **B** 2.8 g **C** 4.4 g **D** 44 g

23. March/2022/Paper_12/No.18

Magnesium is added to dilute hydrochloric acid.

25 cm^3 of gas is given off in the first 30 s of the reaction.

The experiment is repeated at a lower temperature. All other reaction conditions are the same.

Which volume of gas is produced in the first 30 s of this reaction?

A 15 cm^3 **B** 25 cm^3 **C** 30 cm^3 **D** 50 cm^3

24. March/2022/Paper_22/No.9

Compound X contains carbon, hydrogen and oxygen only.

By mass, it contains 26.7% carbon and 2.2% hydrogen.

What is the empirical formula of X?

A CHO **B** C_2HO **C** CH_2O **D** CHO_2

25. March/2022/Paper_22/No.12

Calcium carbonate, $CaCO_3$, reacts with dilute hydrochloric acid to produce carbon dioxide.

The equation for the reaction is shown. The relative formula mass of calcium carbonate is 100.

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

10 g of calcium carbonate is reacted with an excess of dilute hydrochloric acid.

Which mass of carbon dioxide is produced?

A 2.2 g **B** 2.8 g **C** 4.4 g **D** 44 g

26. March/2022/Paper_32/No.2(a),(c)

(a) Biogas is a mixture of gases produced when agricultural waste is broken down in the absence of oxygen.

The table compares the percentage by mass of the gases present in two samples of biogas, **X** and **Y**.

gas	biogas **X** /% by mass	biogas **Y** /% by mass
carbon dioxide	26	32
hydrogen	1	1
hydrogen sulfide	0.5	0.5
methane	67	56
nitrogen	4	9.5
oxygen	0.5	0.5
other gases		0.5

Answer these questions using only the information in the table.

(i) Deduce the percentage by mass of the other gases in biogas **X**.

..... [1]

(ii) Describe **two** major differences in the compositions of biogas **X** and biogas **Y**.

1 .....

2 .....

[2]

(c) Hydrogen sulfide burns in air to produce sulfur dioxide and water.

(i) Complete the chemical equation for this reaction.

$$.....H_2S + ...O_2 \rightarrow 2H_2O + 2SO_2$$ [2]

(ii) Explain how this equation shows that hydrogen sulfide is oxidised.

.....

..... [1]

27. March/2022/Paper_32/No.3(d)

(d) When 4.8 g of magnesium reacts with excess oxygen, 8.0 g of magnesium oxide is formed.

Calculate the minimum mass of magnesium needed to produce 24.0 g of magnesium oxide.

minimum mass = ... g [1]

28. March/2022/Paper_32/No.8(e)

(e) A compound of chlorine has the formula $C_3H_6Cl_2$.

Complete the table to calculate the relative molecular mass of $C_3H_6Cl_2$.

atom	number of atoms	relative atomic mass	
carbon	3	12	$3 \times 12 = 36$
hydrogen		1	
chlorine		35.5	

relative molecular mass = ... [2]

29. March/2022/Paper_42/No.2(e)

(e) Determine the volume of CO_2 gas given off when excess $MgCO_3$ is added to 25.0 cm^3 of 0.400 mol/dm^3 HCl at room temperature and pressure.

$$MgCO_3 + 2HCl \rightarrow MgCl_2 + H_2O + CO_2$$

Use the following steps.

- Calculate the number of moles of HCl in 25.0 cm^3 of 0.400 mol/dm^3 of acid.

..... mol

- Determine the number of moles of CO_2 gas given off.

..... mol

- Calculate the volume of CO_2 gas given off in cm^3.

..... cm^3
[3]