Week 6

IGCSE Chemistry

Homework bundle for this week

本周作业合集

exercises.lol

Contents 目录

IGCSE Chemistry Name: _____ Score: _____

1. How many hydrogen atoms are in one molecule of H_2O?

   _____

2. A balanced equation must have the same number of each atom on both sides because:

   ☐ atoms are not created or destroyed

   ☐ atoms disappear

   ☐ mass is lost

   ☐ energy is created

3. Using Ar(H)=1 and Ar(O)=16, what is the Mr of water (H_2O)?

   _____

4. How many moles are in 36 g of water (Mr = 18)?

   _____

5. What volume (dm^3) does 3 moles of a gas occupy at rtp (1 mole = 24 dm^3)?

   _____

6. How many moles are in 4 g of hydrogen gas (Mr = 2)?

   _____

7. To balance an equation you change the:

   ☐ big numbers in front of formulae

   ☐ subscripts inside formulae

   ☐ names of the elements

   ☐ arrow direction

8. In $2H_2 + O_2 \rightarrow 2H_2O$, the mole ratio of H_2 to H_2O is:

   ☐ 2 : 2 (i.e. 1 : 1)

   ☐ 1 : 2

   ☐ 2 : 1

   ☐ 1 : 0

9. Atoms combine in fixed ratios because of their:

   ☐ combining power (valency)

- ☐ colour
- ☐ temperature
- ☐ mass number

10. In an equation, the substances on the left of the arrow are the:
    - ☐ reactants
    - ☐ products
    - ☐ catalysts
    - ☐ solvents

IGCSE Chemistry

1. **2**

   The subscript 2 means two hydrogen atoms.

2. **atoms are not created or destroyed**

   Conservation of mass: atoms are only rearranged.

3. **18**

   $(2 \times 1) + 16 = 18$.

4. **2**

   moles $= 36 \div 18 = 2$.

5. **72**

   volume $= 3 \times 24 = 72$ dm^3.

6. **2**

   moles $= 4 \div 2 = 2$.

7. **big numbers in front of formulae**

   Only coefficients may be changed, not subscripts.

8. **2 : 2 (i.e. 1 : 1)**

   2 moles of H_2 give 2 moles of water.

9. **combining power (valency)**

   Valency sets how many bonds an atom forms.

10. **reactants**

    Reactants → products.

IGCSE CHEMISTRY • EXERCISE SHEET

3.1 Formulae

Name: _____ Class: _____ Date: _____ **Total: 9 marks**

KEY WORDS formula 化学式 • compound 化合物 • symbol equation 化学方程式 • aqueous 水溶液 • ionic equation 离子方程式

Objective

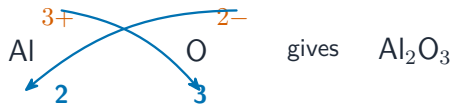
Build the skills to answer exam questions on **formulae** 化学式 — working out ionic formulae from charges, **balancing equations** 配平方程式, **state symbols** 状态符号, and **ionic equations** 离子方程式.

You must be able to:

- work out an ionic formula by balancing charges
- balance a symbol equation and add state symbols
- write a simple ionic equation (leaving out spectator ions)

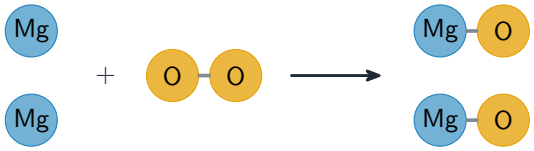
1 Worked examples

■ Formulae and balancing



the charge numbers cross over to become the subscripts (then simplify if they share a factor)

The ion charges cross over to give the formula (here Al_2O_3)



$2Mg + O_2 \rightarrow 2MgO$

2 Mg and 2 O on each side: balanced

A balanced equation has the same number of each atom on both sides

Ionic (acid + alkali): $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$.

2 Practice

2.1 Give the formula of the compound formed from Mg^{2+} and Cl^-. [1]

2.2 State what the symbol (aq) means. [1]

3 Exam-style questions

3.1 The formula of the ionic compound from Ca^{2+} and NO_3^- is: [1]

- **A** $CaNO_3$
- **B** $Ca(NO_3)_2$
- **C** Ca_2NO_3
- **D** $Ca_2(NO_3)_3$

3.2 Balance the equation, adding state symbols:

$$Zn + HCl \rightarrow ZnCl_2 + H_2$$

[3]

3.3 Write the ionic equation for the neutralisation of a strong acid by a strong alkali, and name the spectator ions when NaOH reacts with HCl. [3]

Solutions

2.1 $MgCl_2$.

2.2 aqueous — dissolved in water.

3.1 B. One Ca^{2+} needs two NO_3^-: $Ca(NO_3)_2$.

3.2 $Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$.

3.3 $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$; the spectator ions are Na^+ and Cl^-.

9 The molecular formulae of four compounds are listed.

1 CH_4

2 C_2H_6

3 C_3H_8

4 C_3H_6

Which molecular formulae are also the empirical formulae for the compounds?

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

11 A compound contains 40.0% carbon, 6.7% hydrogen and 53.3% oxygen only.

The relative molecular mass, M_r, of the compound is 60.

Which row shows the empirical formula and the molecular formula of the compound?

	empirical formula	molecular formula
A	CH_2O	CH_2O
B	CH_2O	$C_2H_4O_2$
C	$C_3H_7O_3$	$C_3H_7O_3$
D	C_3H_8O	C_3H_8O

9 Which compound has an empirical formula that is the same as its molecular formula?

A butane

B but-1-ene

C butanoic acid

D butan-1-ol

10 Which row identifies the charge on the chromium ion and on the sulfate ion in $Cr_2(SO_4)_3$?

	Cr	SO_4
A	2+	3–
B	2–	3+
C	3+	2–
D	3–	2+

IGCSE Chemistry: **s25 21**

8 Three organic molecules are described.

- The molecular formula of propanoic acid is CH_3CH_2COOH.
- The molecular formula of lactic acid is $CH_3CH(OH)COOH$.
- A glucose molecule consists of 6 carbon atoms, 6 oxygen atoms and 12 hydrogen atoms only.

Which molecules have the same empirical formula?

A propanoic acid, lactic acid and glucose

B propanoic acid and lactic acid only

C propanoic acid and glucose only

D lactic acid and glucose only

IGCSE Chemistry: **s25 22**

8 Aluminium reacts with iron(III) oxide to form aluminium oxide and iron.

Which chemical equation for the reaction between aluminium and iron(III) oxide is correct?

A $Al + FeO \rightarrow AlO + Fe$

B $2Al + Fe_2O \rightarrow Al_2O + 2Fe$

C $Al + Fe_2O_3 \rightarrow Al_2O_3 + Fe$

D $2Al + Fe_2O_3 \rightarrow Al_2O_3 + 2Fe$

IGCSE Chemistry: **s25 23**

8 A compound is analysed and found to contain 85.7% carbon and 14.3% hydrogen only.

What is its empirical formula?

A CH **B** CH_2 **C** C_2H_4 **D** C_6H

IGCSE Chemistry: **m25 22**

9 Which formula for the named compound is correct?

A calcium oxide, CaO

B cobalt(II) chloride, Co_2Cl

C sulfur dioxide, S_2O_2

D anhydrous copper(II) sulfate, $Cu(SO_4)_2$

11 An organic compound, Q, contains carbon, hydrogen and oxygen only.

Q contains 40.0% carbon and 6.7% hydrogen by mass.

What is the empirical formula of Q?

A CHO **B** CH_2O **C** C_2HO_2 **D** $C_3H_6O_3$

3.2 Relative masses of atoms and molecules

Name: _____ Class: _____ Date: _____ **Total: 9 marks**

KEY WORDS mass 质量 • relative atomic mass 相对原子质量 • relative formula mass 相对式量 • relative molecular/formula mass 相对分子 • relative masses 相对质量

Objective

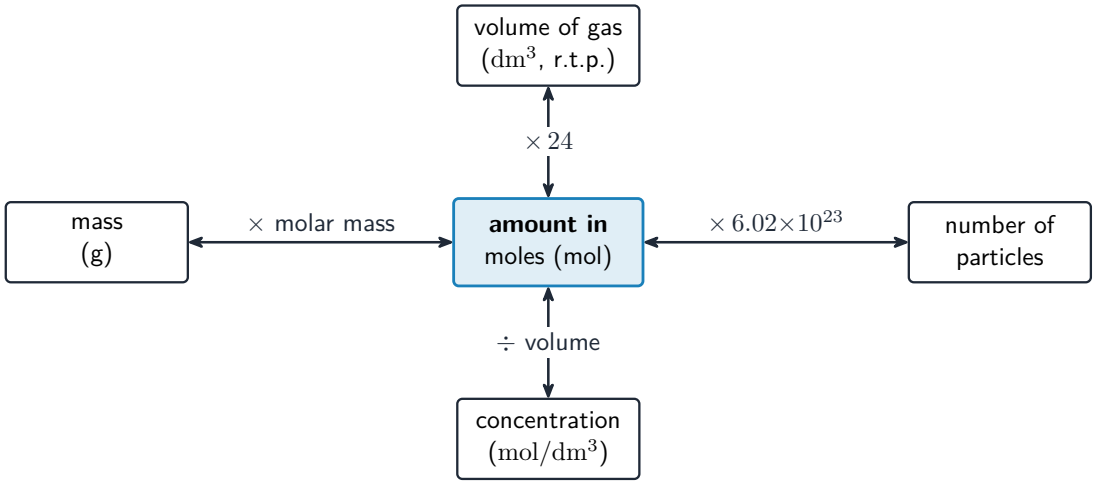
Build the skills to answer exam questions on **relative masses** 相对质量 — **relative atomic mass** 相对原子质量 (A_r), **relative molecular/formula mass** 相对分子/式量 (M_r), and reacting masses by simple proportion.

You must be able to:

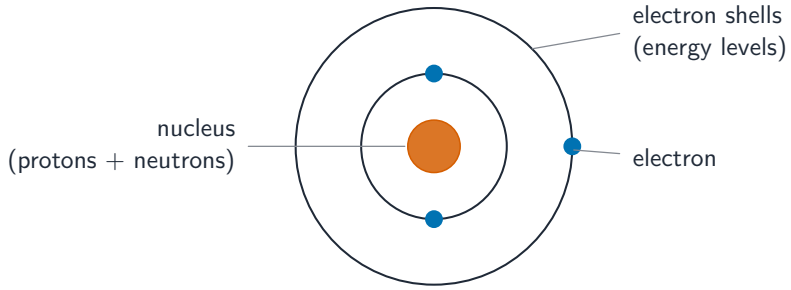
- state what A_r and M_r mean
- calculate M_r from a formula
- find a reacting mass by simple proportion

1 Worked examples

■ Calculating M_r



M_r is the sum of the A_r values of all the atoms in the formula



lithium, Li: 3 protons, 4 neutrons
electron configuration 2,1

Relative mass comes from the protons and neutrons in the nucleus

$M_r(\mathbf{H_2O}) = (2 \times 1) + 16 = 18$**.**

Proportion: if 24 g of Mg makes 40 g of MgO, then 12 g of Mg makes 20 g of MgO.

2 Practice

2.1 Calculate the M_r of carbon dioxide, CO_2 (A_r: C = 12, O = 16). [2]

2.2 State what relative atomic mass means. [1]

3 Exam-style questions

3.1 The relative formula mass of $CaCO_3$ (A_r: Ca = 40, C = 12, O = 16) is: [1]

- **A** 68
- **B** 82
- **C** 100
- **D** 116

3.2 Calculate the M_r of ammonium nitrate, NH_4NO_3 (A_r: N = 14, H = 1, O = 16). [2]

3.3 48 g of magnesium reacts completely with oxygen to form 80 g of magnesium oxide.

(a) Find the mass of magnesium oxide formed from 12 g of magnesium. [2]

(b) Find the mass of oxygen that reacted with the 48 g of magnesium. [1]

Solutions

2.1 $M_r = 12 + (2 \times 16) = 44$.

2.2 the average mass of an atom of the element compared with $\frac{1}{12}$ the mass of a carbon-12 atom.

3.1 C. $40 + 12 + (3 \times 16) = 100$.

3.2 $(2 \times 14) + (4 \times 1) + (3 \times 16) = 28 + 4 + 48 = 80$.

3.3 (a) 12 g is a quarter of 48 g, so mass of MgO $= \frac{1}{4} \times 80 = 20$ g.
(b) oxygen $= 80 - 48 = 32$ g.

3.3 The mole and the Avogadro constant

Name: _____ Class: _____ Date: _____ **Total: 32 marks**

KEY WORDS volume 体积 • concentration 浓度 • solution 溶液 • the mole 摩尔 • titration 滴定

Objective

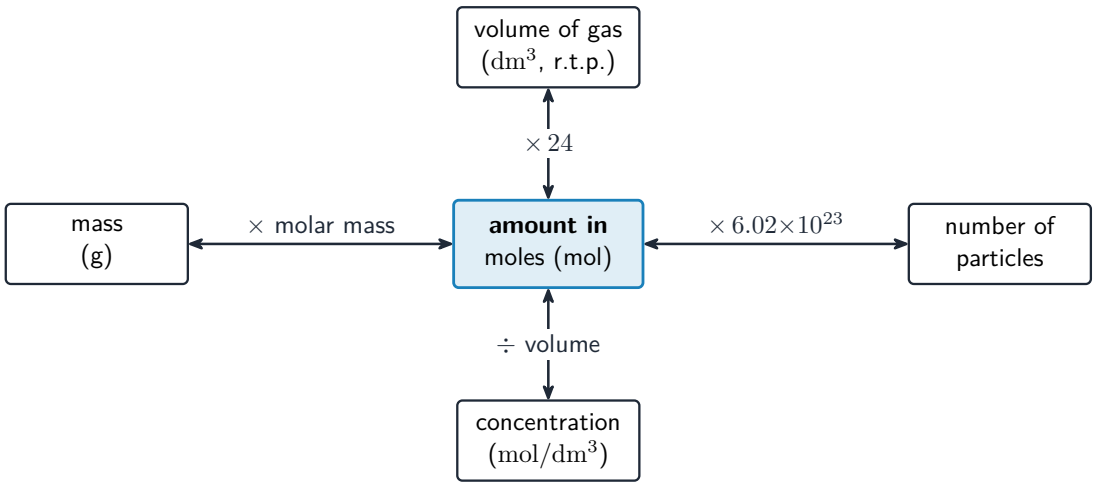
Build the skills to answer exam questions on **the mole** 摩尔 — $n = \dfrac{\text{mass}}{M_r}$, gas volumes, **concentration** 浓度, reaction calculations, and the **limiting reactant** 限量反应物.

You must be able to:

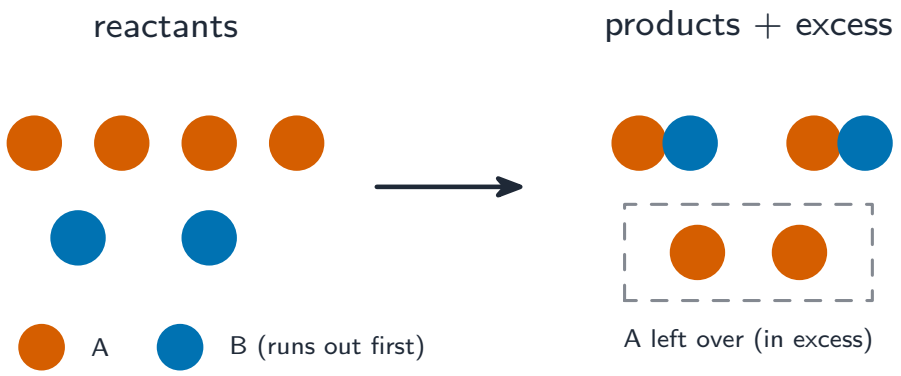
- use $n = \dfrac{\text{mass}}{M_r}$ and the molar gas volume (24 dm^3)
- use $c = \dfrac{n}{V}$ and do reacting-mass / titration calculations
- find the limiting reactant and an empirical formula

1 Worked examples

■ Mole calculations



$$n = \frac{mass}{M_r};\ volume\ of\ gas = n \times 24\ dm^3;\ c = \frac{n}{V}$$



The limiting reactant runs out first and sets how much product forms

36 **g water:** $n = \dfrac{36}{18} = 2$ mol.

The four calculations, each as a route through the mole

Every quantitative question is the same three steps: **convert what you are given into moles**, **use the balanced equation to get the moles of what you want**, then **convert those moles into the answer's unit**.

$$n = \frac{m}{M_r} \qquad n = \frac{V(\text{cm}^3)}{24\,000}\ \text{(gas at r.t.p.)} \qquad n = c \times V(\text{dm}^3)$$

Worked example 1 (mass to mass). Calculate the mass of magnesium oxide formed when 4.8 g of magnesium burns completely. (A_r: Mg 24, O 16.)

1. Balanced equation: $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$.
2. Moles of Mg: $n = \dfrac{4.8}{24} = 0.20$ mol.
3. The ratio Mg : MgO is 2 : 2, so moles of MgO $= 0.20$ mol.
4. $M_r(\text{MgO}) = 24 + 16 = 40$, so $m = n \times M_r = 0.20 \times 40 = 8.0$ g.

Worked example 2 (titration, concentration). 25.0 cm^3 of sodium hydroxide needs 20.0 cm^3 of 0.100 mol/dm^3 hydrochloric acid. Find the concentration of the alkali.

1. Moles of HCl $= c \times V = 0.100 \times \dfrac{20.0}{1000} = 2.00 \times 10^{-3}$ mol.
2. $\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}$ is 1 : 1, so moles of NaOH $= 2.00 \times 10^{-3}$ mol.
3. $c = \dfrac{n}{V} = \dfrac{2.00 \times 10^{-3}}{0.0250} = 0.0800$ mol/dm^3.

Worked example 3 (limiting reactant, then percentage yield). 6.0 g of carbon reacts with 16.0 g of oxygen. Determine the limiting reactant, the maximum mass of carbon dioxide, and the percentage yield if 19.8 g is collected.

1. $C + O_2 \rightarrow CO_2$; $n(C) = \dfrac{6.0}{12} = 0.50$; $n(O_2) = \dfrac{16.0}{32} = 0.50$.
2. The ratio is $1 : 1$ and the moles are equal, so neither is in excess; had one been smaller, that one would be **limiting** because it runs out first and sets how much product forms.
3. Maximum $CO_2 = 0.50 \times 44 = 22.0$ g.
4. percentage yield $= \dfrac{\text{actual}}{\text{theoretical}} \times 100\% = \dfrac{19.8}{22.0} \times 100\% = 90.0\%$.

Percentage composition and empirical formula. Divide each percentage by the element's A_r, then divide every answer by the smallest of them to get the whole-number ratio: 40.0% C, 6.7% H, 53.3% O gives $\frac{40.0}{12} = 3.33$, $\frac{6.7}{1} = 6.7$, $\frac{53.3}{16} = 3.33$, which is $1 : 2 : 1$, so CH_2O.

2 Practice

2.1 Find the amount (in mol) in 8.0 g of NaOH ($M_r = 40$). [2]

2.2 Find the volume of 0.50 mol of a gas at r.t.p. [2]

2.3 Calculate the number of moles in 8.8 g of carbon dioxide. ($M_r = 44$.) [2]

2.4 Calculate the volume, at r.t.p., of 0.25 mol of hydrogen gas. [2]

2.5 Determine the empirical formula of a compound containing 52.2% carbon, 13.0% hydrogen and 34.8% oxygen. (A_r: C 12, H 1, O 16.) [3]

3 Exam-style questions

3.1 The number of moles in 22 g of CO_2 ($M_r = 44$) is: [1]

- **A** 0.25
- **B** 0.50
- **C** 1.0
- **D** 2.0

3.2 Magnesium burns: $2Mg + O_2 \rightarrow 2MgO$ (A_r: Mg = 24, O = 16).

(a) Find the moles in 12 g of magnesium. [1]

(b) Find the mass of magnesium oxide formed. [3]

3.3 25.0 cm^3 of sodium hydroxide is neutralised by 20.0 cm^3 of 0.10 mol/dm^3 HCl. $NaOH + HCl \rightarrow NaCl + H_2O$.

(a) Find the moles of HCl. [2]

(b) Find the concentration of the sodium hydroxide. [2]

3.4 Calcium carbonate decomposes when heated: $CaCO_3 \rightarrow CaO + CO_2$. A student heats 25.0 g of calcium carbonate until there is no further change. (A_r: Ca 40, C 12, O 16.)

(a) Calculate the number of moles of calcium carbonate used. [2]

(b) Determine the maximum mass of calcium oxide that can be formed. [3]

(c) The student collects 12.6 g of calcium oxide. Calculate the percentage yield. [2]

(d) Calculate the volume of carbon dioxide, at r.t.p., released in the reaction. [2]

(e) The carbon dioxide is bubbled through 50.0 cm^3 of limewater of concentration 0.0200 mol/dm^3. Calculate the number of moles of calcium hydroxide present, and state whether it is enough to react with all the gas. [3]

Solutions

2.1 $n = \dfrac{8.0}{40} = 0.20$ mol.

2.2 $V = 0.50 \times 24 = 12$ dm^3.

2.3 $n = \dfrac{8.8}{44} = 0.20$ mol.

2.4 $V = 0.25 \times 24 = 6.0$ dm^3, which is 6000 cm^3.

2.5 $\dfrac{52.2}{12} = 4.35$, $\dfrac{13.0}{1} = 13.0$, $\dfrac{34.8}{16} = 2.175$; dividing by the smallest, 2 : 6 : 1; the empirical formula is C_2H_6O.

3.1 B. $n = \dfrac{22}{44} = 0.50$ mol.

3.2 (a) $n = \dfrac{12}{24} = 0.50$ mol.
(b) ratio Mg : MgO is 1 : 1, so 0.50 mol MgO; $M_r(\text{MgO}) = 40$; mass $= 0.50 \times 40 = 20$ g.

3.3 (a) $n = 0.10 \times \dfrac{20.0}{1000} = 0.0020$ mol.
(b) ratio 1 : 1, so 0.0020 mol NaOH in 25.0 cm^3; $c = \dfrac{0.0020}{25.0/1000} = 0.080$ mol/dm^3.

3.4 (a) $M_r(\text{CaCO}_3) = 40 + 12 + 48 = 100$; $n = \dfrac{25.0}{100} = 0.250$ mol.
(b) The ratio CaCO_3 : CaO is 1 : 1, so $n(\text{CaO}) = 0.250$ mol; $M_r(\text{CaO}) = 56$; $m = 0.250 \times 56 = 14.0$ g.
(c) $\dfrac{12.6}{14.0} \times 100\% = 90.0\%$.
(d) $n(\text{CO}_2) = 0.250$ mol; $V = 0.250 \times 24 = 6.0$ dm^3.
(e) $n = c \times V = 0.0200 \times \dfrac{50.0}{1000} = 1.00 \times 10^{-3}$ mol; this is far less than the 0.250 mol of carbon dioxide, so the limewater is not enough to react with all of it.

10 The equation for the reaction between copper(II) oxide, CuO, and ammonia is given.

$$3CuO + 2NH_3 \rightarrow 3Cu + 3H_2O + N_2$$

[M_r: CuO, 80; NH_3, 17; H_2O, 18; N_2, 28]

[A_r: Cu, 64]

Which statements about this reaction are correct?

1 80.0 g of copper(II) oxide reacts exactly with 17.0 g of ammonia.

2 4.0 g of copper(II) oxide reacts with excess ammonia to produce 3.2 g of copper.

3 The mass of water produced in this reaction is greater than the mass of nitrogen.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

11 How many atoms are present in 1.00 mol of argon?

A 2.06×10^{23} **B** 3.02×10^{26} **C** 6.02×10^{23} **D** 6.32×10^{20}

10 The equation for the combustion of ethanol is shown.

$$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$$

The relative molecular mass, M_r, of ethanol is 46.

Which statement about the reaction is correct?

A 4.6 g of ethanol produces 4.4 g of carbon dioxide.

B 92 g of ethanol produces 88 g of carbon dioxide and 108 g of water.

C 138 g of ethanol reacts with 32 g of oxygen.

D 184 g of ethanol produces 216 g of water.

12 Calcium carbonate decomposes when heated strongly.

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

How many gaseous molecules are produced when 10.0 g of calcium carbonate is completely decomposed?

A 1.00×10^{22} **B** 1.20×10^{23} **C** 6.02×10^{22} **D** 6.02×10^{23}

3 A student makes crystals of the salt sodium sulfate, Na_2SO_4. The student reacts 0.200 mol / dm^3 dilute sulfuric acid, $H_2SO_4(aq)$, with aqueous sodium hydroxide, NaOH(aq).

The student uses the following steps.

step 1 The student places 40.0 cm^3 of NaOH(aq) into a conical flask. This volume contains 0.0100 moles of NaOH.

step 2 The student adds a few drops of methyl orange indicator to the NaOH(aq) in the conical flask.

step 3 The student adds 0.200 mol / dm^3 $H_2SO_4(aq)$ to the flask until the end-point is reached.

step 4 The student transfers the mixture from the conical flask to an evaporating basin and obtains dry crystals.

(a) Complete the symbol equation for the reaction. Include state symbols.

$$H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(.....) + ...(.....)$$

[2]

(b) State the type of exothermic reaction taking place.

..... [1]

(c) Calculate the concentration of NaOH(aq) used in **step 1**.

concentration of NaOH(aq) = ... mol / dm^3 [1]

(d) Name the item of apparatus the student uses to add $H_2SO_4(aq)$ in **step 3**.

..... [1]

(e) Calculate the volume of $H_2SO_4(aq)$, in cm^3, added in **step 3**.

volume of $H_2SO_4(aq)$ = ... cm^3 [2]

(f) State the colour change observed in **step 3**.

from ..... to ..... [2]

(g) The dry crystals formed in **step 4** are coloured and **not** white. This is because the student should do an additional step between **step 3** and **step 4**.

Suggest what the student should do in this additional step to produce white crystals.

.....

..... [1]

(h) In **step 4**, the student gently heats the solution in the evaporating basin until the solution is saturated. The student then stops heating and leaves the hot solution to cool. Crystals start to appear.

(i) Explain the term saturated solution.

.....

.....

..... [2]

(ii) Explain why crystals start to appear as the hot solution cools.

.....

..... [1]

(iii) Suggest the effect, if any, on the mass of crystals collected in **step 4** if the solution in the evaporating basin is allowed to dry without gentle heating.

..... [1]

[Total: 14]

3 A student prepares a sample of the insoluble salt barium sulfate, $BaSO_4$.
The student adds aqueous sodium sulfate, $Na_2SO_4(aq)$, to aqueous barium chloride, $BaCl_2(aq)$.

The student carries out the following steps.

step 1 Dissolve 0.100 moles of solid $BaCl_2$ in 100 cm^3 of distilled water in a beaker to form $BaCl_2(aq)$.

step 2 Add an aqueous solution which contains 0.100 moles of $Na_2SO_4(aq)$ to the beaker containing the $BaCl_2(aq)$ from **step 1**.

step 3 Stir the mixture and then filter it.

step 4 Dry the solid left in the filter paper.

(a) Complete the symbol equation for the reaction. Include state symbols.

$$BaCl_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(.....) + ...(.....)$$

[2]

(b) Calculate the mass of solid $BaCl_2$ dissolved in **step 1**.

mass = ... g [2]

(c) The concentration of $Na_2SO_4(aq)$ in **step 2** is 1.25 mol/dm^3.

Calculate the volume, in cm^3, of 1.25 mol/dm^3 $Na_2SO_4(aq)$ added in **step 2** which contains 0.100 moles of Na_2SO_4.

volume = ... cm^3 [1]

(d) State the colour of the solid formed in **step 2**.

..... [1]

(e) The mixture is filtered in **step 3**.

State the general term given to a solid left in the filter paper after filtration.

..... [1]

(f) The actual mass of dry $BaSO_4$ collected in **step 4** is greater than the expected mass. This is because the student should do an additional step between **step 3** and **step 4**.

Suggest what the student should do in this additional step, and explain why the actual mass collected is greater than the expected mass.

.....

.....

.....

..... [2]

(g) State the name of this method of salt preparation.

..... [1]

(h) State the name of a different:

- barium salt that can be used in place of $BaCl_2$ .....
- sulfate salt that can be used in place of Na_2SO_4 .....
- barium salt that can be made by this method. .....

[3]

[Total: 13]

9 Calcium carbonate reacts with dilute hydrochloric acid.

The equation for the reaction is shown.

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

1.00 g of calcium carbonate is added to 50.0 cm^3 of 0.0500 mol / dm^3 hydrochloric acid.

Which volume of carbon dioxide is made in this reaction?

A 30 cm^3 **B** 60 cm^3 **C** 120 cm^3 **D** 240 cm^3

20 The formulae of two hydrated salts are shown.

- $CuSO_4 \cdot xH_2O$
- $CoCl_2 \cdot yH_2O$

What are the values of *x* and *y*?

	x	*y*
A	5	5
B	5	6
C	6	5
D	6	6

9 The concentration of a solution of aqueous sodium hydroxide is 0.50 mol / dm^3.

Which mass of sodium hydroxide is used to make 500 cm^3 of this solution?

A 10 g **B** 20 g **C** 40 g **D** 160 g

12 The value of the Avogadro constant is 6.02×10^{23}.

What is the total number of atoms in 2.00 mol of ammonia gas?

A 1.20×10^{24} **B** 2.41×10^{24} **C** 4.82×10^{24} **D** 2.89×10^{25}