

Week 7

IGCSE Chemistry

Homework bundle for this week

本周作业合集

exercises.lol

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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 $\text{Ar}(\text{H})=1$ and $\text{Ar}(\text{O})=16$, what is the Mr of water (H_2O)?

4. How many moles are in 36 g of water ($\text{Mr} = 18$)?

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

6. How many moles are in 4 g of hydrogen gas ($\text{Mr} = 2$)?

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 $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$, 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**

$$\text{moles} = 36 \div 18 = 2.$$

5. **72**

$$\text{volume} = 3 \times 24 = 72 \text{ dm}^3.$$

6. **2**

$$\text{moles} = 4 \div 2 = 2.$$

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 $\rightarrow$ products.

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 • ionic equation 离子方程式
• aqueous 水溶液

Objective

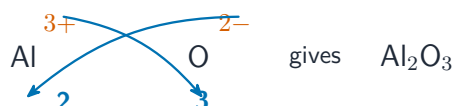
Build the skills to answer exam questions on **formulae** 化学式 — working out ionic formulae from charges, **balancing equations** 配平方程式, **state symbols** 状态符号, and **ionic equations** 离子方程式.

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)

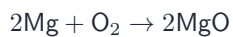
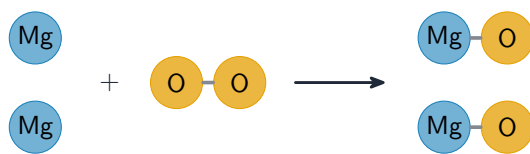
1 Worked examples

■ 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 Al₂O₃)



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): $\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l})$.

2 Practice

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

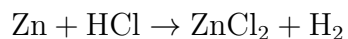
2.2 State what the symbol (*aq*) means. [1]

3 Exam-style questions

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

- **A** CaNO_3
- **B** $\text{Ca}(\text{NO}_3)_2$
- **C** Ca_2NO_3
- **D** $\text{Ca}_2(\text{NO}_3)_3$

3.2 Balance the equation, adding state symbols:



[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^- : $\text{Ca}(\text{NO}_3)_2$.

3.2 $\text{Zn}(s) + 2\text{HCl}(aq) \rightarrow \text{ZnCl}_2(aq) + \text{H}_2(g)$.

3.3 $\text{H}^+(aq) + \text{OH}^-(aq) \rightarrow \text{H}_2\text{O}(l)$; the spectator ions are Na^+ and Cl^- .

9 The molecular formulae of four compounds are listed.

- 1 CH₄
- 2 C₂H₆
- 3 C₃H₈
- 4 C₃H₆

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 ₂ O	CH ₂ O
B	CH ₂ O	C ₂ H ₄ O ₂
C	C ₃ H ₇ O ₃	C ₃ H ₇ O ₃
D	C ₃ H ₈ O	C ₃ H ₈ O

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 Cr₂(SO₄)₃?

	Cr	SO ₄
A	2+	3–
B	2–	3+
C	3+	2–
D	3–	2+

8 Three organic molecules are described.

- The molecular formula of propanoic acid is $\text{CH}_3\text{CH}_2\text{COOH}$.
- The molecular formula of lactic acid is $\text{CH}_3\text{CH}(\text{OH})\text{COOH}$.
- 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** $\text{Al} + \text{FeO} \rightarrow \text{AlO} + \text{Fe}$
- B** $2\text{Al} + \text{Fe}_2\text{O} \rightarrow \text{Al}_2\text{O} + 2\text{Fe}$
- C** $\text{Al} + \text{Fe}_2\text{O}_3 \rightarrow \text{Al}_2\text{O}_3 + \text{Fe}$
- D** $2\text{Al} + \text{Fe}_2\text{O}_3 \rightarrow \text{Al}_2\text{O}_3 + 2\text{Fe}$

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, $\text{Cu}(\text{SO}_4)_2$

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 CH₂O

C C₂HO₂

D C₃H₆O₃

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 mass 相对分子质量
 • relative masses 相对质量

Objective

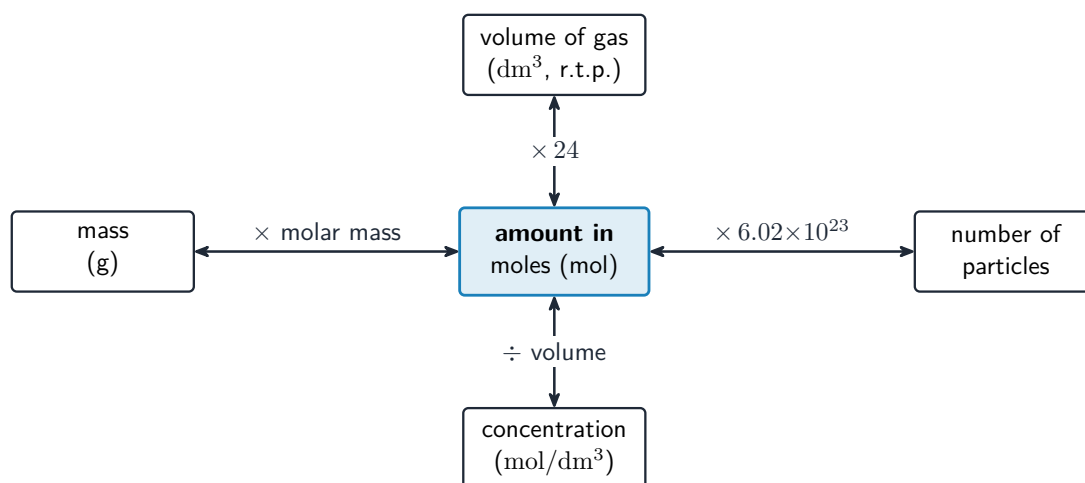
Build the skills to answer exam questions on **relative masses** 相对质量 — **relative atomic mass** 相对原子质量 (A_r), **relative molecular/formula mass** 相对分子/式量 (M_r), and reacting masses by simple proportion.

You must be able to:

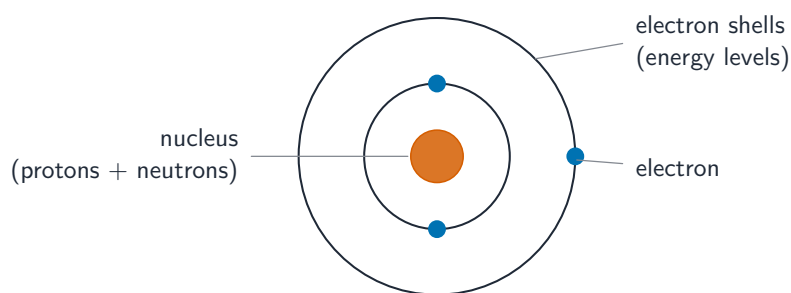
- state what A_r and M_r mean
- calculate M_r from a formula
- find a reacting mass by simple proportion

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

$$M_r(\text{H}_2\text{O}) = (2 \times 1) + 16 = 18.$$

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: 13 marks

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

Objective

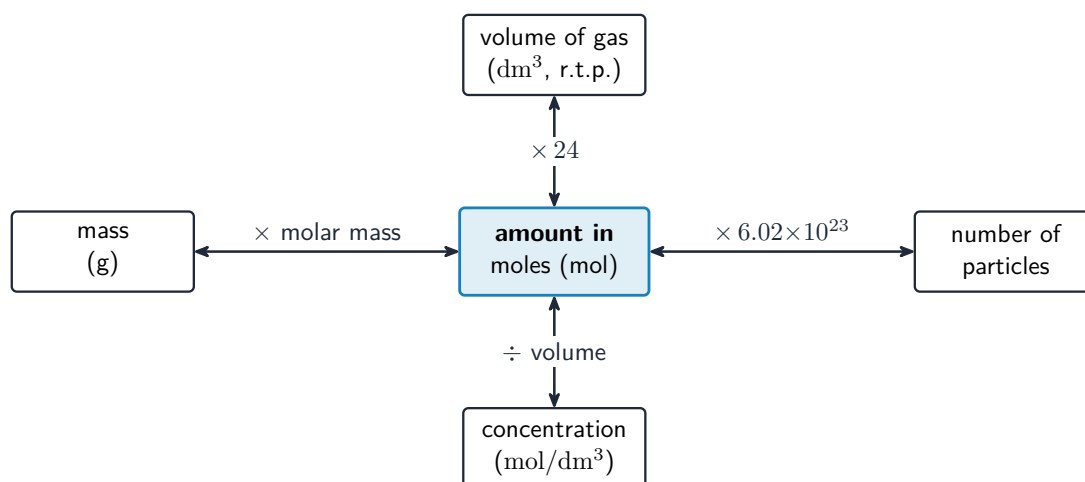
Build the skills to answer exam questions on **the mole** 摩尔 — $n = \frac{\text{mass}}{M_r}$, gas volumes, **concentration** 浓度, reaction calculations, and the **limiting reactant** 限量反应物.

You must be able to:

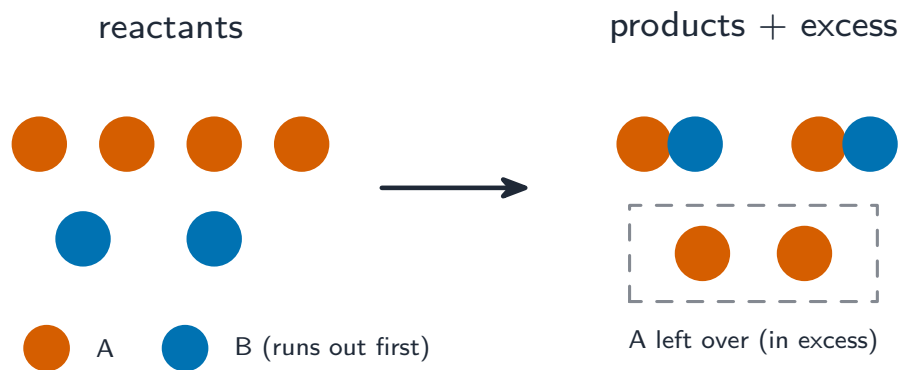
- use $n = \frac{\text{mass}}{M_r}$ and the molar gas volume (24 dm^3)
- use $c = \frac{n}{V}$ and do reacting-mass / titration calculations
- find the limiting reactant and an empirical formula

1 Worked examples

■ Mole calculations



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



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

36 g water: $n = \frac{36}{18} = 2 \text{ mol.}$

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]

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: $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$ (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.
 $\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}$.

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

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

Solutions

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

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

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

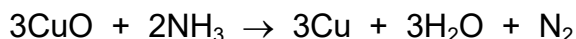
3.2 (a) $n = \frac{12}{24} = 0.50 \text{ mol.}$

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

3.3 (a) $n = 0.10 \times \frac{20.0}{1000} = 0.0020 \text{ mol.}$

(b) ratio 1 : 1, so 0.0020 mol NaOH in 25.0 cm^3 ; $c = \frac{0.0020}{25.0/1000} = 0.080 \text{ mol/dm}^3.$

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



[M_r : CuO, 80; NH₃, 17; H₂O, 18; N₂, 28]

[A_r : Cu, 64]

Which statements about this reaction are correct?

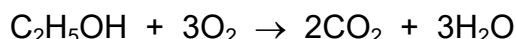
- 1 80.0 g of copper(II) oxide reacts exactly with 17.0 g of ammonia.
- 2 4.0 g of copper(II) oxide reacts with excess ammonia to produce 3.2 g of copper.
- 3 The mass of water produced in this reaction is greater than the mass of nitrogen.

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.



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.



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

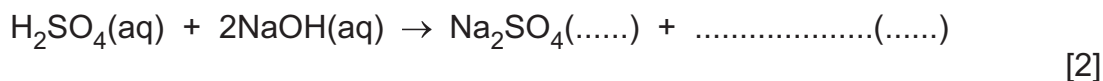
A 1.00×10^{22} **B** 1.20×10^{23} **C** 6.02×10^{22} **D** 6.02×10^{23}

- 3** A student makes crystals of the salt sodium sulfate, Na_2SO_4 . The student reacts 0.200 mol/dm^3 dilute sulfuric acid, $\text{H}_2\text{SO}_4(\text{aq})$, with aqueous sodium hydroxide, $\text{NaOH}(\text{aq})$.

The student uses the following steps.

- step 1** The student places 40.0 cm^3 of $\text{NaOH}(\text{aq})$ 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 $\text{NaOH}(\text{aq})$ in the conical flask.
- step 3** The student adds 0.200 mol/dm^3 $\text{H}_2\text{SO}_4(\text{aq})$ 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.



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

..... [1]

- (c)** Calculate the concentration of $\text{NaOH}(\text{aq})$ used in **step 1**.

concentration of $\text{NaOH}(\text{aq}) = \text{..... mol/dm}^3$ [1]

- (d)** Name the item of apparatus the student uses to add $\text{H}_2\text{SO}_4(\text{aq})$ in **step 3**.

..... [1]

- (e)** Calculate the volume of $\text{H}_2\text{SO}_4(\text{aq})$, in cm^3 , added in **step 3**.

volume of $\text{H}_2\text{SO}_4(\text{aq}) = \text{..... cm}^3$ [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, $\text{Na}_2\text{SO}_4(\text{aq})$, to aqueous barium chloride, $\text{BaCl}_2(\text{aq})$.

The student carries out the following steps.

- step 1** Dissolve 0.100 moles of solid BaCl_2 in 100cm^3 of distilled water in a beaker to form $\text{BaCl}_2(\text{aq})$.
- step 2** Add an aqueous solution which contains 0.100 moles of $\text{Na}_2\text{SO}_4(\text{aq})$ to the beaker containing the $\text{BaCl}_2(\text{aq})$ 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.



[2]

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

mass = g [2]

- (c) The concentration of $\text{Na}_2\text{SO}_4(\text{aq})$ in **step 2** is 1.25mol/dm^3 .

Calculate the volume, in cm^3 , of 1.25mol/dm^3 $\text{Na}_2\text{SO}_4(\text{aq})$ 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.



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.

- $\text{CuSO}_4 \cdot x\text{H}_2\text{O}$
- $\text{CoCl}_2 \cdot y\text{H}_2\text{O}$

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}