

2.1 Relative masses of atoms and molecules

Name: _____ Class: _____ Date: _____ **Total: 11 marks**

KEY WORDS relative atomic mass 相对原子质量 • unified atomic mass unit 统一原子质量单位
 • relative formula mass 相对式量 • relative molecular mass 相对分子质量 • isotope 同位素

Objective

Build the skills to answer exam questions on **relative masses of atoms and molecules** — the **unified atomic mass unit** 统一原子质量单位 and the relative masses A_r , M_r and relative formula mass.

You must be able to:

- define the unified atomic mass unit
- define relative atomic, isotopic, molecular and formula mass
- calculate A_r from isotopic abundances and M_r from a formula

1 Worked examples

■ The relative masses

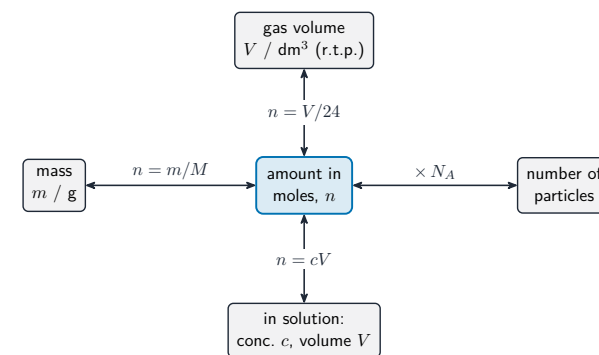
The **unified atomic mass unit** (u) is $\frac{1}{12}$ of the mass of a carbon-12 atom. Masses are then simple numbers relative to it.

- **relative atomic mass** A_r — the weighted average mass of an element's atoms, over all **isotopes** 同位素.
- **relative molecular mass** M_r — the sum of the A_r values of all atoms in a molecule.
- **relative formula mass** — the same, for an ionic compound.



$$A_r = \frac{(75 \times 35) + (25 \times 37)}{100} = 35.5$$

A_r is a weighted average: $75\% \text{ } ^{35}\text{Cl} + 25\% \text{ } ^{37}\text{Cl} \rightarrow A_r = 35.5$



Relative masses connect to amount in moles

■ Calculating M_r

For sulfuric acid, H_2SO_4 (A_r : H 1, S 32, O 16): $M_r = 2(1) + 32 + 4(16) = 98$.

2 Practice

2.1 Define relative atomic mass. [2]

2.2 Calculate the relative molecular mass of calcium carbonate, CaCO_3 (A_r : Ca 40, C 12, O 16). [1]

3 Exam-style questions

3.1 Why is the relative atomic mass of chlorine 35.5 and not a whole number? [1]

- **A** chlorine atoms are damaged
- **B** it is a weighted average of two isotopes
- **C** chlorine has half a neutron
- **D** the value is rounded

3.2 What is the relative formula mass of magnesium hydroxide, $\text{Mg}(\text{OH})_2$ (A_r : Mg 24, O 16, H 1)? [1]

- A 41
- B 49
- C 58
- D 74

3.3 Magnesium has three isotopes: ^{24}Mg (79%), ^{25}Mg (10%) and ^{26}Mg (11%).

(a) Calculate the relative atomic mass of magnesium to 1 decimal place. [3]

(b) Explain why this value is not a whole number. [1]

3.4 Calculate the relative molecular mass of ethanol, $\text{C}_2\text{H}_5\text{OH}$ (A_r : C 12, H 1, O 16). [2]

Solutions

2.1 the average mass of an element's atoms (over its isotopes) compared with $\frac{1}{12}$ of a carbon-12 atom.

2.2 $40 + 12 + 3(16) = 100$.

3.1 B. It is a weighted average of ^{35}Cl and ^{37}Cl .

3.2 C. $24 + 2(16 + 1) = 24 + 34 = 58$.

3.3 (a) $A_r = \frac{(24 \times 79) + (25 \times 10) + (26 \times 11)}{100} = \frac{2432}{100} = 24.3$.

(b) it is a weighted average of isotopes of different mass.

3.4 $2(12) + 6(1) + 16 = 24 + 6 + 16 = 46$.