

3.2 Relative masses of atoms and molecules

Name: _____ Class: _____ Date: _____

Total: 9 marks

KEY WORDS mass • relative atomic mass • relative formula mass
 • relative molecular/formula mass • relative masses

Objective

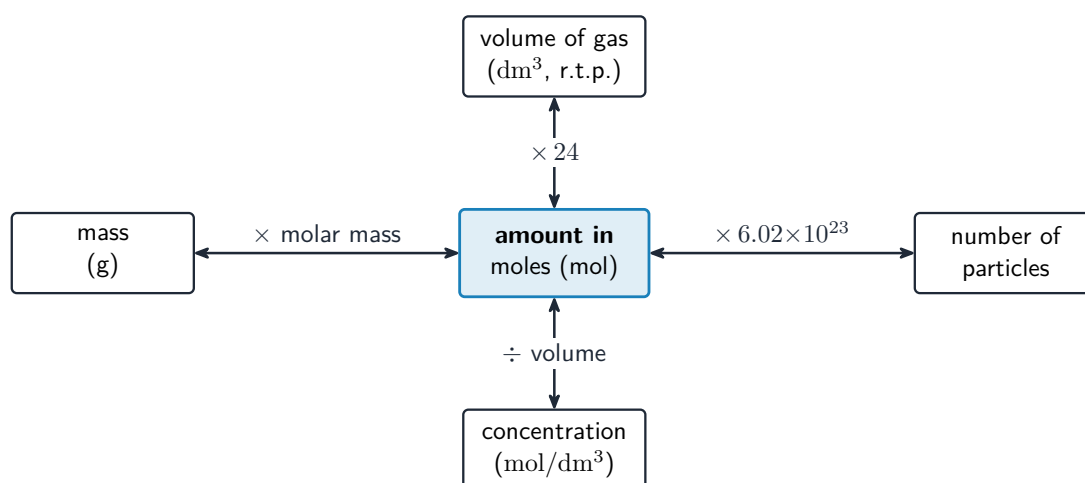
Build the skills to answer exam questions on **relative masses** – **relative atomic mass** (A_r), **relative molecular/formula mass** (M_r), and reacting masses by simple proportion.

You must be able to:

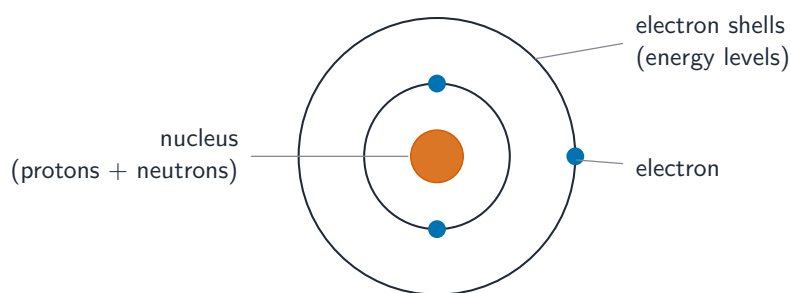
- state what A_r and M_r mean
- calculate M_r from a formula
- find a reacting mass by simple proportion

1 Key knowledge and 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]

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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

Each answer shows the steps, then the **result**.

2.1

- $M_r(\text{CO}_2) = 12 + (2 \times 16)$
- 44

2.2

- relative atomic mass is the **average mass of an atom** compared with $\frac{1}{12}$ the mass of a carbon-12 atom

3.1 C

- $M_r(\text{CaCO}_3) = 40 + 12 + (3 \times 16) = \mathbf{100}$
- A and B miss oxygen atoms; D overcounts

3.2

- $M_r(\text{NH}_4\text{NO}_3) = (2 \times 14) + (4 \times 1) + (3 \times 16)$
- $28 + 4 + 48 = \mathbf{80}$

3.3

(a)

- 12 g is $\frac{1}{4}$ of 48 g

$$m(\text{MgO}) = \frac{1}{4} \times 80 \text{ g} = \mathbf{20 \text{ g}}$$

(b)

- mass of oxygen $m_{\text{O}} = m_{\text{oxide}} - m_{\text{metal}} = 80 \text{ g} - 48 \text{ g} = \mathbf{32 \text{ g}}$