

Mass and the Mole - A 3rd Conversion Factor

atomic mass - found on the period table

- equals the mass in grams of 1 mole of an element

e.g. carbon 1 mol C = 12.01 g C

* Always round to 2 decimal places

molar mass - uses the periodic table

- equals the mass in grams of 1 mole of a compound

- add up the atomic masses of the elements in the compound

e.g. Calculate the molar mass for H₂O

$$M_{\text{H}_2\text{O}} = 2 (1.01 \text{ g/mol H}) + 1 (16.00 \text{ g/mol O})$$

$$= 18.02 \text{ g/mol H}_2\text{O}$$

$$1 \text{ mol H}_2\text{O} = 18.02 \text{ g c.f}$$

e.g. Calculate the molar mass for Mg(OH)₂

$$M_{\text{Mg(OH)}_2} = 1 (24.30 \text{ g/mol Mg}) + 2 (16.00 \text{ g/mol O}) + 2 (1.01 \text{ g/mol H})$$

$$= 58.32 \text{ g/mol Mg(OH)}_2$$

$$1 \text{ mol Mg(OH)}_2 = 58.32 \text{ g c.f}$$

e.g. How many moles of H₂O are present in 3.5 g of H₂O?

e.g. What is the mass in grams of 0.832 moles of $\text{Mg}(\text{ClO}_3)_2$?

e.g. How many molecules of H_2O are present in 24.9 g of H_2O ?

Per Cent Composition by Mass

- the fraction of a compound which is a certain element based on mass
- based on the Law of Constant Composition: elements combine in a definite proportion or ratio to form compounds

$$\% \text{ element} = \frac{\text{atomic mass of element}}{\text{molar mass of compound}} \times 100\%$$

e.g. Determine the per cent composition of hydrogen in water

$$\begin{aligned} M_{\text{H}_2\text{O}} &= 2 (1.01 \text{ g/mol H}) + 1 (16.00 \text{ g/mol O}) \\ &= 18.02 \text{ g/mol H}_2\text{O} \end{aligned}$$

$$\begin{aligned} \% \text{ H} &= \frac{2 \text{ mol H} (1.01 \text{ g/mol H})}{1 \text{ mol H}_2\text{O} (18.02 \text{ g/mol H}_2\text{O})} \times 100\% \\ &= 11.2 \% \end{aligned}$$

Note: There exist some compounds that retain water as part of their chemical formula when solutions of this compound evaporate. This water retained is in a specific ratio to the compound and can be driven off with heat. These compounds are called hydrates and a Latin prefix is used to show the number of water molecules associated with the compound.

e.g. cobalt (II) chloride dihydrate $\text{CuCl}_2 \cdot 2 \text{H}_2\text{O}$

e.g. Determine the per cent composition of water in $\text{CuCl}_2 \cdot 2 \text{H}_2\text{O}$

$$\begin{aligned} M_{\text{hydrate}} &= 1 (63.55 \text{ g/mol Cu}) + 2 (35.45 \text{ g/mol Cl}) + 2 (18.02 \text{ g/mol H}_2\text{O}) \\ &= 170.49 \text{ g/mol CuCl}_2 \cdot 2 \text{H}_2\text{O} \end{aligned}$$

$$\begin{aligned} \% \text{H}_2\text{O} &= \frac{2 (18.02 \text{ g/mol H}_2\text{O})}{170.49 \text{ g/mol CuCl}_2 \cdot 2 \text{H}_2\text{O}} \times 100\% \\ &= 21.1 \% \end{aligned}$$