

Chemistry 2.1

Quantitative Analysis

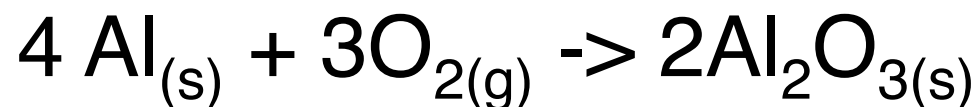
Chemical Calculation 2

Stoichiometry

- Stoichiometry is the determination of the numerical ratio of the mole relationships in a chemical reaction.
- Stoichiometry follows the basic principle of “matter cannot be created or destroyed”
- Using Stoichiometry, chemist can accurately estimate the amount of reactant required or the amount of product forms.

Example

- For reaction



The stoichiometry (ratio) between

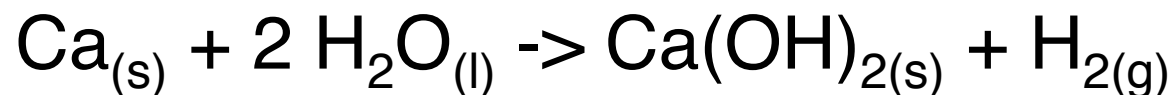
$$\text{Al} : \text{O}_2 = 4 : 3$$

$$\text{Al} : \text{Al}_2\text{O}_3 = 2 : 1$$

$$\text{O}_2 : \text{Al}_2\text{O}_3 = 3 : 2$$

Calculation example 1

Calculate the mass of water that will react completely with 4.0 g of pure calcium metal according to the following equation

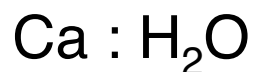


Step 1: calculate the mole of Ca

$$\text{g} \div \text{gmol}^{-1} = \text{mol}$$

$$4.0 \text{ g} \div 40.0 \text{ gmol}^{-1} = 0.1 \text{ mol}$$

Step 2: determine the ratio between



$$\text{Ca} : \text{H}_2\text{O} = 1 : 2$$

Step 3: determine the mole of H_2O by applying the ratio

$$2 \times 0.1 \text{ mol} = 0.2 \text{ mol}$$

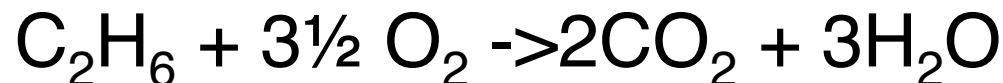
Step 4: calculate the mass of H_2O

$$\text{mol} \times \text{gmol}^{-1} = \text{g}$$

$$0.2 \text{ mol} \times 18.0 \text{ gmol}^{-1} = \underline{\underline{3.6 \text{ g}}}$$

Calculation example 2

Calculate the mass of CO₂ formed when 10.0 g of ethane is fully combusted

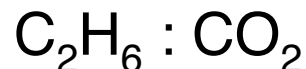


Step 1: calculate the mole of C₂H₆

$$\text{g} \div \text{g mol}^{-1} = \text{mol}$$

$$10.0\text{g} \div 30.0\text{g mol}^{-1} = 0.333\text{mol}$$

Step 2: determine the ratio between



$$\text{C}_2\text{H}_6 : \text{CO}_2 = 1 : 2$$

Step 3: determine the mole of CO₂ by applying the ratio

$$2 \times 0.33 \text{ mol} = 0.667 \text{ mol}$$

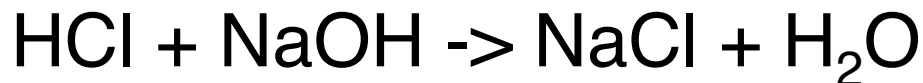
Step 4: calculate the mass of CO₂

$$\text{mol} \times \text{g mol}^{-1} = \text{g}$$

$$0.667 \text{ mol} \times 44 \text{ g mol}^{-1} = \underline{\underline{29.3 \text{ g}}}$$

Calculation example 3

Calculate the volume of 0.1 molL^{-1} of HCl is needed to react with 20.0mL of 0.0986 molL^{-1} of NaOH



Step 1: calculate the mole of NaOH

$$\text{molL}^{-1} \times \text{L} = \text{mol}$$

$$0.0986\text{molL}^{-1} \times 0.02\text{L} = 1.972 \times 10^{-3} \text{ mol}$$

Step 2: determine the ratio between



$$\text{HCl} : \text{NaOH} = 1 : 1$$

Step 3: determine the mole of HCl by applying the ratio

$$1.972 \times 10^{-3} \text{ mol}$$

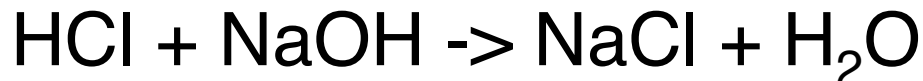
Step 4: calculate the volume

$$\text{mol} \div \text{molL}^{-1} = \text{L}$$

$$1.972 \times 10^{-3} \text{ mol} \div 0.1\text{molL}^{-1} = \underline{\underline{0.01972 \text{ L} = 19.7 \text{ mL (3s.f.)}}$$

Calculation example 4

Calculate the concentration of HCl when 20.7mL of 0.103 molL⁻¹ of NaOH is needed to react with 20.0 mL of HCl.



Step 1: calculate the mole of NaOH

$$\text{molL}^{-1} \times \text{L} = \text{mol}$$

$$0.103\text{molL}^{-1} \times 0.0207\text{L} = 2.1321 \times 10^{-3} \text{ mol}$$

Step 2: determine the ratio between



$$\text{HCl} : \text{NaOH} = 1 : 1$$

Step 3: determine the mole of HCl by applying the ratio

$$2.1321 \times 10^{-3} \text{ mol}$$

Step 4: calculate the volume

$$\text{mol} \div \text{L} = \text{molL}^{-1}$$

$$2.1321 \times 10^{-3} \text{ mol} \div 0.02 \text{ L} = \underline{\underline{0.107 \text{ molL}^{-1} (3\text{s.f.})}}$$