

Solution Stoichiometry & Titrations

$n = MV$ stoichiometry, acid-base and redox titrations, standards, purity, and gravimetric analysis.

01 Balance first

CORE RULE

A titration is stoichiometry in solution. Write and balance the reaction before any calculation.

02 $n = MV$

CORE RULE

Moles from a solution: $n = M \times V$ (V in litres). Rearrange: $V = n / M$. Use it wherever a mass-based path would use molar mass.

03 Titration vocabulary

REFERENCE

Titrant: known solution from the buret. **Analyte:** unknown being measured. **Equivalence point:** titrant volume delivering the exact stoichiometric amount (equal moles only for a 1:1 reaction). **Endpoint:** measured volume (indicator colour change). **Primary standard:** high-purity weighable solid (e.g. KHP).

04 KHP acid standard

CORE RULE

KHP ($\text{KHC}_8\text{H}_4\text{O}_4$, 204.22 g/mol) is a monoprotic solid acid that reacts 1:1 with NaOH; used to standardize base solutions.

05 Polyprotic neutralization

CORE RULE

Polyprotic acids neutralize stepwise (a separate equivalence point per proton). At complete neutralization: H_3PO_4 needs 3 NaOH; H_2SO_4 and $\text{H}_2\text{C}_2\text{O}_4$ each need 2 NaOH.

06 Unknown concentration

METHOD

mol titrant ($M \times V$) $\rightarrow$ mol analyte (stoichiometric factor) $\rightarrow$ divide by analyte volume: $M = n / V$.

07 Purity of a solid

METHOD

Titration $\rightarrow$ mass of pure analyte; percent purity = (mass analyte / total sample mass) $\times$ 100.

08 Redox titrations

REFERENCE

Titrant Balanced half-context (acidic)



09 Limiting reactant in solution

CORE RULE

Same as with pure substances, but moles come from $n = MV$. Compare each reactant's moles against the balanced ratio to find the limiting one.

10 Precipitation & gravimetric

METHOD

Identify the precipitate (solubility rules), find moles of each reactant, pick the limiting one, then compute precipitate mass.

Gravimetric: mass of precipitate $\rightarrow$ mol precipitate ($\div$ MM) $\rightarrow$ mol analyte (ratio) $\rightarrow$ mass analyte; mass % = (mass analyte / sample mass) $\times$ 100.

11 Hydrated reagents

WATCH OUT

For a hydrated base (e.g. $\text{LiOH} \cdot \text{H}_2\text{O}$), molar mass includes the water, but the stoichiometry uses the base formula, so one mole of hydrate gives one mole of LiOH.