3.2.6 Reactions of Ions in Aqueous Solution

★ A-LEVEL ONLY — not examined at AS level

3.2.6 *Reactions of aqua ions with OH■, NH■ and CO■²■. Amphoteric behaviour.*

Acidity: [M(H■O)■]³■ more acidic than [M(H■O)■]²■ (higher charge/size ratio polarises O–H bonds more).

With NaOH: Fe²■ → Fe(OH)■ green ppt (insoluble in excess). Fe³■ → Fe(OH)■ brown ppt (insoluble). Cu²■ → Cu(OH)■ blue ppt (insoluble). Al³■ → Al(OH)■ white ppt — dissolves in excess NaOH (amphoteric): Al(OH)■ + OH■ → [Al(OH)■]■.

With NH■: same initial precipitates. Cu(OH)■ dissolves in excess NH■ → deep blue [Cu(NH■)■(H■O)■]²■ (ligand exchange). Al(OH)■ and Fe hydroxides insoluble in excess NH■.

With Na■CO■: all form precipitates. M³■ ions also produce CO■ (CO■²■ acts as base due to acidity of [M(H■O)■]³■).

★ REQUIRED PRACTICAL RP11 **Test-Tube Reactions to Identify Transition Metal Ions in Aqueous Solution**

Method: Prepare ~2 cm³ solutions of FeSO■ (Fe²■), FeCl■ (Fe³■), CuSO■ (Cu²■), AlCl■ (Al³■).

With NaOH: add dropwise → observe precipitate colour. Add excess → record if dissolves. Fe²■: green (insoluble). Fe³■: brown (insoluble). Cu²■: blue (insoluble). Al³■: white (dissolves in excess — amphoteric).

With NH■: same initial ppts. Cu(OH)■ dissolves in excess → deep blue [Cu(NH■)■(H■O)■]²■. Fe and Al hydroxides remain.

With Na■CO■: all form ppts. M³■ ions also produce CO■ effervescence.

Common errors: cross-contamination; not adding sufficient excess; Fe²■ oxidising to Fe³■ in air (green → brown at surface).

Improvements: freshly prepared solutions; add reagent dropwise then in clear excess; white tile; record immediately.