

Qualitative analysis in chemistry focuses on identifying the chemical components present in a sample, rather than their quantity. It determines the presence or absence of specific elements, ions, compounds, or functional groups. In essence, it answers the question "what" is in the sample, not "how much".

Test for Cation

Cation	Reaction with NaOH (aq) (<i>strong alkali</i>)	Reaction with NH ₃ (aq) (<i>weak alkali</i>)
Copper (II) Cu²⁺	- Blue precipitate of Cu(OH) ₂ forms - Precipitate is insoluble in excess NaOH	- Blue precipitate of Cu(OH) ₂ forms - Precipitate dissolves in excess NH ₃ to give dark blue solution
Iron (II) Fe²⁺	- Green precipitate of Fe(OH) ₂ forms - Precipitate is insoluble in excess NaOH	- Green precipitate of Fe(OH) ₂ forms - Precipitate is insoluble in excess NH ₃
Iron (III) Fe³⁺	- Red-brown precipitate of Fe(OH) ₃ forms - Precipitate is insoluble in excess NaOH	- Red-brown precipitate of Fe(OH) ₃ forms - Precipitate is insoluble in excess NH ₃
Calcium Ca²⁺	- White precipitate of Ca(OH) ₂ forms - Precipitate is insoluble in excess NaOH	No visible reaction
Aluminium Al³⁺	- White precipitate of Al(OH) ₃ forms - Precipitate dissolves in excess NaOH to give colourless solution	- White precipitate of Al(OH) ₃ forms - Precipitate is insoluble in excess NH ₃
Zinc Zn²⁺	- White precipitate of Zn(OH) ₂ forms - Precipitate dissolves in excess NaOH to give colourless solution	- White precipitate of Zn(OH) ₂ forms - Precipitate dissolves in excess NH ₃ to give a colourless solution
Ammonium NH₄⁺	- Upon heating, ammonia gas produced turns moist red litmus paper blue	-

Test for Anion

Anion	Test	Observation + Ionic Equation
Carbonate CO_3^{2-}	Add dilute hydrochloric acid and bubble the gas through limewater (calcium hydroxide, $\text{Ca}(\text{OH})_2$)	Effervescence of colourless and odourless gas forms. When bubbled through limewater, a white precipitate of CaCO_3 is produced. $2\text{H}^+(\text{aq}) + \text{CO}_3^{2-}(\text{aq}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$
Sulfate SO_4^{2-}	Add dilute nitric acid, followed by aqueous barium nitrate	A white precipitate of barium sulfate is produced. $\text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{BaSO}_4(\text{s})$
Chloride Cl^-	Add dilute nitric acid, followed by aqueous silver nitrate	A white precipitate of silver chloride is produced. $\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$
Iodide I^-	Add dilute nitric acid, followed by aqueous silver nitrate	A yellow precipitate of silver iodide is produced. $\text{Ag}^+(\text{aq}) + \text{I}^-(\text{aq}) \rightarrow \text{AgI}(\text{s})$
Nitrate NO_3^-	Add aqueous sodium hydroxide, followed by aluminium foil. Warm the mixture.	Pungent ammonia gas is produced which turns moist red litmus paper blue . $\text{NH}_4^+ + \text{OH}^- \rightarrow \text{NH}_3 + \text{H}_2\text{O}$

Test for Gases

Gas	Colour and Odour	Test	Observation
Carbon dioxide CO₂	Colourless, odourless	Bubble the gas through limewater, Ca(OH) ₂	A white precipitate, CaCO ₃ , is produced
Ammonia NH₃	Colourless, pungent	Test with a piece of moist red litmus paper	Moist red litmus paper turns blue
Chlorine Cl₂	Yellow-green, pungent	Test with a piece of moist blue litmus paper	Blue litmus paper first turns red and then bleached
Hydrogen H₂	Colourless, odourless	Place a lighted splint near the gas	Gas extinguishes lighted splint with a “pop” sound
Oxygen O₂	Colourless, odourless	Place a glowing splint near the gas	Gas reignites glowing splint
Sulfur dioxide SO₂	Colourless, pungent	Bubble the gas through a solution of acidified potassium dichromate(VI), K ₂ Cr ₂ O ₇	Acidified potassium dichromate(VI) turns from orange to green
		Alternate: Bubble the gas through a solution of acidified potassium manganate(VII), KMnO ₄	Acidified potassium manganate(VII) turns from purple to colourless