



Chem!stry

Name: ()

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Identification of Gases

Gas	Observations
Ammonia, $\text{NH}_3(\text{g})$	Colourless. Pungent. Damp red litmus paper turns blue. White fumes of $\text{NH}_4\text{Cl}(\text{s})$ are observed when a glass rod dipped in concentrated hydrochloric acid is brought near the gas.
Chlorine, $\text{Cl}_2(\text{g})$	Pale green-yellow. Pungent. Damp blue litmus paper turns red and is then bleached white.
Water vapour, $\text{H}_2\text{O}(\text{g})$	Colourless. Odourless. Anhydrous copper(II) sulfate paper changes colour from white to blue. Anhydrous cobalt(II) chloride paper changes colour from blue to pink.
Sulphur dioxide, $\text{SO}_2(\text{g})$	Colourless. Pungent. Acidified potassium manganate(VII) changes colour from purple to colourless.
Carbon dioxide, $\text{CO}_2(\text{g})$	Colourless. Odourless. White precipitate of $\text{CaCO}_3(\text{s})$ forms when the gas is bubbled into limewater. Note: Colourless solution of $\text{Ca}(\text{HCO}_3)_2(\text{aq})$ formed if excess $\text{CO}_2(\text{g})$ is used.
Oxygen, $\text{O}_2(\text{g})$	Colourless. Odourless. Relights a glowing splint.
Hydrogen, $\text{H}_2(\text{g})$	Colourless. Odourless. Lighted splint is extinguished with a 'pop' sound.
Hydrogen chloride, $\text{HCl}(\text{g})$	Colourless. Pungent. Damp blue litmus paper turns red. White fumes of $\text{NH}_4\text{Cl}(\text{s})$ are observed when a glass rod dipped in aqueous ammonia is brought near the gas.

Identification of Cations Part #1 – Test-tube Reactions

Cation	Using aqueous sodium hydroxide – $\text{NaOH}(\text{aq})$	*Using aqueous ammonia – $\text{NH}_3(\text{aq})$
Aluminium cation, $\text{Al}^{3+}(\text{aq})$	White precipitate of $\text{Al}(\text{OH})_3(\text{s})$ – soluble in excess $\text{NaOH}(\text{aq})$ giving a colourless solution.	White precipitate of $\text{Al}(\text{OH})_3(\text{s})$ – insoluble in excess $\text{NH}_3(\text{aq})$.
Calcium cation, $\text{Ca}^{2+}(\text{aq})$	White precipitate of $\text{Ca}(\text{OH})_2(\text{s})$ – insoluble in excess $\text{NaOH}(\text{aq})$.	No observed reaction. No precipitate formed.
Zinc cation, $\text{Zn}^{2+}(\text{aq})$	White precipitate of $\text{Zn}(\text{OH})_2(\text{s})$ – soluble in excess $\text{NaOH}(\text{aq})$ giving a colourless solution.	White precipitate of $\text{Zn}(\text{OH})_2(\text{s})$ – soluble in excess $\text{NH}_3(\text{aq})$ giving a colourless solution.
Lead(II) cation, $\text{Pb}^{2+}(\text{aq})$	White precipitate of $\text{Pb}(\text{OH})_2(\text{s})$ – soluble in excess $\text{NaOH}(\text{aq})$ giving a colourless solution.	White precipitate of $\text{Pb}(\text{OH})_2(\text{s})$ – insoluble in excess $\text{NH}_3(\text{aq})$.
Iron(II) cation, $\text{Fe}^{2+}(\text{aq})$	Green precipitate of $\text{Fe}(\text{OH})_2(\text{s})$ – insoluble in excess $\text{NaOH}(\text{aq})$. Turns red-brown on standing.	Green precipitate of $\text{Fe}(\text{OH})_2(\text{s})$ – insoluble in excess $\text{NH}_3(\text{aq})$. Turns red-brown on standing.
Iron(III) cation, $\text{Fe}^{3+}(\text{aq})$	Red-brown precipitate of $\text{Fe}(\text{OH})_3(\text{s})$ – insoluble in excess $\text{NaOH}(\text{aq})$.	Red-brown precipitate of $\text{Fe}(\text{OH})_3(\text{s})$ – insoluble in excess $\text{NH}_3(\text{aq})$.
Copper(II) cation, $\text{Cu}^{2+}(\text{aq})$	Blue precipitate of $\text{Cu}(\text{OH})_2(\text{s})$ – insoluble in excess $\text{NaOH}(\text{aq})$.	Blue precipitate of $\text{Cu}(\text{OH})_2(\text{s})$ – soluble in excess $\text{NH}_3(\text{aq})$ to give a dark blue solution.
Ammonium cation, $\text{NH}_4^+(\text{aq})$	No precipitate – ammonia gas produced on warming (turns damp red litmus paper blue).	Test not applicable.

*Note: In balanced chemical equations, aqueous ammonia should be written as $\text{NH}_4\text{OH}(\text{aq})$, **not** $\text{NH}_3(\text{aq})$.

Identification of Cations Part #2 – Flame Tests

Cation	Observation
Sodium, Na ⁺	Yellow / orange flame colour.
Potassium, K ⁺	Lilac flame colour.
Calcium, Ca ²⁺	Brick red flame colour.
Barium, Ba ²⁺	Apple green flame colour.
Copper(II), Cu ²⁺	Green flame colour.

Identification of Anions

Anion	Observation
Carbonate, CO ₃ ²⁻ (aq)	Add dilute acid. Effervescence is observed. Carbon dioxide gas is produced (carbon dioxide gas produces a white precipitate of CaCO ₃ (s) when bubbled through limewater).
Chloride, Cl ⁻ (aq)	Add dilute nitric acid followed by dilute aqueous silver nitrate. A white precipitate of AgCl(s), which is soluble in aqueous ammonia, but insoluble in dilute nitric acid, confirms chloride ions. Note: Pb(NO ₃) ₂ can be used in place of AgNO ₃ . A white precipitate of PbCl ₂ (s) will be observed.
Iodide, I ⁻ (aq)	Add dilute nitric acid followed by dilute aqueous silver nitrate. A yellow precipitate of AgI(s), which is insoluble in aqueous ammonia and insoluble in dilute nitric acid confirms iodide ions. Note: Pb(NO ₃) ₂ can be used in place of AgNO ₃ . A yellow precipitate of PbI ₂ (s) will be observed.
Nitrate, NO ₃ ⁻ (aq)	Add aqueous sodium hydroxide followed by Al(s) or Zn(s) and warm the mixture. Ammonia gas is produced (turns damp red litmus paper blue). Note: Should exclude NH ₄ ⁺ before testing for NO ₃ ⁻ .
Sulfate, SO ₄ ²⁻ (aq)	Add dilute nitric acid followed by either dilute aqueous barium chloride or dilute aqueous barium nitrate. A white precipitate of BaSO ₄ (s) indicates the presence of sulfate ions.

Effect of Heat on a Solid

	Observation
Carbonate, CO ₃ ²⁻ (s)	Generally decompose on strong heating to produce the metal oxide and carbon dioxide gas. Carbon dioxide gas produces a white precipitate when bubbled through limewater.
Group 1 nitrate, NO ₃ ⁻ (s)	Decompose on strong heating to produce the Group 1 metal nitrite (e.g. NaNO ₂) and oxygen gas. Oxygen gas will relight a glowing splint.
Other nitrates, NO ₃ ⁻ (s)	Decompose on strong heating to produce metal or metal oxide, oxygen and nitrogen dioxide. Oxygen gas will relight a glowing splint. Nitrogen dioxide gas is reddish-brown in colour.
Ammonium salt, NH ₄ ⁺ (s)	Sublime on heating. White solid will be observed on the cooler regions of the test-tube.
Hydrated salt, X·H ₂ O(s)	Produces steam on strong heating. Steam will condense on the cooler regions of the test-tube. Water causes anhydrous cobalt(II) chloride paper to change colour from blue to pink.

Test for Oxidising Agents and Reducing Agents

	Observation
Oxidising agent	Add an aqueous solution of FeSO ₄ (aq). Colour changes from pale green to yellow / reddish-brown. Add an aqueous solution of KI(aq). Colour changes from colourless to brown – blue / black with starch.
Reducing agent	Add an acidified solution of KMnO ₄ (aq). Colour changes from purple to colourless. Add an acidified solution of K ₂ Cr ₂ O ₇ (aq). Colour changes from orange to green.

