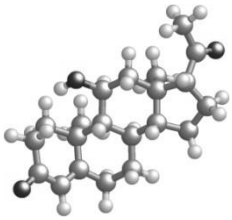

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Identification of Gases

Gas	Observations
Ammonia, NH_3(g)	Colourless. Pungent. Damp red litmus paper turns blue. White fumes of NH_4Cl(s) are observed when a glass rod dipped in concentrated hydrochloric acid is brought near the gas.
Chlorine, Cl_2(g)	Pale green-yellow. Pungent. Damp blue litmus paper turns red and is then bleached white.
Water vapour, H_2O(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, SO_2(g)	Colourless. Pungent. Acidified potassium manganate(VII) changes colour from purple to colourless.
Carbon dioxide, CO_2(g)	Colourless. Odourless. White precipitate of $CaCO_3$(s) forms when the gas is bubbled into limewater. **Note:** Colourless solution of $Ca(HCO_3)_2$(aq) formed if excess CO_2(g) is used.
Oxygen, O_2(g)	Colourless. Odourless. Relights a glowing splint.
Hydrogen, H_2(g)	Colourless. Odourless. Lighted splint is extinguished with a '*pop*' sound.
Hydrogen chloride, HCl(g)	Colourless. Pungent. Damp blue litmus paper turns red. White fumes of NH_4Cl(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 – NaOH(aq)	*Using aqueous ammonia – NH_3(aq)
Aluminium cation, Al^{3+}(aq)	White precipitate of $Al(OH)_3$(s) – soluble in excess NaOH(aq) giving a colourless solution.	White precipitate of $Al(OH)_3$(s) – insoluble in excess NH_3(aq).
Calcium cation, Ca^{2+}(aq)	White precipitate of $Ca(OH)_2$(s) – insoluble in excess NaOH(aq).	No observed reaction. No precipitate formed.
Zinc cation, Zn^{2+}(aq)	White precipitate of $Zn(OH)_2$(s) – soluble in excess NaOH(aq) giving a colourless solution.	White precipitate of $Zn(OH)_2$(s) – soluble in excess NH_3(aq) giving a colourless solution.
Lead(II) cation, Pb^{2+}(aq)	White precipitate of $Pb(OH)_2$(s) – soluble in excess NaOH(aq) giving a colourless solution.	White precipitate of $Pb(OH)_2$(s) – insoluble in excess NH_3(aq).
Iron(II) cation, Fe^{2+}(aq)	Green precipitate of $Fe(OH)_2$(s) – insoluble in excess NaOH(aq). Turns red-brown on standing.	Green precipitate of $Fe(OH)_2$(s) – insoluble in excess NH_3(aq). Turns red-brown on standing.
Iron(III) cation, Fe^{3+}(aq)	Red-brown precipitate of $Fe(OH)_3$(s) – insoluble in excess NaOH(aq).	Red-brown precipitate of $Fe(OH)_3$(s) – insoluble in excess NH_3(aq).
Copper(II) cation, Cu^{2+}(aq)	Blue precipitate of $Cu(OH)_2$(s) – insoluble in excess NaOH(aq).	Blue precipitate of $Cu(OH)_2$(s) – soluble in excess NH_3(aq) to give a dark blue solution.
Ammonium cation, NH_4^+(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 NH_4OH(aq), **not** NH_3(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 dilute aqueous barium nitrate. **Note:** Aqueous barium chloride can be used for some tests. 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, $X \cdot H_2O$(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 $K_2Cr_2O_7$(aq). Colour changes from orange to green.