

POLYATOMIC IONS

- Carbonate (CO_3^{-2}), Bicarbonate (HCO_3^{-1})
- Phosphate (PO_4^{-3}), Phosphite (PO_3^{-3})
- Sulphate (SO_4^{-2}), Sulphite (SO_3^{-2})
- Nitrate (NO_3^{-1}), Nitrite (NO_2^{-1})
- Ammonium (NH_4^{+1})
- Hydroxide (OH^{-1})

ACIDS (They produce H^{+1} ions when dissolved in water)

- Hydrochloric Acid (HCl)
- Nitric Acid (HNO_3), Nitrous Acid (HNO_2)
- Sulphuric Acid (H_2SO_4), Sulphurous Acid (H_2SO_3)
- Phosphoric Acid (H_3PO_4), Phosphorous Acid (H_3PO_3)
- Carbonic Acid (H_2CO_3)

BASES/ALKALIS

$\text{NH}_3/\text{NH}_4\text{OH}$, Metal Oxides and Metal Hydroxides are all Bases. Bases that dissolve in water are alkalis – All Gp1/ NH_4^+ Hydroxides are soluble and those lower down in GpII ($\text{Ba}(\text{OH})_2$, $\text{Sr}(\text{OH})_2$ & partially $\text{Ca}(\text{OH})_2$)

SOLUBILITY OF SALTS

- All nitrate/Gp1 and NH_4^+ compounds are soluble
- All sulphate salts are soluble except PbSO_4 , BaSO_4 & partially CaSO_4
- All carbonate and phosphate salts are insoluble except Group 1 and NH_4^{+1} salts
- Group 1 and NH_4^{+1} salts are all soluble
- All chlorides/bromides/iodides are soluble except Ag^{+1} , Pb^{+2} salts.
 - AgCl , PbCl_2 are white ppt soluble in dilute $\text{NH}_3(\text{aq})$
 - AgBr , PbBr_2 are cream ppt soluble in concentrated $\text{NH}_3(\text{aq})$
 - AgI , PbI_2 are yellow ppt insoluble in $\text{NH}_3(\text{aq})$

REACTIONS OF ACIDS/BASES

- Acid + Base \rightarrow Salt + water
- Acid + Metal carbonate \rightarrow Salt + Water + CO_2
- Acid + Metal \rightarrow Salt + H_2
- Acid + $\text{NH}_3 \rightarrow$ Ammonium Salt
- Ammonium Salt + Base/Alkali \rightarrow Salt + Ammonia + Water
- Metal Carbonate \rightarrow Metal Oxide + CO_2
- Metal Nitrate \rightarrow Metal Oxide + NO_2 + O_2 (For Metals other than Group1)
- Metal Nitrate \rightarrow Metal Nitrite + O_2 (For Group1 Metals)

PREPARATION OF SALTS**TITRATION:**

Soluble Reactants \rightarrow soluble Products

PRECIPITATION

Soluble Reactants \rightarrow Insoluble Products

EXCESS METHOD

Insoluble Reactants \rightarrow Soluble or Insoluble Product

INDICATOR COLORS**Methyl Orange**

- Red in Acid (below pH 4)
- Orange/Yellow in Alkali (above pH 4)

Phenolphthalein

- Pink in Alkali (Above pH 8)
- Colorless in Acid (Below pH 8)

Universal Indicator

- Strong Acid (Red), Weak Acid (Orange)
- Weak Alkali (Blue), Strong Alkali (Purple)
- Neutral (Green)

REACTIVITY SERIES/EASE OF DISCHARGE

(most reactive) K, Na, Ca, Mg, Al, (C), Zn, Fe, Sn, Pb, (H) Cu, Ag, Au, Pt (least reactive)

EASE OF DISCHARGE OF ANIONS

I^{-1} , Br^{-1} , OH^{-1} , Cl^{-1} , SO_4^{-2} , NO_3^{-1} etc (underlined ions get discharged when present in concentrated amount)

EXTRACTION OF IRON

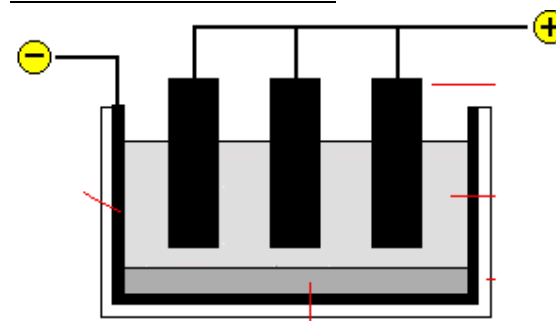
Iron Ore (Haematite) – Fe_2O_3 is reduced with Coke (Carbon) in blast furnace.

- $\text{Fe}_2\text{O}_3 + \text{C} \rightarrow \text{Fe} + \text{CO}_2$
- $\text{Fe}_2\text{O}_3 + \text{CO} \rightarrow \text{Fe} + \text{CO}_2$

Calcium Carbonate is added to the blast furnace to get rid of sand SiO_2

- $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$ (decomposes due to heat)
- $\text{CaO} + \text{SiO}_2 \rightarrow \text{CaSiO}_3$ (which forms slag)

Heat is produced in blast furnace when Coke (Carbon) combusts in hot air.

EXTRACTION OF ALUMINIUM

Bauxite is Al_2O_3 . Al_2O_3 is amphoteric and is dissolved in NaOH . Other metal oxides which are basic don't dissolve and are filtered out.

Cryolite Na_3AlF_6 is added to reduce melting point.

Graphite anode burns away ($\text{C} + \text{O}_2 \rightarrow \text{CO}_2$)

Cathode: $4\text{Al}^{+3} + 12\text{e}^- \rightarrow 4\text{Al}$

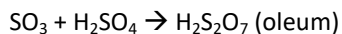
Anode: $6\text{C} \rightarrow 3\text{CO}_2 + 12\text{e}^-$

CONTACT PROCESS

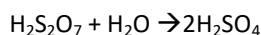
$\text{S} + \text{O}_2 \rightarrow \text{SO}_2$

$2\text{SO}_2 + \text{O}_2 \leftrightarrow 2\text{SO}_3$

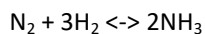
Conditions for the reversible reaction above: V_2O_5 catalyst, 450°C , 1-2 atm pressure



Oleum diluted in water to get H_2SO_4



HABER PROCESS



Conditions: 200 atm, 450°C, Iron Catalyst

DI-ATOMIC MOLECULES: H_2 , N_2 , O_2 , & Group VII (F_2 , Cl_2 , Br_2 , I_2)

ACIDIC/BASIC/NEUTRAL GASES

Acidic: CO_2 , P_2O_5 , NO_2 , SO_2 , SO_3

Neutral: H_2 , O_2 , N_2 , CO , NO

Basic: NH_3

Amphoteric: ZnO , Al_2O_3 , PbO

OXIDATION STATES (OS)

- Free element is "0" e.g. Na , O_2 , I_2 etc

Elements present in compounds

- Group 1 is +1, Group 2 is +2, Group 3 is +3,
- Transition Metals have Variable OS.
- Oxygen is -2
- Hydrogen is +1
- Group 7 is -1 except when bonded to Oxygen

OXIDIZING/REDUCING AGENTS

Strong Oxidizing Agents:

- Potassium di Chromate $\text{K}_2\text{Cr}_2\text{O}_7$ (orange). Turns green when reduced.
- Potassium Manganate KMnO_4 (purple). Turns colorless when reduced.

Strong Reducing Agents:

- SO_2 is a strong reducing agent, Gets oxidized to SO_3 (SO_2 is a bleaching Agent, and a Food Preservative)
- I^- iodide is a strong reducing agents. Gets oxidized to I_2 iodine.

ORGANIC CHEMISTRY

- Free Radical Substitution of Alkanes (UV light required) $\text{CH}_4 + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{HCl}$
- Cracking of Alkanes (400°C, Al_2O_3)
- Bromination of Alkenes (alkenes decolorize bromine) $\text{CH}_2=\text{CH}_2 + \text{Br}_2 \rightarrow \text{CH}_2\text{BrCH}_2\text{Br}$
- Hydration of Alkenes (H_3PO_4 catalyst, 300°C, 60 atm pressure): Alcohol is formed
- Hydrogenation of Alkenes (Nickel catalyst, 200°C) (Vegetable Oil to Margarine)
- Alcohols get oxidized to Carboxylic Acids
 - Reagents: Reflux + Oxidizing Agent ($\text{K}_2\text{Cr}_2\text{O}_7$ Orange to Green, or KMnO_4 Purple to Colorless)
- Alcohol + Carboxylic Acid \rightarrow Ester + H_2O
 - Reflux and Few drops of concentrated H_2SO_4
 - Esters are Sweet smelling compounds
- Addition Polymer (Monomers(Alkene) at high T°C and Pressure) e.g. Polyethene, Plastics
- Condensation Polymer

- Polyamide (Nylon):** (di)Carboxylic Acid + (di)Ammine \rightarrow Polyamide(e.g. Nylon) + H_2O
- Polyamide (Proteins):** Amino Acid + Amino Acid \rightarrow Polyamide + H_2O
- Polyester:** (di)Carboxylic Acid + (di)Alcohol \rightarrow Polyester (e.g. Fats, Terylene) + H_2O
- Glucose + Glucose \rightarrow Starch + H_2O

COLOR OF COMPOUNDS

CuO (black), PbO (yellow), Group 1, 2 and 3 are generally white. Anhydrous CuSO_4 is white. Hydrated $\text{CuSO}_4 \cdot x\text{H}_2\text{O}$ is blue. $\text{CuSO}_4(\text{aq})$ is blue solution. Fe_2O_3 is red. Cl_2 is greenish gas, Br_2 is red brown liquid, I_2 is blue black solid. $\text{AgCl}/\text{PbCl}_2$ is white, $\text{AgBr}/\text{PbBr}_2$ is cream, AgI/PbI_2 is yellow. Hydrated CoCl_2 is pink, Anhydrous CoCl_2 is blue.

SOME NAMES OF COMPOUNDS

Lime – $\text{Ca}(\text{OH})_2$, Limestone – CaCO_3

TEST OF CATIONS

- NH_4^+ : Ammonia gas released with NaOH (aq)
- Fe^{+2} : insoluble green ppt with both excess NaOH (aq) and NH_3 (aq)
- Fe^{+3} : insoluble red/brown ppt with both excess NaOH (aq) and NH_3 (aq)
- Ca^{+2} : white ppt with NaOH (aq) insoluble in excess. No or slight ppt with NH_3 (aq)
- Cu^{+2} : Pale blue ppt with NaOH (aq) insoluble in excess. Pale blue ppt with NH_3 (aq) soluble in excess, giving a deep blue solution
- Al^{+3} : White ppt with both NaOH (aq) and NH_3 (aq) but only soluble in excess NaOH (aq)
- Zn^{+2} : White ppt, soluble in excess with both NaOH (aq) and NH_3 (aq).

TEST FOR ANIONS

- CO_3^{-2} : CO_2 gas produced (effervescence) with aqueous Acid
- Cl^- : Acidify with dilute aqueous nitric acid and add with Ag^+ or Pb^{+2} . White ppt produced.
- I^- : Acidify with dilute aqueous nitric acid and add with Ag^+ or Pb^{+2} . Yellow ppt produced.
- NO_3^- : Add Aluminium foil/powder + NaOH and heat. Ammonia gas is given off
- SO_4^{-2} : Acidify with nitric acid and add Ba^{+2} . White ppt produced

TEST FOR GASES

- CO_2 : Turns lime water ($\text{Ca}(\text{OH})_2$) milky
- NH_3 : Turns damp red litmus paper blue
- H_2 : Pop sound produced when ignited
- O_2 : Relights a glowing splint
- Cl_2 : Bleaches damp litmus paper
- SO_2 : Turns acidified potassium dichromate (VI) from orange to green