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}), Mangnate(VII) MnO_4^{-1})
- Hydroxide (OH^{-1}), Dichromate(VI) ($Cr_2O_7^{-2}$)
- Hydrogensulfate (HSO_4^{-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

NH_3/NH_4OH, 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 ($Ba(OH)_2$, $Sr(OH)_2$ & partially $Ca(OH)_2$)

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 NH_3(aq)
  - AgBr, $PbBr_2$ are cream ppt soluble in concentrated NH_3(aq)
  - AgI, PbI_2 are yellow ppt insoluble in NH_3(aq)

REACTIONS OF ACIDS/BASES

- Acid + Base -> Salt + water
- Acid + Metal carbonate -> Salt + Water + CO_2
- Acid + Metal -> Salt + H_2
- Acid + NH_3 -> Ammonium Salt
- Ammonium Salt + Base/Alkali -> Salt + Ammonia + Water
- Metal Carbonate → Metal Oxide + CO_2
- Metal Nitrate → Metal Oxide + NO_2 + O_2 (For Metals other than Group1)
- Metal Nitrate → Metal Nitrite + O_2 (For Group1 Metals)

PREPARATION OF SALTS

TITRATION:

Soluble Reactants → soluble Products

PRECIPITATION

Soluble Reactants → Insoluble Products

EXCESS METHOD

Insoluble Reactants → Soluble or Insoluble Product

INDICATOR COLORS

Methyl Orange

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

Phenolpthalein

- 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.

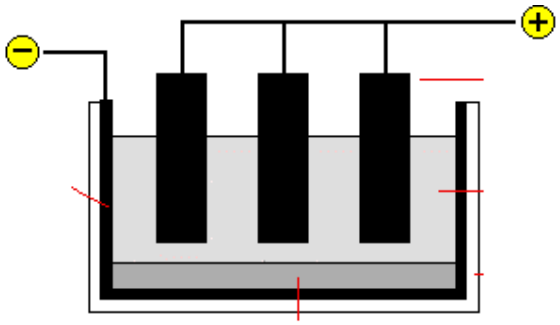
- Fe_2O_3 + C -> Fe + CO_2
- Fe_2O_3 + CO -> Fe + CO_2

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

- $CaCO_3$ -> CaO + CO_2 (decomposes due to heat)
- CaO + SiO_2 -> $CaSiO_3$ (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 (C+O_2->CO_2)

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

Anode: $6O^{-2} \rightarrow 3O_2 + 12e$

CONTACT PROCESS

$S + O_2 \rightarrow SO_2$

$2SO_2 + O_2 \leftrightarrow 2SO_3$

Conditions for the reversible reaction above: V_2O_5 catalyst, 450^0 C, 1-2 atm pressure

$SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$ (oleum)

Oleum diluted in water to get H_2SO_4

$H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$

HABER PROCESS

$N_2 + 3H_2 <-> 2NH_3$

Conditions: 200 atm, 450^0C, 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 $K_2Cr_2O_7$ (orange). Turns green when reduced.
- Potassium Mangnate $KMnO_4$ (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^{-1} iodide is a strong reducing agents. Gets oxidized to I_2 iodine.

ORGANIC CHEMISTRY

- Free Radical Substitution of Alkanes (UV light required) $CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$
- Cracking of Alkanes (400^oC, Al_2O_3)
- Bromination of Alkenes (alkenes decolourize bromine) $CH_2=CH_2 + Br_2 \rightarrow CH_2BrCH_2Br$
- Hydration of Alkenes (H_3PO_4 catalyst, 300^0C, 60 atm pressure): Alcohol is formed
- Hydrogenation of Alkenes (Nickel catalyst, 200^0C) (Vegetable Oil to Margarine)
- Alcohols get oxidized to Carboxylic Acids
  - Reagents: Reflux + Oxidizing Agent ($K_2Cr_2O_7$ Orange to Green, or $KMnO_4$ Purple to Colorless)
- Alcohol + Carboxylic Acid → Ester + H_2O
  - Reflux and Few drops of concentrated H_2SO_4
  - Esters are Sweet smelling compounds
- Addition Polymer (Monomers(Alkene) at high T^{0}C and Pressure) e.g. Polyethene, Plastics
- Condensation Polymer
  - **Polyamide (Nylon):** (di)Carboxylic Acid + (di)Ammine → Polyamide(e.g. Nylon) + H_2O
  - **Polyamide (Proteins):** Amino Acid + Amino Acid → Polyamide + H_2O
  - **Polyester:** (di)Carboxylic Acid + (di)Alcohol → Polyester (e.g. Fats, Terylene) + H_2O
  - Glucose + Glucose → Starch + H_2O

COLOR OF COMPOUNDS

CuO (black), PbO (yellow), Group1, 2 and 3 are generally white. Anhydrous $CuSO_4$ is white. Hydrous $CuSO_4.xH_2O$ is blue. $CuSO_4$(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. AgCl/$PbCl_2$ is white, AgBr/$PbBr_2$ is cream, AgI/PbI_2 is yellow. Hydrous $CoCl_2$ is pink, Anhydrous $CoCl_2$ is blue.

SOME NAMES OF COMPOUNDS

Lime – $Ca(OH)_2$, Limestone – $CaCO_3$

TEST OF CATIONS

- **NH_4^{+1}:** 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^{-1}:** Acidify with dilute aqueous nitric acid and add with Ag^{+1} or Pb^{+2}. White ppt produced.
- **I^{-1}:** Acidify with dilute aqueous nitric acid and add with Ag^{+1} or Pb^{+2}. Yellow ppt produced.
- **NO_3^{-1}:** 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 ($Ca(OH)_2$) 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