# CLASS 11 CHEMISTRY Chapter 10 s- Block Elements

s-block elements consists of group-I (Alkali metals) and group-2 (Alkalineearth metals).

- Group 1st elements — Li, Na, K, Rb, Cs, Fr.
- Group 2nd elements — Be, Mg, Ca, Sr, Ba, Ra.

The group 1 elements have $ns^1$ electronic configuration and are highly reactive metals.

| Element | Symbol | Electronic configuration |
|---|---|---|
| Lithium | Li | $1s^2 2s^1$ |
| Sodium | Na | $1s^2 2s^2 2p^6 3s^1$ |
| Potassium | K | $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$ |
| Rubidium | Rb | $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 5s^1$ |
| Caesium | Cs | $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$ $4p^6 4d^{10} 5s^2 5p^6 6s^1$ or [Xe] $6s^1$ |
| Francium | Fr | [Rn]$7s^1$ |

## Physical Properties

- **Atomic radius:** Atomic radius of alkali metals are greater than alkaline earth metals.
- **Hydration enthalpy:** Decreases with increases in ionic sizes.
- **Ionic mobility:** Smaller the size of ion, more highly it is hydrated and hence lower is its ionic mobility.

  $Li^+ < Na^+ < K^+ < Rb^+ < Cs^+$

- **Ionization enthalpies:** 1st I.E. of group 1st is smaller than group 2nd elements but 2nd I.E. of group 2nd is smaller than group 1st elements.
- **Oxidation States:** Alkali metal show +1 oxidation state and alkaline earth metal exibit +2.

- **Flame coloration:** Due to low I.E., *s*-block elements and their salts imparts characteristics color of oxidizing flame (except Be and Mg). Be and Mg do not show flame coloration because they have small size and very high ionization enthalpy.

- **Reactivity:** the reactivity of alkali metals and alkaline earth metals goes on increasing down the group which means from Li to Cs and Be to Ra.

- **Density:** Alkali metals have large size which accounts for their low density. Atomic weight increases from Li to Cs in the group and volume also increases but increase in atomic weight is more than increase in volume. Thus, density increases from Li to Cs. The size of group 2 elements are smaller then those of group 1 elements. Density increases from Be to Ra.

- **Reducing character:** Due to large negative electrode potentials alkali metals are stronger reducing agent than alkaline earth metal.

- **Reactivity towards air:**

  $4Li + O_2 \longrightarrow 2Li_2O$ (Lithium oxide)

  $2Na + O_2 \longrightarrow Na_2O_2$ (Sodium peroxide)

  $M + O_2 \longrightarrow MO_2$ (M = K, Rb, Cs metal superoxide)

  Alkaline earth metals being smaller in size do not from superoxides.

- **Reactivity towards $H_2O$:**

  $2M + 2H_2O \longrightarrow 2MOH + H_2$

  (Alkali metal)

  $M + 2H_2O \longrightarrow M(OH)_2 + H_2$

  (Alkaline earth metals)

- **Reactivity towards hydrogen:**

  $2M + H_2 \longrightarrow 2MH$ (M = Li, Na, K, Rb, Cs)

$$M + H_2 \longrightarrow MH_2 \qquad (M = Mg, Ca, Sr, Ba)$$

$$2BeCl_2 + LiAlH_4 \longrightarrow 2BeH_2 + LiCl + AlCl_3.$$

- **Reactivity towards halogens:**

  $$2M + X_2 \longrightarrow 2MX \ (M = Li, Na, K, Rb, Cs)$$

  $$M + X_2 \longrightarrow MX_2 \ (M = Mg, Ca, Sr, Ba)$$

  $$BeO + C + Cl_2 \xrightleftharpoons{600\text{-}800\ K} BeCl_2 + CO$$

- **Solution in liquid ammonia:** The fresh solution of alkali metals and alkaline earth metals (except Be and Mg) is deep blue, paramagnetic and highly reducing due to presence of ammoniated electrons.

- **Solubility of alkaline earth metal carbonate in water:**

  $$Li_2CO_3 < Na_2CO_3 < K_2CO_3 < RbCO_3 < Cs_2CO_3$$

- **Solubility of alkaline earth metal carbonates in water.**

  $$BaCO_3 < SrCO_3 < CaCO_3 < MgCO_3 < BeCO_3$$

- **Solubility of alkaline earth metal sulphates in water:**

  $$BaSO_4 < SrSO_4 < CaSO_4 < MgSO_4 < BeSO_4$$

- **Thermal stability of alkali metal carbonates:**

  $$Li_2CO_3 < Na_2CO_3 < K_2CO_3 < Rb_2CO_3 < Cs_2CO_3$$

- **Thermal stability of alkaline earth metal carbonates:**

  $$BeCO_3 < MgCO_3 < CaCO_3 < SrCO_3 < BaCO_3$$

- **Anamolous behavior of Li and B :** It is due to very small size, high I.E. and high polarizing power (*i.e.*, charge/radius)

- **Diagonal relationship (similarities) between Li and Mg:**

  (i) Both Li and Mg are hard.

  (ii) Both react with $N_2$ to form nitrides.

  $6Li + N_2 \longrightarrow 2Li_3N$

  $3Mg + N_2 \longrightarrow Mg_3N_2$

  (iii) Decomposition of carbonates:

  $Li_2CO_3 \longrightarrow Li_2O + CO_2$

  $MgCO_3 \xrightarrow{\Delta} MgO + CO_2$

  (iv) Both LiCl and $MgCl_2$ are deliquescent. They form hydrates salts $LiCl.2H_2O$ and $MgCl_2.6H_2O$.

  (v) Decomposition of nitrates:

  $4LiNO_3 \xrightarrow{\Delta} 2Li_2O + 4NO_2 + O_2$

  $2Mg(NO_3)_2 \xrightarrow{\Delta} 2MgO + 4NO_2 + O_2$

- **Diagonal relationship (similarities) between Be and Al:**

  (i) Both are passive to acids due to formation of oxide layer.

  (ii) Hydroxides of both dissolve in alkali to form $[Be(OH)_4]^{2-}$ and $[Al(OH)_4]^{-}$.

  (iii) Chloride of both has bridged structure.

  (iv) Both have tendency to form complexes of $BeF_4^{2-}$, $AlF_6^{3-}$.

- **Manufacturing of washing soda ($Na_2CO_3.10H_2O$):Solvay process:**

$NH_3(g) + CO_2(g) + H_2O\ (l) \longrightarrow NH_4HCO_3\ (aq)$

$NH_4HCO_3\ (aq) + NaCl\ (aq) \longrightarrow NaHCO_3(s) + NH_4Cl\ (aq)$

$2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + H_2O(l) + CO_2(g)$

$2NH_4Cl\ (aq) + Ca(OH)_2 \rightarrow CaCl_2(s) + 2H_2O(l) + 2NH_3\ (g)$

- **Manufacturing of caustic soda (NaOH):** Castner-Kellner cell.

**Cathode:** $Na^+ + e^- \xrightarrow{Hg} Na\text{-}Hg$

**Anode:** $Cl^- \longrightarrow \frac{1}{2}Cl_2 + e^-$

$2Na\text{-}Hg + 2H_2O \longrightarrow 2NaOH + 2Hg + H_2$

- **Plaster of paris:** ($CaSO_4.½H_2O$)

$\underset{\text{Gypsum}}{2(CaSO_4.2H_2O)} \xrightarrow[393K]{\Delta} 2(CaSO_4).H_2O + 3H_2O$

## Uses of Alkali Metals

(i) Lithium metal is used to make useful alloys, for example with lead to make 'white metal' bearings for motor engines, with aluminium to make aircraft parts, and with magnesium to make armour plates. It is used in thermonuclear reactions. Lithium is also used to make electrochemical cells.

(ii) Sodium is used to make a Na/Pb alloy needed to make PbEt4 and PbMe4. These organo-lead compounds were earlier used as anti-knock additives to petrol, but nowadays lead-free petrol is used in vehicles. Liquid sodium metal is used as a coolant in fast breeder nuclear reactors.

(iii) Potassium has a vital role in biological systems. Potassium chloride is used as a fertilizer. Potassium hydroxide is used in the manufacture of soft soap. It is also used as an excellent absorbent of carbon dioxide.

(iv) Caesium is used in devising photoelectric cells

## Uses of Alkaline Earth Metals

(i) Beryllium is used in the manufacture of alloys. Copper -beryllium alloys are used in the preparation of high strength springs.

(ii) Metallic beryllium is used for making windows of X-ray tubes.

(iii) Magnesium forms alloys with aluminium, zinc, manganese and tin. Magnesium-aluminium alloys being light in mass are used in air-craft construction.

(iv) A suspension of magnesium hydroxide in water (called milk of magnesia) is used as antacid in medicine. Magnesium carbonate is an ingredient of toothpaste.

(v) Calcium is used in the extraction of metals from oxides which are difficult to reduce with carbon. Calcium and barium metals, owing to their reactivity with oxygen and nitrogen at elevated temperatures, have often been used to remove air from vacuum tubes. Radium salts are used in radiotherapy