

CLASS 11 CHEMISTRY Chapter 10 s- Block Elements

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



- **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 exhibit +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 than 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:**

$$4\text{Li} + \text{O}_2 \longrightarrow 2\text{Li}_2\text{O} \text{ (Lithium oxide)}$$

$$2\text{Na} + \text{O}_2 \longrightarrow \text{Na}_2\text{O}_2 \text{ (Sodium peroxide)}$$

$$\text{M} + \text{O}_2 \longrightarrow \text{MO}_2 \text{ (M = K, Rb, Cs metal superoxide)}$$

Alkaline earth metals being smaller in size do not form superoxides.
- **Reactivity towards H₂O:**

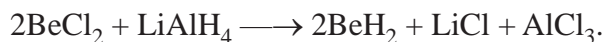
$$2\text{M} + 2\text{H}_2\text{O} \longrightarrow 2\text{MOH} + \text{H}_2$$

(Alkali metal)

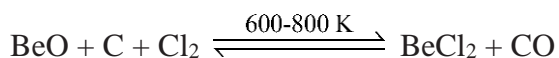
$$\text{M} + 2\text{H}_2\text{O} \longrightarrow \text{M(OH)}_2 + \text{H}_2$$

(Alkaline earth metals)
- **Reactivity towards hydrogen:**

$$2\text{M} + \text{H}_2 \longrightarrow 2\text{MH} \quad (\text{M} = \text{Li, Na, K, Rb, Cs})$$



- **Reactivity towards halogens:**



- **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:**



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



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



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



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

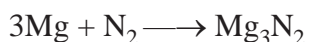


- **Anomalous behavior of Li and B :** It is due to very small size, high I.E. and high polarizing power (*i.e.*, charge/radius)

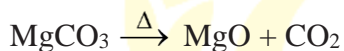
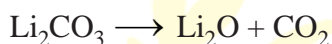
- **Diagonal relationship (similarities) between Li and Mg:**

(i) Both Li and Mg are hard.

(ii) Both react with N_2 to form nitrides.



(iii) Decomposition of carbonates:



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

(v) Decomposition of nitrates:



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

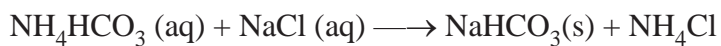
(i) Both are passive to acids due to formation of oxide layer.

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

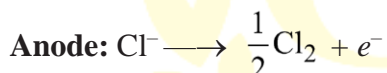
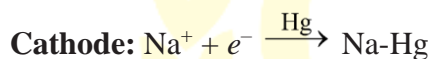
(iii) Chloride of both has bridged structure.

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

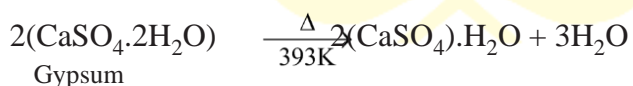
- **Manufacturing of washing soda**
($\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$): Solvay process:



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



- **Plaster of paris:** ($\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$)



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 PbEt_4 and PbMe_4 . 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

