

S-BLOCK ELEMENTS

INTRODUCTION

The s-block elements of the Periodic Table are those in which the last electron enters the outermost s-orbital. As the s-orbital can accommodate only two electrons, two groups (1 & 2) belong to the s-block of the Periodic Table.

IA - Alkali metals Li Na K Rb Cs

IIA - Alkaline earth metals Be Mg Ca Sr Ba

PHYSICAL PROPERTIES OF S-BLOCK ELEMENTS

The atomic, physical and chemical properties of alkali metals are discussed below.

PHYSICAL STATE

ALKALI METAL

- One electron in outermost shell & **General electronic configuration is ns^1** .
- Francium is radioactive element.
- All are silvery white
- Light soft, malleable and ductile metals with metallic lustre.
- Alkali metals are paramagnetic, while their ions are diamagnetic and colourless.

ALKALINE EARTH METAL

- Two electrons in outer most shell & **General configuration is ns^2** .
- Radium is radioactive element.
- All are greyish white.
- These metals are harder than alkali metals.
- These are diamagnetic and colourless in form of ions or in metal states.

ATOMIC SIZE

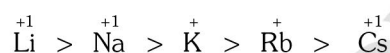
- Biggest in their respective period (except noble gas element)
- Size increases from Li to Fr due to addition of an extra shell.

- Smaller than IA group elements, since extra charge on nucleus attracts the electron cloud more.
- Size increases gradually from Be to Ra
Be < Mg < Ca < Sr < Ba

in atomic and gaseous state



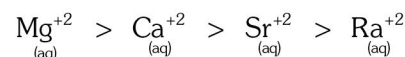
in aquatic state



In s-block elements

Be is the smallest, Cs is the biggest

in aq. state



SOFTNESS

- Alkali metals are soft because of -
(a) Large atomic size
(b) BCC crystal structure (HCP in Li)
(c) Loose packing (68% packing efficiency)
(d) Weak metallic bond
- Cs is the softest metal in s-block

- These metals are slightly harder than IA group because of -
(a) Smaller atomic size
(b) FCC, HCP crystal structures
(c) Packing capacity 74%
(d) Stronger metallic bond due to presence of two electrons in valence shell.
- Be is the hardest metal in s-block.

MELTING POINT AND BOILING POINT

- Decreasing order of melting point and boiling point is
Li > Na > K > Rb > Cs

- Metallic bond is stronger than IA group elements due to smaller atomic size and two electrons in valence shell hence melting point and boiling point are higher.
- Decreasing order of melting point and boiling point is
Be > Ca > Sr > Ba > Mg

Melting & Boiling point \propto Strength of metallic bond

IONISATION POTENTIAL (I.P.)

- Decreasing order of ionisation potential -
Li > Na > K > Rb > Cs
- I.P._{II} > I.P._I
- Decreasing order of ionisation potential -
Be > Mg > Ca > Sr > Ba
- I.P._I > I.P._{II}

OXIDATION STATE

- The alkali metals shows only + 1 oxidation state. (1st and 2nd ionisation potential difference > 16eV)
- Alkaline earth metal shows +2. Oxidation state (1st and 2nd ionisation potential difference < 11eV)

ELECTRO POSITIVE CHARACTER OR METALLIC CHARACTER

- Electropositivity $\propto \frac{1}{\text{Ionisation Potential}}$
Electropositivity in both groups \uparrow down the group
- Their atomic size is smaller than IA group so these are lesser electro positive than IA group. Electropositivity increases from Be to Ba

DENSITY

- (D = M/V)
- Li < K < Na < Rb < Cs
- Ca < Mg < Be < Sr < Ba
- K < Na < Ca < Mg

FLAME TEST

- | | | | |
|----------------|------------------|----------|--|
| Li-Crimson red | Na-Golden yellow | K-Violet | <ul style="list-style-type: none"> Be and Mg atoms, due to small size, bind their electrons more strongly, so are not excited to higher level, hence no flame test. Ca-Brick red Sr-dark red Ba-apple green or Crimson red |
| Rb-Red violet | Cs-Blue | | |

PHOTO ELECTRIC EFFECT

- Due to very low ionisation potential their valence shell electrons gets excited even by absorbing visible light. That's why Cs is used in photo cells.
- These elements do not show this property as their atomic size is small hence ionisation potential is higher than IA group.

HYDRATION ENERGY (HEAT OF HYDRATION)

- Alkali metals salts are generally soluble in water due to hydration of cations by water molecules.
- Smaller the cation, greater is the degree of its hydration.
- Li⁺ Na⁺ K⁺ Rb⁺ Cs⁺
 $\xrightarrow{\hspace{10em}}$
 * Degree of hydration decreasing
 * Hydration energy decreasing
 * Hydrated ion size decreasing
 * Ionic conductance increasing
- Due to smaller ionic size and higher charge density their hydration energy is high.
- Its decreasing order is
Be⁺² > Mg⁺² > Ca⁺² > Sr⁺² > Ba⁺²
- Hydration energy $\propto 1/\text{cation size}$**

REDUCING PROPERTY

- Since alkali metals have high standard oxidation potential, so these are strongest reductants.
- Reducing property increases down the group in gaseous or molten state
Li < Na < K < Rb < Cs
- But in aqueous solution order is -
Li > K \approx Rb > Cs > Na
- Less reductant than alkali metals
- Order of reducing property in aqueous and gaseous medium is
Be < Mg < Ca < Sr < Ba

NITRIDES

- Only Li reacts directly with N_2 to form nitride which gives NH_3 on hydrolysis.

$$6Li + N_2 \rightarrow 2Li_3N$$

$$Li_3N + 3H_2O \rightarrow 3LiOH + NH_3 \uparrow$$
- Only Be and Mg burns in N_2 to give M_3N_2 (Be_3N_2, Mg_3N_2)

$$Be_3N_2 + 6H_2O \rightarrow 3Be(OH)_2 + 2NH_3$$

$$Mg_3N_2 + 6H_2O \rightarrow 3Mg(OH)_2 + 2NH_3$$

SULPHATES

- All alkali metal sulphates are ionic. Ionic properties increases from Li to Cs.
 - Li_2SO_4 Least soluble in water.
 - These sulphates on burning with C forms sulphides

$$M_2SO_4 + 4C \rightarrow M_2S + 4CO$$
 - Except lithium, sulphates of IA group reacts with sulphates of trivalent metals like $Fe^{+3}, Cr^{+3}, Al^{+3}$ etc. to form double salts called alum.

$$I \quad III$$

$$M_2SO_4 \cdot M_2(SO_4)_3 \cdot 24H_2O$$
 - Ionic nature of alkaline metal sulphat is increases from Be to Ba

$$BeSO_4 < MgSO_4 < CaSO_4 < SrSO_4 < BaSO_4$$
 - Order of solubility–

$$BeSO_4 > MgSO_4 > CaSO_4 > SrSO_4 > BaSO_4$$
 - Order of thermal stability–

$$BeSO_4 < MgSO_4 < CaSO_4 < SrSO_4 < BaSO_4$$
- $\xrightarrow{\hspace{10em}}$
 Ionic nature increases, Thermal stability increases

SOLUBILITY IN LIQUID AMMONIA

- All the alkali metals dissolves in NH_3 (liq.) and produces blue solution.
- This blue solution conducts electricity and possesses strong reducing power, due to the presence of ammoniated electrons.

$$Na_{(s)} + (x+y) NH_3 \rightarrow [Na(NH_3)_x]^+ + [e(NH_3)_y]^-$$

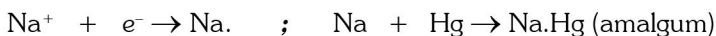
ammoniated
electron
- Dark blue colour of solution becomes fade if it allowed to stand for a long time, it is because of metal amide formation.
- This dilute solution is paramagnetic in nature.
- $2Li + NH_3 \rightarrow Li_2NH$ (Lithimide) + H_2
- $2Na + 2NH_3 \rightarrow 2NaNH_2 + H_2 \uparrow$
(Sodamide)
- Only Ca, Sr and Ba gives blue solution due to ammoniated electron.
- Be and Mg are small in size and have high ionisation potential so do not dissolves in liquid NH_3 .
- Blue colour of solution disappears on addition of ammonium salt, due to NH_3 formation.

$$NH_4^+ + NH_2^- \rightarrow 2NH_3$$
- On increasing metal ion concentration solution converts into bronze colour due to cluster formation of metal ions.

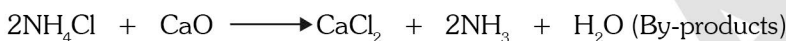
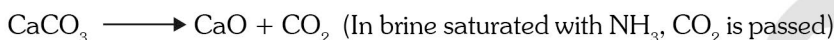
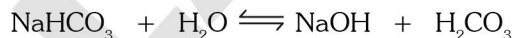
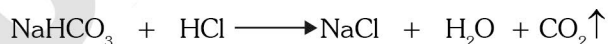
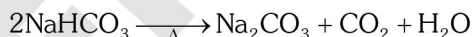
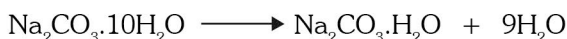
Sodium Hydroxide (NaOH), Caustic Soda**(a) Manufacture :****Castner – Kellner Cell :** (Hg – Cathode Process)

On electrolysis–

At Cathode (Hg)



At anode (Graphite)

**Sodium Bicarbonate or Baking soda (NaHCO₃)****(a) Preparation : Solvay process** (Commercial Scale)**(b) Properties :****Hydrolysis****Effect of heat** (temp. > 100°C)
(Process occurs during preparation of cake)**Reaction with acids** – gives CO₂**Reaction with base****Sodium Carbonate or Washing Soda (Na₂CO₃·10H₂O)****(a) Occurrence :** Na₂CO₃ – Soda ash.**(b) Manufacture : Solvay process**(i) Concentrated aqueous solution of NaCl is saturated with NH₃.(ii) Current of CO₂ passed through the solution.(iii) NaHCO₃ precipitated –(iv) Potassium bicarbonate (KHCO₃) cannot be prepared by solvay process as it is highly soluble in water.**(c) Properties :****(i) Efflorescence :**Na₂CO₃·10H₂O when exposed to air it gives out nine out of ten H₂O molecules.

(Monohydrate)

This process is called efflorescence. Hence washing soda losses weight on exposure to air.

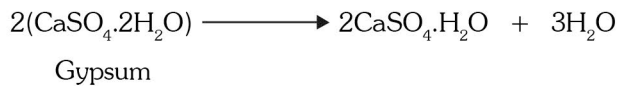
(ii) **Hydrolysis** : Aqueous solution of Na₂CO₃ is alkaline in nature due to anionic hydrolysis.

(c) Uses

- (i) For making fusion mixture ($\text{Na}_2\text{CO}_3 + \text{K}_2\text{CO}_3$)
- (ii) In the manufacturing of glass, caustic soda, soap powders etc.
- (iii) In laundries and softening of water.

Plaster of Paris (CaSO_4)₂·H₂O or CaSO_4 ·1/2 H₂O

(a) Preparation : It obtained when gypsum is heated at 120°C

**(b) Properties :**

- (i) It is a white powder.
- (ii) It has the property of setting to a hard mass when a paste with water is allowed to stand aside for sometime.
- (iii) When it heated at 200°C, anhydrous CaSO_4 is formed K/as dead burnt P.O.P.

(c) Uses