

Short-cut Revision Notes

Chapter : s-block

Synopsis

- Elements in which the last electron enters the s-orbital are called s-block elements. Thus, elements of group 1 (alkali metals) and group 2 (alkaline earth metals) constitute s-block elements.

ALKALI METALS

- General electronic configuration: ns^1
- The elements of group 1 : Lithium, sodium, potassium, rubidium, caesium and francium besides hydrogen.
- These elements are called alkali metals because they form hydroxides on reaction with water which are strongly alkaline in nature.

Physical properties :

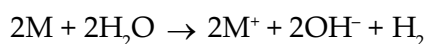
- Alkali metals are soft with low melting and boiling points due to weak metallic bonding.
- Alkali metals have low density which increases down the group from Li to Cs.
- On exposure to moist air, all alkali metals except lithium get tarnished quickly so they are always kept in kerosene to protect them from air.
- All alkali metals are paramagnetic but their salts are diamagnetic in nature.
- Alkali metals and their compounds impart characteristic colour to the flame.

Li	Na	K	Rb	Cs
Crimson red	Golden yellow	Pale violet	Reddish violet	Sky blue

- Due to large negative electrode potentials, alkali metals are strong reducing agents. Li is the strongest reducing agent in solution due to its large heat of hydration.
- The alkali metals are good conductors of heat and electricity.

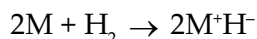
Chemical properties :

- The alkali metals are highly reactive (most electropositive) elements due to their large size and low value of ionisation enthalpy.
- Alkali metals decompose water with evolution of hydrogen.

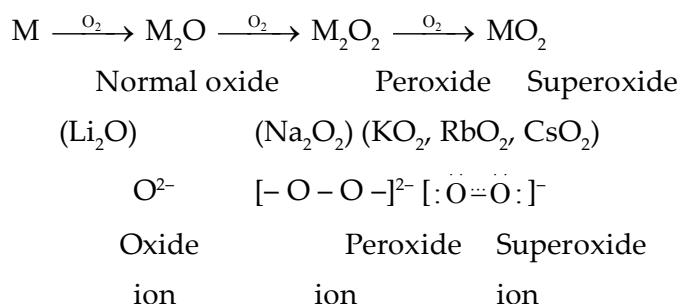


[\therefore M = Alkali metal]

iii) Alkali metals combine directly with hydrogen to form metal hydrides (MH).



iv) Affinity towards oxygen increases when heated in atmosphere of oxygen.

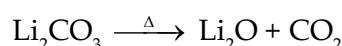


The peroxides and superoxides become more stable with increase in atomic number of the alkali metal.

v) The alkali metals directly react with halogens forming halides (MX) which are all soluble in water except LiF.

vi) The low solubility of LiF is due to high lattice energy, whereas low solubility of CsI is due to smaller hydration enthalpy of two ions.

vii) All the alkali metals form carbonates of type M₂CO₃. All carbonates are stable towards heat except Li₂CO₃.



viii) Nitrates of the type MNO₃ are known. All the nitrates decompose to nitrites and oxygen on heating but LiNO₃ decomposes to oxide with evolution of NO₂ and O₂.

ix) Alkali metals dissolve in liquid ammonia giving deep blue solutions (due to ammoniated electron) which are conducting in nature.



x) Lithium shows anomalous properties due to its small size and high polarising power and resembles magnesium (diagonal relationship) because of their similar sizes.

❑ Some general trends of alkali metals and their compounds :

i) Electropositive character: Li < Na < K < Rb < Cs

ii) Hydration enthalpy: Li⁺ > Na⁺ > K⁺ > Rb⁺ > Cs⁺

iii) Solubility and basic character: LiOH < NaOH < KOH < RbOH < CsOH

iv) Reducing character : Na < K < Rb < Cs < Li

v) Stability of carbonates :

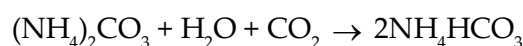


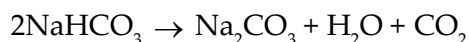
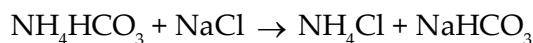
vi) Stability of bicarbonates:



❑ Some important compounds of sodium :

i) **Sodium carbonate (washing soda)** : Na₂CO₃·10H₂O is generally prepared by Solvay process also called ammoniasoda process. The raw materials are NaCl, NH₃ and limestone.





Solvay process cannot be employed for the manufacture of K_2CO_3 because KHCO_3 is fairly soluble in water.

ii) **NaCl**: Crude sodium chloride is generally obtained by crystallisation of brine solution, contains Na_2SO_4 , CaSO_4 and impurities like MgCl_2 and CaCl_2 which are deliquescent (absorb moisture easily from the atmosphere).

iii) **NaOH**: Sodium hydroxide (caustic soda) is prepared commercially by the electrolysis of sodium chloride in Castner–Kellner cell using a mercury cathode and a carbon anode.

iv) **Sodium hydrogen carbonate (baking soda)**:

NaHCO_3 is obtained by saturating a solution of Na_2CO_3 with CO_2 . NaHCO_3 being less soluble, gets separated out.



v) **Biological importance of Na and K**: Na^+ ions (found outside the cells, in blood plasma and in the interstitial fluids) participate in the transmission of nerve signals, in regulating the flow of water across cell membranes and in the transport of sugars and amino acids into cells while K^+ ions (present within cell fluids) activate many enzymes, participate in the oxidation of glucose to produce ATP and along with Na, are responsible for transmission of nerve signals.

ALKALINE EARTH METALS

- **General electronic configuration**: ns^2
- **The elements of group 2**: Beryllium, magnesium, calcium, strontium, barium and radium which is radioactive.
- These elements are called alkaline earth metals because their oxides and hydroxides are alkaline in nature and these metal oxides are found in the earth's crust.

Physical properties:

- All are silvery white, lustrous and relatively soft but harder than the alkali metals.
- The melting and boiling points are quite low but higher than the corresponding alkali metals due to smaller sizes.
- Except Be and Mg, other alkaline earth metals impart a characteristic colour to the flame.

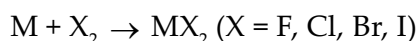
Ca	Sr	Ba
Brick red	Crimson	Apple green

- They act as reducing agents. Reducing nature increases from Be to Ba as the ionisation potentials and oxidation potentials decrease from Be to Ba.
- They have high thermal and electrical conductivities.
- Divalent ions have noble gas configurations with no unpaired electrons, their compounds are colourless and diamagnetic. The metals are also diamagnetic in nature.

Chemical properties:

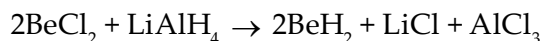
- Alkaline earth metals are quite reactive elements due to their low ionisation potentials.
- Be does not decompose water. Mg decomposes hot water. Ca, Sr and Ba react with cold water, liberating H_2 gas.
- Except Be, alkaline earth metals are easily tarnished in air as a layer of oxide is formed on their surface.

- iv) All the alkaline earth metals combine with halogen at elevated temperatures forming their halides.



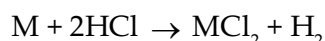
- v) Except Be, all alkaline earth metals combine directly with H_2 and form hydrides of the type MH_2 .

BeH_2 is prepared by the reaction,

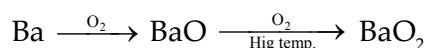


It is a polymeric hydride $(BeH_2)_n$ and possesses hydrogen bridges (two electrons–three centre bonds).

- vi) Like alkali metals, alkaline earth metals react with acids and displace hydrogen.



- vii) Mg, Ca, Sr when burnt in oxygen form oxides of the type MO . Ba and Ra, being highly electropositive, form peroxides, MO_2 .

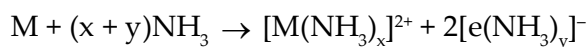


- viii) Alkaline earth metals form nitrates of the type $M(NO_3)_2$. Nitrates decompose on heating into corresponding oxides with evolution of a mixture of NO_2 and O_2 .



(M = Be, Mg, Ca, Sr, Ba)

- ix) Alkaline earth metals dissolve in liquid ammonia to give deep blue black solutions, forming ammoniated ions.

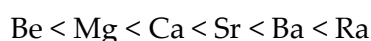


Some general trends in alkaline earth metals and their compounds:

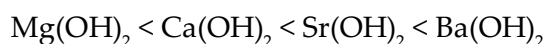
- i) Hydration enthalpy :



- ii) Reducing character :



- iii) Solubility, thermal stability and basic character of hydroxides:



- iv) Solubility of carbonates :



- v) Stability and ionic character of carbonates :



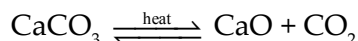
- vi) Solubility of sulphates :



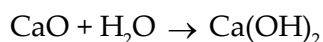
- vii) Beryllium shows anomalous behaviour in the group (due to exceptionally small atomic and ionic size, high ionization enthalpy and absence of d-orbital in the valence shell) and resembles aluminium (diagonal relationship).

☐ **Some important compounds of calcium :**

- I. **Quick lime:** CaO is prepared on a commercial scale by heating limestone (CaCO_3) at 1070–1270 K in a rotary kiln.



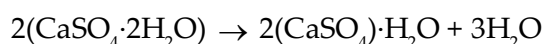
On adding water, quick lime gives a hissing sound and forms calcium hydroxide, known as slaked lime.



A suspension of slaked lime in water is called milk of lime while the filtered and clear solution is known as lime water. Chemically both are Ca(OH)_2 .

Quick lime is used for making caustic soda, bleaching powder, calcium carbide, mortar, cement, glass, dye stuffs and purification of sugar.

- II. **Gypsum:** $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ when heated at 393 K, loses three-fourth of its water of crystallisation and forms hemihydrate ($\text{CaSO}_4 \cdot \frac{1}{2} \text{H}_2\text{O}$) known as Plaster of Paris.



It becomes anhydrous above 393 K and anhydrous CaSO_4 is called dead burnt plaster.

- Plaster of Paris has the property of setting to a hard mass when a paste with water is allowed to stand aside. Slight expansion occurs during setting as water is absorbed to reform $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$.

- III. **Cement** is a dirty greyish heavy powder containing calcium silicates and aluminates and is an important building material. Cement consists of tricalcium silicate, $3\text{CaO} \cdot \text{SiO}_2$, dicalcium silicate, $2\text{CaO} \cdot \text{SiO}_2$, tricalcium aluminate, $3\text{CaO} \cdot \text{Al}_2\text{O}_3$, and tetracalcium alumino-ferrite, $4\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot \text{Fe}_2\text{O}_3$.

- The average composition of Portland cement is CaO (50–60%), SiO_2 (20–25%), Al_2O_3 (5–10%), MgO (2–3%), Fe_2O_3 (1–2%) and SO_3 (1–2%).
- Cement sets into a hard mass when mixed with water and gypsum is added to slow down the process of setting so that it gets sufficiently hardened.

- ☐ **Biological importance of Mg and Ca :** Mg acts as the cofactor for the enzymes that utilise ATP in phosphate transfer and is present in chlorophyll while Ca is present in bones and teeth, plays important role in neuromuscular function, interneuronal transmission, cell membrane integrity and blood coagulation.