

Complete  
**CHEMISTRY**

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CLASS 11 & 12th



Learning Inquiry  
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CLASS 11th

S-Block Elements

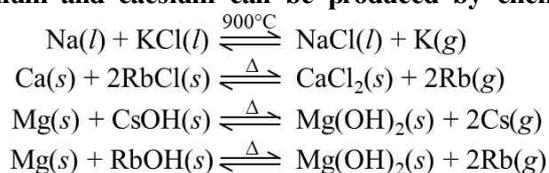
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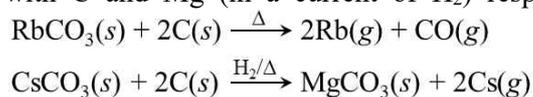
## 01. Introduction

S.No.	Properties	Alkaline earth metals	Alkali metals
(i)	Electronic configuration	Two electrons are present in the valency shell. The configuration is $ns^2$ .	One electron is present in the valency shell. The configuration of $ns^1$ .
(ii)	Valency	Bivalent	Monovalent
(iii)	Electropositive nature	Less electropositive	More electropositive.
(iv)	Hydroxides	Weak bases less soluble and decompose on heating.	Strong bases, highly soluble and stable towards heat.
(v)	Bicarbonates	These are not known in free state. Exist only in solution.	These are known in solid state.
(vi)	Carbonates	Insoluble in water. Decompose on heating.	Soluble in water. Do not decompose on heating ( $\text{Li}_2\text{CO}_3$ is an exception).
(vii)	Action of nitrogen	Directly combine with nitrogen and form nitrides.	Do not directly combine with nitrogen.
(viii)	Action of carbon	Directly combine with carbon and form carbides.	Do not directly combine with carbon.
(ix)	Nitrates	Decompose on heating evolving a mixture of $\text{NO}_2$ and oxygen.	Decompose on heating evolving only oxygen.
(x)	Solubility of salts	Sulphates, phosphates, fluorides, chromates, oxalates, etc. are insoluble in water.	Sulphates, phosphates, fluorides, chromates, oxalates, etc. are soluble in water.
(xi)	Physical properties	Comparatively harder. High melting points. Diamagnetic.	Soft, low melting points, Paramagnetic.
(xii)	Hydration of compounds	The compounds are extensively hydrated $\text{MgCl}_2 \cdot 2\text{H}_2\text{O}$ , $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ are hydrated chlorides.	The compounds are less hydrated, $\text{NaCl}$ , $\text{KCl}$ , $\text{RbCl}$ form non-hydrated chlorides.
(xiii)	Reducing power	Weak as ionisation potential values are high and oxidation potential values are low.	Strong, as ionisation potential values are low and oxidation potential values are high.

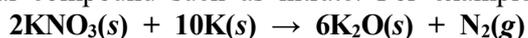
Potassium, rubidium and caesium can be produced by chemical reductions.



These reactions occur in the direction indicated only because the metal formed escape as a gas out of the reaction mixture. Rubidium and caesium can even be obtained by reduction of their carbonates with C and Mg (in a current of  $\text{H}_2$ ) respectively.



In order to get simple oxides of alkali metals like Na, K, Rb, Cs it is necessary to reduce some alkali metal compound such as nitrate. For example,



Insoluble compounds of sodium with Si, O and Al are present in many clays. Zeolite and permutit are insoluble complex compounds containing sodium ions.

Superoxides react with water to give  $\text{H}_2\text{O}$  and  $\text{O}_2$

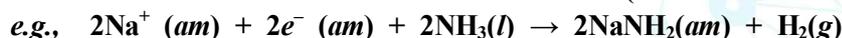


The solubility of alkali metals in liquid ammonia may be as high as 5M. Such solutions are called expanded metals. This is because when alkali metals are dissolved in liquid ammonia, there is a considerable expansion in total volume.

When alkali metals are dissolved in liquid ammonia, a blue coloured solution is obtained. It is paramagnetic in nature. However, on increasing the concentration of alkali metal a bronze-coloured solution is obtained. This solution is diamagnetic in nature. These solutions are meta-stable and the alkali metal slowly reacts with  $\text{NH}_3$  to give amide and  $\text{H}_2$ .



(M = alkali metal, am = ammonia)



However under anhydrous conditions and in the absence of catalytic impurities (such as transition metal ions), these solutions can be stored for several days.

Heavier alkali metal hydroxides form numerous hydrates e.g.  $\text{NaOH}$ ,  $n\text{H}_2\text{O}$  (where  $n = 1, 2, 3, 4, 5$  and  $7$ ). Although Li has the most negative  $E_{\text{Li}^+/\text{Li}}$  (i.e. highest oxidation potential) its reaction with water is considerably less vigorous than that of sodium which has the least negative  $E^\circ$  among the alkali metals. Other metals react explosively with water.

All the alkali metal halides have high enthalpies of formation ( $\Delta H_f^\circ$ ).

- $\Delta H_f^\circ$  values for fluorides become less negative as we move down the group.
- $\Delta H_f^\circ$  values for fluorides, bromides and iodides become more negative as we move down the group, e.g.,  $\Delta H_f^\circ(\text{NaCl}) = -411.15 \text{ kJ mol}^{-1}$ ,  $\Delta H_f^\circ(\text{KCl}) = -435.9 \text{ kJ mol}^{-1}$ ,
- For a given alkali metal,  $\Delta H_f^\circ$  values always become less negative from  $\text{F}^-$  to  $\text{I}^-$ .  
 $\Delta H_f^\circ(\text{kJ mol}^{-1})$ ; NaF ( $-573.65$ ); NaCl ( $-411.15$ ); NaBr ( $-361.06$ ); NaI ( $-287.78$ ).

Melting and boiling points of halides always follow the trend

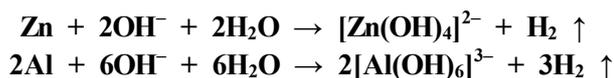
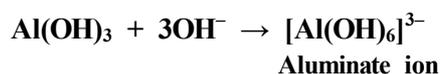
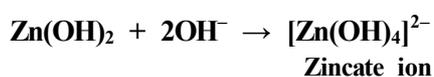
**fluoride > chloride > bromide > iodide.**

In water, the low solubility of LiF is due to its high lattice energy and the low solubility of CsI in water is due to smaller hydration energies of its two ions. Other halides of Li ( $\text{Cl}^-$ ,  $\text{Br}^-$  and  $\text{I}^-$ ) are soluble in ethyl alcohol, acetone and ethyl acetate. LiCl is soluble in pyridine. Lithium is least reactive but strongest reducing agent among all the alkali metals. Lithium unlike other alkali metals forms no acetylide on reaction with acetylene.

- Both LiCl and  $\text{MgCl}_2$  are soluble in ethanol.
- Both lithium perchlorate and magnesium perchlorate are extremely soluble in alcohol.
- Both  $\text{LiCl}_2$  and  $\text{MgCl}_2$  are deliquescent and crystallise from aqueous solution as hydrates  $\text{LiCl} \cdot 2\text{H}_2\text{O}$ ,  $\text{MgCl}_2 \cdot 8\text{H}_2\text{O}$ .
- Solid bicarbonates are not formed by Li and Mg.

In the Castner-Kellner cell, during the electrolysis of aqueous NaCl, Na is preferentially discharged at the mercury cathode forming sodium amalgam. This is due to the fact that hydrogen has a high over voltage at mercury cathode. Nafion membrane is now widely used in the membrane cell for the manufacture of NaOH and  $\text{Cl}_2$  from  $\text{NaCl}(\text{aq})$  by electrolysis. Nafion is a copolymer of tetrafluoromethylene and pentafluorosulphonyl ethoxy ether. The copolymer is supported by a Teflon mesh. Hydroxides of Al, Zn, Pb and Sn dissolve in excess of NaOH.

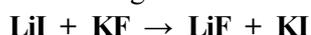
Metals/metalloids like Al, Sn, Zn, Si, Pb etc. react with  $\text{NaOH}(aq)$  to give  $\text{H}_2$



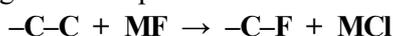
The lesser solubility of  $\text{NaHCO}_3$  in soda solvay process is partly due to common ion effect of the  $\text{Na}^+$  ions from the excess  $\text{NaCl}$  present.

*Larger cation stabilises larger anion e.g.,* For example,

- Li forms  $\text{Li}_2\text{O}$ , Na forms mostly  $\text{Na}_2\text{O}_2$ . K, Rb and Cs mostly form superoxides ( $\text{KO}_2$ ,  $\text{RbO}_2$ ,  $\text{CsO}_2$ )
- LiI reacts with KF to give LiF and KI



- The following reaction proceed better with KF than with NaF.

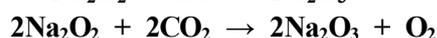


Lithium peroxide can be obtained by the action of  $\text{H}_2\text{O}_2$  and alcohol on  $\text{LiOH}(aq)$ .



Anhydrous peroxide can be obtained by dehydrating with  $\text{P}_2\text{O}_5$ .

$\text{Na}_2\text{O}_2$  reacts with CO and  $\text{CO}_2$  in dry state to give  $\text{Na}_2\text{CO}_3$



Solubility of  $\text{Na}_2\text{CO}_3 \cdot \text{H}_2\text{O}$  decreases with increase in temperature. Baking soda is  $\text{NaHCO}_3$ . Baking powder is a mixture of  $\text{NaHCO}_3$ , corn starch and an acid salt. Glauber's salt is  $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ . One of the most insoluble salt of sodium is sodium hexa hydroxoantimonate,  $\text{Na}[\text{Sb}(\text{OH})_6]$ . Polyhalite is  $\text{K}_2\text{SO}_4 \cdot \text{MgSO}_4 \cdot 2\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ . The iodides of K, Rb and Cs combine with  $\text{I}_2$  to give triiodides  $\text{KI}_3$ ,  $\text{RbI}_3$  and  $\text{CsI}_3$  of which the last one is most stable. In these compounds, the metal is not trivalent as the salts are derived from the complex acid  $\text{HI}_3$ . A colloidal solution of Na in ether is violet in colour. It is obtained by suspending metal in ether and passing an oscillatory discharge from a Leyden jar arrangement (*Svedberg's method*).

- ♦ The density of potassium is lesser than that of sodium contrary to the expectations. This is probably because of the abnormal increase in atomic size on moving from Na (186 pm) to K (227 pm). Hence, potassium is lighter than sodium. Lithium is lightest known metal (density = 0.534 g/cc). The second ionisation energies of all the alkali metals are very large because when one electron is lost from these elements, the resulting ions acquire noble gas configuration which are very stable and have high effective nuclear charge. Thus, large amount of energies are required to remove the second electron. Caesium is the most electropositive of all the alkali metals. Since alkali metals are highly electropositive
  - (a) they (except Li) mostly form ionic compounds.
  - (b) their electronegativity values are low. Due to their low ionization energies, alkali metals (except Li) show photoelectric effect. Cs can emit photoelectrons even with red light. All the alkali metals are silvery white, soft and light metals. Relative ionic radii :

