

s-Block Elements

Alkali Metals; Group -1 Elements

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

Elements	Symbols	Atomic Number	Electronic Configuration
Lithium	Li	3	[He]2s ¹
Sodium	Na	11	[Ne]3s ¹
Potassium	K	19	[Ar]4s ¹
Rubidium	Rb	37	[Kr]5s ¹
Caesium	Cs	55	[Xe]6s ¹
Francium	Fr	87	[Rn]7s ¹

Physical Properties of Alkali Metals :

1. Atomic Size

Largest in their respective period (except noble gas element)

Size increases from Li to Cs due to addition of an extra shell

$Li < Na < K < Rb < Cs$

$Cs > Rb > K > Ba > Sr > Ca > Na > Mg > Li > Be$

Comparison of atomic size of Group 1 and 2

Li 152	Be 112
Na 186	Mg 160
K 227	Ca 197
Rb 248	Sr 215
Cs 265	Ba 222

Concept Ladder



Francium occurs only in traces as a radioactive decay product because its half life period is very small (half-life 21 minutes).

Previous Year's Questions



Alkali metals lose electrons in

[AIPMT]

- (1) s-orbitals (2) p-orbitals
(3) d-orbitals (4) f-orbitals

**2. Oxidation State**

The group 1 elements exhibit +1 oxidation state

3. Ionization Energy

- The value of first ionization energies for the atoms in this group are lower than those for any other group in the whole periodic table. (Li > Na > K > Rb > Cs)
- Second ionization energy of alkali metals is very high because by losing one electron they achieve inert gas configuration.
- Li > Na > K > Rb > Cs (Ionization energy)

4. Density

Alkali metals have large size which accounts for their low density.

$$\text{Density} = \frac{\text{Atomic Mass (M)}}{\text{Atomic Volume (V)}}$$

Atomic mass increases from Li to Cs in the group and volume also increases but increase in atomic weight is more than increase in volume. Therefore density increases from Li to Cs.

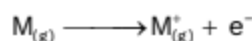
**5. Melting and Boiling point**

M.P. and B.P. of alkali metals are low due to weak interatomic bonds because of their large atomic radii and presence of only 1 valence electron. (Li > Na > K > Rb > Cs)

6. Electropositive Character

$$\text{Electropositivity} \propto \frac{1}{\text{Ionization Energy}}$$

Alkali metals have the tendency to lose the electron.

**7. Conductivity**

Due to the presence of loosely held valence electrons which are free to move in a metal structure, these elements are good conductor of heat and electricity.

Rack your Brain

Why second ionization enthalpy values of alkali metals are very high?

**Concept Ladder**

Alkali metals have largest size and lowest ionization energies in their respective periods.

Rack your Brain

Why density of K is less than Na?

**Concept Ladder**

Densities of alkali metals increase from Li to Cs
Exception : K is lighter than Na.



8. Nature of Bonds

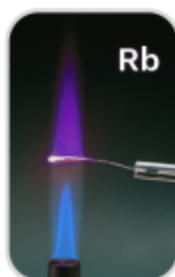
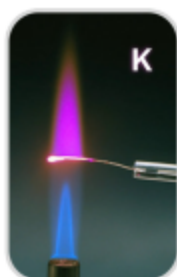
The electronegativity values being low, they combine with other elements to form ionic bond.

9. Flame Test

First group elements and their salts gives characteristic color to Bunsen flame. By flame energy electron of outer most shell get excited, which on returning back to its ground state releases absorbed flame energy as a visible light.

The energy released is min. in the case of Li^+ and increases in order Li^+ , Na^+ , K^+ , Rb^+ , Cs^+ .

Elements	Colour
Li	Crimson red
Na	Golden Yellow
K	Violet
Rb	Red Violet
Cs	Blue



Concept Ladder



Alkali metals are soft with low melting and boiling points. This is due to weak metallic bond.

Concept Ladder



Solution of alkali metals in liquid ammonia is highly conductive and deep blue in colour. This is due to presence of ammoniated electrons.

**10. Electronegativity**

The tendency to attract elements is low as the alkali metals are electropositive. The electronegativity, thus decreases from Li to Cs as the electropositive character increases.

11. Specific Heat

The specific heat values decrease from Li to Cs.

12. Heat of Atomisation

Heat of atomisation decreases from Li to Cs.

13. Hydration of Ions

The ions are heavily hydrated. The smaller the size of the ion, the greater is the degree of hydration. Thus the degree of hydration decreases down the group from Li^+ to Cs^+ . Thus with the increase in hydration electrical conductivity decreases.

14. Lattice Energy

Salts of alkali metals are ionic solids. Lattice energy of salts of alkali metals having common anion decreases on descending down the group.

15. Photoelectric Effect

K, Rb and Cs have quite large atomic size, so their ionization energy is very low.

Due to very low ionization energy their valence shell electrons get excited even by absorbing visible light.

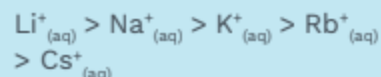
That's why Cs is used in photoelectric cells.

16. Reducing Character

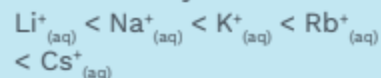
Alkali metals are strong reducing agents. Reducing character increases down the group.

Concept Ladder

Hydrated radii are in the order :



Ionic mobility :

**Rack your Brain**

Why, LiHCO_3 exists in solution?

Previous Year's Questions

The sequence of ionic mobility in aqueous solution is

[AIPMT-2008]

- (1) $\text{Rb}^+ > \text{K}^+ > \text{Cs}^+ > \text{Na}^+$
- (2) $\text{Na}^+ > \text{K}^+ > \text{Rb}^+ > \text{Cs}^+$
- (3) $\text{K}^+ > \text{Na}^+ > \text{Rb}^+ > \text{Cs}^+$
- (4) $\text{Cs}^+ > \text{Rb}^+ > \text{K}^+ > \text{Na}^+$



PROPERTIES OF ALKALI METALS

3
Li
Lithium

11
Na
Sodium

19
K
Potassium

37
Rb
Rubidium

55
Cs
Caesium

87
Fr
Francium

VERY SOFT



- Alkali metals can be easily cut with a knife
- Among all alkali metals lithium is hardest.

ELECTRONIC CONFIGURATION



- They have one valence shell electron.
- Electronic configuration ns^1

ATOMIC SIZE



- Size increases down the group due to added extra orbit.

ELECTROPOSITIVE

- It is the ability to remove an electron

Cs

- Electropositivity increases down the group
- Caesium has the highest Electropositivity character.

STORED IN KEROSENE

- Alkali metals react with air easily to form oxide layer therefore they are stored in kerosene



REACTS WITH WATER



- They reacts violently with water and form hydroxides.
- Don't even dare to go near when caesium reacts with water

USES

- **LITHIUM**
Anti depressants
Batteries



- **SODIUM**
Street lamps
Salt



- **POTASSIUM**
Fertilizers



- **CAESIUM**
Atomic Clocks



REACTS WITH AMMONIA

On dissolving NH_3 forms ammoniated cation and electron. solution turns blue



Q.1 Alkali metals are paramagnetic but their salt are diamagnetic. Why?

A.1 In metals, the outermost energy shell is singly occupied but in cations, all the orbitals are doubly occupied (inert gas configuration).

Chemical Properties

Reaction	Comment
$2M + 2H_2O \rightarrow 2MOH + H_2$	Hydroxides are strongest base known
$4Li + O_2 \rightarrow 2Li_2O$	Monoxide formed by Li and to a small extent by Na
$2Na + O_2 \rightarrow Na_2O_2$	Na and small extent by Li form their peroxide ion.
$K + O_2 \rightarrow KO_2$	Superoxide formed by K, Rb, Cs.
$2M + H_2 \rightarrow 2MH$	Ionic salt like hydrides
$6Li + N_2 \rightarrow 2Li_3N$	Nitride formed only by Li
$2M + S \rightarrow M_2S$	All metals form sulphides
$2M + X_2 \rightarrow 2MX$	All the metals form halides
$2M + 2NH_3 \rightarrow 2MNH_2 + H_2$	All the metals form amides

Reactivity

These elements are very reactive, so do not found in free state in nature.

$$\text{Reactivity} \propto \frac{1}{\text{Ionization Potential}}$$

Order of reactivity – $Li < Na < K < Rb < Cs$

- They have low values of ionisation energies and readily lose their valence electron to form M^+ ion.

Rack your Brain



Why $NaHCO_3$ and $NaOH$ can't exist together?

Concept Ladder



Alkali metals (except Lithium) show photoelectric effect. This tendency is maximum for caesium.

Rack your Brain



Why Li can't be store in Kerosene?

Previous Year's Questions



Which one of the alkali metals, forms only the normal oxide, M_2O on heating in air

[AIPMT-2012]

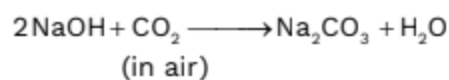
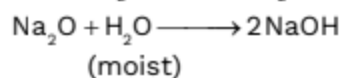
- (1) Rb (2) K
(3) Li (4) Na

- They have low heat of atomisation and easily come into vaporised form.
- They have higher heats of hydration.

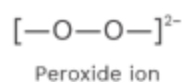
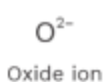
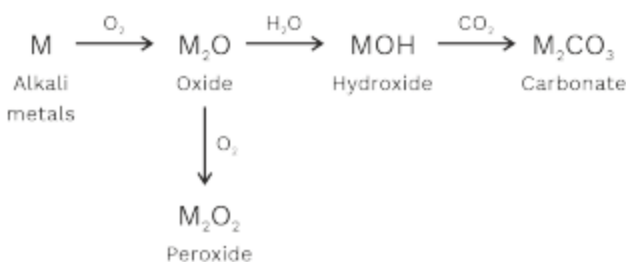
Reactivity towards air

Alkali metals gets tarnish in air due to the formation of oxide at their surface hence they are kept in kerosene or paraffine wax.

Alkali metals when reacts with moist air form carbonates.



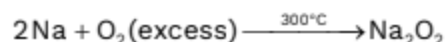
Reactivity towards oxygen



Normal oxides – Monoxide

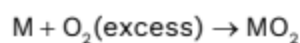


Peroxides



Superoxides

Superoxides are ionic oxides M^+O_2^-



(M = K, Rb, Cs)

Concept Ladder



Exception :

Lithium is strongest reducing agent due to its highest hydration energy.

Rack your Brain



Why alkali metals are highly reactive in air?

Concept Ladder



Alkali metal superoxides have unpaired electron and hence are paramagnetic whereas oxides and peroxide are diamagnetic and colourless.

Superoxides are stronger oxidizing agents than peroxides.

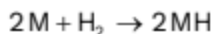
The stability of these superoxides is in the order :



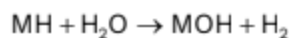
Stability of Oxides : Normal oxide > Peroxide > Superoxide

Reaction with Hydrogen

Alkali metals combine with H_2 forming ionic hydrides



Hydrides of alkali metals are attacked by water to give back hydrogen

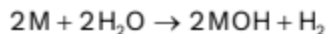


Thermal stability : $LiH > NaH > KH > RbH > CsH$

Basic property : $CsH > RbH > KH > NaH > LiH$

Reaction with Water

Alkali metals react vigorously with H_2O forming hydroxides with the liberation of H_2 .



Reactivity with water increase from Li to Cs.

Li → least reactive towards water

Na → reacts vigorously

K → reacts producing a flame

Rb, Cs → reacts explosively

Monoxides give strongly alkaline solution with water



Reaction with dilute acids

Due to alkaline nature, these metals react rapidly with dilute acids and the rate of reaction increases from Li to Cs because of increase in basic character.

Rack your Brain

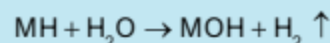


What is the reason for the increasing stability of peroxides and superoxides of alkali metals down the group?

Concept Ladder



The electrolysis of the fused hydride (LiH) yields hydrogen at anode.



Previous Year's Questions



The alkali metals form salt-like hydrides by the direct synthesis at elevated temperature. The thermal stability of these hydrides decreases in which of the following orders

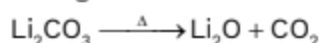
[AIPMT-2008]

- (1) $NaH > LiH > KH > RbH > CsH$
- (2) $LiH > NaH > KH > RbH > CsH$
- (3) $CsH > RbH > KH > NaH > LiH$
- (4) $KH > NaH > LiH > CsH > RbH$

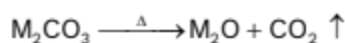


Carbonates and Bicarbonates

- (a) Small size and strong polarisation of Li distorts the e^- cloud of the near by oxygen atom of the large CO_3^{2-} to such an extent that the C—O bond gets weakened.



- (b) Replacement of the larger carbonate ion by a smaller ion leads to increased lattice energy and thus favours the decomposition.



Halides

All the metals in this group form halides of type MX. Li^+ is the smallest ion among alkali metals, it would be expected to form hydrated salts more readily than other metals.

Properties :

As evident from their following properties, alkali metal halides are ideal ionic compounds.

- All alkali halides except lithium fluoride are freely soluble in water (LiF is soluble in non-polar solvents).
- They have high melting and boiling points. For the same alkali metal, the melting and boiling points decrease regularly in the order: Fluoride > chloride > bromide > iodide.



Concept Ladder



Stability and solubility of carbonates, bicarbonates and nitrates increases down for group 1 elements.



Rack your Brain

Amongst LiF and LiI which has more covalent character and Why?



Previous Year's Questions

Which compound will show the highest lattice energy?

[AIPMT]

- | | |
|---------|---------|
| (1) RbF | (2) CsF |
| (3) NaF | (4) KF |

Q.2 LiBr has lower melting point than LiF. Why?

A.2 Br^- ion, on account of bigger size than F^- ion, is more polarisable than F^- ion, is more polarisable than F^- ion. Hence, LiBr is more covalent than LiF and thus, it has lower melting point.

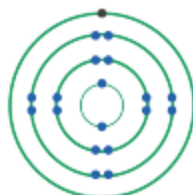


GROUP -1 THE ALKALI METALS

GROUP -1 elements are shiny, soft, and highly reactive metals, none of occur as a natural free element



MELTING POINTS



All of the Group-1 metals have one Valence Electron

The reactivity of the group-1 metals increases down the group as the outer electron gets further from the nucleus & becomes easier to remove.

METAL HYDROXIDES

The alkali metals react with water



METAL OXIDES

Alkali Metals react with oxygen



IONIC SALTS

Alkali metals react with halogens



PROPERTIES OF ALKALI METALS

Silver-like lustre	High ductility
Low melting point	High malleability

Excellent Conductor Of Heat And Electricity

Sodium :

(a) **Ores** : -

- **Chile salt peter** – NaNO_3
- **Rock salt** – NaCl
- **Glauber's salt** $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$

Extraction of sodium :

- Na is obtained on large scale by 2 processes.

Castner's process :

- In this process, electrolysis of fused NaOH is carried out at 330°C using iron as cathode and nickel as anode.



Previous Year's Questions



In which of the following processes, fused sodium hydroxide is electrolysed at 330°C temperature for extraction of sodium?

[AIPMT]

- (1) Castner's process
- (2) Down's process
- (3) Cyanide process
- (4) Both (2) and (3)

At cathode : $2\text{Na}^+ + 2\text{e}^- \rightarrow 2\text{Na}$

At anode : $4\text{OH}^- \rightarrow 2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^-$

- During electrolysis, O_2 and H_2O are produced. H_2O formed at the anode gets partly evaporated and is partly broken down and H_2 is discharged at cathode.



At cathode : $2\text{H}^+ + 2\text{e}^- \rightarrow 2\text{H} \rightarrow \text{H}_2$

Down's process :

- It involves the electrolysis of fused NaCl containing CaCl_2 and KF , using iron as cathode and graphite as anode, at about 600°C .

Concept Ladder

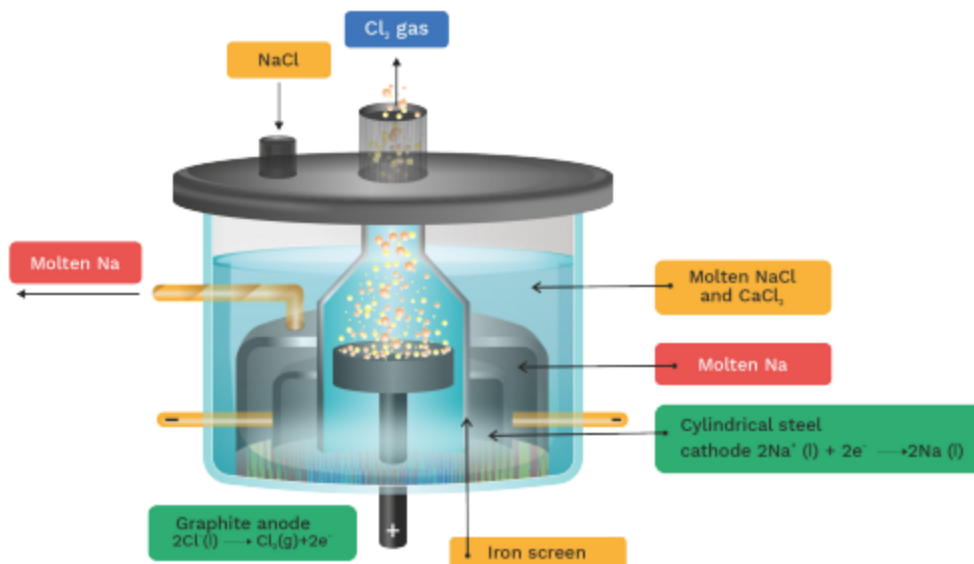


In Down's process Na is obtained by electrolysis of a mixture of NaCl (40%) and CaCl_2 (60%) in fused state.

Rack your Brain



In Down's process which gas is liberated at cathode side?



Reactions : $\text{NaCl} \rightleftharpoons \text{Na}^+ + \text{Cl}^-$

At cathode : $2\text{Na}^+ + 2\text{e}^- \rightarrow 2\text{Na}$

At anode : $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^-$



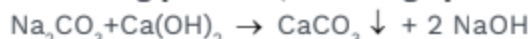
Na obtained by this method is 99.5% pure.

- (i) The fusion temperature of NaCl is high, i.e., 803°C (1076 K) which is difficult to maintain.
 - (ii) Sodium is volatile at this temperature and therefore, a part of it vapourises and forms a metallic fog.
 - (iii) At this temperature, the products of electrolysis, sodium and chlorine are corrosive and may attack the material of the cell.
- To remove the above difficulties, pure sodium chloride is mixed with calcium chloride and potassium fluoride.

Sodium Hydroxide (Caustic Soda)

Methods involving sodium carbonate as a starting material

Causticing process (or **Gossage process**)



Methods involving sodium chloride as a starting material

Electrolytic process : Electrolysis of aq. NaCl



Four methods are used in electrolysis of NaCl

- (i) Porous diaphragm process (Nelson cell process)
- (ii) Castner-Kellner cell
- (iii) Solvay-Kellner cell
- (iv) Diaphragm cell

Porous diaphragm process (Nelson cell process)

Nelson cell consist of a perforated steel tube lined inside with asbestos. The tube acts as a cathode.



Concept Ladder



In Down's process Na metal obtained is about 99% pure. Cl_2 is by product of this process.

Rack your Brain



Name the two important processes used to extract sodium metal?

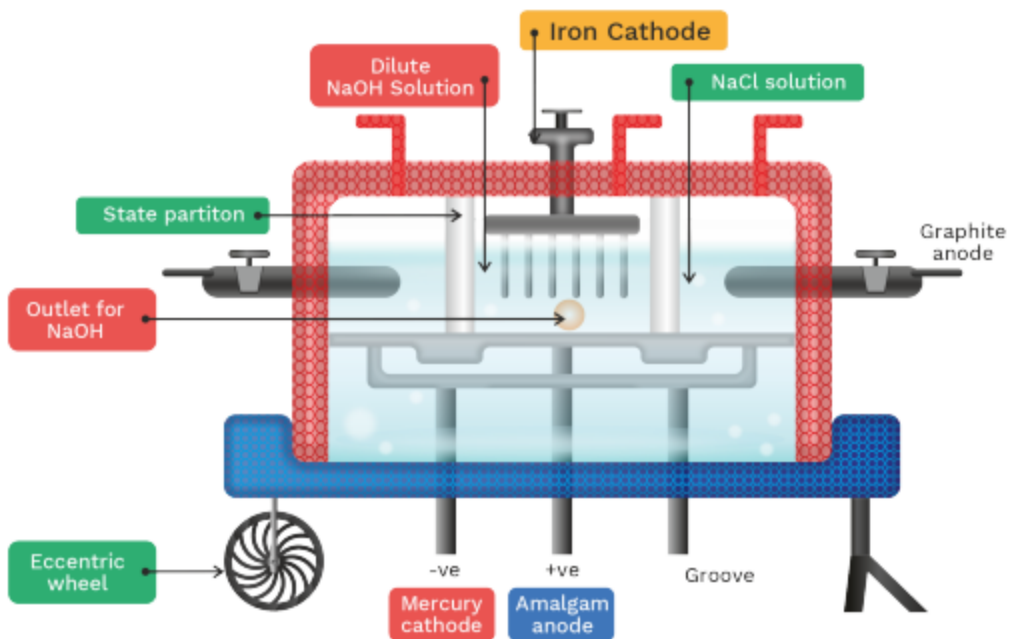
Previous Year's Questions



Which of the following is known as fusion mixture?

[AIPMT]

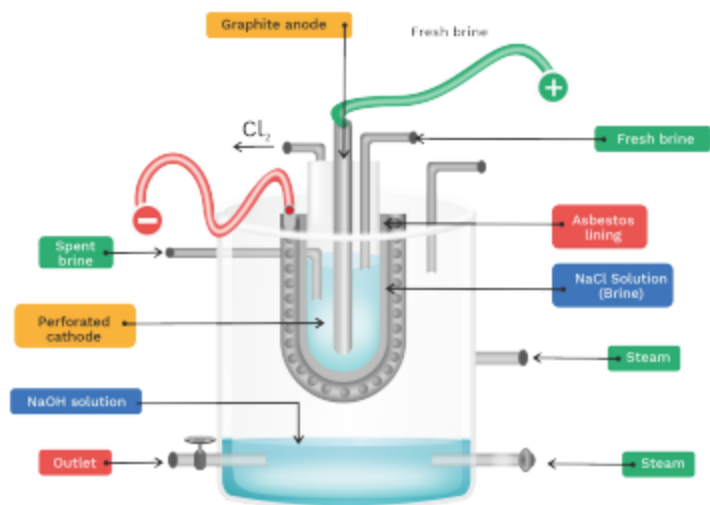
- (1) Mixture of $\text{Na}_2\text{CO}_3 + \text{NaHCO}_3$
- (2) $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$
- (3) Mixture of $\text{K}_2\text{CO}_3 + \text{Na}_2\text{CO}_3$
- (4) NaHCO_3



At cathode : $2\text{H}_2\text{O} + 2\text{e}^- \rightleftharpoons \text{H}_2 + 2\text{OH}^-$

$\text{Na}^+ + \text{OH}^- \rightleftharpoons \text{NaOH}$

At anode: $2\text{Cl}^- \rightleftharpoons \text{Cl}_2 + 2\text{e}^-$



The sodium containing NaOH and NaCl as impurity is taken out and evaporated to dryness.

Concept Ladder



Nelson cell is used for the industrial production of Cl_2 . As well as this cell can be used for the production of Na_2CO_3 , for which CO_2 is mixed with steam.

Rack your Brain



Name the element which when heated with NaOH reduces it metal?

Castner-Kellner cell :**At anode :****At cathode :**

- The sodium amalgam thus formed comes in the inner compartment due to rocking. Here, the sodium amalgam acts as the anode and ions rods act as cathode.

At anode :**At cathode :**

- The concentrated solution of sodium hydroxide (about 20%) is taken out from inner compartment and evaporated to dryness to get solid NaOH.

Solvay-Kellner cell :**At anode :****At cathode :**

- The amalgam flows out in a vessel containing water. Sodium hydroxide is formed with evolution of hydrogen.

**Concept Ladder**

In Castner-Kellner cell sodium amalgam is removed from the cell. It is then decomposed in a separate cell by water giving NaOH, hydrogen & Hg. Then Hg is recirculated to the cell.

**Previous Year's Questions**

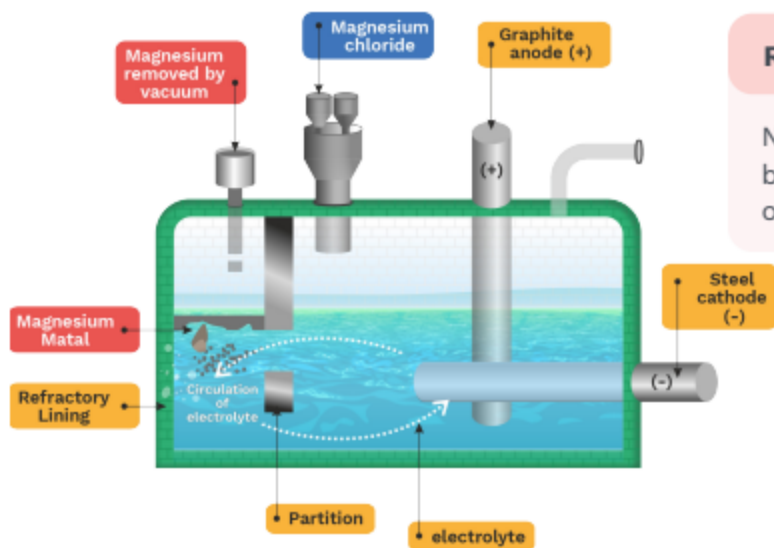
In Castner-Kellner cell for production of sodium hydroxide

[NEET-2013]

- Brine is electrolyzed using graphite electrodes
- Molten sodium chloride is electrolyzed
- Sodium amalgam is formed at mercury cathode
- Brine is electrolyzed with Pt electrodes

Q.3 Name the compound form when CO_2 and H_2O react with Na_2CO_3 ?

A.3 Sodium Hydrogen Carbonate
 $\text{Na}_2\text{CO}_3 + \text{CO}_2 + \text{H}_2\text{O} \rightarrow 2\text{NaHCO}_3$



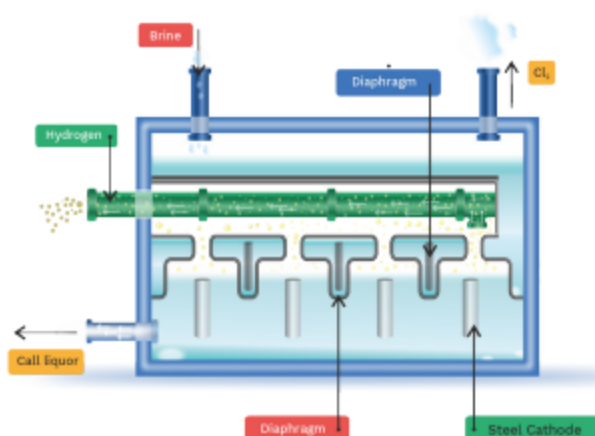
Rack your Brain



Name the component used in baking powder for manufacturing of fire extinguishers?

Diaphragm cell :

Most modern method for the production of sodium hydroxide from brine (aqueous sodium chloride solution) uses a diaphragm cell, containing steel and titanium electrodes which are separated by porous diaphragms to isolate the products.



Abnormal behaviour of lithium :

- The lithium, being the first member of alkali group, exhibits the characteristic properties of alkali metals but it differs at the same time in many respects from them.

Concept Ladder



NaOH can be used in manufacturing of paper, soap and artificial silk. It is also used for petroleum refining, purification of bauxite.

Rack your Brain



Name the compound which will be reduced in diaphragm cell to discharge hydrogen?

Reasons for its abnormal behaviour are mainly due to the following reasons:

- Forms only monoxide while others form per and superoxides also.
- Li reacts with N_2 to form Li_3N , other alkali metals do not react with N_2 .
- $Li_2CO_3 \xrightarrow{\Delta} Li_2O + CO_2$, other carbonates do not give CO_2 .
- LiOH is weak base which decomposes on heating and other hydroxide are stable.
- Salts of Li are insoluble in H_2O but that of other alkali metals are soluble.
- $LiNO_3$ on heating evolves NO_2 and O_2 while other nitrates give only O_2

Diagonal relationship between Li and Mg :

- Both hard and ductile metal.
- LiOH and $Mg(OH)_2$ both weak bases.
- Nitrates of both on heating evolve NO_2 and O_2
- $LiHCO_3$ does not exist in solid state.
- Both react with N_2 to form nitride (Li_3N and Mg_3N_2).

Concept Ladder



Li shows anomalous property because it has exceptionally small in size and have greater polarizing power in lithium ion.

Concept Ladder



Due to its anomalous property, there is increase in covalent character of lithium compounds which is responsible for their solubility in organic solvents.

Q.4 Alkali metals are paramagnetic but their salts are diamagnetic. Explain :

A.4 In metals, the outermost energy shell is singly occupied, but in cations, all the orbitals are doubly occupied (inert gas configuration).

e.g., Na, $1s^2, 2s^2 2p^6, 3s^2 3p^6, 4s^1$ ($4s^1$) paramagnetic

$Na^+ 1s^2, 2s^2 2p^6, (3s^2 3p^6)$ Diamagnetic.

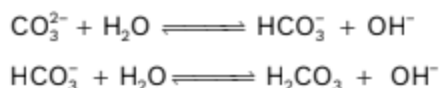
Q.5 Which alkali metal ion has the maximum polarising power and why ?

A.5 Li^+ ion has the maximum polarising power among all alkali metal ions. This is due to small size of Li^+ ion.



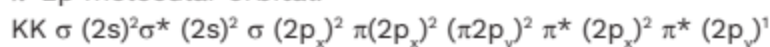
Q.6 Sodium salts in aqueous solutions are either neutral or alkaline in nature. Explain.

A.6 The anions in sodium salts are either from strong acids or weak acids. When anions are from strong acids, there is no hydrolysis and aqueous solutions are neutral (NaCl, NaNO₃, Na₂SO₄ solutions are neutral). On the other hand, when anions are from weak acids, there is hydrolysis and the solutions are alkaline in nature. For example, in the case of sodium carbonate or bicarbonate, solutions are alkaline.



Q.7 Why is KO₂ paramagnetic ?

A.7 The superoxide O₂⁻ is paramagnetic because of one unpaired electron in π*2p molecular orbital.



Q.8 What happens when following compounds are heated ?



A.8

$$\text{Li}_2\text{CO}_3 \longrightarrow \text{Li}_2\text{O} + \text{CO}_2$$

$$\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O} \longrightarrow \text{Na}_2\text{CO}_3 + 10\text{H}_2\text{O}$$

$$4\text{LiNO}_3 \longrightarrow 2\text{Li}_2\text{O} + 4\text{NO}_2 + \text{O}_2$$

$$2\text{NaNO}_3 \longrightarrow 2\text{NaNO}_2 + \text{O}_2$$

Q.9 Why do alkali metals tarnish in air?

A.9 They tarnish because of formation of their oxides.



Alkaline Earth Metals; Group 2 Elements

- The group two elements have ns^2 electronic configuration.

Elements	Symbols	Atomic Number	Electronic Configuration
Beryllium	Be	4	[He] $2s^2$
Magnesium	Mg	12	[Ne] $3s^2$
Calcium	Ca	20	[Ar] $4s^2$
Strontium	Sr	38	[Kr] $5s^2$
Barium	Ba	56	[Xe] $6s^2$
Radium	Ra	88	[Rn] $7s^2$

Physical properties of alkaline earth metal :

(1) Atomic Size :

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

(2) **Oxidation State** : The group 2 elements exhibit +2 oxidation state.

(3) Ionisation Energy :

- First ionisation energy is higher than IA group because of smaller atomic size and completely filled s-orbital (stable electronic configuration).

Decreasing order of ionisation energy :



- Second ionisation energy is lesser than IA group.

Rack your Brain



Why first I.E. of alkaline earth metals is higher than that of corresponding alkali metals?

Concept Ladder



Exception :

Radium and its all isotopes are radioactive. The longest lived isotope being Ra^{226} with half-life 1600 years. This isotope is formed in natural decay series of U^{238} .

(4) Density :

The size of group 2 elements are smaller than those of group 1 thus these elements have higher density than group 1 elements. Density increases from Be to Ra.

(5) Melting and Boiling point :

Since the cohesive force decreases down the group the melting point of elements of group 2 decreases down the group.

Exception :

Mg has the lowest melting point. Boiling points do not show regular trends. They are harder than alkali metals.

(6) Electro-positive Character or Metallic Character :

Their atomic size is smaller than IA group so these are lesser electro-positive than IA group. Electropositivity increases from Be to Ba.

(7) Conductivity :

These are also good conductor of heat and electricity due to presence of two free electrons.

(8) Nature of Bonds :

Be mainly forms covalent compound. The rest of the elements in group 2 forms ionic bond.

(9) Flame Test :

Element	Colour
Ca	Brick red
Sr	Crimson red
Ba	Apple green
Ra	Crimson

Previous Year's Questions



In context with beryllium, which one of the following statements is incorrect **[NEET-2016]**

- (1) Its hydride is electron-deficient and polymeric
- (2) It is rendered passive by nitric acid
- (3) It forms Be_2C
- (4) Its salts rarely hydrolyse

Concept Ladder



Exception :

Magnesium has lowest while beryllium has highest melting point among alkaline earth metals.

Concept Ladder



- Be has smallest size,
- While Cs has largest size.
- Atomic size increases down the group.



(10) Electronegative Values :

The electronegativity values of group 2 are low but are higher than the values of group 1. The value of decreases down the group.

(11) Lattice Energy :

Lattice energy of salts of alkali metals having common anion decreases on descending down the group.

(12) Hydration Energy :

The hydration energies of the alkaline earth metal ions are 4 or 5 time greater than for alkali metal ions due to their smaller size and increased charge. $\Delta H_{\text{hydration}}$ decreases down the group as the size of the ions increases.

(13) Photoelectric Effect :

These elements do not show this property as their atomic size is small hence ionisation energy is higher than IA group.

Previous Year's Questions



Which of the following compounds has the lowest melting point

[AIPMT-2011]

- (1) CaF_2 (2) CaCl_2
(3) CaBr_2 (4) CaI_2

Concept Ladder



M.P. and B.P. are more than that of alkali metals due to smaller size and closed packed structure.

Q.10 Write the trend in hydration enthalpies of alkaline earth metal ions?

A.10 Like group 1 metal ions, the hydration enthalpies of group 2 metal ions decreases with increase in ionic size down the group.





(14) Standard Oxidation Potential :

Standard oxidation potential of alkaline earth metals :

Element	Oxidation Reaction	Standard Oxidation Potential (volt)
Be	$\text{Be} \rightarrow \text{Be}^{2+} + 2\text{e}^{-}$	1.85
Mg	$\text{Mg} \rightarrow \text{Mg}^{2+} + 2\text{e}^{-}$	2.37
Ca	$\text{Ca} \rightarrow \text{Ca}^{2+} + 2\text{e}^{-}$	2.87
Sr	$\text{Sr} \rightarrow \text{Sr}^{2+} + 2\text{e}^{-}$	2.89
Ba	$\text{Ba} \rightarrow \text{Ba}^{2+} + 2\text{e}^{-}$	2.90

Chemical properties of alkaline earth metal :

Reactivity : Less reactive than alkali metals.

Order of reactivity : $\text{Be} < \text{Mg} < \text{Ca} < \text{Sr} < \text{Ba}$

Reactivity towards air :

- Except Be, these metals easily tarnished in air.
- Beryllium in powdered form, burns brilliantly on ignition in air.
- In moist air, except Be all the elements convert into carbonates.
- In dry air all elements of II-A give nitride and oxide both.

Reactivity towards oxygen :

- Alkaline earth metals reacts with O_2 to form 'MO' type oxides.
(M = Be, Mg, Ca, Sr, Ba)
- In II-A only Ca, Sr, Ba form peroxide.
Ex : CaO_2 , SrO_2 , BaO_2
- BeO shows amphoteric property.
 $\text{MgO} \rightarrow$ weak basic
 CaO , SrO and $\text{BaO} \rightarrow$ Strong basic
- Basic properties increases from BeO to BaO.



Concept Ladder



(i) Be, Mg and Ca form monoxides while Sr and Ba form peroxides.

(ii) The solubilities of hydroxides of alkaline earth metals increases on moving down the group i.e., $\text{Be}(\text{OH})_2 < \text{Mg}(\text{OH})_2 < \text{Ca}(\text{OH})_2 < \text{Sr}(\text{OH})_2 < \text{Ba}(\text{OH})_2$.

Rack your Brain



Why Be and Mg don't show any colour?



Previous Year's Questions

In which of the following the hydration energy is higher than the lattice energy [AIPMT-2007]

- (1) BaSO_4 (2) MgSO_4
(3) RaSO_4 (4) SrSO_4

**Reactivity towards hydrogen :**

- Except Be all the alkaline metals forms MH_2 type hydrides (MgH_2 , CaH_2 , SrH_2 , BaH_2) on heating directly with H_2 .
- BeH_2 is prepared by action of $BeCl_2$ with $LiAlH_4$
 $2BeCl_2 + LiAlH_4 \rightarrow 2BeH_2 + LiCl + AlCl_3$
Reducing agent
- BeH_2 and MgH_2 are covalent, other are ionic.

Reactivity towards water :

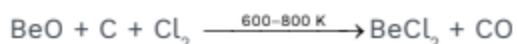
- Calcium, strontium, barium and radium decompose cold water readily with evolution of hydrogen.
 $M + 2H_2O \longrightarrow M(OH)_2 + H_2$
- Magnesium decomposes boiling water but beryllium does not react with water, even when red hot, its protective oxide film survives even at high temperature as its oxidation potential is lower than the other members.
- Reactivity of alkaline earth metals increases on moving down the group as the oxidation potential increases. However, the reaction of alkaline earth metals is less vigorous than alkali metals.

Reactivity towards halogens :

- All the group 2 elements combine with halogen at elevated temperatures forming their halides.



- Thermal decomposition of $(NH_4)_2BeF_4$ is the best route for the preparation of BeF_2 , and $BeCl_2$ is conveniently made from the oxide.

**Reactivity towards acids :**

- The alkaline earth metals readily react with acids liberating dihydrogen.
 $M + 2HCl \rightarrow MCl_2 + H_2$

Concept Ladder

$BeCl_2$ — Polymer in solid state

$BeCl_2$ — Dimer in gaseous state

Rack your Brain

How Be_2H is different from the hydrides of other members of group 2 ?

Concept Ladder

- Alkaline metals reacts with X (Halogen) to form MX_2 .

- Order of ionic nature
 $BeCl_2 < MgCl_2 < CaCl_2 < SrCl_2 < BaCl_2$

Diagonal relationship – Be and Al :

- (i) Both do not impart colour to flame.
- (ii) Carbides of both on reaction with H_2O give CH_4 .
- (iii) Both are rendered passive by conc. HNO_3 .
- (iv) Oxides and hydroxides of both are amphoteric.

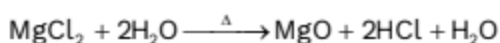
Magnesium

(a) Ores of Magnesium :

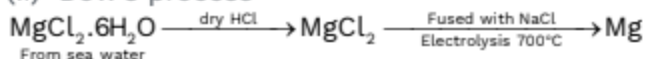
- (i) Magnesite MgCO_3
- (ii) Carnallite $\text{KCl} \cdot \text{MgCl}_2 \cdot 6\text{H}_2\text{O}$
- (iii) Asbestos $\text{Mg}_3(\text{Si}_2\text{O}_5)(\text{OH})_4$
- (iv) Epsom salt $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$

- (b) Extraction of Mg is done by electrolysis of fused MgCl_2 which in turn is obtained from carnallite or magnesite.

- (i) Carnallite can't be used directly to get anhydrous MgCl_2 by heating because all the water of crystallisation cannot be removed by heating. Strong heating may change Carrallite into MgO .



- (ii) Dow's process



- (c) Compounds and uses Magnesium :

- (i) Sorel's Cement – $(\text{MgO} + \text{MgCl}_2)$ used in dentistry.
- (ii) Epsom salt $(\text{MgSO}_4 \cdot 7\text{H}_2\text{O})$ – used as purgative in medicine and mordant in dyes.
- (iii) Magnesia alba $[3\text{MgCO}_3 \cdot \text{Mg}(\text{OH})_2 \cdot 3\text{H}_2\text{O}]$ is used in tooth paste and cosmetics.

Calcium :

- (a) Ores

- (i) Dolomite – $\text{MgCO}_3 \cdot \text{CaCO}_3$
- (ii) Gypsum – $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$
- (iii) Flusopar – CaF_2
- (iv) Phosphorite – $\text{Ca}_3(\text{PO}_4)_2$

Concept Ladder



The charge/radius ratio of Be^{2+} is nearly the same as that of the Al^{3+} ion. Hence Be resembles Al in some ways.

Rack your Brain



Why Mg can't be obtained by electrolysis of carnallite?

Concept Ladder



The mixed oxides $(\text{CaO} \cdot \text{MgO})$ obtained from calcination of dolomite $(\text{CaCO}_3 \cdot \text{MgCO}_3)$ are reduced by ferrosilicon.

Rack your Brain



Why $\text{Mg}(\text{OH})_2$ is called 'milk of magnesia'?

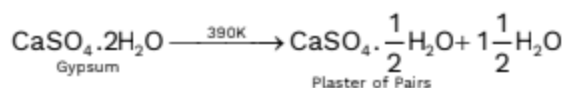
(b) Calcium oxide CaO (Burnt lime or quick lime)



(ii) Mortar = CaO + Sand + Water

(iii) Limelight – When exposed to oxyhydrogen flame, it starts emitting light called limelight.

(c) Gypsum or alabaster ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$)



Plaster of Paris settles and becomes hard or cooling.

(d) Milk of lime : Suspension of Ca(OH)_2 in water

Cement :

(i) Cement is chemically – Calcium silicate + Calcium aluminate + 1% gypsum

(ii) Raw material – Limestone (Provides CaO)
Clay (Provides $\text{SiO}_2, \text{Fe}_2\text{O}_3, \text{Al}_2\text{O}_3$)

(iii) Approximate composition of cement

CaO	50-60%
SiO_2	20-25%
Al_2O_3	5-10%
MgO	1-3%
Fe_2O_3	1-3%

(iv) If cement has

- Excess of lime cracks appear
- Excess of silica slow setting
- Less of lime weak cement
- Excess of Al_2O_3 fast setting

(v) Cement with Fe is white cement

(vi) Setting of cement is exothermic process.

(vii) Concrete = cement + sand + gravel.

(viii) Mortar = CaCO_3 and sands in 1 : 3 ratio.

(ix) Reinforced cement = cement + sand + iron rod

Previous Year's Questions



HCl was passed through a solution of CaCl_2 , MgCl_2 and NaCl. Which of the following compound(s) crystallise(s)?

[NEET-2020]

- (1) Both MgCl_2 and CaCl_2
- (2) Only NaCl
- (3) Only MgCl_2
- (4) NaCl, MgCl_2 and CaCl_2

Rack your Brain



Why Ca(OH)_2 is used in white washing?

Concept Ladder



Cement was first introduced in England in 1824 by Joseph Aspdin. It is also called Portland cement.

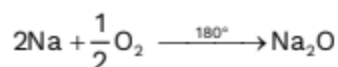
Group-I and II

Oxides

Sodium Oxide : (Na_2O) :

Preparation :

- (i) Na_2O is obtained by burning Na at 180°C in a limited supply of air or O_2 and distilling off the excess of Na in vacuum.

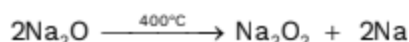


- (ii) By heating sodium peroxide or nitrate with sodium.



Properties :

- (i) It is white amorphous mass.
(ii) It decomposes at 400°C into Na_2O_2 and Na.



- (iii) It dissolve violently in H_2O , yielding NaOH.

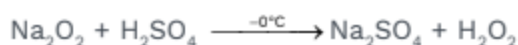
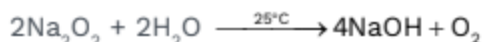
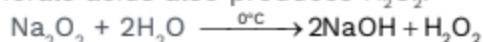


Sodium peroxides (Na_2O_2) :

Preparation : Na_2O_2 is formed by heating the metal in excess of air or O_2 at 300° , which is free from moisture and CO_2 .

Properties :

- (i) Na_2O_2 is a pale yellow solid, becoming white in air from the formation of a film of NaOH and Na_2CO_3 .
(ii) In cold water (0°C) it produce H_2O_2 but at room temperature it produce O_2 . In ice- cold minerals acids also produces H_2O_2 .



Concept Ladder



Na_2O_2 can also be prepared by heating sodium metal on aluminium trays in air (free from CO_2)



Rack your Brain



Write various uses of sodium oxide?

Concept Ladder



Uses :

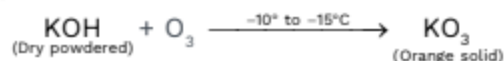
- For preparing H_2O_2 , O_2 .
- Oxygenating the air in submarines.
- Oxidising agent in the laboratory.

Rack your Brain



Name the oxides formed by sodium.

KO₃ :



(Ozonised oxygen)

Magnesium Oxide (MgO) :

- It is obtained by heating natural magnesite and also called magnesia.



Properties :

- It is white powder.
- Its melting point is 2850°C, hence used in manufacture of refractory brick for furnaces.
- It is slightly soluble in H₂O imparting alkaline reaction.

Calcium Oxide (CaO) :

- CaO is commonly called as quick lime or lime and made by decomposing lime stone at a high temperature about 1000°C.



Properties :

- It is white amorphous powder of melting point 2570°C.
- It ejects intense light (lime light), when heated in O₂-H₂ flame.
- It combines with some acidic oxide and have properties similar to basic oxide.



- It combines with H₂O to produce Ca(OH)₂.



Magnesium Peroxide (MgO₂) and Calcium Peroxide (CaO₂) :

- MgO₂ and CaO₂ are obtained by passing H₂O₂ in a solution of Mg(OH)₂ and Ca(OH)₂ respectively.

Concept Ladder



Uses :

- MgO₂ is used as an antiseptic in tooth paste as a bleaching agent.

Rack your Brain



- What is slaking of lime?
- Quick lime combines with which types of oxides?

Concept Ladder



MgO can also be obtained by burning Mg in air, by heating hydroxide, nitrate, sulphate or carbonate. Oxide prepared by heating magnesite (MgCO₃) is called Calcined Magnesia.

Hydroxides

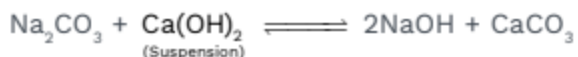
Sodium Hydroxides :

Preparation :

(i) Electrolysis of Brine :



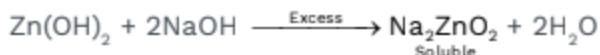
(ii) Caustication of Na_2CO_3 (Gossage's method) :



Since the $K_{sp}(\text{CaCO}_3) < K_{sp}(\text{Ca(OH)}_2)$, the reaction shifts towards right.

Properties :

- (i) NaOH is highly corrosive solid and white crystalline.
- (ii) It has stablized form towards heat.
- (iii) It's aqueous solution alkaline in nature and soapy in touch.



[Same with AlCl_3 , SnCl_2 , PbCl_2]

- (v) Amphoteric and acidic oxides gets dissolved easily e.g.



- (vi) Al and Zn metal gives hydrogen from NaOH



- (vii) Several non metals such as P, Cl, S etc. yield a hydride instead of H_2 e.g.

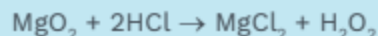


(Disproportionation reaction)

Concept Ladder



All peroxides of alkaline earth metals are white crystalline ionic solids containing the peroxide ion, O_2^{2-} . Treatment of peroxide with acids librates with hydrogen peroxides.



Rack your Brain



Which cell is used for manufacturing of sodium hydroxide?

Previous Year's Questions



Which of the following oxides is not expected to react with sodium hydroxide?

[AIPMT]

- (1) CaO
- (2) SiO_2
- (3) BeO
- (4) B_2O_3



Potassium Hydroxide :

Preparation : By electrolysis of aqueous solution of KCl.

Properties : Same as NaOH.

- (a) It has stronger base compared to NaOH.
- (b) Solubility in H_2O is more compared to NaOH.
- (c) In alcohol, sodium hydroxyde is sparingly soluble but KOH is highly soluble.
- (d) As a reagent potassium hydroxide is less frequently used but in absorption of CO_2 , potassium hydroxide is preferably used compared to sodium hydroxide, because potassium bicarbonate formed is soluble whereas sodium bicarbonate is insoluble, hence choke the tubes of apparatus used.

Magnesium Hydroxide : It occurs in nature as mineral brucite.

Preparation : $Mg(OH)_2$ can be prepared by adding caustic soda solution to a solution of Mg-sulphate or chloride solution.



Properties :

- (i) (i) It can be dried at temp. upto $100^\circ C$ only, otherwise at higher temp. it breaks down into its oxide.



- (ii) It dissolves in ammonium chloride solution.



- Thus, magnesium hydroxide is not therefore precipitated from a solution of Mg^{2+} ions by NH_4OH in presence of excess of NH_4Cl .

Calcium Hydroxide :

Preparation : By spraying water on quick lime.



Properties :

- (i) It is sparingly soluble in water.
- (ii) It's solubility in hot H_2O is less than that of cold H_2O . Therefore solubility decreases with increase in temperature.



Concept Ladder



The hydroxides of all alkali metals are white crystalline solids. They are strongest of all the bases and readily dissolve in water with the evolution of extent heat.



Rack your Brain

Write the increasing order of basic strength in hydroxides of alkaline earth metals?



Previous Year's Questions

The suspension of slaked lime in water is known as **[NEET-2016]**

- (1) Aqueous solution of slaked lime
- (2) Limewater
- (3) Quicklime
- (4) Milk of lime

- (iii) $\text{Ca}(\text{OH})_2$ readily absorbs CO_2 as used as a test for the gas.
- (iv) It is used as a mortar, which is a mixture of slaked lime (1 Part) and sand (3 Parts) made into paste with H_2O .

Carbonates

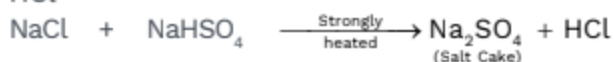
Sodium Carbonate :

Preparation :

(i) Leblanc Process :



HCl



(ii) Solvay Process :

It is used for the preparation of washing soda. ($\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$) soda (NaHCO_3)

Concept Ladder

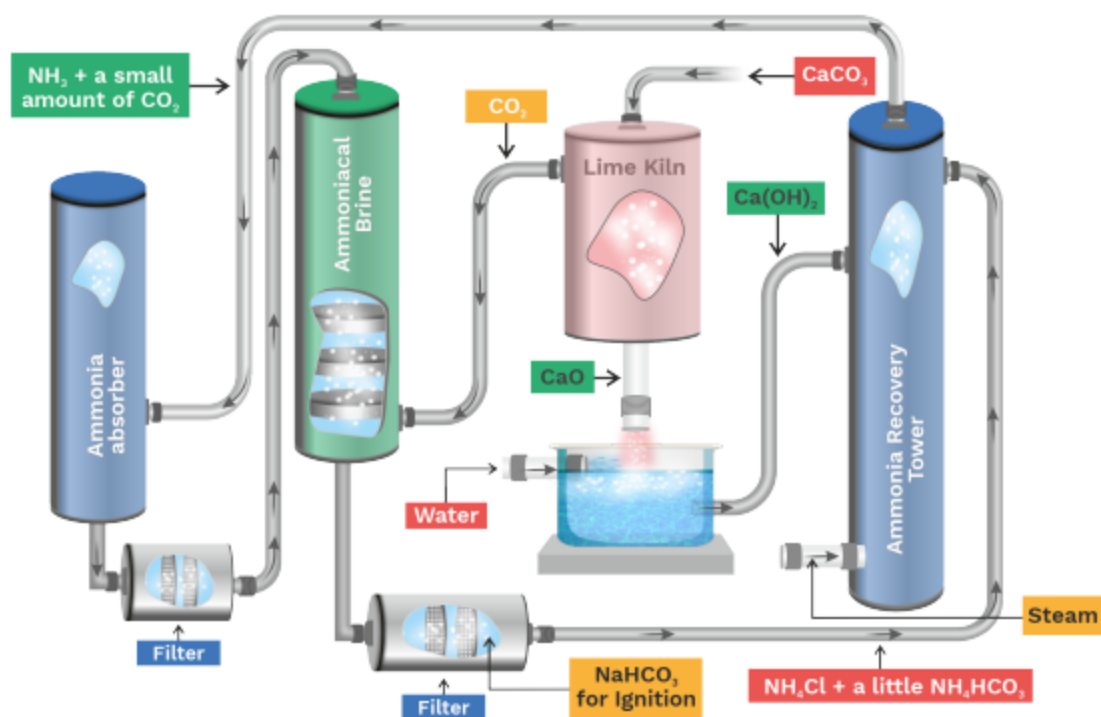


The hydroxides of alkaline earth metals are less basic corresponding alkali metal hydroxides because of higher ionization energies, smaller ionic sizes and greater lattice energies.

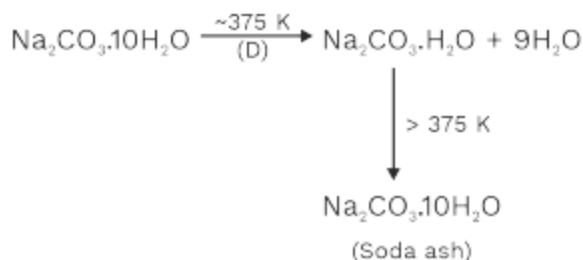
Rack your Brain



Arrange alkaline earth metals in increasing order of their solubility in water?



H_2CO_3 can not be prepared from Solvay's process since KHCO_3 is water soluble. (no PPT)
Washing soda ($\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$) also shows efflorescence just like blue vitriol.

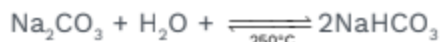


Properties :

- (i) Anhydrous Na_2CO_3 is called as soda ash, which melts at 852°C but does not decompose on heating.
- (ii) It forms number of hydrates.



- (iii) Sodium carbonate absorbs CO_2 yielding sparingly soluble NaHCO_3 which can be calcined at 250° to get pure Na_2CO_3 .



- (iv) It dissolved in acid with effervescence of carbon dioxide and causticized by lime to give NaOH .



Potassium Carbonate :

- By Leblanc process, it can be prepared but by Solvay process it cannot be prepared because KHCO_3 is soluble in water.

Concept Ladder



The Na_2CO_3 exists in various forms, namely anhydrous sodium carbonate Na_2CO_3 (soda-ash); monohydrate $\text{Na}_2\text{CO}_3 \cdot \text{H}_2\text{O}$ (crystal carbonate); heptahydrate $\text{Na}_2\text{CO}_3 \cdot 7\text{H}_2\text{O}$ and decahydrate $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ (washing soda).

Rack your Brain



Write down the raw materials used in Solvay process?

Previous Year's Questions



On heating which of the following releases CO_2 most easily?

[NEET-2015]

- | | |
|------------------------------|-----------------------------|
| (1) Na_2CO_3 | (2) MgCO_3 |
| (3) CaCO_3 | (4) K_2CO_3 |

Properties :

- It resembles with Na_2CO_3 , melting point is 900°C but a mixture of Na_2CO_3 and K_2CO_3 melts at 712°C .

Calcium Carbonate :

- It occurs in nature as chalk, calcite, coral, limestone, marble etc. It is prepared by dissolving limestone or marble in HCl and removing Al and Fe present, by precipitating with ammonia and then adding ammonium carbonate to the solution.

**Properties :**

- (i) It dissociates above 1000°C as follows :



- (ii) CaCO_3 dissolves in water containing CO_2 forming $\text{Ca}(\text{HCO}_3)_2$ but is precipitated from the solution by boiling.

**Magnesium Carbonate :**

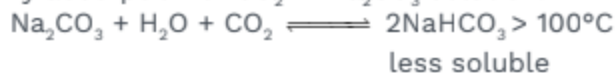
- $\text{Mg}(\text{CO}_3)_2$ occurs in nature as magnesite, isomorphous with calcite. It is obtained as a white ppt by adding NaHCO_3 to a solution of a magnesium salt; but only basic carbonate, called magnesita alba, having the approximate composition $\text{MgCO}_3 \cdot \text{Mg}(\text{OH})_2 \cdot 3\text{H}_2\text{O}$ is precipitated.

Properties :

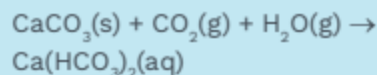
Same as calcium carbonate.

Bicarbonates**Sodium Bicarbonates :****Preparation :**

By adsorption of CO_2 in Na_2CO_3 solution.

**Concept Ladder**

All the carbonates of alkaline earth metals are however more soluble in the presence of CO_2 due to the formation of corresponding bicarbonates.

**Rack your Brain**

Why potassium carbonate cannot be prepared by Solvay process?

Previous Year's Questions

Which of the following substance is used in the laboratory for fast drying of neutral gases [AIIMS]

- Sodium phosphate
- Phosphorus pentoxide
- Sodium sulphate
- Anhydrous calcium chloride

Uses : It is used as baking powder and in medicine.

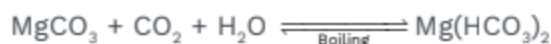
Potassium bicarbonates :

Preparation : Same as NaHCO_3

Properties : Same as NaHCO_3

But KHCO_3 is soluble in H_2O and more alkaline compared to NaHCO_3 .

Magnesium bicarbonate :



Calcium bicarbonate :



Chlorides

Sodium Chloride :

Prepared from brine containing 25% NaCl.

Properties :

- It is nonhygroscopic but the presence of magnesium chloride in common salt renders it hygroscopic.
- It is used to prepare freezing mixture in laboratory (Ice-common salt mixture is called freezing mixture and temperature goes down to -23°C).
- For melting ice and snow on road.

Potassium Chloride :

KCl is also occurs in nature as sylvine (KCl) or carnalite ($2\text{KCl}, \text{MgCl}_2, 6\text{H}_2\text{O}$)

Uses : It is used as fertiliser.

Preparation : By dissolving MgCO_3 in dil. HCl.



Properties :

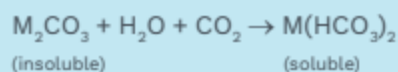
- It crystallises as hexahydrate, $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$.
- It is deliquescent solid.
- This hydrate undergoes hydrolysis as follows.



Concept Ladder



The bicarbonates of alkaline earth metals are prepared by passing CO_2 through a suspension of metal carbonates in water.



Rack your Brain



Write some uses of bicarbonates of K, Mg and Ca.

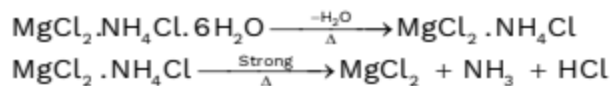
Concept Ladder



All the bicarbonates of alkaline earth metals are stable only in solution and have not been isolated in the pure state.

- Hence, anhydrous magnesium chloride cannot be prepared by heating this hydrate.
 - Because of this formation of HCl. Sea water cannot be used in marine boilers which corrodes the iron body.
- (iv) Anhydrous MgCl_2 can be prepared by heating a double salt like.

$\text{MgCl}_2 \cdot \text{NH}_4\text{Cl} \cdot 6\text{H}_2\text{O}$ as follows :



Sorel Cement :

Sorel cement is set to hard mass on standing when MgO and MgCl_2 (paste like). This is used in flooring, dental filling etc.

Calcium Chloride :

- It is the by-product in Solvay process.
- CaCl_2 may also be prepared by dissolving the carbonate in HCl.



Properties :

- It is deliquescent crystals.
- CaCl_2 gets hydrolysed like MgCl_2 hence anhydrous CaCl_2 cannot be prepared.



Hence, anhydrous CaCl_2 is prepared by heating $\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$ in a current of HCl (dry).

- Anhydrous calcium chloride is used in drying gases and organic compounds but not ammonia or alcohol due to the formation of $\text{CaCl}_2 \cdot 8\text{NH}_3$ and $\text{CaCl}_2 \cdot 4\text{C}_2\text{H}_5\text{OH}$.

Sulphates

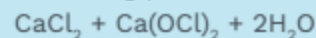
Sodium Sulphate :

Preparation : Na_2SO_4 is formed in the 1st step of Leblanc process by heating common salt with sulphuric acid.

Concept Ladder



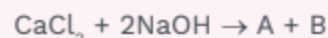
Slaked lime reacts with chlorine to form calcium hypochloride; a constituent of bleaching powder.



Rack your Brain



What are A and B for given reaction?



Previous Year's Questions



Solubility of the alkaline earth's metal sulphates in water decreases in the sequence? [AIPMT-2015]

- $\text{Ca} > \text{Sr} > \text{Ba} > \text{Mg}$
- $\text{Sr} > \text{Ca} > \text{Mg} > \text{Ba}$
- $\text{Ba} > \text{Mg} > \text{Sr} > \text{Ca}$
- $\text{Mg} > \text{Ca} > \text{Sr} > \text{Ba}$

Thus the salt cake formed is crystallised out from its aq. solution as $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$. This termed as Glauber's salt.

- When it is crystallised below 32.4° , then $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ is obtained but above 32.4°C , Na_2SO_4 (anhyd.) comes out.

Properties :

Na_2SO_4 is reduced to Na_2S when fused with C.



Magnesium Sulphate :

Preparation :

- It is obtained by dissolving $\text{MgSO}_4 \cdot \text{H}_2\text{O}$ in boiling water and then crystallising the solution as a hepta hydrate. i.e. $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$. It is called as Epsom salt.
- It is also obtained by dissolving MgCO_3 in hot dil. H_2SO_4 .

$$\text{MgCO}_3 + \text{H}_2\text{SO}_4 \longrightarrow \text{MgSO}_4 + \text{H}_2\text{O} + \text{CO}_2$$
- By dissolving dolomite ($\text{CaCO}_3 \cdot \text{MgCO}_3$) in hot dil. H_2SO_4 and removing the insoluble CaSO_4 by filtration.
- It is isomorphous with $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$, $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$.

Calcium Sulphate :

It occurs as anhydrite calcium sulphate and as the dihydrate gypsum, alabaster or satin-spar.

Properties :

- $$\text{Gypsum}(\text{CaSO}_4 \cdot 2\text{H}_2\text{O}) \xrightleftharpoons[+\text{H}_2\text{O}]{120^\circ\text{C}} 2\text{CaSO}_4 \cdot \text{H}_2\text{O} \text{ (Plaster of Paris)}$$

$$\downarrow 200^\circ\text{C}$$

(anhydrous) CaSO_4
Dead burnt plaster

- Solubility of CaSO_4 at first increase upto

Concept Ladder



Out of minerals of sodium like

- Soda feldspar ($\text{Na}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot 6\text{SiO}_2$)
- Rock salt (NaCl)
- Chile salt (NaNO_3)
- Glauber's salt ($\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$)
- Borax ($\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$)

Only NaCl has been used economically to extract the sodium metal.



Previous Year's Questions

Crude sodium chloride obtained by crystallisation of brine solution does not contain

[NEET-2019]

- | | |
|---------------------|------------------------------|
| (1) MgCO_3 | (2) Na_2SO_4 |
| (3) MgCl_2 | (4) CaSO_4 |

a certain point and then decreases with rise of temperature.

- (iii) POP is used in mould making due to its porous body.
- (a) Mg_3N_2 when reacted with water, gives off NH_3

Q.11

but HCl is not obtained from MgCl_2 on reaction with water at room temperature. Why ?

- (b) The crystalline salts of alkaline earth metals contain more water of crystallization than corresponding alkali metal salts. Why ?

A.11

- (a) Mg_3N_2 is a salt of a strong base and weak acid hence its hydrolysis is possible.



MgCl_2 is a salt of a strong base, $[\text{Mg}(\text{OH})_2]$, and a strong acid, (HCl), and hence its hydrolysis is not possible.

- (b) Alkaline earth metal ions have higher tendency of hydration in comparison to alkali metal ions due to its small size and high Z_{eff} . Thus, the salts of alkaline earth metals contain more water of crystallization than the salts of alkali metals.

Q.12

What happens when :

- (i) Beryllium carbide reacts with water.
(ii) Magnesium nitrate is heated.
(iii) Quick lime is heated in electric furnace with powdered coke.

A.12

- (i) Methane gas is evolved.



- (ii) Brown coloured gas, NO_2 , is evolved.



- (iii) Calcium carbide is formed with evolution of CO gas.





	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 is 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 (Li_2CO_3 is an exception).
(ix)	Nitrates	Decompose on heating evolving a mixture of 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	Are less reactive and comparative harder metals. High melting points. Diamagnetic.	Soft, low melting points. Paramagnetic.
(xii)	Hydration of compounds	The compounds are extensively hydrated. $MgCl_2 \cdot 6H_2O$, $CaCl_2 \cdot 6H_2O$ and $BaCl_2 \cdot 2H_2O$ are hydrated chlorides.	The compounds are less hydrated. $NaCl$, KCl and $RbCl$ form non-hydrated chlorides.
(xiii)	Reducing power	Weaker, as ionization potential values are high and oxidation potential values are low.	Stronger, as ionization potential values are low and oxidation potential values are high.

Q.13 Why cannot sodium and potassium be prepared by the electrolysis of their aqueous solutions ?

A.13 The electrode potential i.e. reduction potential of Na (-2.71 V) or K (-2.92) is much lower than that of H₂O (-0.83 V), therefore, upon electrolysis, water gets reduced in preference to Na⁺ or K⁺ ions. In other words, sodium and potassium cannot be obtained by electrolytic reduction of Na⁺ or K⁺ ions in aqueous solution.

Q.14 Amongst alkali metals, why is lithium regarded as strongest reducing agent in aqueous solutions ?

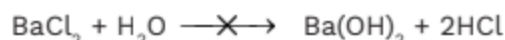
A.14 Li⁺ has the smallest size among alkali metals therefore, it has highest hydration energy.
In other words, it has the lowest electrode potential ($E^\circ = -3.04$ V), i.e., it has the maximum tendency to lose electrons and hence is the strongest (most apt) reducing agent amongst alkali metals.

Q.15 Why Be and Mg do not give characteristic colour to the flame whereas other alkaline earth metals do give?

A.15 Be and Mg have high ionization enthalpies and hence their valence electrons are not easily excited.

Q.16 Explain why halides of beryllium fume in moist air but other alkaline earth metal halides do not?

A.16 BeCl₂ being a salt of weak base, Be(OH)₂ and a strong acid, HCl undergoes hydrolysis by water to form HCl which fumes in air. BaCl₂, on the other hand, being a salt of a strong base, Ba(OH)₂ and strong acid, HCl does not undergo hydrolysis by water to form HCl and hence does not fume in air.





Summary



- General Electronic Configuration ns^1
- General Oxidation State is +1
- Atomic Size $Li < Na < K < Rb < Cs$
- Ionisation Energy $Li > Na > K > Rb > Cs$
- Density $Li < K < Na < Rb < Cs$
- Reducing property
 - (i) $Li < Na < K < Rb < Cs$ (Molten)
 - (ii) $Li > K \approx Rb > Cs > Na$ (Aqueous)
- Simple ionic radii are in the order $Li^+ < Na^+ < K^+ < Rb^+ < Cs^+$
- Hydrated radii $Li^+(aq) > Na^+(aq) > K^+(aq) < Rb^+(aq) < Cs^+(aq)$
- Ionic mobility $Li^+(aq) < Na^+(aq) < K^+(aq) < Rb^+(aq) < Cs^+(aq)$
- Li shows resemblance with Mg, an element of group IIA. This resemblance is termed as diagonal relationship.
 - (i) Ionic radii and atomic radii of Li and Mg are not very much different.
 - (ii) Both have high polarising power (Ionic potential).
- General Electronic Configuration ns^2
- General Oxidation State is +2
- Atomic Size $Be < Mg < Ca < Sr < Ba$
- Ionisation Energy $Be > Mg > Ca > Sr > Ba$
- Reducing Property $Be^{+2} < Mg^{+2} < Ca^{+2} < Sr^{+2} < Ba^{+2}$
(in aqueous and gaseous medium)
- $Mg(OH)_2$ is called 'milk of magnesia' and is used as antacid. $Ca(OH)_2$ is called 'milk of lime'.
- Be shows diagonal relationship with aluminium, the second element of III A group.
 - (a) The polarising power of Be^{2+} and Al^{3+} ions is high, consequently the compounds are covalent.
 - (b) The electronegativity of both the elements is nearly the same.
 - (c) Be_2C and Al_4C_3 on hydrolysis evolve CH_4 .