

● Alkali and Alkaline Earth Metals

Group-1 (Group of Alkali Metals)

Elements, Atomic Number and Electronic configuration of first group in periodic table.

Element	Atomic Number	Electronic configuration
Li (Lithium)	3	[He] $2s^1$
Na (Sodium)	11	[Ne] $3s^1$
K (Potassium)	19	[Ar] $4s^1$
Rb (Rubidium)	37	[Kr] $5s^1$
Cs (Cesium)	55	[Xe] $6s^1$
Fr (Francium)	87	[Rn] $7s^1$

● Occurrence

- The proportion of sodium and potassium in the composition of soil is about 4%.
- Francium is highly radio active.
- The half life period of its isotope ^{223}Fr is having longest life of only 21 minutes.
- The chief minerals and compositions of elements of group-1 are as follows :

- (i) Lithium Spodumine- $\text{Li}(\text{AlSiO}_3)_2$
 Lapidolyte $(\text{Li, Na, K})_2 \text{Al}_2(\text{SiO}_3)_3 [\text{F}(\text{OH})]_6$
- (ii) Sodium Rock salt- NaCl
 Carnite - $\text{Na}_2\text{B}_4\text{O}_7 \cdot 4\text{H}_2\text{O}$
 Borax - $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$
 Chile salt petre - NaNO_3
- (iii) Potassium : Sylvine - KCl
 Carnalite - $\text{KCl, MgCl}_2 \cdot 6\text{H}_2\text{O}$

These metals give different colour flames in oxidizing (blue) flame.

Metal	Li	Na	K	Rb	Cs
Colour	Crimson red	Yellow	Violet	Red violet	Blue violet
λ (nm)	670.8	589.2	766.5	780.0	455.5

- The amounts of Na and K can be determined with the help of instruments like **flame photometer** or **atomic absorption spectrophotometer**.
- **Cesium** and **potassium** are used in photoelectric cells because of this property.

● **Atomic size and Ionic size** : As we move from Li to Cs, atomic number **increases**, atomic size increases and ionic size **decreases**.

● **Ionization Enthalpy** : Ionization enthalpy is the lowest for alkali metals.

● As we move from Li to Cs, ionization enthalpy gradually decreases.

● Alkali elements are good conductors of heat, some of them are used as **coolants** in **nuclear reactor**.

● **Hydration Enthalpy** : The **hydration enthalpy** of alkali elements **decreases** with **increase** in **their ionic sizes**.



The degree of hydration of Li is the highest due to which lithium salts are mainly hydrated.
eg. $\text{LiCl} \cdot \text{H}_2\text{O}$.

1. Which salt of Na and K are in more proportion obtained in ash of shrubs or plants ?

- (A) CO_3^{2-} (B) PO_4^{3-} (C) SO_4^{2-} (D) NO_3^{-1}

2. Which of the following element of first group is radio active ?

- (A) Li (B) Na (C) K (D) Fr

3. Which metals are obtained as by-product during metallurgy of lithium ?

- (A) Rb (B) Cs (C) both Rb and Cs (D) None

4. What is electronic configuration of francium ?

- (A) $[\text{Kr}] 6s^1$ (B) $[\text{Rn}] 7s^1$ (C) $[\text{Xe}] 5s^1$ (D) $[\text{Xe}] 6s^1$

5. Which form of salt of sodium is chile saltpetre ?

- (A) Silicate (B) Nitrate (C) Borate (D) Chloride

6. Half life of ^{223}Fr is minute.

- (A) 21 (B) 42 (C) 63 (D) 84

7. How much Fr will remain in sample of 500 gm Fr after 63 minutes ?

- (A) 166.66 gm (B) 500 gm (C) 250 gm (D) 62.5 gm

8. Which metal is used in photoelectric cell ?

- (A) Cd (B) K (C) Rb (D) Na

9. Match correct pair :

Alkali Metal	Colour in flame test
(P) Li	(T) Blue
(Q) Na	(U) Purple
(R) K	(V) Yellow
(S) Cs	(W) Dark red

(A) (P)-(W), (Q)-(V), (R)-(U), (S)-(T)

(B) (P)-(T), (Q)-(W), (R)-(V), (S)-(U)

(C) (P)-(U), (Q)-(T), (R)-(W), (S)-(V)

(D) (P)-(V), (Q)-(U), (R)-(T), (S)-(W)

10. Cesium is more reactive in alkali metals because
 (A) Its incomplete orbital is closer to nucleus.
 (B) Its valence shell has only one electron
 (C) It is the heaviest alkali metal.
 (D) Its outermost electron combine weakly than other alkali metals
11. Elements of group (I) gives coloured flame when heated in Bunsen burner flame because ...
 (A) low ionization enthalpy (B) low melting point
 (C) soft (D) only one e^- in valence orbit
12. Which alkali metal starts melting if room temperature increases more than 30°C ?
 (A) Na (B) K (C) Rb (D) Cs
13. Select the factor of Li to prepare strong reducing agent in aqueous solution.
 (A) Sublimation enthalpy (B) Ionization enthalpy
 (C) Hydration enthalpy (D) Electron gain enthalpy
14. Which of the following is decreasing order of ionization enthalpy for alkali metal elements ?
 (A) $\text{Na} > \text{Li} > \text{K} > \text{Rb}$ (B) $\text{Li} > \text{Na} > \text{K} > \text{Rb}$ (C) $\text{Rb} > \text{Na} > \text{K} > \text{Li}$ (D) $\text{K} < \text{Li} < \text{Na} < \text{Rb}$
15. Which alkali metal having more wavelength emit light in flame test ?
 (A) Na (B) K (C) Cs (D) Li
16.has maximum photoelectric effect.
 (A) Cs (B) K (C) Na (D) Li
17. Which of the following statement is not appropriate for alkali metal elements ?
 (A) Their ions are isoelectronic with noble gas. (B) Their melting point are low.
 (C) It possess low electro negativity. (D) It possess high ionisation enthalpy
18. Sylvine is a mineral of metal.
 (A) K (B) Na (C) Li (D) Rb
19. Arrange the species Li_2 , Li_2^- , Li_2^+ in the increasing order of stability.
 (A) $\text{Li}_2^- < \text{Li}_2^+ < \text{Li}_2$ (B) $\text{Li}_2 < \text{Li}_2^- < \text{Li}_2^+$ (C) $\text{Li}_2^- < \text{Li}_2 < \text{Li}_2^+$ (D) $\text{Li}_2 < \text{Li}_2^+ < \text{Li}_2^-$
20. Sodium can't be possible to make Na^{2+} ion because...
 (A) It's first and second ionization enthalpy are very low.
 (B) It's first and second ionization enthalpy are very high.
 (C) It's first ionization enthalpy is high but second ionization enthalpy is low.
 (D) It's first ionization enthalpy is low but second ionization enthalpy is high.
21. First ionization potential of Na is 5.1 eV; then what is the value of electron gain enthalpy of Na^+ ion ?
 (A) -5.1 eV (B) -10.2 eV (C) +2.55 eV (D) -2.55 eV

Answers : 1. (A), 2. (D), 3. (C), 4. (B), 5. (C), 6. (A), 7. (D), 8. (B), 9. (A), 10. (D), 11. (A), 12. (D), 13. (C), 14. (B), 15. (B), 16. (A), 17. (D), 18. (A), 19.(A), 20. (D), 21. (C)

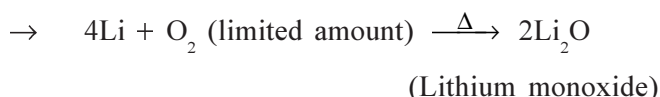
● Chemical Reactivity of Alkali metals

The reactivity of these elements increase as we go down the group.

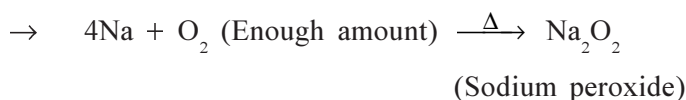
● Chemical Reactions

(1) **Reactivity towards air or oxygen** : The alkali metals get tarnished in dry air because of the formation of their oxides which further reacts with moisture and forms hydroxides. They burn vigorously in air and form **oxides**.

- Lithium forms monoxide.



- Sodium forms peroxide.



The other metals form superoxides. Superoxide ions (O_2^{1-} ion) are stable only in presence of large cations like K, Rb, Cs.



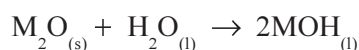
The oxidation state of alkali metal in all these oxides is +1.

Lithium as an exception also form lithium nitride (**Li_3N**) by direct reaction with nitrogen of air.

Alkali metals are kept in **kerosene** because of their high reactivity.

● Oxide and hydroxide compounds and reactions towards dihydrogen, dihalogen, water, ammonia.

(1) **M_2O type oxides of alkali metals react with water and gives strong basic solutions** :



→ Sodium hydroxide is called caustic soda and potassium hydroxide is called caustic potash. It **burns** the skin.

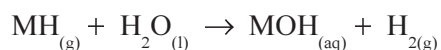
→ LiOH is **sparingly soluble** in water while the hydroxides of Na, K, Rb and Cs are **soluble** in water.

(2) **Reactivity towards water** : Alkali metals react with water and form hydroxides and dihydrogen.



Due to its **small size** and **high hydration enthalpy**, it reacts less vigorously than sodium.

(3) **Reactivity towards dihydrogen (H_2)** : Alkali metals when heated with dihydrogen form their hydrides which on reaction with water release hydrogen gas.

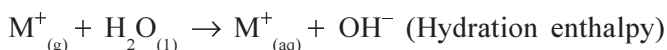
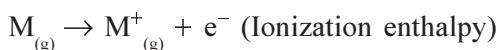


● Reduction Nature

Alkali metals are strong reducing agents.

Lithium is the strongest and sodium is the least strong reducing agent.

The standard electrode potential (E°) determines the strength as reducing agent.



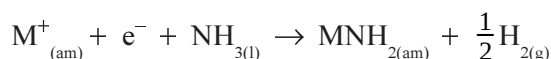
(4) Reactivity towards halogen : The distortion electron cloud of electron produced by cation is called **polarization**.

- Lithium halide is partially **covalent** due to **high polarization capability** of lithium ions.
- Lithium iodide is the most co-valent.
- Halogens act as oxidizing agent in formation of halides.
- The melting point and boiling point of any alkali metal is in order : $F > Cl > Br > I$
- All halide compounds **except lithium fluoride** are **soluble in water**.

(5) Reactivity towards liquid ammonia : The alkali metals dissolve in liquid ammonia and gives deep blue coloured solutions which are electric conductor in nature.

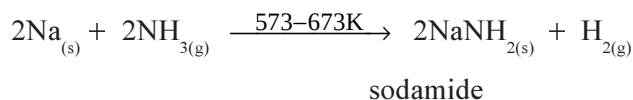


→ The blue colour of the solution is due to **ammoniated electron** which absorbs light from visible spectrum and gives blue colour to solution. These solutions are **paramagnetic** and liberate hydrogen slowly on standing and form **amide**.



Where, 'am' indicates ammonia solution.

→ The blue colour in strong solution changes to bronze colour and becomes **diamagnetic**.



(6) Salts of oxoacids : Alkali metals form salts with all oxo acids. They are generally soluble in water and are thermally stable.

→ Their carbonates (M_2CO_3) and most of the hydrogen carbonates (bicarbonates) ($MHCO_3$) are more stable towards heat.

→ As we go down in the group the stability of carbonates and bicarbonates **increases**.

→ Lithium carbonate is unstable towards heat.

→ Lithium being small in size, in Li_2O and CO_2 . Its hydrogen carbonate does not exist as solid.

22. What is obtained when sodium is heated with enough amount of oxygen and low temperature ?
 (A) Na_2O (B) Na_2O_2 (C) NaO_2 (D) Na_2O_3
23. Which alkali metal forms super oxide with excess oxygen at high temperature ?
 (A) K (B) Rb (C) Cs (D) All above
24. Which alkali metal gives common oxide like M_2O when heated in presence of air ?
 (A) Rb (B) K (C) Li (D) Na
25. Which of the following is the strongest base ?
 (A) LiOH (B) KOH (C) NaOH (D) RbOH
26. Which of the following compound is insoluble in water ?
 (A) LiF (B) LiCl (C) LiBr (D) LiI
27. is sparingly soluble in water.
 (A) Li_2CO_3 (B) LiCl (C) Li_3PO_4 (D) LiOH
28. Which of the following compound is the most stable ?
 (A) LiF (B) LiCl (C) LiBr (D) LiI
29. Which salt does not exist in solid state ?
 (A) Na_2CO_3 (B) NaHCO_3 (C) LiHCO_3 (D) KHCO_3
30. Which of the following is the highest co-valent compound ?
 (A) LiCl (B) LiF (C) LiBr (D) LiI
31. What is obtained when sodium is heated with moisturised air ?
 (A) NaO (B) NaOH (C) Na_2O (D) Na_2CO_3
32. Which reaction does not occur when enough amount of Na metal dissolve in liquid ammonia at low temperature ?
 (A) give blue coloured solution (B) Na^+ ion prepared in solution
 (C) Sodium amide (D) Ammonium sodium ion.
33. Which of the following is responsible for blue coloured solution, when sodium dissolves in liquid ammonia ?
 (A) Sodium ion (B) Ammonium electron
 (C) Sodium amide (D) Ammonium sodium ion
34. Which of the following compound is generally not possible ?
 (A) K_2O (B) KO_4 (C) KO_2 (D) K_2O_2
35. Which acts as reductant and oxidant both ?
 (A) NaNO_3 (B) N_2O (C) Na_2O_2 (D) KNO_3
36. KO_2 is used in oxygen cylinder in spaceship and submarine because
 (A) It absorbs CO_2 and increase proportion of O_2 (B) It decreases moisture
 (C) It prepares ozone. (D) None

37. Give tendency of co-valency in increasing order for alkali halide compounds.
- (A) $MI > MBr > MCl < MF$ (B) $MF < MCl < MBr < MI$
 (C) $MBr < MCl < MI < MF$ (D) $MF < MBr < MCl < MI$
38. Which of the following is unstable towards heat ?
- (A) K_2CO_3 (B) Na_2CO_3 (C) $BaCO_3$ (D) Li_2CO_3
39. How many elements from Li, Na, K, Rb and Cs form directly superoxide with oxygen in presence of heat ?
- (A) 5 (B) 2 (C) 3 (D) 4
40. Which reaction is not correct ?
- (A) $2Li_2O \xrightarrow{673\text{ K}} Li_2O_2 + 2Li$ (B) $2K_2O \xrightarrow{673\text{ K}} K_2O_2 + 2K$
 (C) $2Na_2O \xrightarrow{673\text{ K}} Na_2O_{2(s)} + 2Na$ (D) $2Rb_2O \xrightarrow{673\text{ K}} Rb_2O_2 + 2Rb$
41. Select correct option to complete following reaction. "When alkali metals dissolve in liquid ammonia then"
- (A) gives blue coloured solution.
 (B) The blue colour in strong solution changes to bronze colour.
 (C) The blue colour of this solution is due to ammoniated electron.
 (D) All statements are correct
42. Which of the following option is wrong ?
- (A) $4LiNO_{3(s)} \rightarrow 2Li_2O_{(s)} + 4NO_{2(g)} + O_{2(g)}$
 (B) $2NaNO_{3(s)} \rightarrow 2NaNO_{2(s)} + O_{2(g)}$
 (C) Li_2O and MgO do not form super oxides combine with more amount of oxygen
 (D) $LiHCO_3$ is in solid form.
43. Very pure dilute solution of sodium in liquid ammonia ...
- (A) gives blue colour. (B) show electric conductance.
 (C) produces sodium amide. (D) both (A) and (B).
44. Which metal gives amide with ammonia at 300°C temperature ?
- (A) Mg (B) Pd (C) Al (D) Na
45. $xLiNO_3 \xrightarrow{\Delta} yLiO + zNO_2 + w NO_2$ stoichiometric co-efficient x,y,z, w in given reaction are respectively
- (A) 4, 2, 4, 1 (B) 2, 4, 2, 1 (C) 3, 2, 3, 2 (D) 3, 2, 3, 1

46. 'P' metal heated with nitrogen gives $X(M_3N)$ compound. X is heated high temperature P metal obtained back. X heated with H_2O produces Y gas, which passes through aqueous solution of $CuSO_4$ gives dark blue coloured. So what is P metal and Y gas ?
- (A) Al and NH_3 (B) Li and NH_3 (C) Al and N_2O (D) Li and N_2O
47. Which of the following is the most stable ?
- (A) Na_3N (B) Li_3N (C) K_3N (D) Rb_3N
48. Which of the following metal carbonate produce CO_2 gas with acid when heated ?
- (A) Na_2CO_3 (B) K_2CO_3 (C) Rb_2CO_3 (D) Li_2CO_3
49. What is produced heated to $NaNO_3$?
- (A) O_2 (B) $O_2 + NO_2$ (C) NO_2 (D) NO
50. What is produced heated to $LiNO_3$?
- (A) O_2 (B) NO_2 (C) $O_2 + NO_2$ (D) NO

Answers : 22. (B), 23. (D), 24. (C), 25. (D), 26. (A), 27. (D), 28. (A), 29. (C), 30. (D), 31. (B), 32. (D), 33. (B), 34. (B), 35. (C), 36. (A), 37. (B), 38. (D), 39. (C), 40. (A), 41. (D), 42. (D), 43. (D), 44. (D), 45. (A), 46. (B), 47. (B), 48. (D), 49. (A), 50. (C)

● **Diagonal relationship and Irregularity :**

Diagonal relationship of lithium with magnesium : (i) Lithium and magnesium elements are harder but softer than the other elements of the corresponding groups.

(ii) Lithium and magnesium react slowly with water. Their oxides and hydroxides are very less soluble in water. Their hydroxides decompose on heating.

(iii) Lithium and magnesium both combine with nitrogen directly and form nitrides (Li_3N_2 and Mg_3N_2).

(iv) The oxides Li_2O and MgO do not give super oxides by combining with more oxygen.

(v) On heating carbonates of lithium and magnesium decompose easily and give oxides and carbon dioxide. Solid hydrogen carbonates are not formed by lithium and magnesium.

(vi) Both $LiCl$ and $MgCl_2$ are soluble in ether.

(vii) Both $LiCl$ and $MgCl_2$ are hygroscopic and crystallise, as $LiCl \cdot 2H_2O$ and $MgCl_2 \cdot 8H_2O$ from their aqueous solutions.

● **Anomalous behaviour of lithium from other elements of the group**

(i) Lithium is very hard. Its melting point and boiling point are higher than those of other alkali metals.

(ii) $LiCl$ crystallises as hydrate while other alkali metals do not form.

(iii) Monoxide Li_2O and nitride Li_3N are formed, while other do not form.

(iv) $LiHCO_3$ is not form in solid form while other elements form.

(v) Lithium unlike other alkali metals do not form ethylide by reaction with ethyne.

(vi) Lithium nitrate when heated gives lithium oxide (Li_2O) while other metal nitrates decompose into their corresponding nitrites.

- (vii) LiF and Li_2O are very less soluble in water compared to corresponding compounds of their metals.

● **Diagonal relationship and Irregularity (Be and Mg) :**

Diagonal relationship of Beryllium and Aluminium

- Beryllium possesses similarities with aluminium.
 - Beryllium like aluminium does not react very fast with acid because of the oxide layer on the surface of metal.
 - Beryllium hydroxide becomes soluble in excess alkali forming beryllate ion $[\text{Be}(\text{OH})_4]^{2-}$
 - The chloride of both Be and Al possess $-\text{Cl}$ bridge in their vapour state. Both chlorides are soluble in organic solvents and are strong lewis acid. AlCl_3 is used as Friedel crafts catalyst.
 - Be like Al is passive towards nitric acid.
 - Al_4C_3 and Be_2C give methane gas.
 - Anomalous behaviour of Be with other elements of the group.
 - Its compounds are formed mostly co-valent because of their high ionization enthalpy, small size and hydrolyse easily.
 - It cannot have co-ordination number more than four.
 - Oxide and hydroxide of Be are amphoteric compared to other member of the group.
-

51. Which alkali metal does not form ethynide when reacts with ethyne ?
(A) Li (B) Na (C) K (D) All above
52. Which metallic nitrate on heating gives metal oxide ?
(A) LiNO_3 (B) NaNO_3 (C) $\text{Ca}(\text{NO}_3)_2$ (D) $\text{Mg}(\text{NO}_3)_2$
53. Which statement is wrong for Li ?
(A) Melting point and boiling point of Li are higher than those of other alkali metals.
(B) Li react with nitrogen gives Li_3N .
(C) Li is softer than other alkali metals.
(D) Except Li all alkali metals ions are hygroscopic in less proportion.
54. Sodium nitrate decompose at 800°C higher temperature to give
(A) N_2 (B) O_2 (C) NO_2 (D) Na_2O
55. Which alkali metal directly reacts with nitrogen to give nitride ?
(A) K (B) Li (C) Na (D) Rb
56. Beryllium hydroxide reacts with excess NaOH to give compound.
(A) $\text{Na}[\text{Be}(\text{OH})_4]$ (B) $\text{Na}_2[\text{Be}(\text{OH})_4]$ (C) $\text{Na}_3[\text{Be}(\text{OH})_4]$ (D) $\text{Na}_4[\text{Be}(\text{OH})_4]$
57. Water reacts with and to produce methane gas.
(A) BeC , Al_2C_3 (B) Be_2C , Al_2C_3 (C) Be_2C_3 , Al_2C_3 (D) Be_2C , Al_4C_3
58. Which hydroxide is insoluble in water ?
(A) $\text{Be}(\text{OH})_2$ (B) $\text{Mg}(\text{OH})_2$ (C) $\text{Ca}(\text{OH})_2$ (D) $\text{Ba}(\text{OH})_2$
-

59. Nature of beryllium oxide is

- (A) basic. (B) amphoteric. (C) acidic. (D) both (A) and (B)

60. What is used as Friedel-Crafts catalyst ?

- (A) AlCl_3 (B) Al_2O_3 (C) AlPO_4 (D) Na_3AlF_6

Answers : 51. (A), 52. (A), 53. (C), 54. (B), 55. (B), 56. (B), 57. (D), 58. (A), 59. (B), 60. (A)

● **Lithium occurrence, properties and uses**

The chief minerals of lithium and their composition are as follows :

(i) Spodumene : $\text{LiAl}(\text{SiO}_3)_2$ (ii) Lepidolite : $(\text{Li, Na, K})_2\text{Al}_2(\text{SiO}_3)_3, (\text{F, OH})_2$

(iii) Amblygonite : $\text{Li}_2\text{Al}(\text{PO}_4)\text{F}(\text{OH})$

● **Extraction :** In the first step, the mineral is heated at 1373 K and then it reacts with H_2SO_4 at 573 K temperature and then mixed with water it converts into $\text{Li}_2\text{SO}_4 \cdot 2\text{H}_2\text{O}$. Then reacts with sodium carbonate and finally reacts with hydrochloric acid, LiCl is formed.

In the second step, the molten mixture of 55 % LiCl and 45 % KCl is electrolysed giving lithium containing 1 % impurity of K.

● **Properties :**

Lithium is silvery white and softer metal than lead, but harder than sodium.

Being smallest in size of elements of group-I the values of its melting point and boiling point, boiling point and ionization enthalpy are the highest.

● **Uses :**

As reducing agent, in formation of alloys, in aeronautic industry, formation of armour plate, formation of very strong and corrosion resistant alloy (1 % Mg + 14 % Li).

● **Sodium : occurrence, properties and uses**

→ **Occurrence :** Sodium is available in large abundance in combined form in the crust of earth, sea water etc.

Its chief minerals and their compositions are as follows :

(i) Rock salt : NaCl (ii) Chile salt petre : NaNO_3 (iii) Borax : $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$

→ **Extraction :** The industrial production of sodium is carried out via **Down's cell** by electrolysis of sodium chloride melted at 1123 K.

In the Down's cell, anode is inert graphite and steel or iron is cathode. Sodium metal is obtained at cathode and Chlorine gas is obtained at anode.

→ **Cell Reaction :** Anode : $2\text{Cl}^-_{(l)} \rightarrow \text{Cl}_{2(g)} + 2e^-$: Oxidation

Cathode : $\text{Na}^+_{(l)} + e^- \rightarrow \text{Na}_{(s)}$: Reduction

● **Properties :**

Physical : Sodium is a silvery shining and soft metal.

It is kept in **kerosene** because it is very reactive.

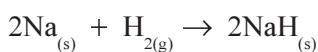
● **Chemical :**

(i) Reactivity towards dioxygen : Sodium metal reacts very fast with dioxygen and gives peroxide in presence of excess of O_2 . $2Na_{(s)} + O_{2(g)} \rightarrow Na_2O_{2(s)}$

Sodium peroxide

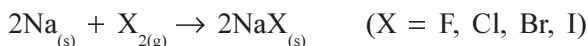
(ii) Reactivity towards water : Sodium metal reacts very fast and vigorously with water and sometimes there is explosion. $2Na_{(s)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_{2(g)}$

(iii) Reactivity towards dihydrogen : Sodium reacts with dihydrogen and forms sodium hydride.



Sodium hydride

(iv) Reactivity towards halogen : Sodium reacts very fast with halogens and forms halides.



● **Uses**

It is reducing agent, as liquid coolant in atomic reactor, dyes industry, vapour in sodium light. For detection of elements in organic compound by **Lassigne test**.

61. Which of the following mineral is not of Li ?

- (A) Spodumene (B) Lepidolyte (C) Amblygonite (D) Carnalite

62. In extraction of Li, in second step, the molten mixture of % LiCl and % KCl is electrolysed.

- (A) 45, 55 (B) 55, 45 (C) 40, 60 (D) 50, 50

63. What percentage proportion of formation of very strong and corrosion resistant alloy in Li ?

- (A) 24 % (B) 14 % (C) 1 % (D) 0.1 %

64. In Down's cell, production of sodium cathode and anode are used and respectively.

- (A) Copper, Nickel (B) Copper, Chromium
(C) Nickel, Chromium (D) Iron, Graphite

65. In extraction of Li, KCl is added in LiCl in electrolysed method because

- (A) to increase the conductivity of LiCl (B) to decrease the melting poing of mixture
(C) to decrease the conductivity of LiCl (D) both (A) and (B)

66. Which of the following known as globar salt ?

- (A) $MgSO_4 \cdot 7H_2O$ (B) $FeSO_4 \cdot 7H_2O$ (C) $CuSO_4 \cdot 5H_2O$ (D) $Na_2SO_4 \cdot 10H_2O$

67. Which element is used in Lassigne test ?

- (A) Li (B) Na (C) K (D) Rb

68. What is used as liquid coolant in nuclear reactor ?
 (A) Na (B) K (C) Rb (D) Cs
69. Which metal keep fixed around by paraffine wax ?
 (A) Na (B) Li (C) K (D) Cs
70. Which of the following is the most soluble in water ?
 (A) CsClO_4 (B) LiClO_4 (C) NaClO_4 (D) KClO_4

Answers : 61. (D), 62. (B), 63. (B), 64. (D), 65. (D), 66. (D), 67. (B), 68. (A), 69. (B), 70. (B)

● Alkaline Earth Metals

Occurrence : Calcium and magnesium are available in greater abundance and strontium and barium in very small proportion.

Radium is radioactive and is obtained in very less proportion in the combined form.

● Elements, Minerals and Composition

Element	Chief minerals and composition
Beryllium	Oxide Beryl : 3BeO , Al_2O_3 , 6SiO_2 , (15 % BeO) Oxide crenaside : BeO , Al_2O_3 , 6SiO_2 , (7 % BeO) Oxide bromalite : BeO (45 % BeO)
Magnesium	Magnesite : MgCO_3 , Epsom salt : $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ Criserite : $\text{MgSO}_4 \cdot \text{H}_2\text{O}$ Carnalite : $\text{MgCl}_2 \cdot \text{KCl} \cdot 6\text{H}_2\text{O}$ Crinite : K_2SO_4 , MgSO_4 , MgCl_2 dolomite : CaCO_3 , MgCO_3
Calcium	Lime stone, chalk, Marble : CaCO_3 Gypsum : $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$, Flourspar : CaF_2 Flourapatite : $[\text{Ca}_5(\text{PO}_4)_3\text{F}]$ Chlorapatite : $[\text{Ca}_5(\text{PO}_4)_3\text{Cl}]$
Strontium	Strontianide : SrCO_3 , Silastine : SrSO_4
Barium	Witherite : BaCO_3 , Baryte : BaSO_4
Radium	In combined salt form in minerals like pitchblende, carnalite.

Electronic configuration : General electronic configuration can be shown as [noble gas] ns^2 .

Ionization Enthapy : As we move from top to bottom, ionization enthalpy decreases.

The first ionization enthalpy of alkaline earth metals is more than that of corresponding group-I metals.

The second ionization enthalpy of alkaline earth metals is less than that of their corresponding alkali metals.

Hydration Enthalpy : The compounds of alkaline earth metal hydrates extensively as compared to alkali metal compounds.

eg., MgCl_2 and CaCl_2 exist as $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$ and $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$ respectively while NaCl and KCl do not form hydrates.

● **Related trends between physical properties**

→ Alkaline earth metals are generally white, shiny and soft but hard in comparison to alkali metals.

→ Due to low ionization enthalpy they are strongly electropositive in nature.

→ This characteristic increases as we move from Be to Ba.

→ Ca, Ba and Sr give characteristics flame.

Ca : Brick red

Ba : Light green

Sr : Crimson red

The electrons of Be and Mg are strongly bonded that they do not get excited.

The quantitative analysis of Ca can be done with flame photometer, atomic absorption spectrometer.

71. Which metal of group-II forms complex salt ?

- (A) Be (B) Ba (C) Ca (D) Sr

72. Which mineral is not of magnesium ?

- (A) Epsom salt (B) Dolomite (C) Witherite (D) Crinite

73. Which is strontium's mineral in the form of sulphate salt ?

- (A) witherite (B) carnelite (C) strontianide (D) silastine

74. Match proper pair.

Name of mineral	Molecular formula
(P) Epsom salt	(T) $\text{CuCO}_3 \cdot \text{MgCO}_3$
(Q) Flourspar	(U) BaCO_3
(R) Witherite	(V) CaF_2
(S) Dolomite	(W) $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$

(A) (P) → (W), (Q) → (V), (R) → (U), (S) → (T)

(B) (P) → (T), (Q) → (W), (R) → (V), (S) → (U)

(C) (P) → (U), (Q) → (T), (R) → (W), (S) → (V)

(D) (P) → (V), (Q) → (U), (R) → (T), (S) → (W)

75. Which mineral do not possess two different metals ?

- (A) Carnalite (B) Dolomite (C) Flourapatite (D) Flourspar

76. Which element is radio-active in group-II ?

- (A) Cu (B) Sr (C) Ba (D) Ra

77. Which element does not give colour in flame test of group-II ?

- (A) Only Be (B) Mg (C) Both Be and Mg (D) Ca

78. Match correct pair :

Alkaline Earth Element	Colour in flame test
(P) Ca	(S) Crimson red
(Q) Sr	(T) light green
(R) Ba	(U) Brick red

(A) (P)-(U), (Q)-(T), (R)-(S)

(B) (P)-(T), (Q)-(S), (R)-(U)

(C) (P)-(S), (Q)-(T), (R)-(U)

(D) (P)-(U), (Q)-(S), (R)-(T)

79. In India, crackers give green flame on marriage occasion. Which element is present in it ?

- (A) Na (B) K (C) Ca (D) Ba

80. Which substance give crimson red colour in flame test which decompose on heating to give oxygen and produce brown coloured gas ?

- (A) Magnesium nitrate (B) Barium nitrate (C) Calcium nitrate (D) Strontium nitrate

81. Which of the following salt is used as free-flo (moistured) from table salt during moonsoon ?

- (A) KCl (B) KI (C) $\text{Ca}_3(\text{PO}_4)_2$ (D) Na_3PO_4

82. Which of the following ion has more hydration enthalpy of Mg^{2+} ion ?

- (A) Al^{3+} (B) Be^{2+} (C) Na^+ (D) Mg^{2+}

83. Which pair of chloride do not show colour in flame test ?

- (A) BeCl_2 and SrCl_2 (B) BeCl_2 and MgCl_2 (C) BaCl_2 and CaCl_2 (D) MgCl_2 and CaCl_2

84. Which option is incorrect for alkaline earth metals ?

- (A) Hydration Enthalpy : $\text{Be} > \text{Mg} > \text{Ca} > \text{Sr}$
 (B) Second ionization enthalpy : $\text{Be} > \text{Mg} > \text{Ca} > \text{Sr}$
 (C) Density : $\text{Sr} > \text{Be} > \text{Mg} > \text{Ca}$
 (D) Atomic size : $\text{Sr} > \text{Ca} > \text{Mg} > \text{Be}$

85. Electronic configuration of metal M is $1s^2 2s^2 2p^6 3s^2$ so what is formula of oxide ?

- (A) MO (B) M_2O (C) M_2O_3 (D) MO_2

86. Molecular formula of carnalite is

- (A) $\text{KCl} \cdot \text{MgCl}_2 \cdot 2\text{H}_2\text{O}$ (B) $\text{K}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot 6\text{H}_2\text{O}$ (C) $\text{KCl} \cdot \text{MgCl}_2 \cdot 6\text{H}_2\text{O}$ (D) $\text{Na}_2 \cdot \text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$

87. Which compound is known as 'bluejohn' ?

- (A) CaH_2 (B) CaF_2 (C) $\text{Ca}_3(\text{PO}_4)_2$ (D) CaO

88. Witherite is which type of salt of barium ?

- (A) Carbonate (C) Chloride (D) Sulphate (D) phosphate

89. Which chief mineral is silestine ?

- (A) Ca (B) Ra (C) Ba (D) Sr

90. Which of the following is not mineral of Ca ?

- (A) limestone (B) Flourspar (C) Dolomite (D) Epsom salt

Answers : 71. (A), 72. (C), 73. (D), 74. (A), 75. (D), 76. (D), 77. (C), 78. (D), 79. (D)
80. (D), 81. (C), 82. (C), 83. (B), 84. (B), 85. (A), 86. (C), 87. (B), 88. (A)
89. (D), 90. (D)

● Chemical Properties

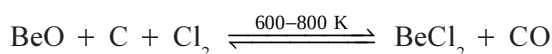
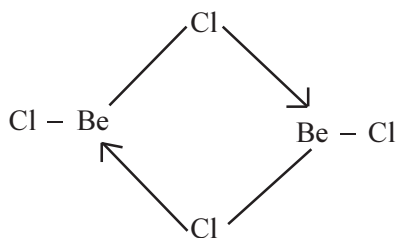
- The alkaline earth metals are less reactive as compared to alkali metals. The reactivity increases as we go down in the group.
- Be and Mg are inert from reactivity point of view because there is a layer of oxide on their surfaces, but powdered Be burns brightly in air and gives BeO and Be_3N_2 .
- Mg being more electropositive burns in air brightly giving shining light and gives MgO and Mg_3N_2 .

● Oxides and hydroxides Compounds

- Alkaline earth metals form oxides of the MO type which are white coloured compounds.
- Beryllium oxide is amphoteric while other oxides are strongly basic.
- $\text{Be}(\text{OH})_2$ and $\text{Mg}(\text{OH})_2$ can be obtained by reaction of NaOH with their water soluble salts.
- As we go down in the group there is gradual increase in the solubility of the hydroxides.

● Halide Compounds

Reactivity towards halogens : The best reaction of formation of BeF_2 is the decomposition of $(\text{NH}_4)_2\text{BeF}_4$. BeCl_2 which can be prepared easily from its oxide.



- BeCl_2 in vapour state forms a dimer having chloro-chloro (Cl – Cl) bridge.
- It dissociates into monomer at about 1200 K.

The tendency of formation of halide hydrates decreases gradually as we go down in the group.
eg. $\text{MgCl}_2 \cdot 8\text{H}_2\text{O}$, $\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$, $\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$, $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$

Fluorides are relatively less soluble than chlorides. The reason for this is **their higher lattice energy**.

- **Solubility and Thermal stability of oxosalts :** Alkaline earth metals form salts of oxo acids. some of them are as follows :

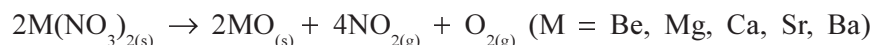
⇒ **Sulphates** → It is a white solid substance and thermally stable.

- BeSO_4 and MgSO_4 dissolve readily in water.
- The solubility decreases as we move from CaSO_4 to BaSO_4 .
- The hydration enthalpy of Be^{2+} and Mg^{2+} ions is more than the lattice enthalpy and so they are soluble in water.

- **Nitrates**

Magnesium nitrate crystallize as magnesium nitrate with water molecules, while barium nitrate crystallizes anhydrous salt. This also shows that with increase in ionic size and with decreasing hydration enthalpy, there is a decrease in tendency of formation of hydrates.

All of them, when heated decompose into oxides like lithium nitrate.



- **Carbonates**

The carbonates of alkaline earth metals are insoluble in water with increase in atomic number the solubility of carbonate salts gradually decreases.

- **Reduction nature of metals :** The alkaline earth metals like alkali metals are strong reducing agents.

In comparison to other alkaline earth metals, the value of Be is less negative.

Its reducing nature is associated with its higher hydration enthalpy which is in accordance with its (Be^{2+}) small size and higher value of metal atomic enthalpy.

- **Solutions in liquid ammonia :** Alkaline earth metals like alkali metals dissolve in liquid ammonia and give dark blue coloured solutions by forming ammoniated ion.

- **Uses**

Cu-Be alloy is used in the formation of springs having more strength. Be-metal is used in windows of X-ray tubes. Mg-Al alloy being light in weight is used in making aeroplanes. Mg powder and ribbons are used in flash powder, bulbs incendiary bombs and signals. In preparation of Grignard reagent. The suspension of $Mg(OH)_2$ in water is known as milk of magnesia. It is used in as antacid in medicines. $MgCO_3$ is one of the components in tooth paste. Salts of Ra are used in radiotherapy. eg. In treatment of Cancer.

91. Which statement is correct for $BeCl_2$ in vapour state ?

- | | |
|-------------------------------------|---|
| (A) Each Be attach with three Cl. | (B) Each Be attach with two Cl. |
| (C) Be-Cl-Be bonds are three times. | (D) Each Be-Cl bond possess equal strength. |

92. Be is used to fill HNO_3 because ...

- | | |
|---|--|
| (A) It is alkaline earth metal. | (B) It is inert towards HNO_3 |
| (C) It has diagonal relationship with Mg. | (D) It has two electrons in valence shell. |

93. Which of the following statement is wrong ?

- (A) Strontium decompose water molecule faster than beryllium.
 (B) $BaCO_3$ melts higher temperature than $CaCO_3$.
 (C) Solubility of water in $Ba(OH)_2$ is more than $Mg(OH)_2$.
 (D) $Be(OH)_2$ is more basic than $Ba(OH)_2$.

94. Which hydroxide is insoluble in water ?

- | | | | |
|----------------|----------------|----------------|----------------|
| (A) $Ca(OH)_2$ | (B) $Ba(OH)_2$ | (C) $Be(OH)_2$ | (D) $Mg(OH)_2$ |
|----------------|----------------|----------------|----------------|

95. Decomposition of $(NH_4)_2 BeF_4$ gives

- | | | | |
|-------------|-------------|-------------|-------------|
| (A) BeF_2 | (B) BeF_4 | (C) BeF_3 | (D) BeF_6 |
|-------------|-------------|-------------|-------------|

96. Which hydroxide salt of metal is amphoteric ?
 (A) Be (B) Mg (C) Ca (D) Ba
97. Reaction between BaO_2 and ozone give
 (A) Ba (B) Ba_2F_3 (C) BaO (D) $\text{Ba}(\text{OH})_3$
98. Cool down the vapour of Ba_2X_2 gives
 (A) BaX_4 (B) Be_2X_2 (C) Be_2X_6 (D) Be_3X_6
99. Which compound has least melting point ?
 (A) CaF_2 (B) CaCl_2 (C) CaBr_2 (D) CaI_2
100. Which metal is used to remove water completely from alcohol ?
 (A) Na (B) K (C) Ca (D) Al
101. Which of the following has maximum water solubility ?
 (A) BeSO_4 (B) MgSO_4 (C) CaSO_4 (D) BaSO_4
102. MgSO_4 reacts with $\text{NH}_4\text{OH} + \text{Na}_2\text{HPO}_4$ give white precipitates. What is the formula for precipitates ?
 (A) $\text{Mg}(\text{NH}_4)\text{PO}_4$ (B) $\text{MgCl}_2 \cdot \text{MgSO}_4$ (C) $\text{Mg}(\text{PO}_4)_2$ (D) MgSO_4
103. Decreasing order of thermal stability of alkaline earth carbonates MgCO_3 , CaCO_3 , BaCO_3 , SrCO_3
 (A) $\text{CaCO}_3 < \text{SrCO}_3 < \text{MgCO}_3 < \text{BaCO}_3$ (B) $\text{BaCO}_3 < \text{SrCO}_3 < \text{MgCO}_3 < \text{CaCO}_3$
 (C) $\text{BaCO}_3 < \text{SrCO}_3 < \text{CaCO}_3 < \text{MgCO}_3$ (D) $\text{MgCO}_3 < \text{CaCO}_3 < \text{SrCO}_3 < \text{BaCO}_3$
104. Which metal carbonate is the most stable thermally ?
 (A) MgCO_3 (B) CaCO_3 (C) SrCO_3 (D) BaCO_3
105. Which metal hydroxide is least basic ?
 (A) $\text{Mg}(\text{OH})_2$ (B) $\text{Ca}(\text{OH})_2$ (C) $\text{Sr}(\text{OH})_2$ (D) $\text{Ba}(\text{OH})_2$
106. Which halide soluble in ethanol ?
 (A) BeCl_2 (B) MgCl_2 (C) CaCl_2 (D) SrCl_2
107. Which hydroxide of group-II is soluble in NaOH ?
 (A) $\text{Be}(\text{OH})_2$ (B) $\text{Mg}(\text{OH})_2$ (C) $\text{Ca}(\text{OH})_2$ (D) $\text{Ba}(\text{OH})_2$
108. Which compound dissolve quickly in water ?
 (A) BeSO_4 (B) MgSO_4 (C) BaSO_4 (D) Both (A) and (B)
109. Which molecular formula is correct for given some compounds of alkaline earth metal halides ?
 (A) $\text{CaCl}_2 \cdot 4\text{H}_2\text{O}$ (B) $\text{SrCl}_2 \cdot 4\text{H}_2\text{O}$ (C) $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ (D) $\text{BaCl}_2 \cdot 4\text{H}_2\text{O}$
110. Which of the following statement is correct for $\text{Ca}(\text{OH})_2$?
 (A) It is used in preparation of bleaching powder
 (B) It is light blue coloured solid substance
 (C) It has no characteristic as antiseptic
 (D) It is used to produce cement

111. In compound of calcium (A) water is added to give compound (B), in which CO_2 gas is passed to become milky and gives compound C. If CO_2 gas is passed excessively to give compound (D) and milky colour is removed, then identify compound (D).
- (A) CaO (B) Ca(OH)_2 (C) CaCO_3 (D) $\text{Ca(HCO}_3)_2$
112. Which alkaline earth metal sulphate least soluble in water ?
- (A) MgSO_4 (B) CaSO_4 (C) BaSO_4 (D) SrSO_4
113. Metal M form quickly water soluble sulphate MSO_4 , which on heated gives insoluble hydroxide and oxide MO . If the hydroxide dissolve in NaOH , identify metal M.
- (A) Be (B) Ca (C) Mg (D) Sr
114. Which oxide is amphoteric ?
- (A) MgO (B) BeO (C) CaO (D) BaO
115. One reactive important component of bleaching powder is
- (A) $\text{Ca(OC}l)_2$ (B) $\text{Ca(OC}l)\text{Cl}$ (C) $\text{Ca(ClO}_2)_2$ (D) $\text{Ca(ClO}_2)_2\text{Cl}$
116. Fill in the blanks with appropriate option. "Except other alkaline earth metal halide are ionic in nature."
- (A) Barium halide (B) strontium halide (C) Beryllium halide (D) Calcium halide
117. 'X' substance reacts with Cl_2 form bleaching powder. What is X ?
- (A) CaO (B) Ca(OH)_2 (C) $\text{Ca(OC}l)_2$ (D) $\text{Ca(ClO}_3)_2$
118. Which alkaline earth metal sulphate has hydration enthalpy > lattice enthalpy ?
- (A) SrSO_4 (B) MgSO_4 (C) CaSO_4 (D) BaSO_4
119. Which of the following is insoluble in CH_3COOH ?
- (A) CaO (B) CaCO_3 (C) Calcium oxalate (D) Ca(OH)_2
120. Which option is correct for decreasing order of ionic character ?
- (A) $\text{BeCl}_2 > \text{MgCl}_2 > \text{BaCl}_2 > \text{CaCl}_2$ (B) $\text{BeCl}_2 > \text{BaCl}_2 > \text{CaCl}_2 > \text{MgCl}_2$
 (C) $\text{BeCl}_2 > \text{BaCl}_2 > \text{MgCl}_2 > \text{CaCl}_2$ (D) $\text{BaCl}_2 > \text{CaCl}_2 > \text{MgCl}_2 > \text{BeCl}_2$
121. Which of the following possess maximum lattice energy ?
- (A) MgO (B) SrO (C) CaO (D) BaO
122. Which of the following obtained when 2 mole magnesium nitride reacts with more proportion of H_2O ?
- (A) 1 mole NH_3 (B) 2 mole HNO_3 (C) 4 mole NH_3 (D) 3 mole NH_3
123. Which metal is used to prepare the windows of X-ray tube ?
- (A) Be (B) Mg (C) Ba (D) Al
124. Which metal is used in flash bulb wire ?
- (A) Mg (B) Cu (C) Ba (D) Ag

125. 30 gm Mg reacts with 30 gm O₂ gives product and byproduct are respectively.

(A) 60 gm MgO

(B) 40 gm MgO and 20 gm O₂

(C) 45 gm MgO and 10 gm O₂

(D) 50 gm MgO and 10 gm O₂

Answers : 91. (A), 92. (B), 93. (D), 94. (C), 95. (A), 96. (A), 97. (C), 98. (D), 99. (D), 100. (C), 101. (A), 102. (A), 103. (C), 104. (D), 105. (A), 106. (A), 107. (A), 108. (D), 109. (C), 110. (A), 111. (D), 112. (C), 113. (A), 114. (B), 115. (A), 116. (C), 117. (B), 118. (B), 119. (C), 120. (A), 121. (A), 122. (C), 123. (A), 124. (A), 125. (D)

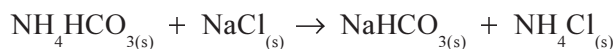
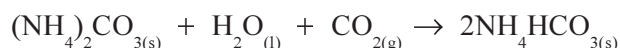
● **Production, Properties and uses of some compounds of sodium**

Sodium Carbonate (Na₂CO₃ · 10H₂O) :

● **preparation :**

Its industrial production is carried out by Solvay's method or process

Ammonium hydrogen carbonate is prepared by passing CO₂ from a solution of NaCl saturated with ammonia (NH₄)₂CO₃ is later on converted to NH₄HCO₃.

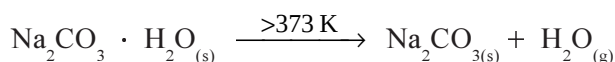
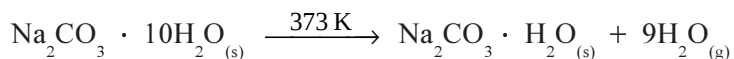


Solvay's process cannot be used for production of K₂CO₃. The reason is that KHCO₃ is very highly soluble that by addition of NH₄HCO₃ to KCl does not get precipitated.

● **Properties :**

It is a white crystalline solid substance which possesses existence as decahydrate which is known as washing soda.

On heating at higher temperature than 373 K it becomes completely anhydrous and changes to white powder form known as soda ash (Na₂CO₃).



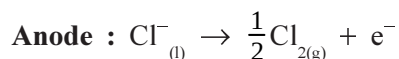
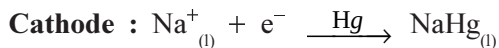
● **Uses**

Softening hard water, washing and cleansing, manufacturing of compounds like glass, soap borax and caustic soda, paper, dye and textile industries and as laboratory reagent in chemical analysis.

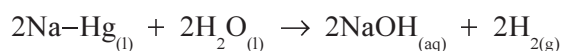
(2) Sodium hydroxide (Caustic soda) (NaOH)

Preparation : Industrial production of NaOH is carried out by electrolysis of a solution of NaCl in **Castner Kelner cell**.

Electrolysis of brine solution is carried out using mercury **cathode** and carbon anode.



NaOH and H₂ gas are produced by reacting amalgum with water.



● Properties

NaOH is white translucent solid substance.

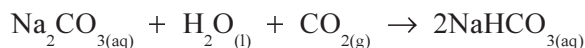
The solution of NaOH absorbs CO₂ from the atmosphere above its surface and reacts, so that Na₂CO₃ is formed.

● Uses

In preparation of soap, paper, artificial silk and number of chemicals, refining of petroleum, purification of bauxite the mineral of Al, textile industry for mercerization of cotton cloth, prepare pure fat and oil, as reagent in laboratory.

(3) NaHCO₃: Sodium bicarbonate or sodium hydrogen carbonate

Preparation : Sodium carbonate solution is saturated with CO₂ to prepare sodium hydrogen carbonate. It can also be obtained by solvay ammonia soda process.



● Properties

It is a white crystalline solid substance.

It is less soluble than Na₂CO₃.

● Uses

It is a mild antiseptic for the infection of skin diseases. It is used as **antiseptic**, fire extinguisher, as antacid for the acid in stomach and as reagent in laboratory.

● Biological importance of Na⁺ and K⁺ ions :

Anybody having weight of 70 kg possesses 90 gm Na and 170 gm K. In its comparison only 5 gm Fe and 0.06 gm Cu are possessed.

These ions play an important role in nerve signal transmission control of flow of water between cell membrane, for transport of sugar and amino acids.

It seems that Na and K possess many similarities from chemistry point of view but differentiate quantitatively in penetration through cell wall, their flow mechanism and efficiency in activating the enzyme.

Thus potassium ions are cation in abundance where they active the enzyme and become responsible for producing ATP by oxidation of glucose and transport of nerve signal with sodium.

The level of Na in red blood cells in blood plasma is about **143 m mol lit⁻¹**

while that of K is only 5 m mol lit⁻¹. These concentration change to 10 m mol lit⁻¹ (Na⁺) and 105 m mol lit⁻¹ (K⁺).

This concentration degradation is the indication of a discriminative mechanism which is called sodium potassium pump.

126. Which by product is obtained in preparation of Na_2CO_3 , by reaction of Ca(OH)_2 and NH_4Cl ammonia can be back obtained ?
 (A) NaCl (B) NaOH (C) CaCl_2 (D) NaHCO_3
127. Molecular formula of soda-ash is
 (A) $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ (B) Na_2CO_3 (C) $\text{Na}_2\text{CO}_3 \cdot 2\text{H}_2\text{O}$ (D) $\text{Na}_2\text{CO}_3 \cdot \text{H}_2\text{O}$
128. K_2CO_3 can't be prepared by solvay-ammonia soda process, because.....
 (A) K_2CO_3 is easily soluble in water. (B) Its crystallization in water does not occur.
 (C) KHCO_3 is more soluble in water. (D) KHCO_3 decompose in water.
129. Which of the following statement is wrong for mechanism of Na^+ ion in human body ?
 (A) An important role in nerve signal transmission.
 (B) Control of flow of water between cell membrane.
 (C) For transport of sugar and amino acids.
 (D) They activate enzymes.
130. Which gas liberates on cathode during preparation of NaOH ?
 (A) Cl_2 (B) H_2 (C) O_2 (D) H_2O
131. Match column I with column II.

Column-I	Column-II
(P) NaOH	(T) Photoelectric cell
(Q) Na_2CO_3	(U) Coolant in atomic reactor
(R) Liquid Na	(V) Absorb SO_2
(S) Cesium	(W) Detergent

- (A) (P)-(W), (Q)-(U), (R)-(T), (S)-(V)
 (B) (P)-(U), (Q)-(T), (R)-(V), (S)-(W)
 (C) (P)-(V), (Q)-(W), (R)-(U), (S)-(T)
 (D) (P)-(T), (Q)-(V), (R)-(W), (S)-(U)

132. Which pump is important in biochemical reaction of human body ?
 (A) Ca-Mg (B) Na-K (C) K-Fe (D) Fe-Ca
133. Which reaction does not occur in solvay-ammonia soda process ?
 (A) $(\text{NH}_4)_2\text{CO}_3 + \text{H}_2\text{O} + \text{CO}_2 \rightarrow 2\text{NH}_4\text{HCO}_3$
 (B) $2\text{KHCO}_3 \xrightarrow{\Delta} \text{K}_2\text{CO}_3 + \text{H}_2\text{O} + \text{CO}_2$
 (C) $2\text{NaHCO}_3 \xrightarrow{\Delta} \text{Na}_2\text{CO}_3 + \text{H}_2\text{O} + \text{CO}_2$
 (D) $2\text{NH}_4\text{Cl} + \text{Ca(OH)}_2 \longrightarrow 2\text{NH}_3 + \text{CaCl}_2 + \text{H}_2\text{O}$
134. What is the weight of 286 gm $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ heated at 373 K temperature at end of reaction ?
 (A) 206 gm (B) 186 gm (C) 162 gm (D) 124 gm
135. Na_2SO_4 dissolves in water while BaSO_4 is sparingly soluble because,
 (A) Hydration enthalpy of sodium sulphate is more than lattice enthalpy
 (B) Lattice enthalpy of Barium sulphate is more than hydration enthalpy
 (C) No role of lattice energy for solubility
 (D) Both (A) and (B)

136. Formula of microcosmic salt is

- (A) $\text{Na}_2\text{HPO}_4 \cdot 2\text{H}_2\text{O}$ (B) $(\text{NH}_4)_2\text{HPO}_4 \cdot 2\text{H}_2\text{O}$
(C) $\text{Na}(\text{NH}_4)\text{HPO}_4 \cdot 4\text{H}_2\text{O}$ (D) None of above

137. Which product is obtained by lablank method ?

- (A) Baking soda (B) Washing soda (C) Potash (D) Plaster of paris

138. Which compound is used in gun powder ?

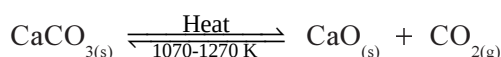
- (A) NaNO_3 (B) KNO_3 (C) LiNO_3 (D) None

Answers : 126. (C), 127. (B), 128. (C), 129. (D), 130. (B), 131. (C), 132. (B), 133. (B), 134. (D), 135. (D), 136. (C), 137. (C), 138. (B)

● Important Compounds of Calcium

Preparation :

(1) **Quick lime (Calcium oxide CaO)** : CaO is obtained on commercial scale by heating lime stone (CaCO_3) at 1070 – 1270 K temperature in rotary kiln.



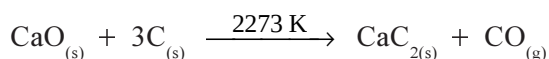
● Properties

Quick lime gives soda lime on mixing with caustic soda.

Being basic it combines with acidic oxides at high temperature.

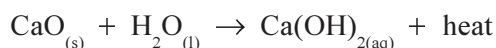


It forms calcium carbide with carbon at 2273 K.



Uses : In preparation of slaked lime, bleaching powder, dyes, distemper, CaC_2 , cement, mortar etc. In purification of sugar, coal, gas and softening of hard water, as layers on the inner side of electric furnace, preparation of NH_3 gas in laboratory.

(2) **Calcium hydroxide (slaked lime ($\text{Ca}(\text{OH})_2$))** : **Preparation :** When H_2O is added to lumps of quick lime large amount of heat is produced and lumps break to give powder which makes the solution containing calcium hydroxide.



● Properties

The suspension of slaked lime is known as ‘milk of lime’ which is alkaline.

Milk of lime forms hypochloride by reaction with chloride which is component of bleaching powder.

Uses : Preparation of mortar which is one of the component of building materials, white

washing of walls, absorption of acidic gases and to get NH_3 from NH_4Cl , glass and leather industry, purification of sugar, preparation of bleaching powder, as antiseptic and softening hard water, laboratory for the test of CO_2 .

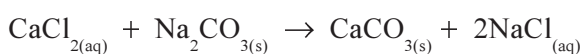
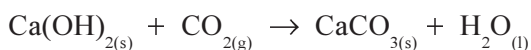
(3) Calcium Carbonate (lime stone, CaCO_3)

● Preparation

Chemical name : Calcium carbonate.

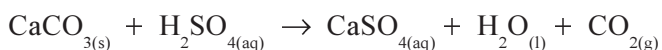
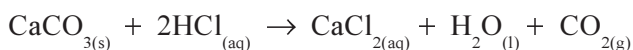
Obtained in two crystalline form : Calcite and aegonite.

It can be prepared by passing CO_2 through slaked lime or adding Na_2CO_3 to CaCl_2 .



● Properties

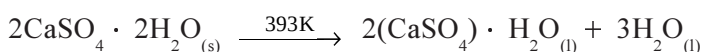
White fluffy powder, almost insoluble in water, on reaction with dilute acids it forms the corresponding calcium salts and CO_2 .



Uses : The mixture of CaCO_3 and MgCO_3 is used as flux in the extraction of metal like iron. specially precipitated CaCO_3 is used for manufacture of high quality paper. As antacid in medicines, as abrasive in tooth pastel as a component in chewingum, as filler in cosmetic materials.

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

Preparation : When gypsum is heated at 393 K plaster of paris is obtained.



There is no water of crystallisation. When heated at more than 393 K it becomes anhydrous CaSO_4 which is known as dead burnt plaster.

● Properties : It is white powder form solid substance.

Its setting velocity can be increased by addition of common salt.

The setting velocity can be decreased by adding borax or alum.

The mixture of alum and plaster of paris which becomes very hard on setting is called keen cement.

Uses : Construction industry and in plastering.

Plastering of fractured bones after operation, in muscles pain, in dentistry for preparation of casts for dentures, casts for ornaments, preparation of statues, as chalks for writing on board.

● Cement

It is one of the important substances for construction. It was introduced by Joseph Aspidin in England in 1824. It is also called portland.

Average composition of cement

CaO : 50–60 %	SiO ₂ : 20–25 %
Al ₂ O ₃ : 5–10 %	MgO : 2–3 %
Fe ₂ O ₃ : 1–2 %	SO ₃ : 1.3 %

For a good quality of cement the ratio of (SiO₂) and (Al₂O₃) must be between 2.5 to 4 and the ratio of CaO and total oxide ((SiO₂ to Al₂O₃ + Fe₂O₃) should be as near as possible raw materials for production of cement are lime stone and clay.

Important ingredients of cement are

dicalcium silicate : (Ca₂SiO₄) 26 %

tricalcium silicate : (Ca₃SiO₃) 51 %

tricalcium aluminate : (Ca₃Al₂O₆) 11%

● Properties

(1) Good quality of portland cement

$$(A) \text{ Silica module : } \eta = \frac{\% \text{ SiO}_2}{\% \text{ Al}_2\text{O}_3 + \% \text{ Fe}_2\text{O}_3}$$

$$(B) \text{ Alumina module ; } \rho = \frac{\% \text{ Al}_2\text{O}_3}{\% \text{ Fe}_2\text{O}_3}$$

Setting of cement : Addition of gypsum is to slow down the time of setting of cement. Its primary strength is **seven** days. The setting of dicalcium and tricalcium silicates are 28 days and one year respectively.

Uses : Construction of roads and buildings.

Around the iron bars the concrete containing portland cement is allowed to set so that very hard reinforce concrete cement is formed and it is used in constructions of slabs, bridges, dams etc.

● Biological importance of Mg⁺² and Ca⁺² ions

The body of an adult contains about 25 gm Mg and 1200 gm Ca as well as 5 gm Fe and 0.06 gm Cu. Its daily requirement in human body is estimated to be 200-300 mg. The chief pigment of absorption of light in the plants is chlorophyll which contains Mg. It also play an important role in neuromuscular function, international transmission cell membrane integrity and coagulation of blood. About 100 mg lit⁻¹ concentration of calcium is regulated in plasma. It is carried out two hormones calcitonin and parathyroid.

139. Addition of Gypsum in cement

(A) setting time of cement decreases.

(B) setting time of cement increases.

(C) colour of cement becomes dull.

(D) cement becomes shiny.

140. Dead plaster of paris is
 (A) CaSO_4 (B) $\text{CaSO}_4 \cdot \text{H}_2\text{O}$ (C) $\text{CaSO}_4 \cdot \frac{1}{2} \text{H}_2\text{O}$ (D) $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$
141. A chief reactive component of bleaching powder is
 (A) $\text{Ca}(\text{OCl})_2$ (B) $\text{Ca}(\text{OCl})\text{Cl}$ (C) $\text{Ca}(\text{ClO}_2)_2$ (D) $\text{Ca}(\text{ClO}_2)\text{Cl}$
142. Which of the following component has maximum proportion in cement ?
 (A) Ca_2SiO_4 (B) Al_2O_3 (C) Ca_3SiO_5 (D) $\text{Ca}_3\text{Al}_2\text{O}_3$
143. Compound $\boxed{\text{X}}$ is heated to produce colourless gas and residue, which dissolves in water gives compound $\boxed{\text{Y}}$ in which excess proportion of CO_2 give compound $\boxed{\text{Z}}$ which obtained in solid from. This solid substance heated to obtain back compound $\boxed{\text{X}}$ so what is that compound ?
 (A) CaCO_3 (B) K_2CO_3 (C) Na_2CO_3 (D) $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$
144. Which of the following is insoluble in CH_3COOH ?
 (A) CaO (B) CaCO_3 (C) Calcium oxalate (D) $\text{Ca}(\text{OH})_2$
145. Fill in the blanks to select proper option. "The important ingredients of portland cement are dicalcium silicate %, tricalcium silicate % and tricalcium aluminate % are present respectively.
 (A) 26 %, 51 %, 11 % (B) 51 %, 26 %, 11 % (C) 11 %, 51 %, 26 % (D) 26 %, 11 %, 51 %
146. A sample of portland cement contains 23 % SiO_2 , 3 % Al_2O_3 , 2 % Fe_2O_3 . What is silica module of that cement ?
 (A) 3.83 (B) 28 (C) 21.73 (D) 4.6
147. For a good quality of cement, the ratio of silica (SiO_2) and alumina (Al_2O_3) must be between
 (A) 3 to 5 (B) 2.5 to 4 (C) 6 to 7.5 (D) 4 to 5.5
148. Chlorophyll and haemoglobin are complex compound of and respectively.
 (A) Mg^{2+} , Ca^{2+} (B) Na^+ , K^+ (C) Mg^{2+} , Fe^{2+} (D) Cl^- , Fe^{2+}
149. Which of the substance is the main component in stone deposited in kidney ?
 (A) $(\text{COO})_2\text{Ca}$ (B) $(\text{COONa})_2$ (C) $(\text{COO})_2\text{Ba}$ (D) $(\text{COO})_2\text{Mg}$
150. Which ion play important role in neuromuscular function ?
 (A) K^+ (B) Mg^{2+} (C) Na^+ (D) Ca^{2+}
151. White enamale of our teeth is
 (A) $\text{Ca}_3(\text{PO}_4)_2$ (B) CaCl_2 (C) CaF_2 (D) CaBr_2
152. Which of the following is obtained when 2 mole magnesium nitride reacts more proportion of H_2O ?
 (A) One mole NH_3 (B) 2 mole HNO_3 (C) 4 mole NH_3 (D) 3 mole NH_3
153. Difference of water molecule is between gypsum and plaster of paris.
 (A) $\frac{5}{2}$ (B) 2 (C) $\frac{1}{2}$ (D) $1\frac{1}{2}$

154. How many and which type of bonds between two carbons atoms in calcium carbide ?
(A) 1 σ , 1 π (B) 1 σ , 2 π (C) 2 σ , 1 π (D) 2 σ , 2 π

155. Select correct option.

- (A) Proportion of Ca is less in gypsum than plaster of paris.
(B) Gypsum is obtained to heat plaster of paris.
(C) Hydration of Gypsum gives plaster of paris.
(D) Partial oxidation of Gypsum gives plaster of paris

156. Setting time of dicalcium silicate is

- (A) 28 days (B) one year (C) one week (D) 24 hours

Answers : 139. (B), 140. (A), 141. (A), 142. (C), 143. (A), 144. (C), 145. (A), 146. (D), 147. (B), 148. (C), 149. (A), 150. (D), 151. (C), 152. (C), 153. (D), 154. (B), 155. (A), 156. (A)

● **There are two statements given. Among one is statement and other is reason (R). Select correct option to read instructions carefully.**

Select correct option for statement (A) and reason (R) given in question.

- (A) Statement (A) is correct, reason (R) is correct
(B) Statement (A) is correct, reason (R) is correct Reason (R) is correct explanation of statement (A)
(C) Statement (A) is correct, reason (R) is wrong.
(D) Statement (A) is wrong, reason (R) is correct.

157. **Statement (A)** : Alkali metals dissolve in ammonia gives blue coloured solution.

Reason (R) : Soluble $[M(NH_3)_x]^+$ species obtained from alkali metals in liquid ammonia.

158. **Statement (A)** : Sodium metal is softer than potassium.

Reason (R) : Potassium possesses weaken metallic bond than sodium.

159. **Statement (A)** : $Be(OH)_2$ is soluble in HCl and NaOH.

Reason (R) : $Be(OH)_2$ is amphoteric.

160. **Statement (A)** : Be is prepared from $[BeF_4]^-$ and Al is prepared from $[AlF_6]^{3-}$

Reason (R) : d-orbitals are not present in Be while Al possess.

161. **Statement (A)** : Li_2CO_3 and Na_2CO_3 are thermally unstable.

Reason (R) : Both carbonates are salts of big cation and big anion.

162. **Statement (A)** : Alkali metals do not show colour in flame test.

Reason (R) : Their ionization enthalpy are very low.

163. **Statement (A)** : Beryllium hydroxide dissolve in excess alkali to give beryllate ion $[Be(OH)_4]^{2-}$.

Reason (R) : Beryllium has strong tendency to form complex.

164. **Statement (A)** : Super oxides of alkali metals are diamagnetic.

Reason (R) : Super oxide ion O^{2-} possess one unpaired electron.

165. **Statement (A)** : Sodium can't obtained sodium metal by reduction from metallurgy ?

Reason (R) : Sodium is strong reducing agent.

Answers : 157. (B), 158. (D), 159. (A), 160. (A), 161. (C), 162. (D), 163. (B), 164. (D), 165. (A).

●