NEET SYLLABUS

s–BLOCK ELEMENTS (Alkali and Alkaline Earth Metals) : *Group I and group II elements:*
General introduction, electronic configuration, occurrence, anomalous properties of the first element of each group, diagonal relationship, trends in the variation of properties (such as ionization enthalpy, atomic and ionic radii), trends in chemical reactivity with oxygen, water, hydrogen and halogens; uses. Preparation and Properties of Some important Compounds: Sodium carbonate, sodium chloride, sodium hydroxide and sodium hydrogencarbonate, biological importance of sodium and potassium. Industrial use of lime and limestone, biological importance of Mg and Ca.

OBJECTIVES

After studying this unit, you will be able to :

- *describe the general characteristics of the alkali metals and their compounds;*
- *explain the general characteristics of the alkaline earth metals and their compounds;*
- *describe the manufacture, properties and uses of industrially important sodium and calcium compounds including Portland cement*
- *appreciate the biological significance of sodium, potassium, magnesium and calcium.*

If human condition were the periodic table, may be love would be hydrogen at number 1. Death would be helium at number 2.

David Mitchell

s-BLOCK ELEMENTS

3.0 INTRODUCTION

The s-block elements of the Periodic Table are those in which the last electron enters in the outermost s-orbital. As the s-orbital can accommodate only two electrons, two groups (1 & 2) belong to the s-block of the Periodic Table. Group 1 of the Periodic table consists of the elements: lithium, sodium, potassium, rubidium, cesium and francium. They are collectively known as the alkali metals. They are so called because they form hydroxides on reaction with water which are strongly alkaline in nature. The elements of Group 2 include Beryllium, Magnesium, Calcium, Strontium, Barium and Radium. These elements with the exception of **beryllium** are commonly known as the alkaline earth metals. They are so called because their oxides and hydroxides are alkaline in nature and these metal oxides are found in the earth's crust.

3.1 PHYSICAL PROPERTIES OF S-BLOCK ELEMENTS

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

Atomic and Physical Properties of the Alkaline Metals

physical properties of s-Block Elements

ALKALI METALS	ALKALINE EARTH METALS
Physical state	
● One electron in outermost shell & **General formula ns^1**. ● Francium is radioactive element. ● All are silvery white ● Light soft, malleable and ductile metals with metallic lustre.	● Two electrons in outer most shell & **General formula ns^2.** ● Radium is radioactive element. ● All are silvery white. ● These metals are harder than alkali metals.
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 **IA** → **IIA** Li → Be Na → Mg K → Ca ↓ ↓ Rb Sr ↓ ↓ Cs Ba	● 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 **In s-block elements** Be has smallest size, while Cs has largest size.
Melting point and Boiling point	
● Weak interatomic bonds are due to their large atomic radii and presence of only one valence electron hence melting point and boiling point are low. ● Decreasing order of melting point and boiling point is Li > Na > K > Rb > Cs	● Metallic bond is stronger than IA group due to smaller atomic size and two electrons in valence shell hence melting point and boiling point are higher. ● Decreasing order of melting point Be > Ca > Sr > Ba > Mg Boiling point Be > Ba > Ca > Sr > Mg

Melting point & Boiling point $\propto$ Strength of metallic bond $\propto$ Number of valence shell e^-

Ionisation energy (I.E.)

- First ionisation energy (I.E.) is very less because of larger atomic size and only one electron in outer most shell.
- Decreasing order of ionisation energy-

  Li > Na > K > Rb > Cs
- Second ionisation energy of alkali metals is very high because by loosing one electron they achieve inert gas configuration.

- 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–

  Be > Mg > Ca > Sr > Ba
- Second ionisation energy is lesser than IA group.

Oxidation state

- The alkali metals shows only + 1 oxidation state.

  (difference between IE_1 and IE_2 > 16eV)

- Alkaline earth metal shows +2. Oxidation state

  (difference between IE_1 and IE_2 < 11eV)

Electro positive character or metallic character

- **Electropositivity $\propto$ 1/Ionisation energy**

  Due to their larger size electron can easily be removed to form M^+ ion. Electro positive property increases from Li to Cs.

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

Density (D = M /V)

- In a group atomic volume also increase along with atomic weight but atomic weight increases more than atomic volume, so density increases from Li to Cs

  Increasing order of density Li < K < Na < Rb < Cs

  Exception : Density of K is less than Na. Why ?

  Ans. This is due to presence of vacant d-orbital in the inner shells of K (volume increases, density decreases)

- Density increases from Be to Ba

  Increasing order of density Ca < Mg < Be < Sr < Ba

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.

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

  Conductivity of IA < Conductivity of IIA

Flame test

- Alkali metals and their salts gives characteristic colour to bunsen flame. The flame energy causes an excitation of the outer most electron which on dropping back to ground state emits absorbed energy as a visible light

  Li-Crimson red Na-Golden yellow K-Violet Rb-Red violet Cs-Blue

- Due to small size of Be & Mg outer most electrons are tightly bounded. So not excited to higher level, hence they do not give flame test.
- Other elements gives characteristic colour to flame **Ca-Brick red Sr-Crimson red Ba-apple green**

Photo electric effect

- Atomic size of K, Rb and Cs is quite large, so their ionisation energy is very low
- Due to very low ionisation energy their valence shell electrons gets excited even by absorbing visible light. That's why Cs is used in photoelectric cells.

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

Standard oxidation potential

- All the alkali metals have high +ve values of standard oxidation potential (tendency of releasing electrons in water or self ionic solutions)
  So they are good reducing agent, having upper most positions in the electro chemical series.
- Li has highest standard oxidation potential (+3.05 eV) due to its high hydration energy. Such that it converts into. Li^+ ion by loosing one electron.
- Order of standard oxidation potential is -
  $Li > Cs \approx Rb \approx K > Na$

- They have lower values of standard oxidation potential due to their high IE.
- Increasing order of standard oxidation potential is -
  Be < Mg < Ca < Sr < Ba

Complex formation tendency

- Only those elements can form complex compounds which have
  (a) Small cation size
  (b) High charge density
  (c) Vacant orbitals to accept electrons.
- Only Li^+ can form complex compound, due to its small size rest alkali metals have very less tendency to form complex compounds.

- Less tendency to form complex compound, but due to small size of cations Be and Mg forms complex compounds like

  $Be–(BeF_4)^{-2}$; $Be_4O(CH_3COO)_6$; Mg – Chlorophyll

Chemical properties of s-block elements

Reactivity

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

  Reactivity $\propto$ 1/Ionisation potential

  order of reactivity – Li < Na < K < Rb < Cs

- Less reactive than alkali metals.
  Order of reactivitity :-
  Be < Mg < Ca < Sr < Ba

Reaction with air

- Alkali metals gets tarnish in air due to the formation of oxide at their surface hence they are kept in kerosene or paraffin wax.
- These elements reacts with moist air to form carbonates

  $4Na + O_2 \rightarrow 2Na_2O$

  $Na_2O + H_2O \rightarrow 2NaOH$
  (moist)

  $2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$
  (in air)

  In dry air only Li gives nitride and oxide both while other elements gives only oxides.

- 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 converts into carbonates.
- In dry air all elements of II-A give nitride and oxide both.

Reaction with oxygen

Oxide ion [O^{2-}] :

- Li forms mainly Li_2O (Lithium oxide).

Peroxide [O_2^{-2}] :

- Na reacts with O_2 to form mainly peroxide (Na_2O_2).

Super oxide [O_2^{-}] :

- K, Rb and Cs forms MO_2 type oxides (super oxides) in excess of oxygen. Super oxides are paramagnetic and coloured.

$$M \xrightarrow{O_2} \underset{\text{Oxide}}{M_2O} \xrightarrow{O_2} \underset{\text{peroxide}}{M_2O_2} \xrightarrow{O_2} \underset{\text{super oxide}}{MO_2}$$

(Li_2O) (Na_2O_2) (KO_2, RbO_2, CsO_2)

- Stability order of different oxide of a metal is due to Lattice Energy

  Normal oxide > Peroxide > Superoxide

- Alkaline earth metals reacts with O_2 to form 'MO' type oxides

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

- In IIA only Ca, Sr, Ba form peroxide.

  Ex. CaO_2, SrO_2, BaO_2

- BeO shows amphoteric property.

  MgO → weak basic

  CaO, SrO & BaO → Strong basic

- Basic properties increases from BeO to BaO.

Reaction with hydrogen

- Alkali metals combine with H_2 forming ionic hydrides

  $2M + H_2 \rightarrow 2MH$

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

  $MH + H_2O \rightarrow MOH + H_2$

  LiH, NaH, KH, RbH, CsH →

  Thermal stability decrease, Basic property increases

- 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.

Reaction with water

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

  $2M + 2H_2O \rightarrow 2MOH + H_2$

- Reactivity with water increases from Li to Cs.

  Li → least reactive towards water

  Na → reacts vigorously

  K → reacts producing a flame

  Rb, Cs → reacts explosively.

- Monoxides gives strongly alkaline solution with water

  $M_2O + H_2O \rightarrow 2MOH$

- These metals reacts slowly with water gives H_2 and metals hydroxides.

  $M + 2H_2O \rightarrow M(OH)_2 + H_2$

- Be does not reacts with water

- Mg reacts only with hot water

- Ca, Sr, Ba reacts with cold water but not as energetically as alkali metals.

- from $Be(OH)_2$ to $Ba(OH)_2$ basic nature increases.

Halides

- Alkali metals reacts directly with halogen to form MX
  (M – alkalimetal, X – Halide ion)
- Ionic nature of MX increases from LiCl to CsCl
- LiCl is covalent in nature (due to polarisation of Cl^- ion by small Li^+ ion). hence its tendency of hydrolysis is more.
- K, Rb and Cs halides reacts with more halogens to gives polyhalides.

$KI + I_2 \rightarrow KI_3$

$CsBr + Br_2 \rightarrow CsBr_3$

- Alkaline metals reacts with X (Halogen) to form MX_2.
- Order of Ionic nature

$BeCl_2 < MgCl_2 < CaCl_2 < SrCl_2 < BaCl_2$

- Hydrolysis tendency of these halides decreases from $BeCl_2$ to $BaCl_2$ due to decrease in covalent nature.
- $BeCl_2$ and $MgCl_2$ are covalent in nature.

$BeO + C + Cl_2 \xrightarrow{\Delta} BeCl_2 + CO$

$(NH_4)_2 BeF_4 \xrightarrow{\Delta} BeF_2 + NH_3 + HF$

Nitrides

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

$6Li + N_2 \rightarrow 2Li_3N$

$Li_3N + 3H_2O \rightarrow 3LiOH + NH_3\uparrow$

- All elements of II-A burns in N_2 to give M_3N_2 (nitrides)

For example :

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

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

Formation of amalgam

- Alkali metals gives amalgam with Hg.
- These metals reacts with other metals to give mixed metals (alloys)

- Shows same properties.

Solubility in liquid ammonia

- All the alkali metals dissolves in NH_3 (liq.) and produces blue coloured solution.
- The blue colour and reducing nature of solution is due to presence of ammoniated electron.
- Solution is a good conductor due to presence of both ammoniated ion and ammoniated electron.

$$Na_{(s)} + (x+y)NH_3 \rightarrow \underbrace{\left[Na(NH_3)_x\right]^+}_{\text{ammoniated ion}} + \underbrace{\left[e(NH_3)_y\right]^-}_{\text{ammoniated electron}}$$

- This dilute solution is paramagnetic in nature.

- Only Ca, Sr and Ba gives blue solution of ammoniated electron.
- Be and Mg are small in size and have high ionisation energy so do not dissolves in liquid NH_3.
- Dark blue colour of solution becomes fade if it is allowed to stand for a long time, it is because of metal amide formation.

$2Na + 2NH_3 \rightarrow \underset{\text{(Sodamide)}}{2NaNH_2} + H_2\uparrow$

Exception $\Rightarrow$ Li forms imide

$2Li + NH_3 \rightarrow Li_2NH + H_2$

- On increasing the concentration of metal in solution, it converts into bronze colour due to cluster formation of metal ions.

BEGINNER'S BOX-1

1. All alkali metal superoxides contain the $[O_2^-]$ ion. They are–
(1) paramagnetic (2) colored compounds (3) oxidizing agents (4) all of these

2. Which of the following is soluble in organic solvents like ethanol?
(1) LiCl (2) NaCl (3) KCl (4) RbCl

3.. Which of the following is the correct order of hydrated radii?
(1) $Li^+ < Na^+ < K^+ < Rb^+ < Cs^+$ (2) $Rb^+ < Na^+ < Li^+ < Cs^+ < K^+$
(3) $Cs^+ < Rb^+ < K^+ < Na^+ < Li^+$ (4) $Li^+ < K^+ < Na^+ < Rb^+ < Cs^+$

4. Which of the following has the maximum solubility in water?
(1) $CsHCO_3$ (2) $NaHCO_3$ (3) $KHCO_3$ (4) $RbHCO_3$

5. As compared to potassium, sodium has
(1) Lower electronegativity (2) Higher ionization potential
(3) Larger atomic radius (4) Lower melting point

6. Which of the following statement is correct regarding alkali metals
(1) Cation is less stable than the parent atom (2) Cation is smaller in size than the parent atom
(3) Size of cation and parent atom is the same (4) Cation is greater in size than the parent atom

7. Which of the following is not true?
(1) Group 2 elements are electropositive & strong reducing agents but not as strong as group 1 elements.
(2) the reducing power of groups 2 elements increases down the group.
(3) Be has the most negative standard reduction potential.
(4) The magnesium cation is more easily reduced than the cations of the heavier members of the group.

8. Which of the following halides are ionic in nature ?
(1) BaX_2 (2) CaX_2 (3) SrX_2 (4) All of these

9. Which of the following compounds is highly soluble in water ?
(1) CaF_2 (2) MgF_2 (3) BeF_2 (4) BaF_2

10. Which of the following carbonates is the most thermally stable ?
(1) $BeCO_3$ (2) $MgCO_3$ (3) $CaCO_3$ (4) $BaCO_3$

COMPOUNDS OF s-BLOCK ELEMENTS

3.2 SODIUM CHLORIDE NaCl

Occurrence : Sea water is the main source and also found in salt lakes.

Preparation :

(i) Sea water NaCl(2.7 – 2.9%) $\xrightarrow[\text{by solar heat}]{\text{Evaporation}}$ crude NaCl

(ii) It contains impurities – Na_2SO_4, $MgCl_2$, $CaCl_2$ etc.

(iii) Insoluble impurities removed by filtration.

(iv) Filtrate $\xrightarrow{\text{HCl gas passed}}$ Pure NaCl precipitation (Common ion effect)

(v) $MgCl_2$ and $CaCl_2$ are more soluble in water so left in solution.

Properties :

i. Table salt is slightly hygroscopic due to the presence of magnesium and calcium chlorides in small amounts.

ii. Reaction with $AgNO_3$

$NaCl + AgNO_3 \rightarrow NaNO_3 + AgCl$(white ppt.)

Uses i. As a preservative for pickles, meat and fish.

ii. For making freezing mixture with Ice.

3.3 SODIUM HYDROXIDE [Caustic Soda(NaOH)]

Manufacture : By electrolysis of NaCl.

(a) **Nelson Cell or Diaphragm Cell :** The following reactions takes place –

$$\left.\begin{array}{l} NaCl(aq.) \rightleftharpoons Na^+ + Cl^- \\ H_2O \rightleftharpoons H^+ + OH^- \end{array}\right\} \rightarrow NaOH + H_2 + Cl_2$$

At cathode (Perforated steel) : $2H^+ + 2e^- \rightarrow H_2(g)$ At anode (Carbon) : $2Cl^-(aq.) \rightarrow Cl_2(g) + 2e^-$

(b) **Castner – Kellner Cell :** (Hg – Cathode Process)

Electrolyte (Brine) $NaCl \rightleftharpoons Na^+ + Cl^-$

On electrolysis –

At Cathode (Hg)

$Na^+ + e^- \rightarrow Na.$ and $Na + Hg \rightarrow Na.Hg$ (amalgam)

At anode (Graphite)

$2Cl^- \rightarrow Cl_2(g) + 2e^-$ and $2Na.Hg + 2H_2O \rightarrow 2NaOH + H_2 + 2Hg$

Properties :

i. It is deliquescent white crystalline solid.

ii. It absorbs CO_2 from air forming Na_2CO_3.

iii. NaOH is **strong base**

$$NaOH \xrightarrow{SiO_2} Na_2SiO_3 + H_2O$$
$$NaOH \xrightarrow{Al_2O_3} 2NaAlO_2 + H_2O$$

iv. **Reaction with non metals :** No reaction with H_2, N_2 and C

$$NaOH \xrightarrow{B} Na_3BO_3 \text{ (sodium borate)}$$
$$NaOH \xrightarrow{Si} Na_2SiO_3 \text{ (sodium silicate)}$$

v. **Reaction with Metal :**

$$NaOH \xrightarrow{\text{Alkali metal}} \text{No reaction}$$
$$NaOH \xrightarrow{2Al + 2H_2O} 2NaAlO_2 \text{ (Sodium meta aluminate)} + H_2$$
$$NaOH \xrightarrow{Be} Na_2BeO_2 \text{ (Sodium Berrylate)} + H_2$$
$$NaOH \xrightarrow{Zn} Na_2ZnO_2 \text{ (Sodium zincate)} + H_2$$
$$NaOH \xrightarrow{Sn} Na_2SnO_2 \text{ (Sodium stannite)} + H_2$$
$$NaOH \xrightarrow{Pb} Na_2PbO_2 \text{ (Sodium plumbite)} + H_2$$

vi. The hydroxides of aluminium, zinc, lead and tin, however, dissolve in excess of sodium hydroxide giving clear solution which can also be obtained when these metals are acted upon by the concentrated solution of sodium hydroxide.

$Zn(OH)_2 + 2OH^- \longrightarrow \underset{\text{Zincate ion}}{[Zn(OH)_4]^{2-}}$ $\quad$ $Al(OH)_3 + 3OH^- \longrightarrow \underset{\text{Aluminate ion}}{[Al(OH)_6]^{3-}}$

vii. **Reaction with $ZnCl_2$ or $ZnSO_4$**

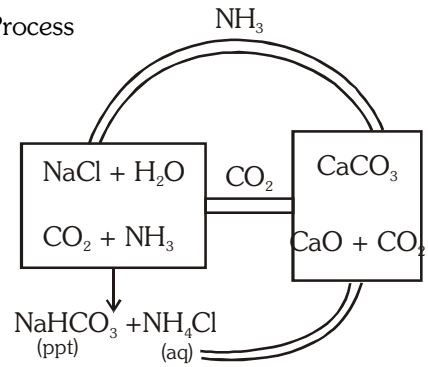
(a) $ZnCl_2 + 2NaOH \longrightarrow Zn(OH)_2\downarrow + 2NaCl$ $\quad$ (b) $Zn(OH)_2 + 2NaOH \longrightarrow \underset{\text{(Soluble complex)}}{Na_2[Zn(OH)_4]}$

Uses (i) In the manufacture of soap, rayon, dyes, paper and drugs.

(ii) In petroleum refining.

3.4 SODIUM BICARBONATE OR BAKING SODA ($NaHCO_3$) and SODIUM CARBONATE OR WASHING SODA [$Na_2CO_3.10H_2O$]

Preparation : Solvay Process (Commercial Scale)/Ammonia Soda Process



(i) $CaCO_3 \longrightarrow CaO + CO_2$

(ii) $NH_3 + H_2O + CO_2 \longrightarrow NH_4HCO_3$

(iii) $NaCl + NH_4HCO_3 \longrightarrow NH_4Cl + NaHCO_3$ (ppt)

(iv) Sodium carbonate is prepared by heating of $NaHCO_3$

$2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + CO_2 + H_2O$

(v) $2NH_4Cl + CaO \longrightarrow \underset{\text{(Bye-product)}}{CaCl_2} + 2NH_3 + H_2O$

Note : Potassium bicarbonate ($KHCO_3$) cannot be prepared by Solvay process as it is more soluble in water as compared to $NaHCO_3$.

Properties of $NaHCO_3$:

(i) **Hydrolysis** $\quad NaHCO_3 + H_2O \rightleftharpoons NaOH + H_2CO_3$

(ii) **Effect of heat** (temp. > 100°C) $\quad 2NaHCO_3 \longrightarrow Na_2CO_3 + H_2O + CO_2\uparrow$

(iii) **Reaction with acids** – gives CO_2 $\quad NaHCO_3 + HCl \longrightarrow NaCl + H_2O + CO_2\uparrow$

(iv) **Reaction with bases** $\quad NaHCO_3 + NaOH \longrightarrow Na_2CO_3 + H_2O$

Note : Reaction (iii) and (iv) explain **amphoteric** behaviour of $NaHCO_3$.

Properties of Na_2CO_3

(i) Efflorescence :

$Na_2CO_3.10H_2O$ when exposed to air it gives out nine out of ten H_2O molecules.

$Na_2CO_3.10H_2O \longrightarrow \underset{\text{(Monohydrate)}}{Na_2CO_3.H_2O} + 9H_2O$

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

(ii) Hydrolysis : Aqueous solution of Na_2CO_3 is alkaline in nature due to anionic hydrolysis.

$Na_2CO_3 \longrightarrow 2Na^+ + CO_3^{-2}$ $\quad$ and $\quad CO_3^{-2} + H_2O \rightleftharpoons \underset{\text{(Carbonic acid)}}{H_2CO_3} + 2OH^-$

Uses of $NaHCO_3$
i. In the preparation of baking powder.
ii. In the preparation of effervescent drinks.
iii. In the fire extinguishers.
iv. As antacid medicine (removing acidity)

Uses of Na_2CO_3
i. For making fusion mixture (Na_2CO_3 + K_2CO_3)
ii. In the manufacture of glass, caustic soda, soap powders etc.
iii. In laundries and softening of water.

3.5 CALCIUM OXIDE [Quick lime (CaO)]

Preparation : By heating limestone at 800^0C.

$$CaCO_3 \overset{800°C}{\rightleftharpoons} CaO + CO_2$$

Properties :

(i) **Action of water :** $CaO + H_2O \longrightarrow Ca(OH)_2$
(quick lime) (Slaked lime)

(ii) **Basic Nature :**

$$CaO + SiO_2 \xrightarrow{\Delta} CaSiO_3$$
(Calcium silicate)

$$CaO + P_4O_{10} \xrightarrow{\Delta} 2Ca_3(PO_4)_2$$ (Calcium phosphate)

(iii) Reaction with carbon :

$$CaO + 3C \xrightarrow{2000°C} CaC_2 + CO\uparrow$$
(Calcium carbide)

$$CaC_2 + NH_2 \longrightarrow CaCN_2 + C$$
Nitrolime

Uses of CaO :

(i) In the manufacture of bleaching powder, cement, glass, calcium carbide etc.
(ii) In the purification of sugar
(iii) As a drying agent for NH_3 and C_2H_5OH
(iv) As basic lining in furnaces
(v) For making Soda lime [NaOH + CaO]

3.6 CALCIUM HYDROXIDE [Slaked limeCa(OH)$_2$]

Preparation : By the action of water on quick lime

$$CaO + H_2O \longrightarrow Ca(OH)_2 + \text{heat (slaking of lime)}$$

Properties of $Ca(OH)_2$

(i) **Action of CO_2 :** Lime water turns milky on passing CO_2 gas.

$$Ca(OH)_2 + CO_2 \longrightarrow \underset{\text{Milkiness}}{CaCO_3} + H_2O$$

$$CaCO_3 \xrightarrow[CO_2 + H_2O]{\text{Excess of}} Ca(HCO_3)_2 \xrightarrow{\Delta} CaCO_3$$
(soluble)

(ii) **Action of Chlorine :**

$$Ca(OH)_2 \text{ (dry)} + Cl_2 \xrightarrow[\text{below } 35^\circ C]{\text{(Room temp.)}} CaOCl_2 + H_2O$$

$$2Ca(OH)_2 + 2Cl_2 \xrightarrow{\text{red hot}} 2CaCl_2 + 2H_2O + O_2\uparrow$$

Uses of $Ca(OH)_2$

(i) For softening of hard water.

(ii) For purification of sugar and Coal gas.

(iii) In the manufacture of bleaching powder, Caustic soda and soda lime

(iv) In preparation of mortar, plaster and white washing.

3.7 CALCIUM SULPHATE [GypsumCaSO$_4$.2H$_2$O]

Preparation : $CaSO_4.2H_2O$ is naturally occuring calcium sulphate. It can be obtained by the action of dil.H_2SO_4 on a soluble calcium salt below 60^0C.

$$CaCl_2 + \underset{\text{dilute}}{H_2SO_4} \longrightarrow 2HCl + \underset{\text{white ppt.}}{CaSO_4}\downarrow$$

Properties of Gypsum

(i) **Action of heat :**

$$\underset{\text{(Gypsum)}}{2(CaSO_4.2H_2O)} \xrightarrow[-3H_2O]{120^\circ C} \underset{\text{(Plaster of paris)}}{2(CaSO_4).H_2O} \xrightarrow{200^\circ C} \underset{\text{(Anhydride)}}{2CaSO_4} + H_2O$$

(ii) It forms an important fertilizer $(NH_4)_2SO_4$

$$CaSO_4 + 2NH_3 + CO_2 + H_2O \longrightarrow CaCO_3\downarrow + (NH_4)_2SO_4$$

Uses of Gypsum

(i) In the preparation of plaster of paris

(ii) Anhydrous $CaSO_4$ used as drying agent.

(iii) Anhydrite ($CaSO_4$) is used for manufacture of sulphuric acid, ammonium sulphate.

3.8 PLASTER OF PARIS [POP] 2(CaSO$_4$).H$_2$O or CaSO$_4$.$\frac{1}{2}$H$_2$O

Preparation : It is obtained when gypsum is heated at 120^0C

$$\underset{\text{(Gypsum)}}{2(CaSO_4.2H_2O)} \longrightarrow \underset{\text{(Plaster of paris)}}{2(CaSO_4).H_2O} + 3H_2O$$

Properties of POP

(i) It is a white powder.

(ii) It has the property of setting to a hard mass when a paste with water is allowed to stand aside for sometime.

(iii) When it is heated at 200^0C, anhydrous $CaSO_4$ is formed.

Uses of POP

(i) In surgery for setting broken bones

(ii) In making casts for toys, statues etc.

(iii) In making blackboard chalks.

3.9 SOME IMPORTANT POINTS TO REMEMBER

ANOMALOUS BEHAVIOR OF LITHIUM

- On account of its small size it exerts the greatest polarising effect out of all the alkali metals and ions, consequently covalent character is developed.
- Li has the highest ionisation energy and electronegativity as compared to other alkali metals.
- It is not affected by air easily and does not lose its lusture even on melting.
- It is more harder and lighter than other alkali metal.
- It reacts slowly with water to liberate hydrogen.
- When burnt in air or oxygen, it forms only monoxide, Li_2O. However, the rest of the alkali metals give peroxide or superoxides.
- Li_2O is less basic oxides than of other alkali metals.
- Lithium hydroxide decomposes when red heated to form Li_2O. Hydroxides of other alkali metals do not decompose.

  $2LiOH \xrightarrow{\Delta} Li_2O + H_2O$
- Li_2CO_3 is less stable, as it decomposes on heating. $Li_2CO_3 \xrightarrow{\Delta} Li_2O + CO_2$
- Li_2SO_4 is the only alkali metal sulphate, which does not form double salts Ex. Alum.
- Li when heated in NH_3 forms imide Li_2NH while other alkali metals form amides. MNH_2
- Lithium shows resemblance with magnesium, an element of group IIA.

  This resemblance is termed as diagonal relationship.

Similariteis between lithium and Magnesium

(i) Both lithium and magnesium are harder and lighter than the other elements in their respective groups.

(ii) Lithium and magnesium reacts slowly with cold water. Their oxides and hydroxides are much less soluble and their hydroxides decomposes on heating. They both form nitride by direct combination with nitrogen, Li_3N and Mg_3N_2.

(iii) The oxides, Li_2O and MgO do not combine with excess oxygen to give a peroxide or a superoxide.

(iv) The carbonates of lithium and magnesium decomposes easily on heating to form the oxide and CO_2. Solid bicarbonates are not formed by lithium and magnesium.

(v) Both LiCl and $MgCl_2$ are soluble in ethanol.

(vi) Both LiCl and $MgCl_2$ are deliquescent and crystallise from their aqueous solution as hydrates, $LiCl.2H_2O$ and $MgCl_2.8H_2O$.

ANOMALOUS BEHAVIOR OF BERYLLIUM

- It is the hardest of all alkaline earth metal as maximum metallic bonding is there due to it's smallest size.
- The melting and boiling points of the beryllium are the highest.
- It is least reactive due to highest ionisation potential.
- Due to high charge density its polarising effect is highest and it forms covalent bond.
- It dissolves in alkalies with the evolution of hydrogen

  $Be + 2NaOH + 2H_2O \longrightarrow \underset{\text{Sodium beryllate}}{Na_2BeO_2.2H_2O} + H_2$

  other alkaline earth metals do not react with alkalies.
- Oxides and hydroxides of beryllium are amphoteric in nature.

  $BeO + H_2SO_4 \rightarrow BeSO_4 + H_2O$ $\qquad$ $BeO + 2NaOH \rightarrow Na_2BeO_2 + H_2O$

  $Be(OH)_2 + 2HCl \rightarrow BeCl_2 + 2H_2O$ $\qquad$ $Be(OH)_2 + 2NaOH \rightarrow Na_2BeO_2 + 2H_2O$

  The hydroxide is Insoluble in water and is covalent in nature.
- Like Al_4C_3, its carbide (Be_2C) on hydrolysis evolves methane.
- Due to its small size it has strong tendency to form complex.
- It shows diagonal relationship with Al.

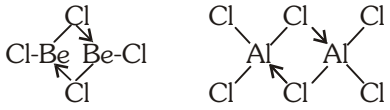
DIAGONAL SIMILARITY BETWEEN BERYLLIUM AND ALUMINIUM :

In many of its properties, beryllium resembles with aluminium. Thus –

(i) The two elements have same electronegativity and their charge/ radius ratios.

(ii) Both metals are fairly resistant to the action of acids due to the formation of a protective film of oxide on their surface. Both metals are acted upon by strong alkalies to form soluble complexes, beryllates $[Be(OH)_4]^{2-}$ and aluminates, $[Al(OH)_4]^-$.

(iii) The chlorides of both beryllium and aluminium have bridged chloride structures in vapour phase.



(iv) Salts of these metals form hydrated ions, Ex. $[Be(OH_2)_4]^{2+}$ and $[Al(OH_2)_6]^{3+}$ in aqueous solutions. Due to similar charge/ radius ratios of beryllium and aluminium ions they have a strong tendency to form complexes. For example beryllium forms tetrahedral complexes such as BeF_4^{2-} and $[Be(C_2O_4)_2]^{2-}$ and aluminium forms octahedral complexes like AlF_6^{3-} and $[Al(C_2O_4)_3]^{3-}$.

3.10 PORTLAND CEMENT

It is a light grey, heavy fine powder, It is a homogenous mixture of silicates and aluminates of calcium, which form more than 90% of the cement are –

(i) Tricalcium silicate - $3CaO.SiO_2$

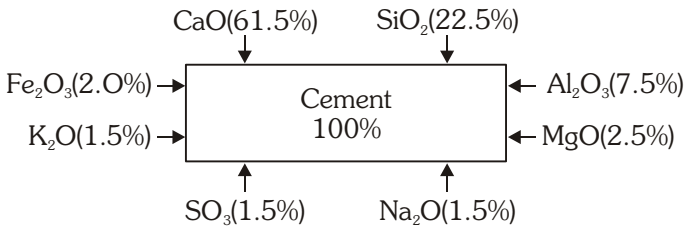
(ii) Dicalcium silicate (slowest setting component) - $2CaO.SiO_2$

(iii) Tricalcium aluminate (fastest setting component) - $3CaO.Al_2O_3$

(iv) Tetracalcium alummino ferrite - $4CaO.Al_2O_3.Fe_2O_3$

Important Points :-

(i) Composition of Cement



For high quality

⇒ SiO_2 to Al_2O_3 Ratio = 2.5–4

⇒ CaO to Rest all oxide = 2

(ii) Raw Materials

- Lime Stone – It provides CaO
- Clay – It provides Al_2O_3 and silica (SiO_2)
- Gypsum – $CaSO_4 \cdot 2H_2O$

(iii) Setting of cement : When water is mixed to cement and the mixture is left it becomes very hard. This property of cement is called setting.

(iv) Mortar : It is a mixture of cement, sand and water to give a proper consistency.

(v) Concrete : A mixture of cement, Sand gravel and water is known as concrete.

(vi) Reinforced concrete cement (RCC) : When concrete is filled in beams made of iron bars, it is called RCC. Iron imparts extra strength to the structure.

3.11 BIOLOGICAL ROLE OF SODIUM, POTASSIUM, MAGNESIUM AND CALCIUM (FROM BIOLOGY PORTION)

Normally % of abundance in human body – K > Na > Fe > Cu

BEGINNER'S BOX-2

1. Potassium carbonate cannot be made by the Solvay process because
(1) potassium hydrogen carbonate is unstable
(2) potassium hydrogen carbonate is rather too soluble in water to be precipitated
(3) potassium carbonate is insoluble in water
(4) potassium carbonate is soluble in water

2. Plaster of Paris, a white powder, is–

(1) $CaSO_4.2H_2O$ (2) $CaSO_4.\frac{1}{2}H_2O$ (3) $CaSO_4$ (4) $CaSO_4.\ H_2O$

3. Which of the following is incorrect?
(1) Cement containing no iron is white.
(2) Cement containing excess amount of lime cracks during setting.
(3) Setting of cement is an endothermic process.
(4) Setting of cement is an example of hydration.

4. On passing excess of CO_2 in lime water, its milky appearance disappears because -
(1) Soluble $Ca(OH)_2$ is formed (2) Soluble $Ca(HCO_3)_2$ is formed
(3) Reaction becomes reversible (4) Calcium compound evaporated

5. In the preparation of sodium carbonate which of the following is used –
(1) Slaked lime (2) Lime stone (3) Lime (4) quick lime

6. When chlorine is passed slow over dry slaked lime $Ca(OH)_2$ at room temperature, the main product is
(1) $CaCl_2$ (2) $CaOCl_2$ (3) $Ca(ClO_2)_2$ (4) $Ca(OCl)_2$

7. Identify the correct statement -
(1) Gypsum contains a lower percentage of Ca than plaster of paris
(2) Gypsum is obtained by heating plaster of paris
(3) Plaster of paris can be obtained by hydration of gypsum
(4) Plaster of paris is obtained by partial oxidation of gypsum

8. Quick lime is prepared on a commercial scale by heating _____ in a rotary kiln at 1070 – 1270 K.
(1) $CaSO_4$ (2) $Ca(NO_3)_2$ (3) $CaCO_3$ (4) $Ca(OH)_2$

9. Ca^{2+} ions play an important role in
(i) neuromuscular function (ii) interneuronal transmission
(iii) cell membrane integrity (iv) blood coagulation
(1) (i), (ii) (2) (ii), (iii) (3) (ii), (iii), (iv) (4) (i), (ii), (iii), (iv)

ANSWER KEY

BEGINNER'S BOX-1	**Que.**	1	2	3	4	5	6	7	8	9	10
	Ans.	**4**	**1**	**3**	**1**	**2**	**2**	**3**	**4**	**3**	**4**

BEGINNER'S BOX-2	**Que.**	1	2	3	4	5	6	7	8	9	
	Ans.	**2**	**2**	**3**	**2**	**2**	**2**	**1**	**3**	**4**	

EXERCISE-I (Conceptual Questions) — Build Up Your Understanding

PROPERTIES AND COMPOUNDS

1. Correct order of density is –
(1) Li > Na (2) K > Na
(3) Mg > Ca (4) Cs < Rb

2. Which is having highest m.p. –
(1) Be (2) Mg (3) Ca (4) Sr

3. Weak reductant in alkali metal is –
(1) Li (2) Na (3) K (4) Cs

4. The metal used in photoelectric cell is –
(1) Na (2) Cs (3) Mg (4) Ca

5. Lithium chloride is highly soluble in –
(1) C_6H_6 (2) H_2O (3) D_2O (4) All

6. Which metal will not form superoxide –
(1) Li (2) Be (3) Na (4) All

7. More stable hydride is –
(1) Cs – H (2) Rb – H
(3) K –H (4) Li – H

8. In which compound hydrogen is electronegative –
(1) CaH_2 (2) CH_4 (3) HCl (4) All

9. Which of the following metal will give apple green colour on Bunsen flame –
(1) Ba (2) Sr
(3) Ca (4) K

10. The density of –
(1) Na > K (2) Na = K
(3) K > Na (4) Li > K

11. Alkali metals salts are –
(1) Diamagnetic and coloured
(2) Diamagnetic and colourless
(3) Paramagnetic and coloured
(4) Paramagnetic and colourless

12. Ionic conductances of hydrated M^+ ions are in the order –
(1) $Li^+(aq) > Na^+(aq) > K^+(aq) > Rb^+(aq) > Cs^+(aq)$
(2) $Li^+(aq) > Na^+(aq) < K^+(aq) < Rb^+(aq) < Cs^+(aq)$
(3) $Li^+(aq) > Na^+(aq) > K^+(aq) > Rb^+(aq) < Cs^+(aq)$
(4) $Li^+(aq) < Na^+(aq) < K^+(aq) < Rb^+(aq) < Cs^+(aq)$

13. Which of the following halides has the highest melting point –
(1) NaCl (2) KCl
(3) NaBr (4) NaF

14. Which of the following does not give an oxide on heating –
(1) $MgCO_3$ (2) Li_2CO_3
(3) $ZnCO_3$ (4) K_2CO_3

15. When strongly heated in steam, Mg burns brilliantly producing –
(1) $Mg(OH)_2$ (2) MgO and H_2
(3) MgO and O_2 (4) MgO and O_3

16. When magnesium ribbon is heated to redness in an atmosphere of nitrogen and subsequently cooled with water, the gas evolved is –
(1) N_2 (2) NH_3 (3) O_2 (4) CO_2

17. Molten potassium chloride conducts electricity due to the presence of –
(1) Free electron
(2) Free ions
(3) Free molecules
(4) Atom of potassium & chloride

18. Which of the following element have maximum tendency to form complex compound –
(1) Be (2) Ba (3) Ca (4) Mg

19. On heating sodium metal in the current of dry ammonia leads to the formation of which gas–
(1) $NaNH_2$ (2) NaN_3 (3) NH_3 (4) H_2

20. Sodium reacts with water more vigorously than lithium because it –
(1) Has higher atomic weight
(2) Is more electronegative
(3) Is more electropositve
(4) Is a metal

21. Which of the following alkali metals has the biggest tendency of the half reaction $M_{(g)} \longrightarrow M^+_{(aq)} + e^-$
(1) Sodium (2) Lithium
(3) Potassium (4) Cesium

22. The strongest reducing agent is –
(1) Be (2) Mg (3) Sr (4) Ba

23. Both Be and Al become passive on reaction with conc. nitric acid due to –
(1) The non reactive nature of the metal
(2) The non reactive nature of the acid
(3) The formation of an inert oxide layer on the surface of the metals
(4) None of these

24. Sodium loses its lustre on exposure to moist air due to formation of –
(1) Na_2O, NaOH and Na_2CO_3
(2) Na_2O and NaOH
(3) Na_2O and Na_2CO_3
(4) NaOH and Na_2CO_3

25. Potassium carbonate when heated to high temperature.
(1) Gives CO_2 (2) Gives O_2
(3) Gives CO (4) Gives no gas at all

26. On Flame test K give -------- colour –
(1) Golden yellow (2) Crimson red
(3) Violet (4) Apple green

27. An element having electronic configuration $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$ will form –
(1) Acidic oxide (2) Basic oxide
(3) Amphoteric oxide (4) Neutral oxide

28. Which decomposes on heating –
(1) NaOH (2) KOH (3) LiOH (4) RbOH

29. Which metal does not form ionic hydride –
(1) Na (2) Rb (3) Ca (4) Be

30. The element of IA group which combines directly with nitrogen is –
(1) Li (2) Na (3) K (4) Cs

31. Which of the following releases 0.2 moles of hydrogen on hydrolysis –
(1) 0.1 mole of LiH (2) 0.2 mole of LiH
(3) 0.3 mole of LiH (4) 0.4 mole of LiH

32. Which of the following is paramagnetic
(1) K_2O (2) K_2O_2 (3) KO_2 (4) Na_2O

33. A compound which upon hydrolysis releases ammonia is –
(1) Li_3N (2) $LiNO_3$
(3) $NaNO_3$ (4) None of these

34. The metal ion which does not give any flame colouration is –
(1) Li^+ (2) Be^{+2} (3) Na^+ (4) K^+

35. Which of the following exists as hydrated salt –
(1) NaCl (2) LiCl
(3) RbCl (4) KCl

36. Strong reductant in IIA and IA group is –
(1) Ba, Li (2) Li, Be
(3) Cs, Ba (4) Ba, Cs

37. Which statement will be true for solution, when Ba is dissolved in ammonia:-
(1) Solution becomes blue
(2) Solution becomes good conductor
(3) Solution remains colourless
(4) Both (1) and (2) are correct

38. In K, Rb and Cs, the decreasing order of reducing power in gaseous state is:-
(1) K > Cs > Rb (2) Cs > Rb > K
(3) K < Cs < Rb (4) Rb > Cs > K

39. The correct order of density of following elements is:- (Be, Mg, Ca, Sr)
(1) Be > Mg > Ca > Sr (2) Ca > Mg > Be > Sr
(3) Ca < Mg < Be < Sr (4) Mg < Ca < Sr < Be

40. Identify the correct statement elemental sodium:-
(1) Is a strong oxidising agent
(2) Can be extracted by electrolysis of aqueous solution
(3) It's density is lower than K
(4) Is easily oxidised

41. On addition of metal, colour of liquid NH_3 solutions converts into bronze, the reason is :-
(1) Ammoniated electrones
(2) Metal amide formation
(3) Liberation of NH_3 gas
(4) Cluster formation of metal ions

42. On allowing ammonia solution of s-block metals to stand for a long time, blue colour becomes fade. The reason is:-
(1) Formation of NH_3 gas
(2) Formation of metal amide
(3) Cluster formation of metal ions
(4) Formation of metal nitrate

43. Which of the following s-block element reacts with NaOH to give water soluble complex :-
(1) Al (2) Ca (3) Be (4) Li

44. Which is having least mpt. :-
(1) Ba (2) Ca (3) Mg (4) Be

45. When Na and Li placed in dry air we get :-
(1) NaOH, Na_2O, Li_2O
(2) Na_2CO_3, Na_2O_2, Li_2O
(3) Na_2O, Li_3N, NH_3
(4) Na_2O, Li_2O, Li_3N

46. Which of the following oxide having O_2^{-2} (peroxide) anion :-
(1) Na_2O (2) BaO_2 (3) RbO_2 (4) KO_2

47. Generally which of the following properties of IA group metals increases as the atomic number rises:
(a) Metallic character (b) Ionic radius
(c) Melting point (d) Density
(e) Ionisation potential
Correct answer is :-
(1) a, b, c (2) a, b, d (3) c, d, e (4) All

48. Which of the following s-block metals do not impart any colour to the flame
(1) Li, Be (2) Cs, Fr (3) Be, Mg (4) Ba, Ra

49. Which can not be used to generate H_2 :–
(1) Al + NaOH (2) Zn + NaOH
(3) Mg + NaOH (4) LiH + H_2O

50. Only those elements of s-block can produce superoxides which have :-
(1) High ionisation energy
(2) High electronegativity
(3) High charge density
(4) Low ionisation potential

51. Which does not exists in solid state :-
(1) $LiHCO_3$ (2) $CaCO_3$
(3) $NaHCO_3$ (4) Na_2CO_3

52. Alkali metals dissolve in liquid NH_3 then which of the following observations is not true:
(1) It becomes paramagnetic
(2) Solution turns into blue due to solvated electrons
(3) It becomes diamagnetic
(4) Solution becomes conducting

53. Alkali metals give colour in bunsen flame due to –
(1) Low electronegativity
(2) One e^- in outer most orbit
(3) Smaller atomic radii
(4) Low ionisation energy

54. Which of the following ions forms a hydroxide that is highly soluble in water ?
(1) K^+ (2) Zn^{2+} (3) Ni^{2+} (4) Al^{3+}

55. The slaked lime is prepared by adding water to-
(1) Quick lime (2) Nitrolim
(3) Lime stone (4) Plaster of paris

56. The plaster of paris is hardened by
(1) Liberating CO_2 (2) Giving out water
(3) Combining with water (4) Changing into $CaCO_3$

57. Which of the following alkali metal carbonate is the least stable and decomposes readily
(1) Li_2CO_3 (2) Na_2CO_3
(3) K_2CO_3 (4) Cs_2CO_3

58. In the reaction $M + O_2 \longrightarrow MO_2$ (super oxide) the metal is
(1) Li (2) Na (3) K (4) Ba

59. Li does not resemble other alkali metals in following properties
(1) Li_2CO_3 decomposes into oxides while other alkali carbonates are thermally stable
(2) LiCl is predominantly covalent
(3) Li_3N is stable
(4) All

60. Be and Al resemble in
(1) Both become passive on reaction with HNO_3 due to formation of oxide layer
(2) Their chlorides are lewis acids
(3) Hydroxides are soluble in alkali as well as in acid
(4) All

61. Consider the following points
(a) Cs is the strongest reducing agent in IA group element
(b) Be does not form peroxide in II A group elements
(c) The density of potassium is less than sodium
(d) In alkali metals Li, Na, K and Rb, lithium has the minimum value of M.P.
Point out that the statement -
(1) (a) & (b) are correct
(2) (a), (b) & (c) are correct
(3) (b) & (c) are correct
(4) (b), (c) & (d) are correct

62. Mg^{+2} does not form either peroxide or superoxide, because
(1) Mg^{+2} ion is relatively bigger
(2) Mg^{+2} ion is relatively smaller
(3) Mg^{+2} ion is stable
(4) Mg^{+2} ion is unstable

63. The stability order of oxide, peroxide and superoxide of alkalimetal is
(1) Normal oxide > super oxide > per oxide
(2) Normal oxide > per oxide > super oxide
(3) super oxide > per oxide > normal oxide
(4) per oxide > normal oxide > super oxide

64. Which of the following is true about Alkali metals
(1) All form solid bicarbonates
(2) All form ionic salt like hydride MH
(3) All form superoxide like KO_2
(4) All form nitrides

65. Which of the following statement is not correct
(1) LiOH is amphoteric in nature
(2) LiCl is soluble in pyridine
(3) Li_3N is stable while Na_3N doesn't exist even at room temperature
(4) BeO is amphoteric in nature

66. In between the metals A and B both form oxide but only B forms nitride, when both burn in air so A and B are
(1) Cs, K (2) Mg, Ca
(3) Li, Na (4) K, Mg

67. Which of the following statement is not correct
(1) BeF_2 forms complex ion with NaF in which Be goes with cation
(2) $BeCO_3$ is kept in the atmosphere of CO_2 since it is least thermally stable
(3) Be dissolves in alkali forming $[Be(OH)_4]^{-2}$
(4) BeF_2 forms complex ion with NaF in which Be goes with anion

68. CO_2 gas along with solid (Y) is obtained when sodium salt (X) is heated. (X) is again obtained when excess CO_2 gas is passed into aqueous solution of (Y). X and Y are :
(1) Na_2CO_3, Na_2O
(2) Na_2CO_3, NaOH
(3) $NaHCO_3$, Na_2CO_3
(4) Na_2CO_3, $NaHCO_3$

69. A compound which can be used in space vehicles both to absorb CO_2 and liberate O_2 is :
(1) NaOH (2) Na_2O
(3) Na_2O_2 (4) CaO + NaOH

70. There is loss in weight when mixture of Li_2CO_3 and $Na_2CO_3.10H_2O$ is heated strongly. This loss is due to :
(1) Li_2CO_3 (2) $Na_2CO_3.10H_2O$
(3) both (4) none

Note : Q.71 to 74 are based on following reaction (s) :

$A \xrightarrow{\Delta} B\text{ (oxide)} + CO_2$
$B + H_2O \longrightarrow C$
$C + CO_2 \longrightarrow A\text{ (milky)}$

$B + NH_4Cl \xrightarrow{\Delta} D\text{ (gas)}$
$D + H_2O + CO_2 \longrightarrow E$
$E + NaCl \longrightarrow F$

$F \xrightarrow{\Delta} Na_2CO_3 + CO_2 + H_2O$

71. Name of the process is :
(1) solvay (2) ammonia-soda
(3) both correct (4) none is correct

72. A is :
(1) $Ca(HCO_3)_2$ (2) $CaCO_3$
(3) CaO (4) Na_2CO_3

73. B and C are :
(1) CaO, $Ca(OH)_2$ (2) $Ca(OH)_2$, $CaCO_3$
(3) $CaCO_3$, $Ca(OH)_2$ (4) $Ca(OH)_2$, CaO

74. D, E and F are :
(1) NH_3, NH_4Cl, NH_4HCO_3
(2) NH_3, NH_4HCO_3, $NaHCO_3$
(3) NH_4HCO_3, Na_2CO_3, $NaHCO_3$
(4) None

75. A wire of an alkaline earth metal X, burnt in air and dipped in water, a gas 'Y' is evolved X and Y are respectively :–
(1) Na, NO_2 (2) Be, NO_2
(3) Mg, CO_2 (4) Mg, NH_3

EXERCISE-I (Conceptual Questions) ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	**3**	**1**	**2**	**2**	**1**	**4**	**4**	**1**	**1**	**1**	**2**	**4**	**4**	**4**	**2**
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	**2**	**2**	**1**	**4**	**3**	**2**	**4**	**3**	**1**	**4**	**3**	**2**	**3**	**4**	**1**
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	**2**	**3**	**1**	**2**	**2**	**1**	**4**	**2**	**3**	**4**	**4**	**2**	**3**	**3**	**4**
Que.	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	**2**	**2**	**3**	**3**	**4**	**1**	**3**	**4**	**1**	**1**	**3**	**1**	**3**	**4**	**4**
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Ans.	**3**	**2**	**2**	**2**	**1**	**4**	**1**	**3**	**3**	**3**	**3**	**2**	**1**	**2**	**4**

EXERCISE-II (Previous Year Questions) AIPMT/NEET & AIIMS (2006-2018)

AIIMS-2006

1. The pair whose both species are used in antacid medicinal preparations is –

(1) $NaHCO_3$ and $Mg(OH)_2$

(2) Na_2CO_3 and $Ca(HCO_3)_2$

(3) $Ca(HCO_3)_2$ and $Mg(OH)_2$

(4) $Ca(OH)_2$ and $NaHCO_3$

AIPMT-2010

2. Compound A on heating gives a colourless gas and a residue that is dissolved in water to obtain B. Excess of CO_2 is bubbled through aqueous solution of B, C is formed which is recovered in the solid form. Solid C on gentle heating gives back A. The compound is :-

(1) Na_2CO_3 (2) K_2CO_3

(3) $CaSO_4 .2H_2O$ (4) $CaCO_3$

AIPMT Mains-2011

3. Which of the following statements is incorrect :-

(1) $NaHCO_3$ on heating gives Na_2CO_3

(2) Pure sodium metal dissolves in liquid ammonia to give blue solution

(3) NaOH reacts with glass to give sodium silicate

(4) Aluminium reacts with excess NaOH to give $Al(OH)_3$

AIIMS-2011

4. Which of the following is not hygroscopic–

(1) NaCl (2) $MgCl_2$

(3) $CaCl_2$ (4) LiCl

AIIMS-2015

5. Which metal easily give H_2 gas when reacts with NaOH

(1) Mg (2) Zn

(3) Cu (4) Ag

NEET-II 2016

6. The suspension of slaked lime in water is known as

(1) milk of lime

(2) aqueous solution of slaked lime

(3) limewater

(4) quicklime

7. In context with beryllium, which one of the following statements is **incorrect** ?

(1) Its salts rarely hydrolyze.

(2) Its hydride is electron-deficient and polymeric.

(3) It is rendered passive by nitric acid.

(4) it forms Be_2C.

AIIMS 2017

8. The % abundance of elements in the human body

(1) K > Fe > Cu (2) Cu > Fe > K

(3) Fe > Cu > K (4) K > Cu > Fe

AIIMS 2018

9. Which of the following compound will remain in dissolved state in NH_3-NH_4Cl(aq) solution :-

(1) $BaCO_3$ (2) $SrCO_3$

(3) $CaCO_3$ (4) $MgCO_3$

10. Which is incorrect for Solvay process :-

(1) NH_3 is reused

(2) $CaCl_2$ is one of final product

(3) Na_2CO_3 is partially changed into $NaHCO_3$

(4) $CaCO_3$ is consumed

EXERCISE-II (Previous Year Questions) ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	1	4	4	1	2	1	1	1	4	3

EXERCISE-III (Analytical Questions) — Check Your Understanding

1. On dissolving moderate amount of sodium metal in liquid NH_3 at low temperature, which one of the following does ***not*** occur
(1) Blue coloured solution is obtained.
(2) Na^+ ions are formed in the solution.
(3) Liquid NH_3 becomes good conductor of electricity.
(4) Liquid ammonia remains diamagnetic.

2. Which of the following pair can't exist in solution ?
(1) $NaHCO_3$ and NaOH
(2) Na_2CO_3 and NaOH
(3) Na_2CO_3 and NaCl
(4) $NaHCO_3$ and NaCl

3. NaOH is manufactured by electrolysis of brine solution. The products of the reaction are
(1) Cl_2 and H_2 (2) Cl_2 and Na–Hg
(3) Cl_2 and Na (4) Cl_2 and O_2

4. Sodium carbonate is manufactured by Solvay process, the products that are recycled are
(1) CO_2 and NH_3
(2) CO_2 and NH_4Cl
(3) NaCl and CaO
(4) $CaCl_2$ and CaO

5. At anode in the electrolysis of fused NaCl :
(1) Na^+ is oxidised (2) Cl^- is oxidised
(3) Cl^- is reduced (4) Na^+ is reduced

6. Which alkali metal on flame test gives red violet colour
(1) Li (2) Cs
(3) Na (4) Rb

7. In presence of iron, alkali metal react with liquid ammonia and form
(1) Metal mixture + H_2
(2) Iron metal mixture + H_2
(3) Metal mixture
(4) Metal amide + H_2

8. Photoelectric effect is maximum in
(1) Cs (2) Na (3) K (4) Li

9. When a standard solution of NaOH is left in air for a few hours,
(1) a precipitate will form
(2) strength will decrease
(3) strength will increase
(4) the concentration of Na^+ ions remain same
(5) all are wrong

10. Which is used in purification of air in the space craft.
(1) Slaked lime (2) Quick lime
(3) Potassium superoxide (4) $CaCl_2$

11. The correct order of ionic character of oxides of alkali earth metal :-
(1) MgO > CaO > SrO > BaO
(2) BaO > SrO > CaO > MgO
(3) CaO > SrO > BaO > MgO
(4) SrO > BaO > MgO > CaO

12. Potassium superoxide is used in oxygen cylinders of space craft as it -
(1) Absorbs O_2
(2) Eliminate moisture
(3) Absorbs CO_2 and increases O_2 content
(4) Forms ozone

13. Compounds of alkaline earth metals are generally less soluble in water than that of alkali metals because of :-
(1) High hydration energy
(2) More covalent character
(3) More ionic character
(4) Less lattice energy

EXERCISE-III (Analytical Questions) — ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	
Ans.	**4**	**1**	**1**	**1**	**2**	**4**	**4**	**1**	**2**	**3**	**2**	**3**	**2**	

EXERCISE-IV (Assertion & Reason) — Target AIIMS

Directions for Assertion & Reason questions

These questions consist of two statements each, printed as Assertion and Reason. While answering these Questions you are required to choose any one of the following four responses.

(A) If both Assertion & Reason are True & the Reason is a correct explanation of the Assertion.

(B) If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

(C) If Assertion is True but the Reason is False.

(D) If both Assertion & Reason are false.

1. ***Assertion*** **:** In the solution of K in liquid NH_3, blue colour appears.
Reason **:** K reacts with NH_3 to form KNH_2
(1) A (2) B (3) C (4) D

2. ***Assertion*** **:** Na_2O_2 is coloured and paramagnetic
Reason **:** Na_2O_2 is superoxide
(1) A (2) B (3) C (4) D

3. ***Assertion*** **:** $KHCO_3$ can not be obtained by solvay process.
Reason **:** $KHCO_3$ is less soluble than $NaHCO_3$.
(1) A (2) B (3) C (4) D

4. ***Assertion*** **:** Mg can burn in the atmosphere of N_2.
Reason **:** Mg reacts with N_2 to form nitride.
(1) A (2) B (3) C (4) D

5. ***Assertion*** **:** Li_2SO_4 do not form double salt like alum.
Reason **:** Atomic size of Li is too small.
(1) A (2) B (3) C (4) D

6. ***Assertion*** **:** NaCl when exposed in air it becomes wet.
Reason **:** NaCl contains hygroscopic impurities like $CaCl_2$, $MgCl_2$ etc.
(1) A (2) B (3) C (4) D

7. ***Assertion*** **:** Lithium is most reducing element.
Reason **:** IP of lithium is minimum in the periodic table.
(1) A (2) B (3) C (4) D

8. ***Assertion*** **:** When cement is mixed with water and left as such, it becomes hard mass.
Reason **:** Setting of cement is exothermic process.
(1) A (2) B (3) C (4) D

9. **Assertion** **:** Beryllium is most reducing s-block element
Reason **:** Hydration energy of Be is greater than its I.P.
(1) A (2) B (3) C (4) D

10. ***Assertion*** **:** Halides of Be dissolve in organic solvents
Reason **:** Atomic size of Be is smallest in the s–block elements.
(1) A (2) B (3) C (4) D

11. ***Assertion*** **:** Be exhibit photoelectric effect.
Reason **:** Be has least IP in the s–block
(1) A (2) B (3) C (4) D

12. **Assertion** **:** Chlorides of Li, Be and Mg are covalent in nature
Reason **:** Li, Be and Mg have large cationic size in the s-block elements
(1) A (2) B (3) C (4) D

13. ***Assertion :-*** Alkaline earth metal and alkali metal form superoxide.
Reason :- Both have tendency to form single bond.
(1) A (2) B (3) C (4) D

EXERCISE-IV (Assertion & Reason) — ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13
Ans.	**2**	**4**	**3**	**1**	**1**	**1**	**3**	**2**	**4**	**2**	**4**	**3**	**4**