s- Block Elements

Alkali Metals (IA Group Elements)

a) General introduction of alkali metals

1. Occurrence:

Alkali metals are not found in Free State in nature due to their high reactivity.

2. Abundance:

Among the alkali metals sodium and potassium are abundant and lithium, rubidium and caesium have much lower abundances.

Order: **Na > K > Rb > Li > Cs**

3. Isotopes of alkali metals:

Francium is highly radioactive; its longest-lived isotope ^{223}Fr has a half-life of only 21 minutes.

4. Electronic configuration of alkali metals:

Element	*Symbol*	*Electronic configuration*
Lithium	*Li*	$1s^2 2s^1$
Sodium	*Na*	$1s^2 2s^2 2p^6 3s^1$
Potassium	*K*	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$
Rubidium	*Rb*	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 5s^1$
Caesium	*Cs*	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 5s^2 5p^6 6s^1$ *or* $[Xe]6s^1$
Francium	*Fr*	$[Rn]7s^1$

5. Atomic and ionic radii order:

Li < Na < K < Rb < Cs

6. Ionization energy order:

Li > Na > K > Rb > Cs

7. Electro Positivity order:

Li < Na < K < Rb < Cs

8. Metalic character of alkali metals order:

Li < Na < K < Rb < Cs

9. Electro Negativity order:

Li > Na > K > Rb > Cs

10.Electron affinity order:

Li > Na > K > Rb > Cs

11.Physical state of alkali metals:

Alkali metals are soft solids and softness increases down the group.

12.Heat of atomization order:

Li > Na > K > Rb > Cs

13.Density of alkali metal:

Li < K < Na < Rb < Cs

14.Conductance in aqueous state:

$Li^+ < Na^+ < K^+ < Rb^+ < Cs^+$

15. Conductance in molten state:

$Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$

16.Specific heat order:

Li > Na > K > Rb > Cs

17.Oxidation state and Valency of alkali metals:

Common oxidation state is +1, and they can form one bond Valency of alkali metals is 1.

18 Flame color:

Metal	colour	Wavelength
Li	Crimson red	670.8 nm
Na	Golden yellow	589.2 nm
K	violet	766.5 nm
Rb	Red violet	780.0 nm
Cs	Blue	455.5 nm

19.Hydration Enthalpy

The hydration enthalpies of alkali metal ions decrease with increase in ionic sizes**.**

$Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$

Li^+ has maximum degree of hydration and for this reason lithium salts are mostly hydrated.

E.g: $LiCl.2H_2O$

20.Standard Reduction potential E^o/V for (M^+/M):

Li has highest standard oxidation potential (+3.05 eV) due to its high hydration energy. Such that it converts into. Li + ion by losing one electron.

Order: **Li > Rb > Cs > K > Na**

Order of standard oxidation potential of s - block element

Li > K > Ba > Sr > C a > Na > M g > Be

21. M. P/K and B.P/K:

Li > Na > K > Rb > Cs

22.Reactivity towards water:

Li < Na < K < Rb < Cs

23.Reactivity towards hydrogen

Cs < Rb < K < Na < Li

b) Chemical properties of alkali metals.

i) Order of Reactivity towards oxygen:

Li < Na < K < Rb < Cs

ii) Oxides(O^{-2}): Lithium forms monoxide $(\mathbf{Li_2O})$ top to bottom decreases. Oxides are Díamagnetic nature.

$\mathbf{Li_2O}$, $\mathbf{Na_2O}$ are color less solids,

$\mathbf{K_2O}$ (Pale yellow),

$\mathbf{Rb_2O}$ (Deep Yellow),

$\mathbf{Cs_2O}$ (orange)

iii) Peroxide(O_2^{-2}):

Sodium forms peroxide $(\mathbf{Na_2O_2})$. Peroxides are Día magnetic nature

iv) Super oxide(O_2^{-}):

K, Rb, Cs forms superoxide KO_2, RbO_2, CsO_2

Thermal stability order of super oxide: $KO_2 > RbO_2 > CsO_2$

Super oxides are para magnetic nature and exhibit color having odd electron bond.

KO_2 (orange), RbO_2 (brown), CsO_2 (orange)

Example: KO_2 is paramagnetic because of one unpaired electron in π^*2p molecular orbital

v) Physical Properties:

The oxides and peroxides are colorless and diamagnetic. While superoxides are yellow or orange in colorand paramagnetic.

Vi) Chemical properties:

$$M \xrightarrow{O_2} M_2O \xrightarrow{O_2} M_2O_2 \xrightarrow{O_2} MO_2$$

$$\mathbf{M_2O + H_2O \rightarrow M(OH)}$$

$$M_2O_2 + H_2O \rightarrow M(OH) + H_2O_2$$

$$MO_2 + H_2O \rightarrow M(OH) + H_2O_2 + O_2$$

Basic nature of Oxides order: $Li_2O < Na_2O < K_2O < Rb_2O < Cs_2O$

2) Reaction with Nitrogen:

Li reacts with nitrogen directly to form Li_3N.

3) Reaction with Air:

$$\mathbf{M + \text{ moist air } O_2 \rightarrow M_2O + H_2O \rightarrow MOH + CO_2 \rightarrow M_2CO_3}$$

$$\mathbf{M + \text{ dry air } O_2 \rightarrow M_2O + M_3N}$$

4) Reaction with water:

$$\mathbf{M + H_2O \rightarrow MOH + H_2}$$

i) Order of reactivity of with water:

Li decomposes water slowly. Nareactswith water quickly and remaining vigorously.

$$\mathrm{Cs} > \mathbf{Rb} > \mathbf{K} > \mathbf{Na} > \mathbf{Li}$$

ii) Basic nature of hydroxides order:

$$\mathbf{LiOH < NaOH < KOH < RbOH < CSOH}.$$

iii) Solubility of hydroxide order:

$$\mathbf{LiOH < NaOH < KOH < RbOH < CsOH}$$

iv) Thermal stability of hydroxides order:

$$\mathbf{LiOH < NaOH < KOH < RbOH < CsOH}$$

5) Reaction of alkali metal with compound containing acidic hydrogen:

i) Reaction of alkali metal with compound containing acidic hydrogen:

$$2Na + CH \equiv CH \rightarrow NaC \equiv CNa + H_2$$

$$2M + 2NH_3 \rightarrow 2MNH_2 + H_2$$

ii) Organo metallic compounds of alkali metals:

alkyl Lithium (R^-Li^+), Sodium acetylide ($R - C \equiv C - Na$)

6. Reaction of alkali metals with acids:

alkali metal reacts with acid to form alkali metal salt and liberate hydrogen gas

$$HX + M \rightarrow MX + \frac{1}{2}H_2$$

7. **Reaction of alkali metals with hydrogen:**

alkali metals react with dihydrogen at about 673K (lithium at 1073K) to form hydrides. All the alkali metal hydrides are ionic solids with high melting points.

$$2M + H_2 \rightarrow 2M^+H^-$$

However, the ease with which they do so decreases from lithium to cesium. These hydrides contain the H^- ion (which is not commonly found, since hydrogen usually forms H^+ ions). It can be proved that H^- ions exist because on electrolysis hydrogen is liberated at the anode

i. **Order of reactivity of alkali metals with hydrogen**:

Decreases as we move down the group from Li to Cs.This is due to that the lattice energys of these hydrides decreases progressively as the size of metal cation increases

ii. **Stability of hydrides of alkali metals with hydrogen:**

LiH > NaH > KH > RbH > CsH

8. Reactions of alkali metals with halogens:

The alkali metals readily react vigorously with halogens to form ionic halides, M^+X^-.However, lithium halides are somewhat covalent. It is because of the high polarisation capability of lithium ion (The distortion of electron cloud of the anion by the cation is called polarization). The Li^+ ion is very small in size and has high tendency to distort electron cloud around the negative halide ion. Since anion with large size can be easily distorted, among halides**, lithium iodide is the most covalent in nature.**

i. Reactivity order of alkali metals with halogens:

All metals form fluorides, chlorides, bromides and iodides. The reactivity of the alkali metals increases as their (IE) decreases giving reactivity order: Cs > Rb > K > Na > Li

ii. Physical properties of alkali halides:

- The alkali metal halides, MX, (X=F,Cl,Br,I) are all high melting,
- colorless crystalline solids
- All of these halides have high negative enthalpies of formation; the Δ_fH^0 values for fluorides become less negative as we go down the group, whilst the reverse is true for Δ_fH^0 for chlorides, bromides and iodides.
- For a given metal Δ_fH^0always becomes less negative from fluoride to iodide.
- The melting and boiling points always follow the trend:

Fluoride > chloride > bromide > iodide.

- All these halides are soluble in water.
- **The low solubility of LiF in water is due to its high lattice enthalpy**
- **low solubility of CsI is due to smaller hydration enthalpy of its two ions**.
- Other halides of lithium are soluble in ethanol, acetone and ethylacetate;
- **LiCl is soluble in pyridine** .

iii) Ionic or covalent nature of alkali metal halides:

- Li halides are covalent remaining alkali metal halides are ionic
- **Ionic character:** · **LiCl < NaCl < KCl < RbCl < CsCl Covalent character:**
  · **LiCl < LiBr < LiI**
- **LiI is most covalent among the alkali metal halides.**

iv) Stability of alkali metal halides:

Stability of alkali metal halide depends on the standard enthalpy of formation.down the group decreases.

LiCl > NaCl > KCl > RbCl > CsCl

v) Lattice enthalpies of alkali metal halides:

MF > MCl > MBr > MI

LiF > NaF > KF > RbF > CsF

vi) Solubility of alkali metal halides:

- LiF < NaF < RbF < KF < CsF
- LiCl > CsCl > RbCl > NaCl > KCl
- LiBr > NaBr > KBr > RbBr > CsBr
- NaI > LiI > KI > RbI > CsI

KCl is less soluble than NaCl. Due to the difference in lattice energy between NaCl and KCl is 67 kJ mol^{-1}, and yet the difference in $\Delta G_{(hydration)}$ for Na^+ and K^+ is 76 kJ mol^{-1}

vii) Poly halides of alkali metals: alkali metal halides react with the halogens and interhalogen compounds forming ionic polyhalide compounds:

$$KI + I_2 \rightarrow K[I_3]$$

$$KBr + ICl \rightarrow K[BrICl]$$

$$KF + BrF_3 \rightarrow K[BrF_4]$$

$$CsBr + Br_2 \rightarrow CsBr_3 \rightarrow Cs^+ + Br_3^-$$

9. Solubility in liquid ammonia:

The alkali metals dissolve in liquid ammonia giving deep blue solutions which are conducting in nature.

$$M + (X+Y)NH_3 \rightarrow [M(NH_3)_x]^+ + [e(NH_3)_y]^-$$

The solutions are paramagnetic and on standing slowly liberate hydrogen resulting in the formation of amide.

$$M^+_{(am)} + e^- + NH_3(l) \rightarrow MNH_{2(am)} + \frac{1}{2}H_2(g)$$

The blue colour of the solution is due to the ammoniated electron (where 'am' denotes solution in ammonia.) In concentrated solution, the blue colour changes to bronze colour and becomes diamagnetic.

i. Solubility order of alkali metals in ammonia: Li < Na < K

ii. Cause of color of alkali metals in ammonia: The blue colour of the solution is due to the ammoniated electron which absorbs energy in the visible region of light and thus imparts blue colour to the solution.

10. Alkali metal carbonates

i) Formation of alkali metal carbonates:

alkali metal hydroxides react with CO_2 giving alkali metal carbonte.

Alkali metal carbonates are the salts of carbonic acid.

ii) Chemical reactivity of alkali metal carbonates: Lithium carbonate is not so stable to heat; lithium being very small in size polarises a large CO_3^{2-} ion leading to the formation of more stable Li_2O and CO_2.

$$M_2CO_3 + H_2O + CO_2 \rightarrow 2MHCO_3$$

$$M_2CO_3 + 2HCl \rightarrow 2MCl + H_2O + CO_2$$

$$Na_2CO_3.10H_2O \xrightarrow{373K} Na_2CO_3.H_2O \xrightarrow{>373k} Na_2CO_3$$

$$Na_2CO_3 + 2H_2O \rightarrow H_2CO_3 + 2Na^+ + 2OH^-$$

ii) Stability order of alkali metal carbonates:

$$Li_2CO_3 < Na_2CO_3 < K_2CO_3 < Rb_2CO_3 < Cs_2CO_3$$

iii)Solubility of alkali metal carbonates:

The solubility of carbonates in water increases as the atomic number of the metal ion increases

$$Li_2CO_3 < Na_2CO_3 < K_2CO_3 < Rb_2CO_3 < Cs_2CO_3$$

iv) Ionic or covalent nature of alkali metal carbonates:

Ionic nature order:

$$Li_2CO_3 < Na_2CO_3 < K_2CO_3 < Rb_2CO_3 < Cs_2CO_3$$

11. Alkali metal bi-carbonates:

i) Formation of bicarbonates: **Lithium hydrogencarbonate is not obtained in the solid form** while all other elements form solid hydrogencarbonates.

$$M_2CO_3 + H_2O + CO_2 \rightarrow 2MHCO_3$$

ii) Chemical reactivity of alkali metal bi-carbonates:No other metals form solid bicarbonates, though NH_4HCO_3 also exists as a solid. Bicarbonates evolve carbon dioxide and turn into carbonates on gentle warming. This is one test for bicarbonates in qualitative analysis. The crystal structures of $NaHCO_3$ and $KHCO_3$ both show hydrogen bonding, but are different. In $NaHCO_3$ the HCO_3^- ions are linked into an infinite chain, whilst in $KHCO_3$ a dimeric anion is formed.on heating bi carbonates decomposes into carbonates and evolution of CO_2

$$2MHCO_3 \rightarrow M_2CO_3 + H_2O + CO_2$$

$$MHCO_3 + HCl \rightarrow MCl + H_2O + CO_2$$

iii) Stability order of alkali metal bi-carbonates:

$$\mathbf{NaHCO_3 < KHCO_3 < RbHCO_3 < CsHCO_3}$$

($LiHCO_3$ does not exist in solid state.)

iv) Solubility of alkali metal bi-carbonates:

Bicarbonates are soluble in water.

$$LiHCO_3 < NaHCO_3 < KHCO_3 < RbHCO_3 < CsHCO_3$$

v) Ionic or covalent nature of alkali metal bi-carbonates:

Ionic Nature order: $\mathbf{NaHCO_3 < KHCO_3 < RbHCO_3 < CsHCO_3}$

12. Alkali metal nitrates:

Alkali metals forms MNO_3 type nitrates (M – alkali metal)

i) **Formation of nitrates of alkali metal nitrates:**

The nitrates can all be prepared by the action of HNO_3 on the corresponding carbonate or hydroxide.

$$2HNO_3 + K_2CO_3 \rightarrow 2KNO_3 + CO_2 + H_2O$$

ii) Chemical reactivity of nitrates of alkali metal nitrates:

Lithium nitrate when heated gives lithium oxide, Li_2O, whereas other alkali metal nitrates decompose to give the corresponding nitrite.

$$4LiNO_3 \rightarrow 2Li_2O + 4NO_2 + O_2$$

$$2NaNO_3 \rightarrow 2NaNO_2 + O_2$$

iii) Stability order of alkali metal nitrates:

$$LiNO_3 < NaNO_3 < KNO_3 < RbNO_3 < CsNO_3$$

iv)Solubility of alkali metal nitrates: Soluble in Water.

$$LiNO_3 < NaNO_3 < KNO_3 < RbNO_3 < CsNO_3$$

v) Ionic or covalent nature-alkali metal nitrates:

Ionic nature order: $LiNO_3 < NaNO_3 < KNO_3 < RbNO_3 < CsNO_3$

13. Alkali metal sulphates: Alkali metals forms M_2SO_4 type sulphates.

i) Formation of alkali metal sulphate:

alkali metal hydroxides or carbonates are treated with H_2SO_4 to give alkali metal sulphates.

$$2MOH + H_2SO_4 \rightarrow M_2SO_4 + 2H_2O$$

$$M_2CO_3 + H_2SO_4 \rightarrow M_2SO_4 + H_2O + CO_2$$

ii) Stability order of alkali metal sulphates:

iii) Solubility of alkali metal sulphates:

Li_2SO_4 in soluble and remaining alkali metal sulphates are soluble

iv) Chemical reactivity of Sulphates of alkali metal sulphates:

- These sulphates on burning with C forms Sulphides.

$$M_2SO_4 + 4C \rightarrow M_2S + 4CO$$

- Except lithium, sulphates of IA group react with sulphates of trivalent metals like Fe^{+3}, Cr^{+3}, Al^{+3} etc. gives double salts called alum.

I III

Alum formula: $M_2SO_4.M_2(SO_4)_3.24H_2O$

v)**Ionic or covalent nature of alkali metal sulphates:**

All alkali metal sulphates are ionic. Ionic properties increase from Li to Cs.

$$Li_2SO_4 < Na_2SO4 < K_2SO_4 < Rb_2SO_4 < Cs_2SO4$$

Glauber's salt: $Na_2SO_4.10H_2O$

14. Anomalous behavior of lithium: The anomalous behavior of Li is due to the exceptionally small size, and Highpolarizing power.

(i)Lithium is much harder. Its M.p. and B.p. are higher than the other alkali metals.

(ii) Lithium is least reactive but the strongest reducing agent among all the alkali metals.On combustion in air it forms mainly monoxide, Li_2O and the nitride, Li_3N unlike other alkali metals.

(iii) LiCl is deliquescent and crystallizes as a hydrate, $LiCl.2H_2O$ whereas other alkali metal chlorides do not form hydrates.

(iv) Lithium hydrogen carbonate is not obtained in the solid form while all other elements form solid hydrogen carbonates.

(v) Lithium unlike other alkali metals forms no ethynide on reaction with ethyne.

(vi) Lithium nitrate when heated gives lithium oxide Li_2O. whereas other alkali metal nitrates decompose to give the corresponding nitrite

$$4LiNO_3 \rightarrow 2Li_2O + 4NO_2 + O_2$$

$$2NaNO_3 \rightarrow 2NaNO_2 + O_2$$

(vii) LiF and Li_2O are comparatively much less soluble in water than the corresponding compounds of other alkali metals.

15.Diagonal relationship-anomalous behavior of lithium:

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

(ii) Lithium and magnesium react slowly with water. Their oxides and hydroxides are much less soluble and their hydroxides decompose on heating. Both form a nitride, Li_3N and Mg_3N_2, by direct combination with nitrogen.

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

(iv) The carbonates of lithium and magnesium decompose easily on heating to form the oxides and CO_2. Solid hydrogen carbonates 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 crystalize from aqueous solution as hydrates, $LiCl{\cdot}2H_2O$ and $MgCl_2{\cdot}8H_2O$.

(c) Extraction of alkali metals:

Extraction of sodium:

- **In the electrolytic reduction method, the metal is extracted by passing electricity through molten oxide, chloride or hydroxide of metal.**
- **Sodium metal is extracted by passing the electricity through the molten Sodium chloride, it decomposes to form Sodium metal and Chlorine gas.**

$$2NaCl_{(l)}(Molten) \xrightarrow{electrolysis} 2Na_{(s)} + Cl_{2_{(g)}}$$

- **The formation of Sodium metal and Chlorine by the electrolysis of molten Sodium Chloride takes place at two electrodes.**
- **The reaction is shown as follows:**

$NaCl_{(s)} \xrightarrow{Heat} Na^{+}{}_{(aq)} + Cl^{-}{}_{(aq)}$

- **At the cathode, reduction takes place, and Sodium metal is obtained.**

$Na^{+}{}_{(aq)} + e^{-} \rightarrow Na_{(s)}$

- **At the anode, oxidation takes place and Chlorine gas is obtained.**

$2Cl^{-}{}_{(aq)} \rightarrow Cl_{2(g)} + 2e^{-}$

- **The overall reaction is mentioned as follows:**
- $2NaCl_{(l)}(Molten) \xrightarrow{electrolysis} 2Na_{(s)} + Cl_{2_{(g)}}$ t

Extraction of potassium:Potassium is a highly reactive metal. It cannot be extracted from its ore by a reducing agent, as it is more reactive than the reducing agents. Hence, it is extracted by the process of electrolysis.

Potassium is prepared by the chemical reduction of KCl rather than of the molten chloride. However, it can be prepared by carrying electrolysis of fused KOH or by electrolysis of fused mixture of KCl and $CaCl_2$.potassium is manufactured by reducing the fluoride with Calcium carbide at 1000^0C in steel cylinder.

$2KF + CaC_2 \xrightarrow{1000^0 C} 2K + CaF_2 + 2C$

i) **Down's process:**Sodium metal is manufactured by this process.

Cathode: Circular steel

Anode: Graphite

Overall reaction takes place in the cell is

$NaCl \rightarrow Na^{+} + Cl^{-}$

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

At anode: $2Cl^{-} \rightarrow Cl_2 + 2e^{-}$

The electrolysis of pure NaCl presents the difficulties:

a) The fusion temperature of NaCl is high. i.e., 801^0C.at this temperature both sodium and chlorine corrosive.

b) Sodium forms a metallic fog at this temperature.

To remove above difficulties the fusion temperature is reduced from 801^0C to 600^0C by adding $CaCl_2$ and KF. This is cheaper method and chlorine as aby product.

(d) Compounds of alkali metals:

1. Sodium hydroxide: Sodium hydroxide is known as **Caustic soda**

i.Synthesis Gossage: Causticizing process is also known as Gossage process.

In this process, milk of lime $\left(\mathrm{Ca(OH)_2}\right)$ is added to hot dilute solution of sodium carbonate to form sodium hydroxide.

$$Na_2CO_3 + Ca(OH)_2 \rightarrow 2NaOH + CaCO_3$$

The obtained caustic soda contains Na_2CO_3 and NaCl or Na_2SO_4 as the impurities

ii.Synthesis Lowig method from sodium:

$Na_2CO_3 + Fe_2O_3 \rightarrow 2NaFeO_2 + CO_2$

$2NaFeO_2 + H_2O \rightarrow 2NaOH + Fe_2O_3$

iii) Synthesis Nelson cell from NaCl:

Electrolyte: Brine solution (aqueous NaCl)

Cathode: U-shaped perforated steel vessel,Anode: Graphite rod

Electrode reactions: $2NaCl \rightarrow 2Na^+ + 2Cl^-$

At anode: $2Cl^- \rightarrow Cl_2 + 2e^-$

At cathode: $2H_2O + 2e^- \rightarrow 2OH^- + H_2$

$2Na^+ + 2OH^- \rightarrow 2NaOH$

ii.Synthesis Castner-Kellner method:

Sodium hydroxide is generally prepared commercially by the electrolysis of sodiumchloride in Castner-Kellner cell.

In the outer compartments:

Electrolyte: brine solution (aq NaCl)

cathode: Mercury

anode: Graphite

$2NaCl \rightarrow 2Na^+ + 2Cl^-$ (Ionization)

At anode(oxidation): $2Cl^- \rightarrow Cl_2 + 2e^-$

At cathode(reduction): $Hg + 2Na^+ + 2e^- \rightarrow Na_2Hg$

Middle compartment:

Cathode: Iron rod

Anode: Mercury

Electrolyte:NaOH

At cathode: $2H_2O + 2e^- \rightarrow 2OH^- + H_2 \uparrow$

At anode: $Na_2Hg \rightarrow 2Na^+ + Hg + 2e^-$

$2Na^+ + 2OH^- \rightarrow 2NaOH$

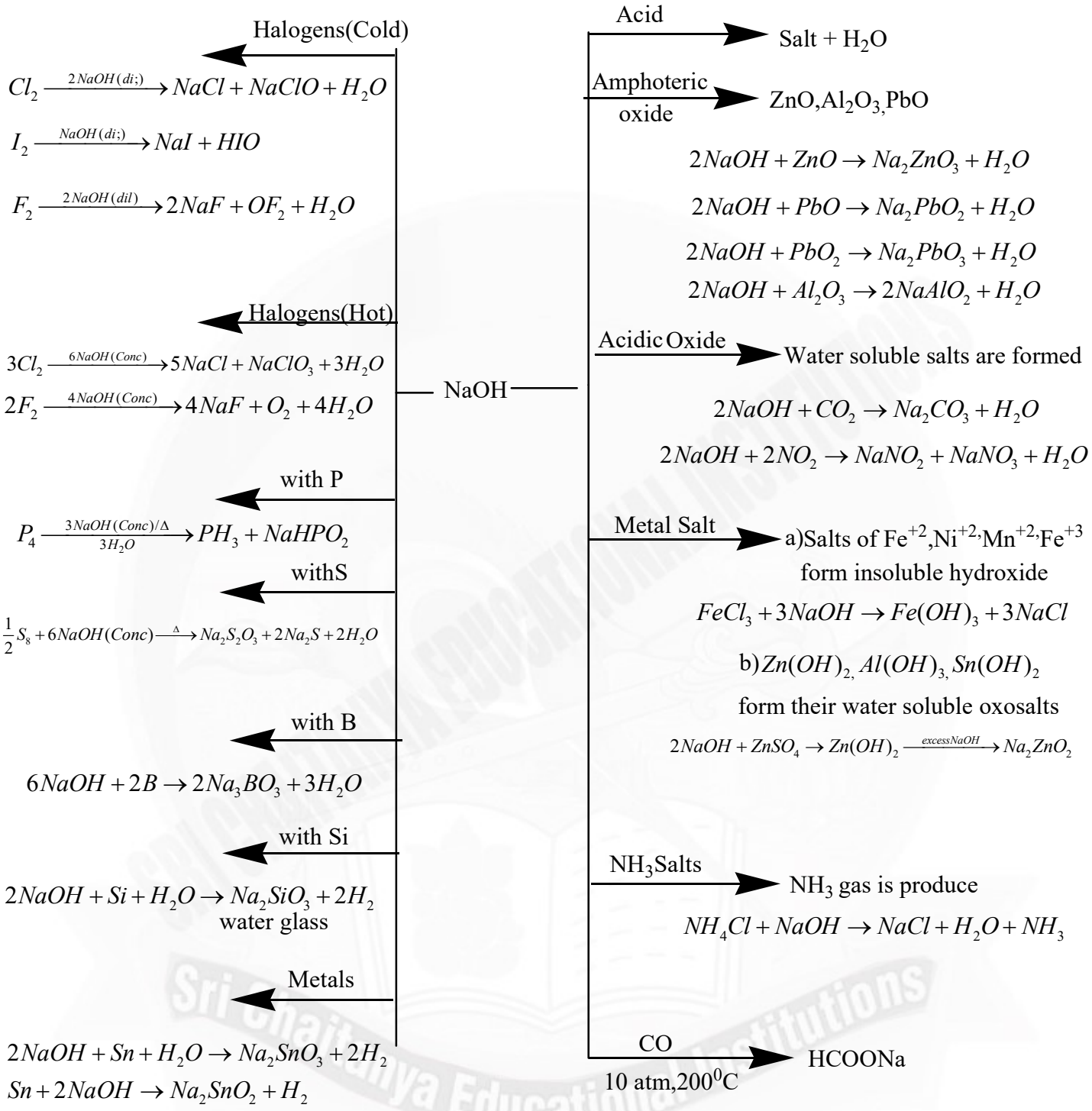
Physical properties of sodium hydroxide:

- Sodium hydroxide is a white, translucent solid. It melts at 591 K.
- It is readily soluble in water to give a strong alkaline solution.
- Crystals of sodium hydroxide are deliquescent.

- The sodium hydroxide solution at the surface reacts with the CO_2 in the atmosphere to form Na_2CO_3It soapy to touch.
- It absorbs $CO_2$from atmosphere. It decomposes the muscle proteins and makes the pulp.

Uses of sodium Hydroxide: It is used in

- The manufacture of soap,paper, artificial silk and a number of chemicals,
- in petroleum refining,
- in the purification of bauxite,
- in the textile industries for mercerising cotton fabrics
- for the preparation of pure fats and oils
- as a laboratory reagent.



2. Sodium carbonate (washing soda):

i) Synthesis by Solvay or ammonia-soda:

Raw materials: NaCl, NH_3, $CaCO_3$

(a) $2NH_3 + H_2O + CO_2 \rightarrow (NH_4)_2CO_3$

$(NH_4)_2CO_3 + H_2O + CO_2 \rightarrow 2NH_4HCO_3$

$NH_4HCO_3 + NaCl \rightarrow NaHCO_3 + NH_4Cl$

$NaHCO_3$, crystal separates out. These are heated to give sodiumcarbonate

$$2NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$$

(b) NH_3 is recovered using $Ca(OH)_2$

$$2NH_4Cl + Ca(OH)_2 \rightarrow 2NH_3 + CaCl_2 + H_2O$$

ii) Le-blanc process:

Raw materials: NaCl, H_2SO_4, Coke, $CaCO_3$

$$NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$$

$$NaHSO_4 + HCl \rightarrow Na_2SO_4 + HCl$$

$$Na_2SO_4 + 4C \rightarrow Na_2S + 4CO$$

$$Na_2S + CaCO_3 \rightarrow Na_2CO_3 + CaS$$

iii) Synthesis by electrolytic method:

In this process first NaOH is prepared by the electrolysis of brine. Then carbon dioxide is passed through sodium hydroxide at high pressure to form sodium carbonate.

$$2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$$

Physical Properties:

$$Na_2CO_3.10H_2O \xrightarrow{373K} Na_2CO_3.H_2O \xrightarrow{>373k} Na_2CO_3$$

Uses of sodium carbonate:

- It is used in water softening, laundering and cleaning.
- It is used in the manufacture of glass,soap, borax and caustic soda.
- It is used in paper, paints and textile industries.
- It is an important laboratory reagent both in qualitative and quantitative analysis.
- **iii) Sodium bicarbonate (baking soda):** Sodium hydrogen carbonate is known asbaking soda because it decomposes on heating to generate bubbles of carbon dioxide (leaving holes in cakes or pastries and making them light and fluffy).

i) Preparation of sodium bicarbonate:

Sodium hydrogen carbonate is made by saturating a solution of sodium carbonate with carbon dioxide. The white crystalline powder of sodium hydrogen carbonate, being less soluble, gets separated out.

$$Na_2CO_3 + H_2O + CO_2 \rightarrow 2NaHCO_3$$

ii) Uses of sodium bicarbonate:

- Sodium hydrogen carbonate is a mild antiseptic for skin infections.
- It is used in fire extinguishers.
- It Is used as medicine as an antacid.
- It is used in effervescent drink.
- It is used in the preparation of baking powder.
- Dry powder extinguisher contains sand and sodium bicarbonate.

- Equimolar mixture of Na2CO3 and K2CO3 is called fusion mixture. It is used to convert in soluble Salts into soluble salts.
- NaHCO3 does not give any colouration with phenolphthalein But gives yellow colour Methyl orange indicator.

BIOLOGICAL IMPORTANCE OF SODIUM AND POTASSIUM:

- A typical 70kg man contains about 90g of Na and 170 grm of K compared with only 5 grm of iron and 0.06g of copper
- Na ions participate in the transmission of nerve signals, in regulating the flow of water across cell membranes and in the transport of sugars and amino acids into cells.
- Sodium and potassium, differ quantitatively in their ability to penetrate cell membranes, in their transport mechanisms and in their efficiency to activate enzymes.
- Potassium ions activate many enzymes. Potassium participates in the oxidation of glucose
- To produce ATP. There is a variation in the concentration of sodium
- and potassium ions found on the opposite sides of cell membranes.
- Oxidation of glucose to produce ATP Blood plasma contains 143 mmol/L of Na^+
- 5 mmol/L K^+in RBC. Concentration of N a^+ ions change to 10m mol/L
- (Mechanism: Sodium-Potassium Pump)
- Concentration of K^+ ions change to 105 mmol/L
- Resting animal utilises > 1/3 ATP during Sodium – Potassium pump

USES OF ALKALI METALS AND THEIR COMPOUNDS:

- White metal – Alloy of Li+ Pb.
- Li is used in thermonuclear reactions.
- Li is used in electro chemical cells.
- Sodium is used to make tetra ethyl lead ($Pb(Et)_4$) These organolead compounds were earlier used as anti-knock additives to petrol,
- Liquid sodium metal is used as coolant in fast breeder nuclear reactors.
- Potassium has vital role in biological system
- KCl is used as fertilizer.
- Caesium is used in photo electric cells.
- $LiNO_3$ is used for fireworks and red-colored distress flares.
- Large deposits of $NaNO_3$, are formed in Chile, and are used as a nitrogenous fertilizer.
- Gun powder is a mixture of KNO_3, sulphur and charcoal.
- Solid $LiNO_3$ and $NaNO_3$ are deliquescent
- Hence KNO_3 is used in gun powder

4. Other compounds of alkali metals:

Sodium Chloride:

The most abundant source of sodium chloride is sea water which contains 2.7 to 2.9% by mass of the salt. Crude sodium chloride, generally obtained by crystallization of brine solution, contains sodium sulphate, calcium sulphate, calcium chloride and magnesium chloride as impurities. Calcium chloride and magnesium chloride, are impurities because they are deliquescent (absorb moisture easily from the atmosphere). To obtain pure sodium chloride, the crude salt is dissolved in minimum amount of water and filtered to remove insoluble impurities. The solution is then saturated with hydrogen chloride gas. Crystals of pure sodium chloride separate out. Calcium and magnesium chloride, being more soluble than sodium chloride, remain in solution. Sodium chloride melts at 1081K. It has a solubility of 36.0 g in 100 g of water at 273 K.The solubility does not increase appreciably with increase in temperature.

Uses :

(i) It is used as a common salt or table salt for domestic purpose.

(ii) It is used for the preparation of Na_2O_2, NaOH and Na_2CO_3 .

5. Chemical properties of compounds of alkali metals:

Uses of $NaNO_3$:

1.as nitrogenous fertilizer in agriculture.

2.in the manufacture of HNO_3, KNO_3

$NaNO_3 + KCl \rightarrow NaCl + KNO_3$

Uses of $NaNO_2$:

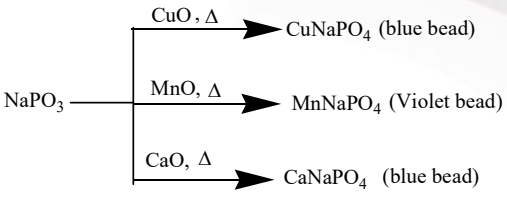
1) In the manufacture of organo-nitrogen compounds like azodyes.

2) As a food preservative and

3) In both qualitative and quantitative analysis.

Microcosmic Salt : $Na(NH_4)HPO_4.4H_2O$

It is used for performing bead test (like borax) for detecting colored ions in qualitative analysis



Pearlash, K_2CO_3:

Preparation:

It is prepared by Leblanc process (previous method of Solvay's process) In this KCl from carnallite is converted to K_2SO_4 which on heating with carbon and limestone gives K_2CO_3.

$$2KCl + H_2SO_4 \rightarrow K_2SO_4 + 2HCl$$

$$K_2SO_4 + CaCO_3 + 4C \rightarrow K_2CO_3 + CaS + 4CO\uparrow$$

$$K_2CO_3 + CaS + H_2O \rightarrow K_2CO_3 + CaS\downarrow$$

Properties:

It is a colourless deliquescent powdered substance, highly soluble in water. Its solubility is highest among K and Li carbonates. Its aq. Solution is alkaline in nature.

$$K_2CO_3 + 2H_2O \rightarrow 2KOH + H_2CO_3$$

Uses:

It is used in making of soft soaps in washing of wool, manufacturing of glass (potash glass)

Potassium Chlorate ($KClO_3$)

Potassium chlorate melts at 345°C and decomposes at 370°C to give potassium chloride and oxygen on further heating molten mass solidifies into a mixture of KCl and $KClO_4$ KClO, then decomposes at 650°C to KCl and O_2

$$2KClO_3 \xrightarrow{370^0C} 2KCl + 3O_2$$

$$4KClO_3 \longrightarrow 3KClO_4 + KCl$$

$$4KClO_4 \xrightarrow{650^0C} 4KCl + 8O_2$$

Efflorescence and Deliquescence:

The salts which are crystalline in nature and are having water of crystallization on exposure to atmosphere loses their water of crystallization partly or completely and changes to their anhydrous amorphous state This phenomenon is called Efflorescence.

Example: $CuSO_45H_2O$, $Na_2SO_4.10H_2O$ The salts which are soluble in water when exposed to the atmosphere absorb moisture and get dissolved in it and changes to their liquid state This phenomenon is called. Deliquescence and the salt is called deliquescent salt.

Example: KOH, NaOH, $MgCl_2$, $CaCl_2$etc

The salts show the above two phenomenon due to the difference in the vapor pressure of crystals and the atmospheric humidity. Efflorescence happens when the vapor pressure of the hydrated salt becomes more than the vapor pressure of the atmospheric humidity. The phenomenon of deliquescence happens when the vapor pressure or aqueous tension of the

salt solution is very less than the vapor pressure of the atmospheric humidity. Therefore, deliquescence is minimum in dry conditions.

EXERCISE -1

SINGLE ANSWER TYPE (PYQ)

(a) General introduction of alkali metal:

1) Which one among the following metals is the weakest reducing agent? (25^{th} jan shift2-2023)

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

Key: 3

Hint: sodium have lowest oxidation potential in alkali metals. Hence it is weakest reducing agent amongalkali metals

2) The correct order of hydration enthalpies is (29^{TH} Janshift1-2023)

(A) K^+ (B) Rb^+ (C) Mg^{2+} (D) Cs^+ (E) Ca^{2+}

Choose the correct answer from the options given below:

1) $C > A > E > B > D$ 2) $E > C > A > B > D$

3) $C > E > A > D > B$ 4) $C > E > A > B > D$

Key: 4

Hint: Hydration enthalpies is

i) $K^+ > Rb^+ > Cs^+$: A>B>D ii) $Mg^{+2} > Ca^{+2}$>: C > E option 4 is correct

$C > E > A > B > D$

3) Which of the following order of density is correct for IA group elements

(April 12^{th} shift2-2023 and **25^{th} July shift1** -2022)

(1) Li < K< Na < Rb < Cs (2) Li < Na <K< Rb < Cs

(3) Cs < Rb<K< Na< Li (4) Cs < K< Na< Rb < Li

Ans. (1)

Sol. Density increase down the group but K is lighter than Na. Order Li <K<Na < Rb < Cs Density / g cm-3; Li= 0.53; Na = 0.97; K = 0.86; Rb = 1.53; Cs =1.90 Due to their large size. The atoms of alkali metals are less closely pocked. Consequently, have low density on going down the group, both the atomic size and atomic mass increase but the air mass compensates the bigger atomic size.As a result, the density of alkali metals increases from

Li to Cs.K is however, lighter than Na. It is probably due to an unusual increase in atomic size

4) S-block element which cannot be qualitatively confirmed by the flame test

(26^{th} June Shift 2 -2022)

(1)Li (2) Na (3) Rb (4) Be

Key: 4

Hint: S-block elements Be, Mg does not impart color of the flame test

5) The correct order of hydration enthalpies of alkali metal ions is (2019 Main, 8 April I)

1) $Li^+ > Na^+ > K^+ > Cs^+ > Rb^+$ 2) $Na^+ > Li^+ > K^+ > Rb^+ > Cs^+$

3) $Na^+ > Li^+ > K^+ > Cs^+ > Rb^+$ 4) $Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$

Key:4

Hint: Hydration Enthalpy is inversely proportional to ionic size

$Li^+ < Na^+ < K^+ < Rb^+ < Cs^+$ - size

$Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$ - Hydration Enthalpy

6) The element having greatest difference between its 1^{st} and 2^{nd} ionization energies is

(12^{th} April morning -2019

1) Ca 2) Sc 3) Ba 4) K

Key: 4

Hint: Alkali metals have high difference in 1^{st} and 2^{nd} ionization energies as they achieve stable noble gas configuration

7) Among the following, the energy of 2s orbital is lowest in (12^{th} April evening -2019)

1) K 2) H 3) Li 4) Na

Key:1

Hint: as the atomic number increases energy of orbital decreases (become more -ve value)

Order of energy of 2s orbital is H > Li > Na > K

8) Which of the following has minimum boiling point? (April 11^{th} shift2-2023)

1) Na (2) K 3) Rb (4) Cs

Key: (4)

Hint: Cs has minimum boiling point as boiling point of Alkali metals decreases down the group

9) The order of decreasing ionization enthalpy in alkali metals is

(1) Na > Li > K > Rb (2) Rb < Na < K < Li

(3) Li > Na > K > Rb (4) K < Li < Na < Rb.

Key:3

Hint: down the group I.E decreases

10) For alkali metal, which of the following trends is incorrect?

1) Hydration Energy: Li > Na > K > Rb 2) Ionization Energy: Li > Na > K > Rb

3) Density: Li < Na < K < Rb 4) Atomic size: Li < Na < K < Rb

Key: 3

Hint: Density of IA metals- Li < K < Na < Rb < Cs

11) Which of the alkali metal is having least melting point?

1) Na 2) K 3) Rb 4) Cs

Key:4

Hint: Cs has bigger size, weak metallic bonding so least melting point.

12) Which of the alkali metal is having highest boiling point?

1) Li 2) K 3) Na 4) Cs

Key:1

Hint: alkali metal is having highest boiling point is Li

13) In vapor the order of reducing property of IA group elements is

1) Li > Na > K > Rb 2) Li < Na < K < Rb 3) Na > Li > K > Rb 4) Na < K < Li < Rb

14) In correct order against the property is (Advanced 2016 paper-2)

1) Density of IA metals- Li < K < Na < Rb < Cs

2) Melting point - Li > Na > K > Rb > Cs

3) Abundance of IA metals in Lithosphere- Na > K > Rb > Li > Cs

4) E^0 red of IA metals- Li > Na > K > Rb > Cs

key: 4

Hint: Standard Reduction potential E^o/V for (M^+/M): Li > Rb > Cs > K > Na

15) The salt of alkali metal gives violet color in the flame test. Its aqueous solution gives a white ppt with $Bacl_2$ in hydrochloric acid medium. The salt is

1) K_2SO_4 2) KCl 3) Na_2SO_4 4) K_2CO_3

Key:2

Hint: K impart violet color to the flame and SO_4^{-2} ions produce white ppt of $BaSO_4$ when treated with $BaCl_2$

16. Sodium forms Na^+ and not Na^{2+} because:

1) Sodium contains only one electron in outer most shell

2) First ionization potential is small and the difference in first and second ionization Potentials is large (Na^+ has neon configuration whereas Na doesn't)

3) Radius of Na^{2+} is much smaller than of Na^+ 4) It has Argon configuration

Key:2

Hint: First ionization potential is small and the difference in first and second ionization Potentials is large (Na^+ has neon configuration whereas Na doesn't)

17. Which of the following is lightest metal?

1) Na 2) K 3) Cs 4) Rb

Key:2

Hint: Potassium density lesser than Sodium.

18. The alkali metals are low melting. Which of the following alkali metal is expected to melt if the room temperature rises to 30°C? [Ncert exemplar]

(A) Na (B) K (C) Rb (D) Cs

key:4

Hint: M.P order: **Li > Na > K > Rb > Cs**

19. The reducing power of a metal depends on various factors. Suggest the factor which makes Li, the strongest reducing agent in aqueous solution. [Ncert exemplar]

(1) Sublimation enthalpy (2) Ionization enthalpy

(3) Hydration enthalpy (4) Electron-gain enthalpy

Key:3

Hint: Li has High Hydration enthalpy

20) Which of the following alkali metal ions has the lowest mobility in aqueous solution?

1) Li^+ 2) Na^+ 3) K^+ 4) Cs^+ **(JEE ADVANCED)**

Key:1

Hint: Mobility depends upon the cationic size and the tendency of the cation to get hydrated. Because Li^+ has the smallest size, so it is highly hydrated and its effective size becomes larger therefore mobility decreases in aqueous medium

21) Which one of the following halides crystallizes from its aqueous solution as hydrate?

1) LiCl 2) KCl 3) NaCl 4) RbCl

Key: 1

Hint: $LiCl.2H_2O$

22) Correct statement about the alkali metals includes that

i) The first ionization energy decreases with increasing atomic number.

ii) An unpaired electron is present in an s-orbital

iii) Chemical reactivity increas with increasing atomic number

iv) Their ions have the electronic configurationof Noble gases.

The correct statements are

1) ii, iii 2) All are correct 3) ii, iv 4) i, ii

Key: 2

Hint: Conceptual

(b) Chemical properties of alkali metals:

21) Order of Covalent bond; (24^{th} Jan shift1-2023)

A) $KF > KI; LiF > KF$ B) $KF < KI; LiF > KF$

C) $SnCl_4 > SnCl_2; CuCl > NaCl$ D) $LiF > KF; CuCl < NaCl$

E) $KF < KI; CuCl > NaCl$

1) C, E only 2) B, C only 3) B, C, E only 4) A, B only

22) Identify the correct statements about alkali metals. (24^{TH} Jan shift 2-2023)

A. The order of standard reduction potential $\left(M^+ / M\right)$ for alkali metal ions is

$Na > Rb > Li$

B. CsI is highly soluble in water

C. Lithium carbonate is highly stable to heat.

D. Potassium dissolved in concentrated liquid ammonia is blue in colour and paramagnetic.

E. All the alkali metal hydrides are ionic solids.

Choose the correct answer from the option s given below

1)A, B, D only 2) C and E only 3) A and E only 4) A, B and E only

23) The magnetic behavior of Li_2O, Na_2O_2 *and* KO_2 respectively, are

(29^{th} Jan shift1-2023)

1) diamagnetic, paramagnetic and diamagnetic

2) Paramagnetic, paramagnetic and diamagnetic

3) paramagnetic, diamagnetic and paramagnetic

4) diamagnetic, diamagnetic and paramagnetic

24) Which of the following reaction is correct? (30^{th} jan shift 2-2023)

1) $2LiNO_3 \xrightarrow{\Delta} 2LiNO_2 + O_2$ 2) $4LiNO_3 \xrightarrow{\Delta} 2Li_2O + 2N_2O_4 + O_2$

3) $4LiNO_3 \xrightarrow{\Delta} 2Li_2O + 4NO_2 + O_2$ 4) $2LiNO_3 \xrightarrow{\Delta} 2Li + 2NO_2 + O_2$

25) Statement-1: Lithium and Magnesium do not form super oxides.

Statement-2: Ionic radius of Li^+ is greater than Mg^{2+}(April 8^{th} shift1-2023)

(1) Both statement-1 & 2 are correct.

(2) Both statement-1 & 2 are incorrect.

(3) Statement-1 is correct but statement-2 is incorrect.

(4) Statement-2 is correct but statement-2 is incorrect.

Key :1

Hint: Conceptual

26)The correct increasing order of the magnitude of Standard enthalpies of formation for group-1 Halides is (April 13th shift2-2023)

1) NaI < NaF < NaBr < NaCl 2) NaI < NaBr < NaCl < NaF

3) NaF < NaCl < NaBr < NaI 4) NaCl < NaBr < NaF < NaI

Answer (2)

Hint: Halide $\Delta^0 H_f$ (kJ mol^{-1})

NaF – 569

NaCl – 400

NaBr – 360

NaI – 288

27) The compound which does not exist.

(April 10th shift1-2023)

1) $BeCl_2$ (2) NaO_2 (3) $PbEt_4$ (4) $(NH_4)_2BeF_4$

Key: (2)

Hint: NaO_2 (Super oxide of sodium is unstable)

28) Which of the following can be used in space capsules?

1) Na_2O 2) K_2O 3) Na_2CO_3 4) All of these

Key:2

Hint: K_2O is used in space capsules.

29) Which of the following statements is correct for? $CsBr_3$

1) It is a covalent compound 2) It contains Cs^{+3} and Br^- ions

3) It contains Cs^+ and Br_3^-ions 4) It contains Cs^+, Br^- and lattice Br_2 molecule

Key:3

Hint: $CsBr_3 \rightarrow Cs^+ + Br_3^-$

30) Alkali metals react with water vigorously to form hydroxides and dihydrogen. Which of the following alkali metals reacts with water least vigorously? [Ncert exemplar]

(1) Li (2) Na (3) K (4) Cs

Key:1

Hint: Li less reactive due to its high I.E

31) The solubility of metal halides depends on their nature, lattice enthalpy and hydration enthalpy of the individual ions. Amongst fluorides of alkali metals, the lowest solubility of LiF in wateris due to[Ncert exampler]

(1) Ionic nature of lithium fluoride

(2) High lattice enthalpy

(3) High hydration enthalpy for lithium ion.

(4) Low ionisation enthalpy of lithium atom

Key: 2

Hint: The low solubility of LiF in water is due to its high lattice enthalpy

32) When sodium is dissolved in liquid ammonia, a solution of deep blue colour is obtained. the colour of the solution is due to [Ncert exemplar] is due to

(1) ammoniated electron (2) sodium ion

(3) sodium amide (4) ammoniated sodium ion

Key: 1

Hint: sodium is dissolved in liquid ammonia; a solution of deep blue colour is due to Ammoniated electron.

33) Which one the following metals is most commonly used in photoelectric cells?

1) Li 2) Ca 3) Cs 4) Fr **(JEE ADVANCED)**

Key:3

Sol: The ionization enthalpies of the alkali metals are considerably low and decrease down the group from Li to Cs. This is because the effect increasing size outweighs the increasing nuclear charge, and the outermost electrons are very well screened from the nuclear charge. When alkali metals are irradiated with light, the light energy absorbed may be sufficient to

make an atom lose an electron. This property makes Caesium and potassium useful as electrodes in photoelectric cells.

34) A blue colored solution of sodium in liquid ammonia at –33ºC behaves as strong reducing agent because of: **(JEE ADVANCED)**

1) The formation of ammoniated sodium

2) The formation of ammoniated electron

3) The formation of sodium amide

4) The formation of sodium nitride

Key: 2

Hint: The solution of metals in liquid ammonia act as powerful reducing agents (it even reduces the aromatic ring) because of ammoniated electron,

$$M + (X+Y)NH_3 \rightarrow \left[M(NH_3)_x\right]^+ + \left[e(NH_3)_y\right]^-$$

35) Select the correct set of statements. **(JEE ADVANCED)**

(A) Solubility of alkali hydroxides is in order: CsOH > RbOH > KOH > NaOH > LiOH

(B) Solubility of alkali carbonates is in order: $Li_2CO_3 > Na_2CO_3 > K_2CO_3 > Rb_2CO_3 > Cs_2CO_3$

(C) Hydrated radii is in order: $Li^+ < Na^+ < K^+ < Rb^+ < Cs^+$

(D) Stability of peroxides is in order, $Na_2O_2 < K_2O_2 < Rb_2O_2 < Cs_2O_2$

1) A, D 2) A,C 3) B,C,D 4) All

Key:1

Hint: Compare the lattice energy and the hydration energy of the cations.

(A) While going from lithium to cesium hydroxide, the decrease in lattice energy is more as compared to that of hydration energy. So, the solubility of hydroxides increases down the group

(D). This is because of fact that the bigger cation stabilizes the bigger anion through crystal lattice energy.

36) About alkali metal-liquid NH3 solution which of following statement is not true?

1) Blue colour is due to ammoniated electrons. **(JEE ADVANCED)**

2) Blue colour changes to bronze on dilution due to formation of metal ion clusters.

3) With an increase in concentration of alkali metals paramagnetic nature decreases due to electron-electron combination.

4) On heating, the blue color becomes colorless due to the formation of a metal amide and H_2gas.

Key: 2

HInt: The change depicts the formation of some complex structures.

Blue color changes to bronze with increase in concentration of alkali metal due to formation of metal ion clusters.

37) The properties of Li are similar to those of Mg. This is because. **(JEE ADVANCED)**

1) Both have nearly the same size

2) The ratio of their charge to size is nearly the same.

3) Both have similar electronic configurations.

4) Both are found together in nature

Key: 2

Hint: We discuss about the diagonal relation of the alkali and the alkaline earth metals over here, wherein similarities are pointed out.

They are diagonally related because of same polarizing power, polarizing power = charge on cation / size of cation.

38) which of these give oxide on strong heating?

1) $LiNO_3$ 2) $NaNO_3$ 3) KNO_3 4) $RbNO_3$

KeY: 1

Hint: Lithium being very small in size polarizes a large NO_3^- ions leading to the formation of oxide $4LiNO_3 \rightarrow 2Li_2O + 4NO_2 + O_2$

39) Amongst the alkali metal hydrides, the most stable one is

1) LiH 2) NaH 3) KH 4) RbH

KeY: 1

Hint: Down the group thermal stability of alkali metal hydrides are decreases.

40) The compound which is coloured and paramagnetic due to the presence of unpaired electron is?

1) K_2O 2) K_2O_2 3) KO_2 4) Na_2O_2

Key: 3

Hint: super oxides are coloured and paramagnetic nature.

(c) Extraction of alkali metals:

38) Sodium can be extracted from.

1) Fused caustic soda 2) Aqueous sodium chloride solution

3) Brine solution 4) Potash lye

Key:1

Hint: sodium extracted from fused caustic soda or molten NaCl

(d) Compounds of alkali metals:

39) Compound A reacts with NH_4Cl and forms a compound B. Compound B reacts with H_2O and excess of CO_2 to form compound C which on passing through or reaction with saturated $NaCl$ solution forms sodium hydrogen carbonate. Compound A, B and C, are respectively. (25^{th} Jan shift1-2023)

1) $CaCl_2, NH_3, NH_4HCO_3$ 2) $CaCl_2, NH_4^+, (NH_4)_2CO_3$

3) $Ca(OH)_2, NH_3, NH_4HCO_3$ 4) $Ca(OH)_2, NH_4^+, (NH_4)_2CO_3$

40) Which of the following is known as fusion mixture?

1) $Na_2CO_3 + K_2CO_3$ 2) $Na_2CO_3 + KOH$ 3) $K_2CO_3 + KHCO_3$ 4) NaOH + KOH

Key:1

Hint: $Na_2CO_3 + K_2CO_3$

41) Which of the following is used in the treatment of manic depression?

1) Li_2CO_3 2) Na_2CO_3 3) $CaCO_3$ 4) K_2CO_3

Key:1

Hint: Li_2CO_3

42) In the synthesis of sodium carbonate, the recovery of ammonia is done by treating NH_4Cl with $Ca(OH)_2$. The by-product obtained in this process is [Ncert exemplar]

(1) $CaCl_2$ (2) NaCl (3) NaOH (4) $NaHCO_3$

Key: 1

Hint: NH_3 is recovered using $Ca(OH)_2$

$$2NH_4Cl + Ca(OH)_2 \rightarrow 2NH_3 + CaCl_2 + H_2O$$

$CaCl_2$ is by product

43) The formula of soda ash is [Ncert exemplar]

(1) $Na_2CO_3.10H_2O$ (2) $Na_2CO_3.2H_2O$ (3) $Na_2CO_3.H_2O$ (4) Na_2CO_3

Key: 4

Hint: soda ash-Na_2CO_3

44) In the Caster-Kellner cell used for the manufacture of NaOH, the cathode in the central compartment is made up of

1) Carbon 2) Iron 3) Mercury 4) Nickel

Key: 2

Hint: conceptual

45) $NaHCO_3$ is used to remove .... of the stomach

1) Acidity 2) Basicity 3) Water 4) Chlorine

Key: 1

Hint: $NaHCO_3$ is used as antacid to remove excess acid in the stomach.

46) In the Solvay's process the reaction

$2NH_4Cl + Ca(OH)_2 \rightarrow CaCl_2 + 2NH_3 + 2H_2O$ takes place

1) Ammonia recovery tower 2) Carbonation tower

3) Saturation tank 4) Filtration unit

Key: 1

Hint: Conceptual

47) 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

Key: 2

Hint: potassium hydrogen carbonate is too soluble to be precipitated by the addition of ammonium hydrogen carbonate to a saturatedsolution of potassium chloride

EXERCISE 2

Objective Type Questions (More than one options are correct):

1. The sulphide of Na can be prepared by the following reactions

(A) $2Na + S \rightarrow Na_2S$ (B) $Na_2SO_4 + 4C \rightarrow Na_2S + 4CO$

(C) $Na_2O_2 + SO_2 \rightarrow Na_2S + 2O_2$ (D) $Na_2O + S \rightarrow Na_2S + \frac{1}{2}O_2$

Key:AB

Hint: $2Na + S \rightarrow Na_2S$

$Na_2SO_4 + 4C \rightarrow Na_2S + 4CO$

Here C acts as a reducing agent and S can not oxidize O^{2-}.

2) The diagonal relationship exists is between

(A) Li and Mg (B) Be and Al (C) Be and Na (D) B and Si

Key:ABD

Hint:Diagonal relationship exist between

Li and Mg

Be and Al

B and Si

3) Which pair of compounds cannot exist together?

(A) $NaHCO_3$ (B) Na_2CO_3 (C) NaOH (D) NaCl

Key:AC

Hint:

$NaHCO_3 + NaOH \rightarrow Na_2CO_3 + H_2O$

4) Chlorides of which of the following metals crystallize from an aqueous solution as hydrates?

(A) Li (B) Na (C) K (D) Mg

Key:AD

Hint: Li and Mg chlorides cystallize as hydrate.

5) Na_2SO_4 is soluble in water while $BaSO_4$ is sparingly soluble because

(A) The lattice energy of BaSO4 is more than its hydration energy

(B) The hydration energy of Na2SO4 is less than its lattice energy

(C) The hydration energy of Na2SO4 is more than its lattice energy

(D) The hydration energy and the lattice energy have no role to play in the solubility of a substance

Key:AC

Hint:For more soluble species hydration energy is more favourable than lattice energy.

6) Potassium iodide act as reducing agent when treated with

(A) Acidified $K_2Cr_2O_7$ solution (B) An acidified $KMnO_4$ solution

(C) A $CuSO_4$ solution (D) A lead acetate solution

Key:ABC

Hint: Kl act as reducing agent when treated with $KMnO_4$, $K_2Cr_2O_7$ and $CuSO_4$.

$2Cu^{+2} + 4I^- \rightarrow 2CuI + I_2$ hydration energy which is inversely proportional to size.

7) Which of the following statements is /are correct?

(A) $NaHCO_3$ is more soluble than Na_2CO_3

(B) NaOH is known as caustic soda

(C) $NaHCO_3$ is used as an antacid

(D) Na_2CO_3 is used in the manufacturing of soap and glass

Key:B C D

Hint:Bicarbonates when react with acid give $CO_2 + H_2O$ and hence act as antacid (anti+acid).

8) Which of the following statements is/are correct?

(A) KCl is a substitute for NaCl for patients of high blood pressure

(B) KOH is a stronger alkali than NaOH

(C) KOH is used in the manufacturing of soft soap

(D) NaOH is a non-deliquescent white crystalline solid

Key:ABC

Hint:Down the group basic character of hydroxide increases, NaOH absorb water so it is deliquescent.

9) Which of the following statement regarding the oxides of alkali and alkaline earth metals is / are correct?

(A) The reactivity of K_2O towards water is more than that of Na_2O towards water

(B) The oxides of alkaline earth metals are more basic than those of alkali metals

(C) MgO is used as a refractory material for lining electric furnace

(D) The milk of lime and lime water are two different solutions

Key:ACD

Hint:Down the group reactivity of oxide increases. Due to high lattice energy MgO is used as refractory material. Limewater is $Ca(OH)_2$ solution, milk of lime is also $Ca(OH)_2$.

10) Which of the following statement(s) is / are correct?

(A) KOH is less strong alkali than NaOH

(B) Milk of magnesia is an aqueous solution of $Mg(OH)_2$

(C) Mg^{+2} ions are not precipitated with the addition of NH_4OH in the presence of NH_4Cl

(D) CaO_2 is less stable than MgO_2

Key:BC

Hint:Milk of magnesia of an aqueous solution of $Mg(OH)_2$. Mg^{+2} ions are not precipitated with the addition of NH_4OH is presence of NH_4Cl. CaO_2 is more stable than MgO_2.

11. The compound(s) formed upon combustion of sodium metal in excess air is(are) [IIT-JEE-2009]

(A) Na_2O_2 (B) Na_2O (C) NaO_2 (D) NaOH

Key:AB

Hint: Conceptual.

12) The pair(s) of reagents that yield paramagnetic species is/are [JEE(Advanced)-2014]

(A) Na and excess of NH_3 (B) K and excess of O_2

(C) Cu and dilute HNO_3 (D) O_2 and 2-ethylanthraquinol

Key:ABC

Hint:Dilute solution of Na in liquid ammonia is paramagnetic.

$$K + O_2 \rightarrow KO_2$$

(excess)

O_2^- is paramagnetic due to unpaired electron in antibonding orbital.

$$3Cu + 8HNO_3 \rightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$$

diluted

NO is paramagnetic due to unpaired electrons on "N".

13) KO_2 finds use in oxygen cylinders used for space and submarines. The fact(s) related to such use ofKO_2 is/are

(A) it produces O_2 (B) it produces O_3

(C) it absorbs CO_2 (D) it absorbs both CO and CO_2

Key: AC

Hint: $KO_2 \xrightarrow{\Delta} K_2O + \frac{1}{2}O_2$

$$2KO_2 + CO_2 \rightarrow K_2CO_3 + \frac{3}{2}O_2$$

14) The compound(s) which have-O-O bond(s) is/are-

(A) BaO_2 (B) Na_2O_2 (C) CrO_5 (D) Fe_2O_3

Key: ABC

Hint: BaO_2 , Na_2O_2 ,CrO_5 are peroxides

15) Highly pure dilute solution of sodium in ammonia

A) Shows blue coloration due to solvated electrons

B) Shows electrical conductivity due to both solvated electrons as well as solvated sodium ions

C) Shows red coloration due to solvated electrons but a bad conductor of electricity

D) Produces hydrogen gas or carbonate

Key: AB

Hint: Sodium when dissolved in liquid ammonia produces solvated electrons which imparts blue colour to the solution.

16) Which of the following compounds are paramagnetic in nature?

(A) KO_2 (B) K_2O_2 (C) Na_2O_2 (D) RbO_2

Key: AD

Hint:Odd no of electrons are paramagnetic nature(KO_2 and RbO_2 -13 valency electrons)

17) Na_2SO_4 is water soluble but $BaSO_4$ is insoluble because-

(A) the hydration energy of Na_2SO_4 is higher than that of its lattice energy

(B) the hydration energy of Na_2SO_4 is less than that of its lattice energy

(C) the hydration energy of $BaSO_4$ is less than that of its lattice energy

(D) the hydration energy of $BaSO_4$ is higher than that of its lattice energy

Key: AC

Hint: For Solubility

Hydration energy Should be greater than Lattice Energy.

H.E < L.E

18) Which of the following statements are false for all the alkali metals?

(A) Their nitrates decompose on heating to give NO_2 and O_2

(B) Their carbonates decompose on heating to give CO_2 and normal oxide.

(C) They react with halogens to give the halides of the type, MX.

(D) They react with oxygen to give mainly the oxideM_2O

Key: ABD

Hint: Conceptual

19) Expected to have highest melting point? Based on lattice energy and other considerations which one of the following alkali metal chlorides is

(A) LiCl (B) NaCl (C) KCl (D) RbCl

Key: B

Hint: NaCl has highest melting point due to lattice enthalpy.

20) Select correct statement:

A)Oxides (M_2O) and peroxides (M_2O_2 of alkali metals are diamagnetic and colorless.

B)Superoxide's (MO_2) of alkali metals are paramagnetic

C) Li and Na do not form superoxide. (D) All are incorrect.

Key: ABC

Hint: Conceptual

21) Which of the following salt does not form any precipitate with excess of NaOH?

A)$ZnCl_2$ (B) $FeCl_3$ (C) $AlCl_3$ (D) $CuSO_4$

Key: AC

Hint: Both Zn^{+2} and Al^{+3} Soluble in excess of NaOH

22) The correct order of stability of hydrides of alkali metals is:

(A) LiH> NaH> KH> RbH (B) NaH>KH> RbH> CsH

(C) RbH>KH>NaH > LIH (D) LIH>RbH >KH>NaH

Key:AB

Hint: As size increases stability decreases.

23)The correct order of mobility of alkali metal ions in aqueous solution is:

(A) K^+> Rb^+> Na^+> Li^+ (B) Rb^+>K^+>Na^+>Li^+

(C) Li^+> Na^+> K^+>Rb^+ (D) Na^+> K^+ > Rb^+>Li^+

Key:B

As hydrated ion size increases mobility decreases.

24) Consider given reaction: $Na_{(s)} + NH_{3_{(liq)}} \xrightarrow{warm} X + Y_{(g)}$

And select correct statement(s) for products 'X' and 'Y':

(A) Hydrolysis of 'X' produces NH_3 gas

(B) as 'Y' is one of the constituents of water gas

(C) Anionic part of 'X' is conjugate acid of NH_3

(D) Gas 'Y' can also be obtained by hydrolysis of saline hydrides.

Key: ABD

Hint: $Na + NH_{3_{(liq)}} \xrightarrow{wram} NaNH_2 + H_{2_{(g)}}$

Anionic part of 'X' is Conjugate base of NH_3

25) Soda ash is used in which of the following process(es):

(A) Hall's process (B) Softening of hard water

(C) Preparation of soda glass (D) preparation of $K_2Cr_2O_7$

Key: ABCD

Hint: Soda ash -Na_2CO_3

26) Sodium metal can be kept under:

A) Kerosene B) Benzene C) Toluene D) alcohol

Key: ABC

Hint: Sodium metal stored in kerosene, benzene and toluene

27) The compounds used in Solvay process are:

A) Na_2SO_4 B) NaCl C) NH_3 D) $CaCO_3$

Key: BCD

Hint: Raw material used in Solvay process are: NaCl, NH_3,$CaCO_3$

28) Sodium chloride is known as:

A) Table salt B)Common salt C) soda ash D) Rock salt

Key:ABD

Hint: Sodium chloride is also known as Table salt,Common salt, Rock salt

29) Which of the following is/are correct?

A) Sodium thiosulphate is called hypo B) Sodium peroxide is called oxone

C) Potassium carbonate is called pearl ash D) Sodium nitrate is called Indian nitre

Key: ABC

Hint: sodium nitrite is called Chile salt peter.

30) An alloy of Na and K is:

A) Liquid at room temperature B) Used in specially designed thermometers

C) Unstable D) Solid at room temperature

Key:AB

Hint: An alloy of Na and K isLiquid at room temperature, used in specially designed thermometers

31) The compound(s) formed upon combustion of sodium metal in excess air is (are) [IIT-2009]

A) Na_2O_2 B) Na_2O C) NaO_2 D) NaOH

Key:AB

Hint: $4Na + O_2 \rightarrow 2Na_2O$

$4Na+2O_2 \rightarrow 2Na_2O_2$

32) Several sodium compounds find use in industries. Which of the following compounds are used in textile industry?

A) Na_2CO_3 B) $NaHCO_3$ C) NaOH D) NaCl

Key; AC

Hint: Sodium carbonate and Sodium hydroxide are used in textile industry.

33) Alkali metals are characterized by which of the following properties?

A) High boiling points B) High negative standard electrode potential

C) High density D) Large atomic size

Key:BD

Hint: Alkali metals are characterized by High negative standard electrode potential, High density

34) Correct match is/are:

A) Soda ash: Na_2CO_3 B) Pearl ash: K_2CO_3

C) Bone ash: $CuCO_3$ D) Baking soda: $NaHCO_3$

Key: ABD

Hint:Bone ash: $Ca_5(OH)(PO_4)_3$

EXERCISE -3

Numerical value and Integer type questions:

1. An alkali metal chloride crystallises as $MCl.xH_2O$. Atomic number of M is Z. Then Z-x=

Key: 1

Hint:M is Li.

LiCl crystallizes as $LiCl.2H_2O$

Z=3 and x=2

2. The maximum change in the oxidation number Cl_2 in the reaction of hot and conc. NaOH with Cl_2

Key: 5

Hint:$6NaOH+3Cl_2 \rightarrow 5NaCl+NaClO_3+3H_2O$

3. Let us consider the following reaction: (unbalanced equation)

$KO_x + H_2O \rightarrow KOH + H_yO_z + O_2$

KO_x is a chrome yellow powder. What is the Value of X?

Key: 2

Hint: $KO_2 + H_2O \rightarrow KOH + H_2O_2 + O2$

4. How many types of products are formed when $LiNO_3$ and $NaNO_3$ are heated at 500°C.

Key:4

Hint:

$4LiNO_3 \rightarrow 2Li_2O + 4NO_2 + O_2$

$2NaNO_3 \rightarrow 2NaNO_2 + O_2$

5. An alkali metal nitrate on thermal decomposition gives reddish brown NO_2 gas as alkaline earth metal nitrates. The atomic number of that alkali metal is Z. Then $\frac{Z-1}{2}$

Key: 1

Hint: $LiNO_3$ gives NO_2 on heating

Atomic number of Li(Z)=3

6. KI combines with I_2 and forms polyiodide. The number of hybrid orbitals on the central iodine atom is

Key:5

Hint:KI_3 undergoes sp^3d hybridization

7. Number of HCO_3^- ions joined by Hydrogen Bonding in $KHCO_3$ is:

Key: 2

Hint: 2 molecules of $KHCO_3$

8. One mole of lithium nitride is decomposed by H_2O and resultant products are neutralised by HCl. Number of moles of HCl required is:

Key: 4

Hint: $Li_3N + 3H_2O \rightarrow 3LiOH + NH_3$

$3LiOH + NH_3 \xrightarrow{4HCl} 3LiCl + NH_4Cl + 3H_2O$

9. Four moles of $NaNO_3$ when heated to 800°C, totally how many moles of paramagnetic gas molecules liberated?

Key: 2

Hint: $4NaNO_3 \rightarrow 2Na_2O + 2N_2 + 5O_2$

10. How many of the following are anomalous properties of lithium?
    (i)Hydrated lithium ion is the largest among alkali metals.
    (ii) The melting and boiling points of lithium are comparatively high.
    (iii) Lithium directly reacts with atmospheric nitrogen on heating.
    (iv) Lithium chloride is the only hydrated salt,among all alkali chlorides.
    (v) Lithium salts shows crimson red colour in flame test.
    (vi) Lithium is softer than that of other alkali Metals
    (vii) Lithium reacts directly with carbon to form an ionic carbide.

Key: 5

Hint: statements (i), (ii), (iii), (iv) and (v) are correct

11. The combustion of sodium in excess air yields a higher oxide. What is the oxidation state of the oxygen in the product? Neglect the negative sign.

Key: 1

Hint: Na_2O_2

12. The decahyrate form of sodium carbonate i.e. washing soda on standing in air efflorescence and crumbles to powder. The number of water molecule(s) present in the compound formed is:

Key:1

Hint: $Na_2CO_3.H_2O$

13. What is the period number of Rb.

Key: 5

Hint: Rubedium belongs to

5 th period element.

14. $CuSO_4$ reacts with NaCN to form a cyanide complex.Write the balanced equation and find the number of NaCN molecules involved in the equation for one mole of $CuSO_4$

Key: 5

Hint: $2CuSO_4 + 10NaCN \rightarrow 2Na_3\left[Cu(CN)_4\right] + (CN)_2 + 2\,Na_2SO_4$

1 mole of $CuSO_4$ =5 moles of NaCN

15. Calculate heat of solution of NaCl from the following data

Hydration energy of Na^+= - 389kJmol^{-1}

Hydration energy of CI^- = - 382kJmol^{-1}

Lattice energy of NaCl = - 776 kJ mol^{-1}

Key: 5

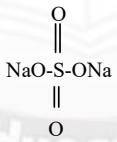
Hint: Hydration energy of NaCl=-389-382=-771

ΔH Solution =-771-(-776)=5 KJ/mol

16. When an in organic compound react with SO_2 in aqueous medium ,it produces (A),(A) on reaction with Na_2CO_3 gives compound (B) which with Sulphur gives (C),(C) is used in photography.The number of π- bonds in (C) is

Key: 2

Hint: Na_2SO_3



17. On heating a mixture containing 3 moles each of Li_2CO_3 and K_2CO_3, how many moles of CO_2 are evolved?

Key: 3

Hint: only Li_2CO_3decomposes and gives CO_2

$Li_2CO_3 \rightarrow Li_2O + CO_2$

1*mole* 1*mole*

18.Washing soda on standing in air efflorensces.How many water molecules are lost.

Key: 9

Hint: $Na_2CO_3.10H_2O \underset{-9H_2O}{\overset{below 100^0 C}{\rightleftharpoons}} Na_2CO_3.H_2O$

ALKALINE EARTH METALS (IIA GROUP)

a) General introduction of alkaline earth metals:

1) Occurrence of alkaline earth metals: Alkaline earth metals are reactive elements and hence do not occur free in nature. Magnesium and calcium are found in abundance in nature. Beryllium is not very abundant. Strontium and barium are much less abundant. Radium is a rare element.Calcium and magnesium are the most common and commercially useful of the alkaline earth elements. calcium is the fifth and magnesium is the sixth most abundant element in the earth's crust.

2)Abundance of alkaline earth metals:

The order of abundance (% by weight): Ca > Mg > Ba > Sr > Be

calcium is the fifth and magnesium is the sixth most abundant element in the earth's crust.

3) Isotopes of alkaline earth metals: All the isotopes of Radium are radioactive. Its longest-lived isotope is $_{88}Ra^{226}$, $t_{1/2}$=1600 yr.

4) Electronic configuration of alkaline earth metals:

General electronic configuration of alkaline earth metals ns^2.

$_4Be \rightarrow [He]\ 2s^2$

$_{12}Mg \rightarrow [Ne]\ 3s^2$

$_{20}Ca \rightarrow [Ar]\ 4s^2$

$_{38}Sr \rightarrow [Kr]\ 5s^2$

$_{56}Ba \rightarrow [Xe]\ 6s^2$

$_{88}Ra \rightarrow [Rn]\ 7s^2$

5) Atomic and ionic Radii of alkaline earth metals: Be < Mg < Ca < Sr < Ba.

6) Ionization Enthalpies of alkaline earth metals: Be> Mg>Ca>Sr>Ra>Ba.

7) Electro positive or metallic character of alkaline earth metals:

Be < Mg < Ca < Sr < Ba.

8) Electro negativity of alkaline earth metals: Be> Mg>Ca>Sr>Ra>Ba.

9) Electron affinity of alkaline earth metals: Be> Mg>Ca>Sr>Ra>Ba.

10) Physical state of alkaline earth metals: All the group IIA elements are metals nd too reactive, so that these do not occur in free state in They are all silvery white metals. They have greyish white lustre when freshly cut, but tarnish soon after their exposure in air due to surface oxidation. They are soft innature but harder than alkali metals because metallic bonding is stronger than IA elements due to possession of 2 properties valency electrons. However, hardness decreases with increase atomic number.

11) Heat of atomization of alkaline earth metals:

12)Density order: Ca < Mg < Be < Sr < Ba.

13) Conductance of alkaline earth metals : $Be^{2+} < Mg^{2+} < Ca^{2+} < Sr^{2+} < Ba^{2+}$

14) Specific heat of alkaline earth metals :

15) Oxidation state and valency of alkaline earth metals :

16) Standard oxidation potential of alkaline earth metals:

Oxidation potential(S.R.P) increases ,Reducing nature increases

Be < Mg < Ca < Sr < Ba

17) Flame color of alkaline earth metals:

Among alkaline earth metals, Be and Mg do not impartany characteristic colour to the flame due to more ionizationenergies.

Be,Mg - No Flame colours
Ca - Brick red
Sr - Crimson red
Ba - Apple green

Ra- Caramine

18) Hydration of alkaline earth metals ions: Hydration enthalpy of alkaline earth metals ions decreases with increase in atomic number.

$Be^{2+} > Mg^{2+} > Ca^{2+} > Sr^{2+} > Ba^{2+}$

The hydration enthalpies of alkaline earth metal ions are larger than those of alkali metal ions. Thus compounds of alkaline earth metals are more extensively hydrated than those of alkali metals, e.g.,
MgCl2 and CaCl2 exist as MgCl2.6H2O and CaCl2· 6H2O while NaCl and KCl do not form such hydrates.

(b) CHEMICAL PROPERTIES OF ALKALINE EARTH METALS

1. Reaction of alkaline earth metals with oxygen

a) Order reaction with alkaline earth metals with oxygen $Be < Mg < Ca < Sr < Ba$

b) Oxides of alkaline earth metals

$BeO(Amphoteric)$

$MgO(Weak\,basic)$

$CaO(Strong\,basic)$

$SrO(Strong\,basic)$

$BaO(Strong\,basic)$

Oxides of these metals are very stable due to high lattice enthalpy and are used for refractory material. Except BeO covalent 4:4 coordination all other Oxides are ionic 6:6 coordination.

c) Peroxides of alkaline earth metals $SrO_2\ BaO_2\ RaO_2$

2. Reaction of alkaline earth metals with Nitrogen

All the alkaline earth metals directly combine with Nitrogen to give ionic nitrides M_3N_2 type Be_3N_2 is volatile. Rest are non volatile ionic crystalline solids formation of nitrides are hydrolysis with water liberate NH_3.

3. Reaction of alkaline earth metals with air and chemical properties:

Except Be these metals easily tarnished in air as a layer of oxide is formed on their surface. Ba in powered form burns in to flame on exposure to air

$M + air \rightarrow MO + M_3N_2$

$M(Ca, Sr, Ba)$

4. Reaction of alkaline earth metals with water:

$Ca, Sr, Ba, and\ Ra$ decompose cold water readily with evolution of Hydrogen.

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

Mg decompose boiling water but Be does not react with H_2O even at red hot, it's protective oxide film survives even at high temperatures . Reactivity of alkaline earth metals increase as we move down the group as oxidation potential increases.

a) Order of reactivity of alkaline earth metals with water $Be < Mg < Ca < Sr < Ba$

b) Basic nature order of hydroxide of alkaline earth metals

$Be(OH)_2 < Mg(OH)_2 < Ca(OH)_2 < Sr(OH)_2 < Ba(OH)_2$

c) Solubility order of hydroxides of alkaline earth metals

$Be(OH)_2 < Mg(OH)_2 < Ca(OH)_2 < Sr(OH)_2 < Ba(OH)_2\ Be(OH)_2\ and\ Mg(OH)$ almost insoluble in water

d) Oder of thermal stability of hydroxides of alkaline earth metals

$Be(OH)_2 < Mg(OH)_2 < Ca(OH)_2 < Sr(OH)_2 < Ba(OH)_2$

e) Hydroxide are decompose on heating

$Mg(OH)_2 ---MgO + H_2O$

$Ca(OH)_2 ----CaO + H_2O$

5. Reaction of alkaline earth metals with Hydrogen:

a) Order of reactive of alkaline earth metals with Hydrogen $Be < Mg < Ca < Sr < Ba$

b) Stability order of Hydrides of alkaline earth metals $BeH_2 < MgH_2 < CaH_2 < SrH_2 < BaH_2$

c) Chemical reaction of Hydrides of alkaline earth metals BeH_2 and MgH_2 are covalent in nature other hydrides are ionic in nature Ca, Sr, Ba. Hydrides liberate Hydrogen at anode on electrolysis in fused State CaH_2 is technically called hydrolith used on large scale for production of hydrogen $CaH_2 + 2H_2O \rightarrow Ca(OH)_2 + 2H_2$

$(BeH)n$ Polymeric. Possesses hydrogen bridge 3 center 2 electron bond also called as banana bond.

6. Reaction of alkaline earth metals with halogens:

a) Reactivity order of alkaline earth metals with halogens $Be < Mg < Ca < Sr < Ba$

b) Reactivity order of halogens with alkaline earth metals $F_2 > Cl_2 > Br_2 > I_2$

c) Physical properties of alkaline earth metals halides

BeX_2 are covalent in nature due to small size and highpolarising power other metal halides are ionic nature of halides increase down the group. Melting point and conductivity increase from magnesium halides to barium halides they are good conductors in molten state. The halide are hygroscopic in nature and readily form hydrates eg.

$MgCl_2.6H_2O, CaCl_2.6H_2O, BaCl_2.2H_2O$ etc.

$CaCl_2$ used as dehydrating agent $BeCl_2$ fumes in moisture due to its hydrolysis.

$BeCl_2 + H_2O \rightarrow Be(OH)_2 + 2H_2O$

$BeCl_2$ has different structure in solid and vapour state.in solid state, it exists in the form of polymeric chain structure in which each Be atom is surrounded by four Cl atoms having two of chlorine atoms covalently bonded while other of coordinated bond 's.in vapour state above 1200k it exists as monomer having liner structure and zero dipole moment but below 1200k it's exist as dimeric structure even in vapour state.

d) Ionic and covalent nature of alkaline earth metals

BeX_2 have covalent character. Do not conduct electricity in molten state. The Ionic character of halides increase from $Be\ to\ Ra$.

e) Stability of alkaline earth metals halides $BeCl_2 < MgCl_2 < CaCl_2 < SrCl_2 < BaCl_2$

f) Hydration enthalpy of alkaline earth metals halides. Decrease in hydrogen energy down the group reason increasing size of metal.

g) Lattices enthalpy of alkaline earth metals increases in lattice enthalpy of alkaline earth metals halides down the group.

h) Solubility of alkaline earth metals halides the solubility of alkaline earth metals halides decrease down the group. Except fluorides , all are fairly soluble in water. BeX_2 being covalent are soluble in organic solvents. Reason decreases in hydration enthalpy and increase size of cation. $MgBr_2\ and\ MgI_2$ are covalent and soluble in organic solvents. BeF_2 highly soluble in water where as other fluorides are less soluble. Reason high hydration enthalpy.

7. Reaction of alkaline earth metals with non-metals

a) Reaction of alkaline earth metals with carbon with the exception of Be, Other metals when heated with carbon to form carbides of type MC_2 these carbides are called acetylides as on hydrolysis they evolve acetylene. $MC_2 + 2H_2O \rightarrow M(OH)_2 + C_2H_2$

MgC_2 on heating changes in to Mg_2C_3 on hydrolysis evolves propyne C_3H_4

$Mg_2C_3 + 4H_2O \rightarrow 2Mg(OH)_2 + C_3H_4$

When BeO is heated with carbon at above 2000degree centigrade a brick re colour carbid formula Be_2C is formed this on in hydrolysis evolves methane and is thus, called methanide.

$Be_2C + 4H_2O \rightarrow 2Be(OH)_2 + CH_4$

It is also ionic but possesses an antifluorite structure. BaC_2 also react with Nitrogen but forms $Ba(CN)_2$ and not cyanamide.

b) Reaction of alkaline earth metals with sulphur

Alkaline earth metals directly combine with sulphur on heating to form MS type sulphides

$M + S \rightarrow MS$

Sulphides on hydrolysis liberate H_2S

Sulphides are decomposed by water $2MS + 2H_2O \rightarrow M(OH)_2 + M(SH)_2$

c) Reaction of alkaline earth metals with phosphorus

Alkaline earth metals directly combine with phosphorus in heating to form M_3P_2 type phospides .

$3M + 2P \rightarrow M_3P_2$

Phospides on hydrolysis to evolve phospine

$M_3P_2 + dil.acid \rightarrow PH_3$

8. Reaction of alkaline earth metals with acids :

Alkaline earth metals are freely react with acid and displace Hydrogen

$M + H_2SO_4 \rightarrow MSO_4 + H_2$

$M + 2HCl \rightarrow MCl_2 + H_2$

Be **is** rendered passive by conc. HNO_3 by forming an oxide layer on the surface.

9. Reaction of alkaline earth metals with alkaline:

Be dissolves caustic alkalines also with libration of hydrogen.it is due to digolanal relationship with Al . Be is thus Amphoteric in nature.

10. Reaction of alkaline earth metals with liquidammonia

Alkaline earth metals dissolve liquid ammonia to form a coloured solutions. Dilute solutions are bright blue in colour due to solvated electrons. The solution decompose very slowly forming amides and evolving hydrogen.

$M \rightarrow M^{+2} + 2e^-$

$2NH_3 + 2e^- \rightarrow 2NH_2^- + H_2$

$M^{+2} + 2NH_2^- \rightarrow M(NH_2)_2$

When the solution evaporated, hexaammonate $M(NH_3)_6$ is formed. These slowly decompose to give amides.

$M(NH_3)_6 \rightarrow M(NH_2)_2 + 4NH_3 + H_2$

Concentrated solution of metals in ammonia are bronze coloured.

11. Reaction of alkaline earth metals with mercury:

Alkaline earth metals are combined with mercury form amalgams.

12. Formation of alkaline earth metals complexes:

Generally alkaline earth metals dovnot form complexes. Be form stable complexes such as $[BeF_3]^-, [BeF_4]^-$ *and* $\left[Be(H_2O)_4\right]^{+2}$ complexes of the type $BeCl_2.R_2$ are formed where R is an ether aldehyde or ketones with an oxygen is an doner atom. Be complexes $\left[Be_4O(R)_6\right]$ where R may be $NO^{-3}, HCOO^-, CH_3COO^-, C_6H_5OO^-$ *etc*

The most important complex formed by Mg is chlorophyll in which Mg bonded to four heterocyclic nitrogen atoms. $Ca, Sr,$ *and* Ba form complexes only with strong complexing agents like acetyl acetone, EDTA , etc

13. Organo-metalic compounds of alkaline earth metals:

Both Be and Mg form an appreciable number of compounds with M-C bond but only few are know for Ca, Sr *and* Ba. Grignard reagents very important in organic chemistry which can be used to form a wide variety of organic compounds.

$Mg + RBr \xrightarrow{dry\ ether} RMgBr\,(R = alkyl\ or\ aryl)$

Dry ether

$BeCl_2$ react with Grignard compounds forming reactive dialkyls and diaryls.

$2RMgCl + BeCl_2 \xrightarrow{dry\ Ether} BeR_2 + 2MgCl_2$

Dialkyls and diaryls of Mg, Ca, Sr *and* Ba can also obtained by similar reaction.

14. Alkaline earth metals carbonates:

a) Formation of carbonates of alkaline earth metals

Bi carbonate are decomposed to form alkaline earth metlas carbonates

$M(HCO_3)_2 \rightarrow MCO_3 + CO_2 + H_2O$

b) Chemical reactivity of carbonates of alkaline earth metals order
$BeCO_3 > MgCO_3 > CaCO_3 > SrCO_3 > BaCO_3$

c) Stability order alkaline earth metals carbonates
$BeCO_3 < MgCO_3 < CaCO_3 < SrCO_3 < BaCO_3$

d) Solubility of alkaline earth metals carbonates
$BeCO_3 > MgCO_3 > CaCO_3 > SrCO_3 > BaCO_3$

e) Ionic and covalent nature alkaline earth metals carbonates
$BeCO_3 > MgCO_3 > CaCO_3 > SrCO_3 > BaCO_3$

f) Ionic and covalent nature alkaline earth metals carbonates
The carbonates all are ionic, but $BeCO_3$ least ionic and unusual because it's contains hydrated ion $\left[Be\left(H_2O\right)_4\right]^{2+}$ rather than Be^{+2}.

15. Alkaline earth metals bicarbonates:

a) Formation of bicarbonate of alkaline earth metals $MCO_3 + H_2O + CO_2 \rightarrow M\left(HCO_3\right)_2$

b) Chemical reactivity of bicarbonate of alkaline earth metals. Down the group reactivity of bicarbonate decrease

c) Stability order of alkaline earth metals bicarbonates
Bi carbonates of alkaline earth metals do not exists in solid state but are know in solution state only on heating their aqueous solution of bicarbonate are decomposed to liberate CO_2

16. Alkaline earth metals nitrates:

a) Formation of nitrates of alkaline earth metals. These are prepared by action of nitric acid with Oxides, hydroxide and carbon of alkaline earth metals

b) Chemicals reactivity of nitrates of alkaline earth metals. On heating they decompose in to their corresponding oxides with evolution of a mixture of nitrogen dioxide and Oxygen
$2M\left(NO_3\right)_2 \rightarrow 2MO + 4NO_2 + O_2$
Be also form basic nitrate in addition to the normal salt. Basic nitrate is a covalent compound $Be\left(NO_3\right)_2 \xrightarrow{125\,C} \left[BeO\left(NO_3\right)_6\right]$

c) Stability order of alkaline earth metals nitrates
$Be\left(NO_3\right)_2 < Mg\left(NO_3\right)_2 < Ca\left(NO_3\right)_2 < Sr\left(NO_3\right)_2 < Ba\left(NO_3\right)_2$

d) Solubility order of alkaline earth metals nitrates
$Be\left(NO_3\right)_2 > Mg\left(NO_3\right)_2 > Ca\left(NO_3\right)_2 > Sr\left(NO_3\right)_2 > Ba\left(NO_3\right)_2$

e) Ionic and covalent Nature of alkaline earth metals nitrates. Ionic nature of alkaline earth metals increase down the group

17. **Alkaline earth metals sulphates:**

a) formation of alkaline earth metals sulphates

These are prepared by the action of sulphuric acid on Oxides, hydroxides, or carbonates.

$MO + H_2SO_4 \rightarrow MSO_4 + H_2O$

b) Reactivity order of alkaline earth metals sulphates .

Reactivity of alkaline earth metals sulphates decrease the down the group

c)Stability order of alkaline earth metals sulphates . Suhates are decompose on heating to give corresponding MO

$2MSO_4 \rightarrow 2MO + 2SO_2 + O_2$

Stability order of alkaline earth metals sulphates increase down the group

d) Solubility of alkaline earth metals sulphates . Solubility of alkaline earth metals sulphates decrease down the group

Note: $CaSO_4$ sparingly soluble. $SrSO_4$ *and* $BaSO_4$ are almost insoluble.

e) Ionic and covalent nature of alkaline earth metals sulphates

Ionic nature of alkaline earth metals sulphates increase down'the group.

18. **Be different from the rest of alkaline earth metals**:

on account of its small size , high electron negativity . Be^{+2} excerts high polarized effect on anions and thus form covalent compound.

Diffences of Be from other alkaline earth metals.

1. *Be* is lightest alkaline earth metals
2. *Be* possesses high m.p. and b.p. then other group members
3. *BeO* is Amphoteric in nature whereas Oxides of other group members are strong base
4. It is not easily affected by dry air and does not decompose water at ordinary temperature .
5. $BeSO_4$ is soluble in water
6. *Be and Mg* carbonates are not precipitate by $(NH_4)_2 CO_3$ in presence of NH_4Cl .
7. *Be and Mg* salts do not impart colour to flame.
8. *Be* does not form peroxides like other alkaline earth metals.
9. It does not evolve hydrogen so readily from acids as other earth metals do so.
10. It as strong tendancy to form complex compound
11. Be_3N_2 is volatile whereas nitrides of other alkaline earth metals are non-volatile
12. Its salts never have more then four molecules of water of crystallization as it has only four available orbital's in its valency shell.
13. *Be* carbides react with water to give methane where as *Mg* carbides and *Ca* carbides give propyne and acetylene, respectively.

19. Other chemical reaction of alkaline earth metals:

1. *Mg* being active mental also burns in CO_2, S vapour etc.

$2Mg + CO_2 \rightarrow 2Mg + C$

$Mg + S \rightarrow MgS$

2. Mg react with Conc H_2SO_4 give SO_2 gas $Mg + 2con.H_2SO_4 \rightarrow MgSO_4 + SO_2 + 2H_2O$
3. Mg act as a strong reducing agent

$2Mg + SO_2 \rightarrow 2MgO + S$

$3Mg + B_2O_3 \rightarrow 3MgO + 2B$

4. Formation of Grignard reagents

$KI + I \rightarrow RMgI$

Alkyl magnesium iodide

5. Heating of $Mg(NO_3)$

$2Mg(NO_3)_2 \rightarrow 2MgO + NO_2 + O_2$

Ca reactions

1. Ca on heating in current of CO_2 to give carbide and oxide.

$5Ca + 2CO_2 \rightarrow 4CaO + CaC_2$

2. Ca absorb ammonia forming $Ca(NH_3)_6$ which on heating give calcium amide and calcium nitride

$Ca(NH_3)_6 \rightarrow Ca(NH_2)_2 + 4NH_3 + H_2$

$3Ca(NH_3)_2 \rightarrow Ca_3N_2 + 4NH_3$

3. It is good reducing agent and reduce less electropositive matelicoxides in to metals

$Cr_2O_3 + 3Ca \rightarrow 2Cr + 3CaO$

20. **Detection of alkaline earth metals and their ions**:

a) Flame test

Ca^{+2} ion flame colour brick-red

Sr^{+2} ion flame colour crimson

Ba^{+2} ion flame colour Grassy green

b) Ca, Sr, Ba are present in 5th group in group separation table for Quality analysis For Ba^{+2} ion

1.Boils off H_2S

2. $NH_4OH + (NH_4)_2CO_3$

1. Filtarate of group $4 \rightarrow$ white PPT $BaCO_3, CaCO_3, SrCO_3$ appear as a white PPT

2. Dissolve the white PPT in acetic acid

$MCO_3 + COOH \rightarrow (CH_3COO)_2 M + H_2O + CO_2 \left(M = Ba^{+2}, Sr^{+2}, Ca^{+2}\right)$ Soluble

$(A) = (CH_3COO)_2 Ba$

$(A) + K_2Cr_2O_4 \rightarrow yelow\ PPT\ (BaCrO_4)$

Flame test…By using the paste of $BaCrO_4$ with Conc. HCl

Apple-green flame Ba^{+2} ion confirmed.

Soluble $(B) = (CH_3COO)_2 Sr$

$(B) + (NH_4)_2 SO_4 \rightarrow white\ PPT.(SrSO_4)$

Flame test…By using the paste of $SrSO_4$ with conc. HCl crimson red flame

$(CH_3COO)Ca^{+2}(NH_4)_2 SO_4 \rightarrow (NH_4)_2\left[Ca(SO_4)\right] + (CH_3COO)NH_4$

$Ca + as(NH_4)_2\left[Ca(SO_4)_2\right] = (c)$

$(C) + (NH)_4 C_2O_4 \xrightarrow{Warm} whitePPT.(CaC_2O_4)$

Flame test…By using a paste of CaC_2O_4

$(B) + (NH_4)_2 SO_4 \rightarrow whitePPT.(SrSO_4)$

Flame test…By using a paste of $SrSO_4$ with conc. HCl crimson red flame

$(CH_3COO)Ca^{+2}(NH_4)_2 SO_4 \rightarrow (NH_4)_2\left[Ca(SO_4)\right] + (CH_3COO)NH_3$

$Ca + as(NH_4)_2\left[Ca(SO_4)_2\right] = (c)$

$(C) + (NH)_4 C_2O_4 \xrightarrow{Warm} white\ PPT.(CaC_2O_4)$

Flame test….By using a paste of CaC_2O_4 with conc. HCl give

Ca^{+2} brick red flame

C) Analysis of Mg^{+2}

Mg^{+2} ion present in 6th group in group separation table.

Filtrate of group

$V + NH_4OH + Na_2HPO_4 \rightarrow$ fine crystalline PPT. On scratching the side of the test tube.

$Mg(NH_4)PO_4\ white\ PPT\ Mg^{+2}$ confirmed

(C) EXTRACTION OF ALKALINE EARTH METALS

These metals are best Isolated by electrolysis of fused metal halides containing $NaCl$. $NaCl$ Lowers the fusion temperature and makes the fused mass a good conductor of electricity.

Beryllium:- It is obtained by reducing BeF_2 with magnesium

Magnesium:-

Method-(1) By heating MgO and C to 2000^0C

$$MgO + C \rightleftharpoons Mg + CO$$

The Gaseous mixture of Mg and CO was then cooled very rapidly to deposit the metal. This quenching is necessary as the reaction is reversible.

Method-(2) Pidgeon Process:-

By reducing calcined Dolomite with Ferrosilicon at 1150^0C under reduced pressure.

$$CaCO_3.MgCO_3 \xrightarrow[\Delta]{} CaO.MgO \xrightarrow{Fe/Si} Mg + Ca_2SiO_4 + Fe$$

Method-(3) From Magnesite:-

$$MgCO_3 \xrightarrow[calcination]{} MgO + CO_2$$

The oxide is dissolved in a mixture of molten fluorides of magnesium, barium and sodium and electrolysed

Anode: Carbon rods

Cathode: Cast Iron rods

Method-(4):- Electrolysis Of Anhydrous $MgCl_2$

Electrolyte anhydrous $MgCl_2 + NaCl + CaCl_2$

Cathode: Iron

Anode: Graphite

$$MgCl_2 \xrightarrow{electrolysis} \underset{Cathode}{Mg} + \underset{Anode}{Cl_2}$$

Calcium:- Electrolysis of fused anhydrous $CaCl_2$

Cathode: Steel

Anode: Graphite

The remaining metals Sr and Ba are produced on a very much smaller scale by the electrolysis of their fused chlorides, or from their oxides by reduction with aluminum.

COMPOUNDS OF ALKALINE EARTH METALS:

(I) EPSOM SALT (OR) MAGNESIUM SULPHATE HEPTA HYDRATE

Preparation:- $MgSO_4.7H_2O$ is called Epsom salt. Magnesium sulphate is prepared by treating the Magnesite (or) Dolamite with dil H_2SO_4 followed by evaporation and crystallization of the resultant solution.

$$\underset{\text{Magnesite}}{MgCO_3} + H_2SO_4 \rightarrow MgSO_4 + H_2O + CO_2$$

$$\underset{\text{Dolamite}}{MgCO_3.CaCO_3} + 2H_2SO_4 \rightarrow MgSO_4 + CaSO_4 + 2H_2O + CO_2$$

(II) PROPERTIES

(1) Epsom salt is soluble in water with evolution of heat.

(2) It is an efflorescent substance.

(3) $MgSO_4.7H_2O \xrightarrow[-6HO]{150\,C} MgSO_4.H_2O \xrightarrow[HO]{200\,C} MgSO_4 \xrightarrow{>200\,C}$

$$+MgO + SO_2 + \frac{1}{2}O_2$$

(4) With alkali metal sulphate, it forms double salts of type $K_2SO_4.MgSO_4.6H_2O$

(5) The salt is Isomorphous with green vitreol $\left(FeSO_4.7H_2O\right)$ and white vitreol $\left(ZnSO_4.7H_2O\right)$.

(III) USES:- (1) Epsom salt is used in medicine as purgative

(2) Epsom salt is used as stimulant to increase bile secretion

(2) CALCIUM OXIDE (OR) QUICKLIME $\left(CaO\right)$

(i) Preparation :- Lime is chemically calcium oxide $\left(CaO\right)$. It is called quicklime.

$$CaCO_3 \xrightleftharpoons{1070-1270k} CaO + CO_2$$

(ii) Properties:-

(1) On exposed to atmosphere, it absorbs moisture and CO_2

$$CaO + H_2O \rightarrow Ca(OH)_2$$

$$CaO + CO_2 \rightarrow CaCO_3$$

The addition of limited amount of water breaks the lump of lime. This process is called slaking of lime.

(2) Composition of milk of lime as well as lime water is $Ca(OH)_2$

(3) $CaO + 2HCl \rightarrow CaCl_2 + H_2O$

$$CaO + SiO_2 \rightarrow CaSiO_3$$

$$6CaO + P_4O_{10} \rightarrow 2Ca_3(PO_4)_2$$

$$CaO + 3C \xrightarrow[\Delta]{} CaC_2 + CO$$

$$CaC_2 + 2H_2O \rightarrow Ca(OH)_2 + C_2H_2$$

$$CaC_2 + N_2 \xrightarrow[\Delta]{} \underset{\text{Calcium cyanamide}}{CaCN_2} + C$$

(iii) Uses:-

(1) It is used in the manufacture of cement, sodium carbonate, dyestuffs.
(2) In the purification of sugar
(3) It is used as a drying agent for Ammonia.

(3) **CALCIUM HYDROXIDE (SLAKED LIME):** $Ca(OH)_2$

(i) Preparation:- Calcium hydroxide is prepared by adding water to quicklime.

$$CaO + H_2O \rightarrow Ca(OH)_2$$

(ii) Properties:-

(1) It is sparingly soluble in water. The aqueous solution is called lime water and a suspension of slaked lime in water is known as milk of lime.
(2) When CO_2 is passed through the lime water it turns milky due to the formation of $CaCO_3$.

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$$

on passing excess of CO_2, the precipitate dissolves to form Calcium hydrogen Carbonate.

$$CaCO_3 + H_2O + CO_2 \rightarrow Ca(HCO_3)_2$$

(3) Milk of lime reacts with Cl_2 to form hypochlorite, a constituent of bleaching powder.

$$2Ca(OH)_2 + 2Cl_2 \rightarrow CaCl_2 + Ca(OCl)_2 + 2H_2O$$

(III)Uses:-

(1) In the preparation of mortar, bleaching powder, glass.
(2) As a white wash
(3) In tanning Industry
(4) In the purification of sugar

(4) CALCIUM CARBONATE (OR) LIME STONE $(CaCO_3)$

(i) Preparation :- It is prepared by passing CO_2 through slaked lime (or) by the addition of Na_2CO_3 to $CaCl_2$

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$$

$$CaCl_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaCl$$

Excess CO_2 should be avoided since this leads to the formation of water soluble calcium hydrogen carbonate.

Properties:-

(1) $CaCO_3 \xrightarrow{1200K} CaO + CO_2$

(2) $CaCO_3 + \underset{dilute}{2HCl} \rightarrow CaCl_2 + H_2O + CO_2$

$$CaCO_3 + \underset{dilute}{H_2SO_4} \rightarrow CaSO_4 + H_2O + CO_2$$

Uses:- (1) $CaCO_3$ along with $MgCO_3$ is used as a flux in the extraction of metals like Iron

(2)Used as an antacid

(5) **GYPSUM** $(CaSO_4.2H_2O)$

Preparation :- $CaCl_2 + H_2SO_4 \rightarrow CaSO_4 + 2HCl$

$$CaO + H_2SO_4 \rightarrow CaSO_4 + H_2O$$

$$CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + H_2O + CO_2$$

Properties:-

1) $CaSO_4 + (NH_4)_2 SO_4 + aq \rightarrow CaSO_4.(NH_4)_2 SO_4.H_2O$

Uses:- (1) It is used in the manufacture of cement

(2)It is used in the manufacture of plaster of paris

(6) **PLASTER OF PARIS (OR) CALCIUM SULPHATE HEMI HYDRATE**

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

Preparations:-

$\underset{Gypsum}{2(CaSO_4.2H_2O)} \xrightarrow{120^{\circ}C} 2CaSO_4.H_2O + 3H_2O$

Properties:-

(1) $CaSO_4.\frac{1}{2}H_2O \xrightarrow[-\frac{1}{2}HO]{above\,393k} \underset{dead\ burnt\ plaster}{CaSO_4}$

(2) Setting of plaster of pairs

$\underset{Plaster\ of\ pairs}{2CaSO_4.H_2O} \xrightarrow[HO]{setting\ stage} \underset{Orthor\,hombic}{CaSO_4.2H_2O} \xrightarrow{hardening\ stage} \underset{Monoclinic}{CaSO_4.2H_2O}$ setting of plaster of Paris may be catalysed by $NaCl$ while it is retarded by borax (or) alum

Uses: - (1) In the building Industry as well as plasters.

(2)For immobilizing the affected part of organ where there is a bone fracture or sprain.

(3) Used in dentistry and for making casts of statues and busts.

(7) PORTLAND CEMENT:-

Preparation:-

The raw materials: lime stone, clay.

When clay and lime are strongly heated together they fuse and react to form 'Cement Clinker'

$Clinker + 2-3\%\,by\,weight\,of\,Gypsum \rightarrow cement$

Properties:-

(1) The important Ingredients in Portland cement are
dicalcium silicate $Ca_2SiO_4 \rightarrow 26\%$

Tricalcicum Silicate $Ca_3SiO_5 \rightarrow 51\%$

Tricalcium Aluminates $Ca_3Al_2O_6 \rightarrow 11\%$

(2) Average Composition of Portland cement are

$CaO : 50-60\%$ $SiO_2 : 20-25\%$

$Al_2O_3 : 5-10\%$ $MgO : 2-3\%$

$Fe_2O_3 : 1-2\%$ $SO_3 : 1-2\%$

(3) For a good quality cement, the ratio of

(a) SiO_2 *to* Al_2O_3 : *between* 2.5 *and* 4

(b) Lime to total of $SiO_2 + Al_2O_3 + Fe_2O_3$: ≈ 2

(4) The purpose of adding gypsum is only to slow down the process of setting of cement

Uses:- It is used in concrete, reinforced concrete, in plastering and in the construction of bridges, dams and buildings.

(8) **CALCIUM CARBIDE (CaC_2)**

Preparation:- CaC_2 is prepared when the metal is heated with carbon in an electric furnace (or) its oxide is heated with carbon.

$$Ca + 2C \xrightarrow{1100\,C} CaC_2$$

$$CaO + 3C \xrightarrow{2000\,C} CaC_2 + CO$$

CaC_2 made in this way is a grey colored solid, but it is colorless when pure.

Properties:-

(1) CaC_2 reacts with water liberating acetylene

$$CaC_2 + 2H_2O \rightarrow Ca(OH)_2 + C_2H_2$$

(2) $$CaC_2 + N_2 \xrightarrow[Electical\ furnace]{1100\,C} \underset{calcium\ Cyanamide}{CaNCN} + C$$

This is an important reaction because it is one method of fixing atmospheric dinitrogen

Uses:- (1) CaC_2 is an important chemical Intermediate

(2) CaC_2 is used in the preparation of C_2H_2

CHEMICAL PROPERTIES OF COMPOUNDS OF ALKALINE EARTH METALS

(1) Magnesium Oxide (MgO (or) (Magnesia)

(a) $MgO + H_2O \rightarrow Mg(OH)_2$

(b) $MgO + H_2SO_4 \rightarrow MgSO_4 + H_2O$

(c) $MgO + 2HCl \rightarrow MgCl_2 + H_2O$

(d) Magnesia cement(or) Sorel's cement: $MgCl_2.5MgO.XH_2O$

(2) MAGNESIUM HYDROXIDE $\left(Mg(OH)_2\right)$

$(a)\ Mg(OH)_2 + 2NH_4Cl \rightarrow MgCl_2 + 2NH_4OH$

$(b)\ Mg(OH)_2 \xrightarrow[\Delta]{Calcination} MgO + H_2O$

(3) MAGNESIUM CARBONATE $(MgCO_3)$

(a) It dissolves in water if CO_2 is passed through it. This is due to the formation of soluble $Mg(HCO_3)_2$

$MgCO_3 + H_2O + CO_2 \rightarrow Mg(HCO_3)_2$

(b) $MgCO_3 + H_2SO_4 \rightarrow MgSO_4 + H_2O + CO_2$

(c) $MgCO_3 \xrightarrow[\Delta]{Calcination} MgO + CO_2$

EXERCISE -1

SINGLE ANSWER TYPE (PYQ)

(a) General introduction of alkaline earth metals:

1) The increasing order of metallic character **(April 10th shift2-2023)**

1) Be > Ca > K (2) K > Ca > Be (3)Ca > K >Be (4) K > Be > Ca

Answer (2)

Sol. Metallic character increases down the group and decreases from left to right along a period.

K > Ca > Be (Metallic character)

2) Which of the following metals cannot give flame test?

1) Be 2) Na 3) K 4) Ca

Key: 1

Hint: Be and Mg does not impart colour to the flame

3) which has a strong reducing character among the following

1) Be 2) Mg 3) Ca 4) Ba

Key: 4

Hint: Reducing character increases down the group.

4) Which of the following is the most abundant alkaline earth Metal?

(1) Be (2) Mg (3) Ca (4) Sr

Key: 3

Hint: Calcium is the fifth most abundant element in the Earth's crust.

5) The alkaline earth metal that forms mainly covalent compounds is

1) Mg 2) Be 3) Ca 4) Ba

Key: 2

Hints: Be forms covalent compounds.

6) The correct order of polarising ability of cations of Alkaline earth metals is

1) $Be^{2+} > Ca^{2+} > Mg^{2+} > Ba^{2+}$ 2) $Be^{2+} < Mg^{2+} > Ca^{2+} = Ba^{2+}$

3) $Be^{2+} < Mg^{2+} > Ca^{2+} < Ba^{2+}$ 4) $Ba^{2+} < Ca^{2+} < Mg^{2+} < Be^{2+}$

Key: 4

Hint: Polarising ability of cations of Alkaline earth metals is decreases

7) Which of the following elements has highest melting point?

1) Ba 2) Sr 3) Ca 4) Be

Key: 4

Hint: M P: Be > Ca > Sr > Ba > Mg

8) A fire work gave brick red coloured flashes. It contains

1) NaCl 2) $BaCl_2$ 3) $CaCl_2$ 4) $SrCl_2$

Key: 3

Hint: $CaCl_2$ gives brick red flame.

9) In Diwali crackers the fireworks are used to give coloured flames. The salt of which one of the following metals is used to obtain green flame for this purpose?

1) Na 2) Ba 3) K 4) Ca

Key: 2

Hint: Barium gives green flame.

10) Which of the following has the highest hydration enthalpy in an aqueous solution? (JEE MAIN)

1) Na^+ 2) Be^{2+} 3) Ba^{2+} 4) Cs^+

Key: 2

Hint: The hydration enthalpies of alkaline earth metal ions are larger than those of alkali metal ions on earth metal

ions decrease with increase in ionic size down the group.

$Be^{2+} > Mg^{2+} > Ca^{2+} > Sr^{2+} > Ba^{2+}$. Therefore (B) option is correct.

(b) Chemical properties of alkaline earth metals:

10) The alkaline earth metal sulphate(s) which are readily soluble in water is /are

(30thJan shift1-2023)

A) $BeSO_4$ B) $MgSO_4$ C) $CaSO_4$ D) $SrSO_4$ E) $BaSO_4$

Choose the correct answer from the option given below:

1) A only 2) B only 3) A and B 4) B and C

Key: 3

Hint: Due to high hydration energy Be^{+2} and Mg^{+2} $BeSO_4$ and $MgSO_4$ are readily soluble in water.

11) Chlorides of which metal are soluble in organic solvents (**30th Jan shift 2-2023)**

1) Ca 2) Mg 3) K 4) Be

Key: 4

Hint: $BeCl_2$ having covalent nature is soluble in organic solvent.

12) Choose the correct statement(s): (1st Feb shift1-2023)

A. Beryllium oxide is purely acidic in nature.

B. Beryllium carbonate is kept in the atmosphere of CO_2

C. Beryllium sulphate is readily soluble in water.

D. Beryllium shows anomalous behavior.

Choose the correct answer from the options given below:

1) A, B and C only 2) B, C and D only

3)A and B only 4) A only

Key: 2

Hint: A. Beryllium oxide is amphoteric in nature.

B. Beryllium carbonate is kept in the atmosphere of CO_2 because it is thermally stable

C. Beryllium sulphate is readily soluble in water due to high degree of hydration

D. Beryllium shows anomalous behaviour due to small size, high I.E

13) $BeCl_2$ exists as in solid state, vapour phase and at high temperature of the order of 1200 K in that order. (April 6th shift 2-2023)

(1) Polymer, Dimer and Monomer (2) Dimer, Polymer and Monomer

(3) Monomer, Dimer and Polymer (4) Polymer, Monomer and Dimer

Key:2

Hint:$BeCl_2$ exists as in solid stateDimer form, vapour phasePolymerform and at high temperatureMonomer form

14) Which of the following the best method for Preparation of BeF_2

(April 13th shift2-2023)

1)$Be + F_2 \rightarrow BeF_2$ 2) $BeH_2 + F_2 \rightarrow BeF_2$

3) $BeH_2 + NaF \rightarrow BeF_2$ 4)By (NH4)2BeF4 (thermal decomposition)

Key: (4)

Hint: Best method for preparation of BeF2 is by thermal decomposition of

$(NH_4)_2BeF_4 \rightarrow NH_4F + BeF_2$

15) Ba^{+2} cannot be precipitated as **(April 13th shift2-2023)**

1) $BaCO_3$ 2) $Ba(OH)_2$ 3) $BaCrO_4$ 4) $BaSO_4$

Key: 2

Hint: $Ba(OH)_2$ is soluble in water

$BaCO_3$ & $BaSO_4$ are white ppt

$BaCrO_4$ – Yellow ppt

16) Consider a reaction.

$Be(OH)_2 + Sr(OH)_2 \longrightarrow$ Product

Incorrect statement regarding the product is **(April 13th shift1-2023)**

1) Be is tetrahedrally bonded in the product 2) Be forms cationic part

3) It is an acid-base reaction 4) $Be(OH)_2$ acts as a Lewis acid

Key: 2

Hint: $Be(OH)_2 + Sr(OH)_2 \rightarrow Sr^{2+}[Be(OH)4]^{2-}$

As Be is present in the anionic part, option (2) is incorrect

17. Metal carbonates decompose on heating to give metal oxide and carbon dioxide. Which of the metal carbonates are most stable thermally? [Ncert exampler]

(1) $MgCO_3$ (2) $CaCO_3$ (3) $SrCO_3$ (4) $BaCO_3$

Key:4

Hint: Thermal stability increases down the group.

18. Which of the carbonates given below is unstable in air and is kept in CO_2 atmosphere to avoid decomposition. [Ncert exampler]

(1) $BeCO_3$ (2) $MgCO_3$ (3) $CaCO_3$ (4) $BaCO_3$

Key:1

Hint: $BeCO_3$ thermally unstable

19. Metals form basic hydroxides. Which of the following metal hydroxide is the least basic? [Ncert exemplar]

(1) $Mg(OH)_2$ (2) $Ca(OH)_2$ (3) $Sr(OH)_2$ (4) $Ba(OH)_2$

Key:1

Hint: Basic nature of hydroxides decreases down the group.

20. Some of the Group 2 metal halides are covalent and soluble in organic solvents. Among the following metal halides, the one which is soluble in ethanol is

[Ncert examplar]

(1) $BeCl_2$ (2) $MgCl_2$ (3) $CaCl_2$ (4) $SrCl_2$

Key:1

Hint: $BeCl_2$ is covalent and soluble in organic solvent.

21.Amphoteric hydroxides react with both alkalies and acids. Which of the following Group-2 metal hydroxides is soluble in sodium hydroxide? [Ncert exampler]

(1) $Be(OH)_2$ (2) $Mg(OH)_2$ (3) $Ca(OH)_2$ (4) $Ba(OH)_2$

Key: 1

Hint:$Be(OH)_2$ is Amphoteric hydroxide.

22.Which of the following elements does not form hydride by direct heating with dihydrogen? [Ncert examplar]

(1) Be (2) Mg (3) Sr (4) Ba

Key: 1

Hint: Be does not form hydride by direct heating with dihydrogen.

23. A substance which gives brick red flame and breaks down on heating to give oxygen and a brown gas is [Ncert exampler]

(1) Magnesium nitrate (2) Calcium nitrate

(3) Barium nitrate (4) Strontium nitrate

KeY: 2

Hint: Calcium compounds gives brick red colour flame

24.Dehydration of hydrates of halides of calcium, barium and strontium i.e., $CaCl_2.6H_2O$, $BaCl_2.2H_2O$, $SrCl_2.2H_2O$, can be achieved by heating. These become wet on keeping in air. Which of the following statements is correct about these halides?

[Ncert examplar]

(1) act as dehydrating agent

(2) can absorb moisture from air

(3) Tendency to form hydrate decreases from calcium to barium

(4) All of the above

Key: 4

Hint: Conceptual

25. Property of alkaline earth metals that increases with their atomic number:

1) Solubility of their hydroxides in water 2) solubility of their sulphates in water

3) Ionisation energy 4) Electronegativity

Key:1

Hint: Solubility of the hydroxides increases as their hydration energies are more than their lattice energies.

26.Halides of alkaline earth metals form hydrates such as $MgCl_2.6H_2O$, $CaCl_2.6H_2O$, $BaCl_2.2H_2O$ and $SrCl_2.2H_2O$. This shows that halides of group 2 elements:

1) Are hygroscopic in nature 2) act as dehydrating agents

3) Can absorb moisture from air 4) All of the above

Key: 4

Hint: Halides of alkaline earth metals form hydrates Are hygroscopic in nature, act as dehydrating agents, and can absorb moisture from air.

27. A metal ' X ' on heating in nitrogen gives Y. Y on treatment with water forms a colourless gas which when passed through $CuSO_4$ solution gives blue colour 'y 'is:

1) $Mg(NO_3)_2$ 2) Mg_3N_2 3) NH_3 4) MgO

Key: 2

Hint:
$$3Mg + N_2 \rightarrow Mg_3N_2$$
$$Mg_3N_2 + 6H_2O \rightarrow 3Mg(OH)_2 + 2NH_3$$
$$NH_3 + H_2O \rightarrow NH_4OH$$
$$CuSO_4 + 4NH_4OH \rightarrow Cu(NH_3)_4SO_4 + 4H_2O$$

28. Which of the following statements is false?

1) Strontium decomposes water more readily than beryllium
2) Barium carbonate melts at higher temperature than calcium carbonate
3) Barium hydroxide is more soluble in water than magnesium hydroxide
4) Beryllium hydroxide is more basic than barium Hydroxide

Key: 4

Hint: Be $(OH)_2$ is amphoteric in nature while Ba $(OH)_2$ is basic

29. Be and Al show diagonal relationship hence both have:

1) Same degree of electronegativity 2) polarising nature
3)Amphoteric nature of oxides 4) All the above properties

Key: 4

Hint: Conceptual

30.Magnesium burns in air to give: (JEE ADVANCED)

1) MgO 2) Mg_3N_2 3) $MgCO_3$ 4) Both MgO and Mg_3N_2

Key: 4

Hint: Mg burns in air to form both MgO and Mg_3N_2

$$2Mg + O_2 \longrightarrow 2MgO;\ 3Mg + N_2 \longrightarrow Mg_3N_2$$

31. Which among the following shows the tendency to form peroxide?

1) Li 2)Mg 3)Be 4) Ba

Key: 4

Hint: Large size of Barium favours the formation of peroxide

(c) Compounds of alkaline earth metals:

32.Which of the following slows down the process of setting of the cement?

(April 6th shift1-2023)

1) Plaster of paris 2) Gypsum 3) caustic soda 4) soda ash

Key: Gypsum

33. In good quality cement ratio of lime stone to total Oxides of silicon (SiO_2), alumina (Al_20_3) and iron (Fe_2O_3) should be close to:

(April 8th shift 2-2023)

(1) 1 (2) 2 (3) 3 (4) 4

Key:(2)

Hint: A good quality cement, the ratio of silica (SiO_2) to alumina (Al_2O_3) should be between 2.5 and 4 and the ratio of lime (CaO) to the total of the oxides of silicon (SiO_2) aluminium (AlO_3) and iron (Fe_2O_3) should be as close as possible to 2.

34. The ratio of silica to alumina in cement is(April 15th shift1-2023)

1) 5.5 (2)2 (3) 3 (4)1.5

Key: (3)

Hint: For good quality cement, the ratio of silica (SiO_2) to Alumina (Al_2O_3) should be between 2.5 and 4.

35. The element playing significant role in neuro muscular function and inter neuronal transmission is:

1) *Be* 2) *Ca* 3) *Li* 4) *Mg*

Key: 2

Hint: Calcium element playing significant role in neuro muscular function and inter neuronal transmission

36. By adding gypsum to cement[Ncert exampler]

(1) setting time of cement becomes less.

(2) setting time of cement increases.

(3) colour of cement becomes light.

(4) shining surface is obtained.

Key: 2

Hint: by adding gypsum is only to slow down the process of setting of the cement

37.Dead burnt plaster is[Ncert exampler]

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

Key:1

Hint: anhydrous $CaSO_4$ is called Dead burnt plaster.[Ncert exampler]

38.Suspension of slaked lime in water is known as

(1) lime water (2) quick lime

(3) milk of lime (4) aqueous solution of slaked lime

Key: 3

Hint: Suspension of slaked lime in water is known as Milk of lime

39.Which of the following statements is true about $Ca(OH)_2$? [Ncert exampler]

(1) It is used in the preparation of bleaching powder

(2) It is a light blue solid

(3) It does not possess disinfectant property.

(4) It is used in the manufacture of cement.

Key: 1

Hint: $Ca(OH)_2$ is used in the preparation of bleaching powder

40. A chemical A is used for the preparation of washing soda to recover ammonia. When CO2 is bubbled through an aqueous solution of A, the solution turns milky. It is used in white washing due to disinfectant nature. What is the chemical formula of A?

[Ncert exampler]

(1) $Ca(HCO_3)_2$ (2) CaO (3) $Ca(OH)_2$ (4) $CaCO_3$

Key: 3

Hint: $Ca(OH)_2$ is used in white washing due to disinfectant nature.

41.Plaster of Paris, a white powder, is

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

Key: 2

Hint: Hemi hydrated Calcium sulphate is called Plaster of Paris.

42. A solid compound 'X' on heating gives CO_2 gas and a residue. The residue mixed with water form on passing an excess of CO_2 through 'Y' in water a clear solution 'Z' is obtained. On boiling 'Z' compound'X' is reformed. The compound 'X' is:

(1) Ca $(HCO_3)_2$ (2) $CaCO_3$ (3) Na_2CO_3 (4) $CaSO_4$

Key:(2)

Hint:

$$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$$

$$CaO + H_2O \rightarrow Ca(OH)_2 (Y)$$

$$Ca(OH)_2 + 2CO_2 + H_2O \rightarrow Ca(HCO_3)_2 (Z)$$

$$Ca(HCO_3)_2 \xrightarrow{\Delta} CaCO_3 + CO_2 + H_2O$$

(X)

EXERCISE -2

More than one options are correct

1) Which of the following statement is incorrect
(A) The atomic radius of Na is greater than that of Mg.
(B) Metallic bond in Mg is stronger than the metallic bond in Na.
(C) Melting and boiling points of K are greater than those of Na.
(D) Mg and Ca both impart characteristic color to the flame.
Key:CD
Hint: Melting and Boiling points of K are lesser than those of Na
Be and Mg do not impart characteristic color to the flame
2) Select correct statement is/are:
A) $CaCO_3$ is more soluble in a solution of CO_2 than in water.
B) Aragonite is a meta stable form of $CaCO_3$ occurring naturally.
C) $CaCO_3$ cannot be decomposed by heat.
D) $LINO_3$ on heating gives $LINO_3$ and oxygen.
Key: AB
Hint: $CaCO_3 \xrightarrow{\Delta} CaO + CO_2$
$4LiNO_3 \rightarrow 2Li_2O + 4NO_2 + O_2$
3) Which of the following statement(s) is/are correct?
A) The chloride of Be is electron deficient and is polymeric with halogen bridges.
B) The reaction of CaO, SrO and BaO with water is exothermic.
C) The bicarbonates of alkaline earth metals are only stable in solutions.
D) BeF_2 is very soluble in water owing the high solvation energy of Be^{+2} but fluorides of other alkaline earth metals are almost insoluble.
KeY: ABCD
Hint: All are correct
4) The oxide(s) having rock salt structure coordination number 6: 6 is/are with
A) MgO B) BeO C) CaO D) Sro

Key:ACD

Hint: BeO has (4,4) coordination number

5) Which of the following statement(s) is/are

(A) Milk of lime is a suspension of $Ca(OH)_2$ Water.

(B) Lime water is a clear solution of $Ca(OH)_2$ |n water.

(C) Baryta water is a clear solution of $Ba(OH)_2$

(D) Nitrolim is the mixture of $CaCN_2$ and carbon.

Key: ABCD

Hint: All statements are correct

6) Aqueous solution of sodium carbonate can react with:

A) $MgCl_2$ B) $Ca(HCO_3)_2$ C) H_2SO_4 D) CO_2

Key: ABCD

Hint: All statements are correct

7) Heating which of the following with C produces a metal sulphide?

(A) Na_2SO_4 (B) $MgSO_4$ (C) $BaSO_4$ D) Li_2SO_4

Key: AC

Hint: B and D do not form sulphidesdue to small size of cations

8) A substance (P) releases a gas (Q) on reaction with H_2O decolourises Br_2water. (P) may be

(A) BeC_2 (B) Be_2C (C) Al_4C_3_ (D) Mg_2C_3

Key: AD

Hint: Q is acetylene are allylene which is unsaturated and decolorizes Bromine water

9) A substance (P), when heated in a dry test tube liberated a colorless odorless gas that rekindled a glowing splinter. It may be:

(A) $KClO_3$ (B) $NaNO_3$ (C) K_2SO_4 (D) $CaCO_3$

Key:AB

Hint: A and B liberate O_2 gas on heating

10) select Correct statement(s) :

(A) $CaCO_3$ is more soluble in solution of CO_2 than in H_2O.

(B) Na_2CO_3 is converted to Na_2O and CO_2 on Heating.

C) Li_2CO_3 is thermally unstable.

(D) Presence of $CaCl_2$ or $CaSO_4$ in water causes temporary hardness.

Key:AC

Hint: $CaCO_3$ forms soluble $Ca(HCO_3)_2$vin presence of $CaCl_2$ or $CaSO_4$ causes permenant hardness

10) Which of the following are correct

A) Be > Ca > Sr > Ba > Mg (Melting Point)

B) Be > Mg > Ca > Sr > Ba (second ionization potential)

C) Be > Mg > Ca > Sr > Ba (hydration energy)

D) Be > Mg > Ca > Sr > Ba (Density)

Key: ABC

Hint: Decreasing order of densities of IIA metal

Ba > Sr > Be > Mg > Ca

11) Which following are incorrect

A) $BeCO_3 > MgCO_3 > CaCO_3 > SrCO_3 > BaCO_3$ (decreasing solubility)

B) $BeF_2 > MgF_2 > CaF_2 < SrF_2 < BaF_2$ (solubility)

C) Beo> MgO> CaO> Sro> BaO (radius ratio)

D) Ba > Sr > Ca > Mg > Be (hydration enthalpy)

Key: CD

Hint: Decreasing radius ratio($-\frac{M^{+2}}{O^{-2}}$)

$BaO > SrO > CaO > MgO > BeO$

Decreasing Hydration energy: Be > Mg > Ca > Sr > Ba

12) Which of the following statements are false regarding $BeCl_2$

A) In solid state, $BeCl_2$ exits in the form of linear structure

B) In vapour state it exits as a trimer with bridged structure

C) Below 1200K it has cyclic structure

D) Invapour state it exits as a solid with bridged structure

Key:ABC

Hint: In solid state, $BeCl_2$ exits as Polymeric structure, In vapour state $BeCl_2$ exits as a Dimer, at 1200K it exist as Monomer.

13) "Be "differs from rest of the elements of the IIA group due to

A) Small size B) Presence of vacant d' orbital

C) low electro negativity D) Absence of vacent d' orbitals

Key: AB

Hint: "Be " has smaller size and vacant d orbital

14) Which of the following compounds are correctly related

Compound	Use
A) $MgSO_4.7H_2O$	Mordant in dying fabrics
B) $Ca(H_2PO_4)_2$	Soluble phosphate fertilizer
C) $BaSO_4$	Paint pigment
D) Mg(OH)2	Milk of magnesia

Key: ABCD

Hint: All are correct explanations

15) Which of the following is/are correct statements?

A) Mg burns in air releasing dazzling light rich in UV rays

B) $CaCl_2 .6H_2O$ when mixed with ice gives freezing mixture

C) 'Mg: cannot form complexes

D) "Be" can form complexes due to is very small size

Key: ABD

Hint: Mg can form complexes

Eg: Chlorophyll pigment

16) The incorrect statement(S) is/are

A) $BeCl_2$ is an ionic compound B) $BeCl_2$ is an electron deficient compound

C) $BeCl_2$ can form dimer D) $BeCl_2$, has seesaw shape

Key: AD

Hint: $BeCl_2$ is covalent compound, $BeCl_2$ is linear shape.

17. Which of the following equations are correct

A) $MgCl_2.2H_2O \xrightarrow{\Delta} Mg(OH)_2 + 2HCl$

B) $MgCl_2.6H_2O \xrightarrow{\Delta} MgCl_2.2H_2O + 4H_2O$

C) $MgO+C+Cl_2 \rightarrow MgCl_2 + CO$

D) $MgSO_4.7H_2O \xrightarrow{100k} MgSO_4$

Key: ABC

Hint: $MgSO_4.7H_2O \xrightarrow[-6H_2O]{423K} MgSO_4.H_2O$

18) Which of the following compounds of Be has polymeric structure?

A) BeH_2 B) $BeCl_2$ C) $Be(OH)_2$ 4) $Be(NO_3)_2$

Key: AB

Hint: BeH_2 and $BeCl_2$ exist as polymer with three centered two electron bond.

19) Which of the following statements are false

A) $Ca(OH)_2$ is called slaked lime

B) Mg^{2+} and Ca^{2+} ions are responsible for the transmission of electrical impulses along the nerve fibre

C) Ca^{2+} ion is present in chlorophyll pigment

D) The enamel on teeth is a double salt of Mg

Key: CD

Hint: Mg^{+2} ion is present in chlorophyll pigment

The enamel on teeth is a double salt of calcium

20) Which of the following statements are correct

A) "Be" like Al is rendered passive on treatment with ConcHNO_3

B)Both "Be" and Al don't impart any colouration to the bunsen flame

C) Both "Be" and Al form carbides which on hydrolysis liberate CH_4 gas

D) Both form halides by the direct reaction of metal and halogen which contain bridge bonds

Key: ABCD

Hint: All are correct explanations

21) In curing cement plasters, water is sprinkled from time to time which of the following statements

are incorrect.

A) Keeping it cool B) Converting sand in to silicic acid

C) hydrated sand gravel mixed with cement

D) Developing interlocking needle like crystals of hydrated silicates

Key: ABC

Hint: The three reasons are not correct.

Reason: Developing interlocking needle like crystals of hydrated silicates

22) Which of the following oxides have rock salt structure with coordination number 6: 6?

A) BeO B) MgO C) CaO D) None of these

Key: BC

Hint: BeO has radius ratio $\{\frac{Be^{+2}}{O^{-2}} = 0.22\}$

23) Yellow phosphorus on reaction with Ca(OH $_2$ gives

A) $Ca(H_2PO_4)_2$ B) $Ca(H_2PO_2)_2$ C) PH_3 D) PH_5

Key: AC

Hint: PH_5 is not formed.

24) Which of the following metals dissolve in liquid

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

Key: ABC

Hint: Be does not dissolve in NH_3

25) The substance(s) which reduce(s) the rate of Setting of plaster of paris is/are :

A) NaCl B) Alum C) Borax D) $CaSO_4$

Key: BCD

Hint: B, C, D delay the setting of plaster of paris

26) Be_2C on hydrolysis yields

(A) $Be(OH)_2$ (B) C_2H_2 (C) CH_4 (D) C_2H_6

Key:AC

Hint: $Be_2C + H_2O \rightarrow Be(OH)_2 + CH_4$

27) Which of the following are good conductors of electricity in the molten state?

(A) $BeCl_2$ (B) $CaCl_2$ (C) $SrCl_2$ (D) $MgCl_2$

Key:BCD

Hint:$CaCl_2$, $SrCl_2$ and $MgCl_2$ are ionic compounds. In molten state ions are mobile and hence conduct electricity.

28) Which of the following statement is correct?

(A) The solubility of group 2 salt depends upon the lattice energy of the solid and hydration energy of the ions

(B) The solubilities of most of the group II salts decrease with increase in atomic weight of the corresponding metal

(C) The solubilities of group 2 sulphates and hydroxide have opposite trends

(D) The solubilities of group 2 fluoride and hydroxides increase with molecular weight

Key:ABC

Hint: Solubility depends on lattice energy and hydration energy. Fluoride and hydroxide of alkaline earth metal, solubilityincreases because lattice energy decreases more than hydration energy along group.

29) Which of the following statements is/are correct for compounds of group 2 metals?

(A) The number of molecules of water of crystallization increases with the size of the metal ions

(B) The number of molecules of water of crystallization increases as the size of the metal ions decreases

(C) The number of molecules of water of crystallisation decreases as the size of the metal ion increases

(D) Mg & Be do not give any characteristic colour to Bunsen flame

Key:BCD

Hint:Mg and Be do not impart any colour to flame. Number of molecules of water of crystallisation depends on

30) Elements which do not undergo flame test?

(A) Be (B) Mg (C) Ba (D) Ra

Key:AB

Hint:In case of Be and Mg, the electrons are tightly held and hence excitation is rather difficult, thus do not show flame colouration.

31) Which category belongs to electron defficient bridge bonds?

(A) Hydrides (B) Carbides (C) Deuterides (D) Halides

Key:AC

Hint: Like CaH2, CaD2

32) The reagent(s) used for softening the temporary hardness of water is(are) [IIT-JEE-2010]

(A) $Ca_3(PO_4)_2$ (B) $Ca(OH)_2$ (C) Na_2CO_3 (D) NaOCl

Key:BC

Hint: $Ca(OH)_2$ and Na_2CO_3 is used to remove hardness of water. $Ca(OH)_2$ is used in Clarke's method.

33) The correct statement is/are-

(A) $BeCl_2$ is a covalent compound (B) $BeCl_2$ is an electron deficient molecule

(C) $BeCl_2$ can form dimer (D) The hybrid state of Be in $BeCl_2$ is sp^2

Key:ABC

Hint: Cl-Be-Cl (sp hybridized-Linear)

Be has 4 valency electron in $BeCl_2$

34) Which of the following statement are false?

(A) $BeCl_2$ is a linear molecule in the vapour state but it is polymeric in the solid state

(B) Calcium hydride is called hydrolith

(C) Carbides of both Be and Al react with water to form acetylene

(D) Oxides of both Be and Ca are amphoteric.

Key:CD

Hint: Oxides of Ca is Basic in Nature

35) Which of the following are ionic carbides?

(A) CaC_2 (B) Al_4C_3 (C) SiC (D) Be_2C

Key:ABD

Hint: SiC is Covalent carbide.

36) Which of the following carbides does not give allylene on hydrolysis?

(A) Mg_2C_3 (B) Be_2C (C) MgC_2 (D) CaC_2

Key:BCD

Hint: $Mg_2C_3 + H_2O \rightarrow Mg(OH)_2 + C_3H_2$

37) Magnesium is not an important component of which biomolecule occurring extensively in living world

A) Haemoglobin (B) Vitamin B6 (C) Chlorophyll (D) Vitamin B12

Key:ABD

Hint: chlorophyll contain Mg^{+2} ion

38) Which of the following will not give any colour to flame?

A) Be (B)Mg (C) Na (D)Li

Key: AB

Hint: Be and Mg does not impart colour to the flame.

39) Select correct match for substance and its use:

A) Suspension of Mg $(OH)_2$ in water: Antacid

B) Beryllium: Windows of X-ray tube

C) Liquid sodium metal: Moderator for neutrons in fast breeder nuclear reactors

D) Na_2EDTA: Estimation of hardness of water

Key: ABD

Hint: Liquid sodium metal is used as coolant in fast Breeder reactors

EXERCISE-3

Numerical value and Integer type questions:

1. In two alkaline earth metal salts, one gives apple green and other gives brick red in flame test. The sum of atomic number of those alkaline earth metals is x. Then the value of $\frac{x+4}{16} =$

Key-5

Sol: - $Ca(Z=20), Ba(Z=56), x=20+56=76$

$$\frac{x+4}{16}=\frac{80}{16}=5$$

2. How many of the following bicarbonates are solid in nature?

$LiHCO_3, NaHCO_3, KHCO_3, RbHCO_3,$

$CsHCO_3, Be(HCO_3)_2, Mg(HCO_3)_2, Ca(HCO_3)_2,$

$Sr(HCO_3)_2, Ba(HCO_3)_2$

Key-4

Sol: -Only $NaHCO_3, KHCO_3, RbHCO_3, CsHCO_3$ are present in solid form.

3. Total no.of moles water in 1 mole of Epsom salt is

Key-7

Sol: - Epsom salt: $MgSO_4,7H_2O$

4. $M+(X+Y)NH_3 \rightarrow \left[M(NH_3)_x\right]^{2+}+2\left[e^-(NH_3)_y\right]^-$ where M=alkaline earth metal.

Value of x is…….

Key-6

Sol: - When alkaline earth metal except Be,Mg is dissolved in liquid NH_3, we get hex ammoniated metal ion.

5. How many of the following statements are correct?

(a) BeO is amphoteric in nature.

(b) $LiHCO_3$ is not found in solid state.

(c) K_2O_2 is diamagnetic but KO_2 is paramagnetic.

(d) White phosphorous react with castic soda and gives phosphine gas.

(e) $AlCl_3$ is soluble in excess of $NaOH$ and form sodium meta-aluminate.

(f) Anhydrous potassium nitrate on heating with potassium metal gives potassium oxide and nitrogen gas.

(g) Lithium chloride is highly soluble in water.

(h) Hydrated magnesium chloride on heating in dry air gives anhydrous $MgCl_2$.

Key-6

Sol:- (a),(b),(c),(d)(e) &(f) are correct

(a) BeO is amphoteric in nature because it reacts with acid as well as base.

(b) $LiHCO_3 \xrightarrow{\Delta} Li_2CO_3+H_2O+CO_2$

(d) $H_2O+NaOH+P_4 \rightarrow NaH_2PO_2+PH_3$

(e) $AlCl_3+4NaOH(excess) \rightarrow NaAlO_2+2H_2O+3NaCl$

(f) $KNO_3+K \rightarrow K_2O+N_2$

(h) $MgCl_2,6H_2O \rightarrow MgO+HCl+H_2O$

6. Out of Be,Mg,Ca,Sr and Ba, number of elements which do not impart any colour to the flame

Key-2

Sol: - Out of S-block elements Be and Mg do not impart any colour to flame

7. Mole of hydrocarbon produced by hydrolysis of 1 mole Mg_2C_3 (Magnesium carbide) are_____

Key-1

Sol: - $Mg_2C_3+4H_2O \rightarrow C_3H_4+2Mg(OH)_2$

8. When CaC_2 reacts with N_2 a compound X is formed, X on reaction with H_2SO_4 gives Y and $CaSO_4$. Then the number of σ bonds in compound Y are_____

Key-4

Sol: - $CaC_2 + N_2 \rightarrow CaCN_2 + C$

$CaCN_2 + H_2SO_4 \rightarrow H_2NCN + CaSO_4$

9. Chlorides of Ca and Ba crystallizes from their saturated aqueous solution as $CaCl_2, YH_2O$ and $BaCl_2, ZH_2O$. Then $\frac{Y}{Z} =$

Key-3

Sol: - $CaCl_2.6H_2O, BaCl_2.2H_2O$

10. On heating magnesium sulphate, the following changes taken place:

$MgSO_4.7H_2O \xrightarrow{150^\circ C} MgSO_4.xH_2O$

$\xrightarrow{200^\circ C} MgSO_4.yH_2O$

The sum of x and y is:

Key-1

Sol: - $MgSO_4.7H_2O \xrightarrow{150^\circ C} MgSO_4.H_2O$

$\xrightarrow{200^\circ C} MgSO_4$

11. How many of the following orders are correct

(A) Basic strength

$Be(OH)_2 < Mg(OH)_2 < Ca(OH)_2 < Ba(OH)_2$

(B) Decomposition temperature

$BaCO_3 > SrCO_3 > CaCO_3 > MgCO_3.$

(C) Size

$Na^+ > Mg^{2+} > Li^+ > Be^{2+}$

(D)Solubility in water

$Li_2CO_3 > Na_2CO_3 > K_2CO_3 > Rb_2CO_3 > Cs_2CO_3$

(E)Thermal stability

$Na_2O_2 < K_2O_2 < Rb_2O_2 < Cs_2O_2$

(F) Thermal stability

$LiHCO_3 < NaHCO_3 < KHCO_3 < RbHCO_3 < CsHCO_3$

(G)Melting point $NaF < NaCl < NaBr < Nal$

(H) Bond length $Na_2O_2 < KO_2 < O_2[AsF_4]O-O$

Key-5

Sol: - ABCEF are correct

12. White crystalline solid of calcium (A), is sparingly soluble in water and solubility decreases when temperature increases. It dissolves in ammonium sulphate due to the formation of double salt. The number of water molecules present in one molecule of the double salt is_____

Key-1

Sol: -$\left(NH_4\right)_2 SO_4.CaSO_4.H_2O$

13. Out of $Mg, Ca, Sr\ and\ Ba$, total number of metals whose nitrates are decomposed according to following reaction are_____ $2M\left(NO_3\right)_2 \xrightarrow{\Delta} "\text{Re}sidue"+4NO_2+O_2$

Key-4

Sol: -$2M\left(NO_3\right)_2 \xrightarrow{\Delta} MO+4NO_2+O_2$

14. In vapour phase and solid phase, the hybridization of $BeCl_2$ and x and y. The number of hybrid orbital's in x are p and y are q. The p+q=

Key-7

Sol: -$x=sp^2, y=sp^3 \therefore p=3, q=4, p+q=7$

15. Magnesium oxide when mixed with a saturated solution of Magnesium chloride sets to a hard mass like cement known as "Sorel cement". The composition of sorel's cement is $MgCl_2.nMgO.xH_2O$. What is the value of n?

Key-5

Sol: -$MgCl_2.5MgO.xH_2O$

16. 6 milli mole of pure gypsum is heated to convert it completely to plaster of pairs. What is the number of milli moles of steam evolved in the process?

Key-9

Sol: -$CaSO_4.2H_2O \rightarrow CaSO_4.\frac{1}{2}H_2O+\frac{3}{2}H_2O$

6milli moles give 9 milli moles of steam.

17. Magnesium heated with carbon in an electric furnace give a compound (A)."A' on heating changes to 'B". Hydrolysis of 'B' gives a hydrocarbon 'C'. The number of sp carbons in the compound 'C' is_____

Key-2

Sol: -$Mg+2C \rightarrow MgC_2\left('A'\right)$

MgC_2 on heating changes to $MgC_3\left(B\right)$

$$Mg_2C_3 + 4H_2O \rightarrow 2Mg(OH)_2 + C_3H_4(C)$$

$$C_3H_4 \rightarrow CH_3 - C \equiv C - H$$

$$sp^3 \quad sp \quad sp$$

EXERCISE- 4

PASSAGES :

Passage – 1:

On treatment with cold water, element (*A*) reacted quietly, liberating colourless gas (*B*) and solution (*C*). Lithium reacted with gas (*B*) giving a solid product (*D*) which gave effervesence with water to give basic solution (*F*). When CO_2 was passed through solution (*C*), an initial white ppt (*E*) was formed but this redissolved forming solution (*G*) when more CO_2 was passed PPT (*E*) effervesced when moistened with $conc.HCl$ and gave a deep red colouration to Bunsen flame. (*E*) on heating with excess of carbon at 2000^0 C gave (*H*) :

1. Metal *A* may be :

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

2. Solution (G) contains a salt. Consider following statements :

(I) It causes permanent hardness of water

(II) It can't be obtained in solid state.

(III) It causes temporary hardness to water

(IV) It can be obtained in solid state

Correct statements are :

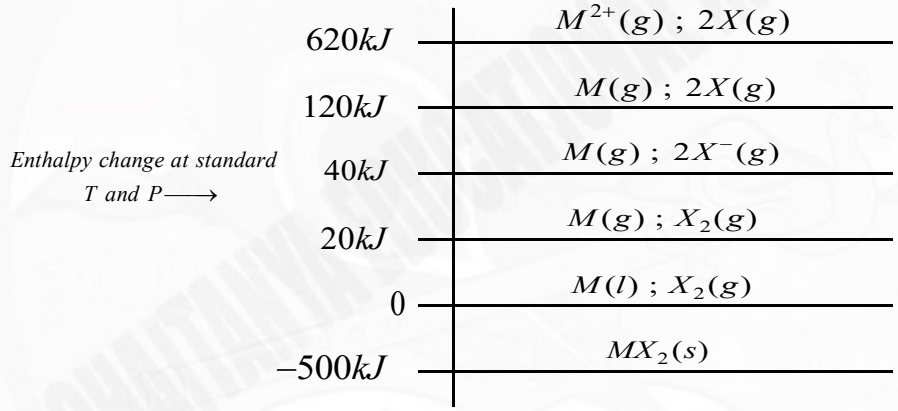
(A) I and II (B) I and IV (C) II and III (D) II and IV

3. Solid (*H*) on hydrolysis gives a gas, this gas when passed through ammonical $AgNO_3$ gives :

(A) white ppt (B) red ppt (C) no ppt (D) brown ppt

Passage – 2:

$$M \equiv Metal \equiv Most\ stable\ state \equiv Liquid$$
$$X_2 \equiv Non-Metal \equiv Most\ stable\ state \equiv Gas$$
$$Compound\ MX_2 \equiv Ionic\ :\ The\ ion\ X\ is\ univalent$$



1. What is lattice energy of MX_2 solid?

(A) $-1040kJ/mol$ (B) $-960kJ/mol$ (C) $-1020kJ/mol$ (D) $-1120kJ/mol$

2. Pick out the correct statement(s).

(A) The enthalpy of vaporization of $M(l)$ is 20 kJ.

(B) The enthalpy of atomization of $X_2(g)$ is 100 kJ.

(C) The electron affinity of gaseous X is 40 kJ.

(D) The electron affinity of gaseous X is 80 kJ.

Passage – 3:

A naturally occurring inorganic salt (*X*) produces a binary compound (*Y*), on heating at low temperature. A gas (*Z*) and a solid (*S*) is produced when it is heated at very high temperature. (*Y*) is neutral towards litmus and liquid at room temperature. Gas (*Z*) produces white turbidity in aq. solution of (*S*) and produces green colour with $Cr_2O_7^{2-}$ solution in acidic medium.

1. Inorganic salt (*X*) is :
   (A) $CaCO_3$ (B) $Na_2SO_4.10H_2O$ (C) $MgSO_4.7H_2O$ (D) $CaSO_4.2H_2O$
2. Inorganic solid (*X*) is :
   (A) freely soluble in water (B) insoluble in water
   (C) sparingly soluble in water (D) soluble in hot water
3. Aq. solution of (*S*) when heated with NH_4Cl, produces :
   (A) blue solution (B) white precipitate (C) ammonia gas (D) *HCl* gas

Passage –4:

The properties of lithium and beryllium and their compounds differ far more from those of the other group-1 and group-2 elements and compounds.

Lithium compounds may show closer similarities with group-2 elements (particularly Mg) than they show towards their own group. Similarly Be is also closer to Al.

1. Which type of salt is formed by only Li in group-1 ?
   (A) Nitrate salt (B) Nitride salt (C) Nitrite salt (D) Carbonate salt
2. Which of the following property of Li and Be is different from the rest of the elements of their group ?
   (A) Smaller size
   (B) Outer shell contains only one s and three *p*-orbitals
   (C) Higher covalent character in their compounds
   (D) All of the above
3. Diagonal relationships does not exist between the pair of :
   (A) Li, Be (B) Li, Mg (C) Be, Al (D) B, Si
4. Which of the following metals react directly with carbon ?
   (I) Li (II) Na (III) Mg (IV) Ca
   (A) I, III, IV (B) II, IV (C) II, III, IV (D) I, II, III, IV

Passage –5:

Magnesium is the sixth most abundant element in earth crust. Magnesium salt occurs to about 0.13% in sea water. Magnesium does not exist in elemental form so that it is extracted by their salts. It forms alloys with Al, Zn, Mn, Sn etc. The similarity between Mg(IIA) and Li (IA) is called diagonal relationship.

1. Select the reaction which is not correct.
   (A) $Mg_3N_2 + 6H_2O \longrightarrow 3Mg(OH)_2 + 2NH_3 \uparrow$

(B) $Mg_2C_3 + 4H_2O \longrightarrow 2Mg(OH)_2 + H_3C - C \equiv CH \uparrow$

(C) $MgCl_2 + 2H_2O \longrightarrow Mg(OH)_2 + 2HCl \uparrow$

(D) $MgCO_3 \xrightarrow{\Delta} MgO + CO_2 \uparrow$

2. Which of the following reaction is written with correct observation?

(A) $Mg^{2+}(aq.) + 2KHCO_3 \longrightarrow$ white ppt.

(B) $Mg^{2+}(aq.) + K_2CO_3 \longrightarrow$ colourless solution.

(C) $Al^{3+}(aq.) + Na_2CO_3 \longrightarrow$ white gelatinous ppt.

(D) $Al^{3+}(aq.) + Na_2SO_4 \longrightarrow$ white gelatinous ppt.

3. Which of the following property of magnesium does not resemble with lithium?

(A) Bicarbonates of both exist in solution state but not in solid form

(B) Carbonates of both produce CO_2 on heating

(C) Both can produce nitride on reaction with N_2

(D) Both produce colour in the flame test.

4. Which of the following pair of ore contain $MgCO_3$?

(A) Dolomite and Epsom (B) Carnalite and Magnesite

(C) Dolomite and Magnesite (D) Epsom and Gypsum

Passage –6:

Solution of alkali metal in liq. ammonia have been developed as versatile reducing agents which effect reduction reactions of organic compounds that are otherwise difficult. Aromatic system are reduced smoothly to cyclic mono or *di*-olefins and alkynes are reduced to steriospecifically to *trans*-alkene.

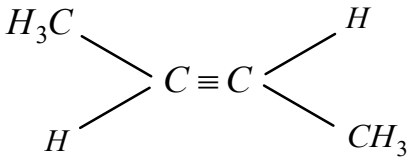
1. Solution of alkali metal (Na) in ammonia is powerful reducing agent due to the presence of :

(A) Na atoms in it

(B) formation of H_2 gas

(C) formation of $NaNH_2$

(D) quasi free electron which is distributed in solvent

$$H_3C-C\equiv C-CH_3 \xrightarrow{Na\ in\ liq.NH_3}$$ 

2.

above reaction is called :

(A) Rimer timen reaction (B) Birch reduction

(C) Perkin reaction (D) Wilkinson reduction

3. $H_3C-C\equiv C-CH_3 \xrightarrow{BaSO_4+Pd+H_2} ?$

(A) $CH_3-CH_2-CH_2-CH_3$ (B) $trans-CH_3-CH=CH-CH_3$

(C) $cisH_3C-CH=CH-CH_3$ (D) none of these

4. Blue solution of Na in is themselves unstable because of . . . . . on standing :

(A) amide formation of Na (B) azide formation of Na

(C) nitride formation of Na (D) hydride formation of Na

Passage –7:

Inorganic compound (***X***) which produces green colour on flame. (***X***) also produces a colourless gas (***G***) and colourless solution (***S***) with $dil.\ CH_3COOH$. Solution (***S***) produces white ppt. with Na_2SO_4 but does not produce ppt. with $NaCl$. Gas (***G***) produces black ppt. with $AgNO_3$ solution.

1. $X \xrightarrow{\Delta\ with\ BaSO_4} Residue + gas\ G'$

Select incorrect about gas G'.

(A) It is triatomic

(B) Produces yellow ppt. with gas G in aq. solution

(C) Produces water soluble salt with KOH solution

(D) Produces black ppt. with $AgNO_3$ solution

2. Resulting solution (***S***) in $CH_3COOH(aq.)$ produces ppt. with :

(A) Na_2S (B) K_2CrO_4 (C) $(NH_4)_2C_2O_4$ (D) KI

3. (***X***) produces an important white pigment lithopone with aq. solution of . . . . . :

(A) $ZnSO_4$ (B) Na_2CO_3 (C) $Cu(NO_3)_2$ (D) $Pb(NO_3)_2$

Passage –8:

$$A(metal) + X_2 \xrightarrow{A} B \xrightarrow{H_2O} Z + D$$

$(A\ gives\ Brick\ red\ to\ colour\ flame)$

$(X_2\ is\ relatively\ inert\ in\ VA\ group)$

$$Z \xrightarrow{\Delta} E + H_2O;\ E \xrightarrow[\Delta]{coke} F + G$$

$$x_2 \downarrow \quad \Delta \quad NaOH \downarrow$$

$$I \qquad Y$$

1. Compound I is
   (A) Ca_3N_2 (B) $CaCN_2$ (C) Ca_3C_2 (D) $Ca(CN)_2$
2. Compound F on hydrolysis gives
   (A) $HCOOH$ (B) C_2H_2 (C) NH_3 (D) CH_4

Passage –9:

$$E + F \xrightarrow[2000^0C]{\Delta} CaC_2 \qquad CaC_2 \xrightarrow[N_2]{\Delta} D + E$$

$$CaC_2 \xrightarrow{H_2O} A\uparrow + B$$

$$B_{(aq)} \xrightarrow{CO_2\ gas\ (excess)} G$$

$$G \xrightarrow{dilute\ HCl} H + I\uparrow + H_2O$$

$[F\ is\ a\ crystalline\ soild,\ E\ is\ obtained$

$in\ elemental\ form,\ J\ is\ precipitated\ out]$

1. Select incorrect statement
   (A) Compound (G) can be obtained in solid form
   (B) The precipitate (J) is soluble in water
   (C) Compound (D) can be used as a fertilizer
   (D) Compound (D) is calcium cyanamide
2. Select correct statement
   (A) Compound (K) gives white precipitate with gas (I)

(B) Compound (H) gives a white precipitate with KF

(C) Compound (K) can also be obtained by the action of dil. HCl on (F)

(D) Compound (J) on strong heating (> 400^0C) gives a solid residue and no gaseous products

3. Select correct statement

(A) The compound (B) is less soluble in water than (G)

(B) Element (E) is a good oxidising agent

(C) Hydrolysis of (D) gives a gas which has carbon in sp hybridisation

(D) Hydrolysis of (D) gives a gas which has nitrogen in sp^2 hybridisation

Passage –10:

$$\underset{(metal\ chloride)}{M} \xrightarrow[NH_4Cl,\ ammonia\ solution]{Na_2HPO_4} B\left(white\ ppt\right)$$

$$B \xrightarrow{\Delta} C + D + E$$

$$\left(D - pungent\ smelling\ gas\ turns\ red\ litmus\ blue\right)$$

1. A is :

(A) $MgCl_2$ (B) $CaCl_2$ (C) $SrCl_2$ (D) $BeCl_2$

2. C is :

(A) $Ca_2P_2O_7$ (B) $Mg_2P_2O_7$ (C) $Ca\left(NH_2\right)_2$ (D) None of these

3. D is :

(A) NH_3 (B) NO_2 (C) HCl (D) PH_3

Passage –11:

Consider the following sequence of reactions :

$A\,(white\ solid) \xrightarrow{\Delta} B + C + D$

$A - white\ solid,\ B - residue,\ D - gas$

$C - gas,\ burns\ with\ blue\ flame$

$A \xrightarrow{flame\ test} Brick\ red\ colour$

$B \xrightarrow{H_2O} Alkaline\ solution + Heat$

$D \xrightarrow{aq\ sol^n\ of\ B} Milky\ suspension$

1. A is :
   (A) CaO (B) $CaCO_3$ (C) CaC_2O_4 (D) $Ca(OH)_2$
2. C is :
   (A) CO (B) CO_2 (C) $H_2O(vapour)$ (D) C_3O_2
3. D is :
   (A) CO (B) CO_2 (C) $H_2O(vapour)$ (D) C_3O_2

Passage –12:

Questions given below are based on the following values of hydration energy and lattice energy:

$Hydration\ energy\ \Delta H_{hyd}\ (kJ\ mol^{-1})$			
Li^+	-499	Na^+	-390
K^+	-305	Cl^-	-382

$Lattice\ energy\ \Delta H_U\ (kJ\ mol^{-1})$	
$LiCl$	-840
$NaCl$	-776
KCl	-703

1. Which salt has maximum heat of hydration?
   (A) $LiCl$ (B) $NaCl$ (C) KCl (D) *LiCl and KCl equally*
2. Heat of hydration (numerical value) of $LiCl$, $NaCl$ and KCl in the increasing order is :
   (A) $LiCl < KCl < NaCl$ (B) $LiCl < NaCl < KCl$
   (C) $LiCl = KCl < NaCl$ (D) $KCl < NaCl < LiCl$
3. Which salt can be used to control humidity?
   (A) $LiCl$ (B) $NaCl$ (C) KCl (D) None of these

Passage –13:

$$\boxed{\text{Brine Solution}} \xrightarrow[\text{Nelson method}]{\text{electrolysis by}} X(aq) + Y(g) + Z(g)$$

Y is a gas which disproportionates on passing through hot and concentrated solution of X, Z is a gas which can also be obtained by the action of solutions of X on zinc

1. The gas Z can be obtained by the action of concentrated solution of X on :
   (A) P_4 (B) Si (C) S (D) F_2
2. In the reaction of Y with hot and concentrated solution of X, the equivalent weight of Y is ____ (Molecular weight of Y is M)
   (A) $M/6$ (B) $M/2$ (C) $3M/5$ (D) $5M/3$
3. Solution of X on treatment with the following forms an unstable hydroxide precipitate which decomposes to given an oxide precipitate :
   (A) $HgCl_2$ (B) $ZnSO_4$ (C) $FeSO_4$ (D) $CuSO_4$

Passage –14:

$$A(alkali) + B + C(g) \xleftarrow{H_2O} KO_2 \xrightarrow[\Delta]{sulphur} D$$

$$KO_2 \xrightarrow{CO_2} E + C(g)$$

1. A is :
   (A) H_2O_2 (B) O_2 (C) KOH (D) K_2CO_3
2. D is :
   (A) K_2S (B) K_2SO_4 (C) $KHSO_4$ (D) $K_2S_2O_8$
3. C is :
   (A) CO_2 (B) CO (C) O_2 (D) CH_4

Passage –15: $2NaNO_3 \xrightleftharpoons{500^0 C} A + B$

$4NaNO_3 \xrightleftharpoons{800^0 C} C + B + D$

1. Compound A is produced by absorbing dinitrogen trioxide in Na_2CO_3 solution. Compound A is

   (A) Na_2O (B) $NaNO_2$ (C) N_2O (D) Na_2O_2

2. Gas B is paramagnetic and support the combustion. Compound B is

   (A) N_2 (B) N_2O (C) O_2 (D) Na_2O

3. D is a inert gas, which is also obtained by strongly heating the ammonium nitric. Compound D is

   (A) N_2O (B) N_2 (C) O_2 (D) N_2

Passage –16:

The first element of a group in many ways differs from the rest of the elements of the group. These differences may be attributed due to following fator:

i) The small size

ii) The high electro negativity and

iii) The non-availability of d-orbitals.

The first element of group often shows resemblance to the second element of the neighbouring group on the right. This is termed diagonal relationship. Lithium and magnesium show resemblance in a number of properties.

1. Which one is the wrong statement?

   (A) Lithium has greater hardness in comparison to other alkali metals.

   (B) $LiHCO_3$ like $Mg(HCO_3)_2$ is not known in solid state.

   (C) Lithium and magnesium form nitrides with nitrogen but other alkali metals do not.

   (D) Fluorides of alkali metals are highly soluble in water.

2. $Metal,\ M + N_2 \longrightarrow Nitride \xrightarrow{H_2O} NH_3$

Metal M can be :

   (A) Na (B) K (C) Li (D) Mg

3. Sodium and lithium are placed in dry air, we get:

   (A) $Na_2OH,\ Na_2O,\ Li_2O$ (B) $Na_2O,\ Li_2O$

   (C) $Na_2O,\ Li_2O,\ Li_3N,\ NH_3$ (D) $Na_2O,\ Li_3N,\ Li_2O$

4. Which will give NO_2 on heating?

(A) $NaNO_3$ (B) $LiNO_3$ (C) NH_4NO_3 (D) NH_4NO_2

Passage –17:

All the alkali metals are tarnished on exposure to air due to formation of oxides, hydroxides and carbonates on their surfaces. When heated in excess of air or oxygen they burn vigorously forming different types of oxides depending upon the nature of the metal. The formation and stability of these oxides can be explained on the basis of size of the cation (alkali metal ion) and the anion. Superoxides are coloured while normal and peroxides are colourless. The normal oxides are basic while peroxides and superoxides act as oxidising agents.

1. Among KO_2, AlO_2^-, Na_2O_2, NO_2^+ unpaired electron is present in :
   (A) NO_2^+ *and* Na_2O_2 (B) KO_2 *and* AlO_2^-
   (C) KO_2 *only* (D) Na_2O_2 *only*
2. In the presence of excess of oxygen, on heating lithium forms:
   (A) Li_2O (B) LiO (C) Li_2O_2 (D) LiO_2
3. Which oxide is formed when potassium is heated in excess of oxygen?
   (A) K_2O (B) KO (C) K_2O_2 (D) KO_2

Passage –18:

Both alkaline earth metals and alkali metals are s-block elements. They resemble with each other in many respects but still here are certain dissimilarities in their properties on account of different number of electrons in the valency shell, smaller atomic adii, higher ionization potential, higher electro negativity. etc.,

Like lithium, beryllium also differs from rest of the alkaline earth metals on account of its small atomic size and high electro negativity. Be^{2+} ion is very small and exerts a high polarizing effect in any anion associated with it.

1. Which is least thermally satble?
   (A) Li_2CO_3 (B) $MgCO_3$ (C) $BaCO_3$ (D) $BeCO_3$
2. Which of the following statements are true for IIA group elements?
   (A) Lattice energy of oxides, carbonates, fluorides decreases from Be to Ba.
   (B) All form nitrides in air.
   (C) The solubility of the hydroxides increases from Be to Ba.
   (D) All of the above are correct.
3. The solubility in water of sulphates down the IIA group is :
   $Be > Mg > Ca > Sr > Ba$

(A) Increase in melting point. (B) Increasing molecular mass.
(C) Decreasing lattice energy. (D) High level of solvation for smaller ions.

Passage –19:

Metal nitrate (A) on heating decomposes, leaving a solid residue (B) which goes into solution with $dil.HCl$. The solution of (B) gives a white precipitate with ammonium carbonate solution. The precipitate (C) is dissolved in $dil.HCl$ and the solution is treated with potassium chromate to get yellow precipitate (D). The solution (B) with $dil.H_2SO_4$ also gives a white precipitate (E) insoluble in $dil.HCl$ and nitric acid. The precipitate (E) is a part of a white pigment lithopone.

1. The compound (E) is :
   (A) $BaSO_4$ (B) $MgSO_4$ (C) $CaSO_4$ (D) Na_2SO_4
2. The yellow precipitate (D) is :
   (A) $PbCrO_4$ (B) $BaCrO_4$ (C) $CaCrO_4$ (D) None of these
3. The metal nitrate (A) is :
   (A) $Ca(NO_3)_2$ (B) $Pb(NO_3)_2$ (C) $Ba(NO_3)_2$ (D) KNO_3
4. The solid residue (B) is :
   (A) CaO (B) PbO (C) ZnO (D) BaO

Passage –20:

Element (A) burns in nitrogen atmosphere to give an ionic compound (B). Compound (B) gets hydrolysed by water giving (C) and (D). A solution of (C) becomes milky on passing CO_2 through it. Element (A) reacts quiet readily with cold water liberating hydrogen and forming metal hydroxide.

1. Select the correct statement with respect to (D).
   (A) It is a gas with a characteristic smell.
   (B) It is pyramidal in shape.
   (C) It can be obtained by hydrolysis of $CaCN_2$.
   (D) All of the above.
2. The compound is :
   (A) $Mg(OH)_2$ (B) CaO (C) $Ca(OH)_2$ (D) $NaOH$
3. Which of the following is incorrect statement?
   (A) Chloride of (A) imparts brick red colour to the flame.
   (B) Compound (C) is basic.
   (C) The solution of compound © is used for the test of carbonate ion.

(D) It does not liberate NH_3 when reacted with ammonium compounds.

$$\left[Hint: \underset{(A)}{3Ca} + N_2 \longrightarrow \underset{(B)}{Ca_3N_2} \xrightarrow{H_2O} \underset{(C)}{Ca(OH)_2} + \underset{(D)}{2NH_3} \right]$$

MATRIX MATCH :

TYPE - 1:

1. Match the matrix :

Column-I (Reaction)	**Column-II (Observation)**
(A) $Al + NaOH$ solution	(1) NH_3 produce
(B) $Zn + NaOH$ solution	(2) H_2 produce
(C) $NH_4Cl + NaOH$ solution	(3)Redox reactions
(D) $NO_3^- + Zn + NaOH$ solution	(4)Resulting solution contain Na_2ZnO_2

2. Match the matrix :

Column-I (Salt)	**Column-II (Physical/Chemical properties)**
(A) Na_2CO_3	(1) Produce CO_2 on heating at 1000^0 C
(B) $NaHCO_3$	(2) Exist in solid form
(C) $CaCO_3$	(3) Water Soluble
(D) $Ca(HCO_3)_2$	(4) Produce CO_2 with dil. HCl
	(5) Does not react with $KMnO_4$ solution

3.Match the matrix :

Column-I (Metal)	**Column-II (Characteristic)**
(A) Li	(1) Produce colour on flame
(B) Mg	(2) Produce blue solution in liquid NH_3
(C) Na	(3) Produce nitride directly with air
(D) Ca	(4) Produce peroxide with excess of O_2
	(5) Produce H_2 with water (Hot/Cold)

4. Match the matrix :

Column-I (Action on moist litmus paper)	**Column-II (Substance)**

(A)	$Red \rightarrow Blue$	(1)	K_2O
(B)	$Blue \rightarrow Red$	(2)	K_2O_2
(C)	$Red \rightarrow White$	(3)	NH_3
(D)	$Blue \rightarrow Blue$	(4)	NO_2
		(5)	CO

5. Match the matrix :

Column-I	**Column-II**
(A) $\underline{P}_4 + NaOH \rightarrow$	(1) Disproportion reaction
(B) $\underline{Cl}_2 + NaOH(cold)(dil.) \rightarrow$	(2) Gases product
(C) $\underline{Cl}_2 + NaOH(hot)(conc.) \rightarrow$	(3)One of the products has lowest O.N. of underlined atom
(D) $\underline{S} + NaOH \xrightarrow{\Delta}$	(4)One of the products has highest O.N. of underlined atom
	(5)One of the products is used in fixing of Black and White photography

6. Match the matrix :

Column-I	**Column-II**
(A) $Metal\ sulphate \xrightarrow{\Delta} metal\ oxide + SO_2 + O_2$	(1) Ba
(B) $Metal\ cation + K_2CrO_4 \longrightarrow yellow\ ppt.$	(2) Sr
(C) $Metal + NH_3 \xrightarrow{liquid} blue\ solution$	(3) Na
(D) $MCl_2 + \text{conc.}H_2SO_4 \longrightarrow white\ ppt.$	(4) Mg

7. Match the matrix :

Column-I	**Column-II**
(A) $Na_2O_2 \xrightarrow{\Delta}$	(1) One of the products is diamagnetic
(B) $KO_2 \xrightarrow[(ii)C\Delta]{(i)S\Delta}$	(2) one of the products acts as reducing agent
(C) $NaNO_3 \xrightarrow{800^0C}$	(3) one of products acts as oxidizing agent
(D) $BaCO_3 \xrightarrow{\Delta}$	(4) one of the products is a basic oxide

8. Match the matrix :

Column-I		Column-II
(A) $BeO(S)$	(1)	Amphoteric in nature
(B) $NaHCO_3(crystalline)$	(2)	Imparts characteristic colour to Bunsen flame.
(C) $BeCl_2(S)$	(3)	Produce H_2O_2 and O_2 on reaction with water
(D) $CsO_2(S)$	(4)	Show hydrogen bonding
	(5)	Has a chain structure

9. Match the matrix :

Column-I	Column-II
(A) CaH_2	(1) Paramagnetic anion
(B) K_2O_2	(2) Homodiatomic,diamagnetic anion
(C) KO_2	(3) Neutral aqueous solution
(D) $NaCl$	(4) Gives hydrogen on hydrolysis

10. Match the matrix :

Column-I	Column-II
(A) $Na_2SO_4 + C + CaCO_3 \xrightarrow{\Delta}$	(1)One of the part of any one of product has sp^2 hybridization central atom
(B) $NaCl + NH_4HCO_3 \longrightarrow$	(2)One of the part of any one of product has sp^3 hybridization of central atom
(C) $Na_2CO_3 + Ca(OH)_2 \longrightarrow$	(3) One of the products is insoluble as it Precipitates.
(D) $KOH + NO(2:4\ by\ mole\ ratio) \longrightarrow$	(4)One of the products is a neutral oxide.

11. Match the matrix :

Column-I	Column-II
(A) $\underset{(slaked\ lime)}{Ca(OH)_2} + Cl_2 \xrightarrow{below\ 35^0C}$	(1) $CaCl_2 + O_2$
(B) $\underset{(milk\ of\ lime)}{Ca(OH)_2} + Cl_2 \xrightarrow{cold}$	(2) $CaCl_2 + Ca(ClO_3)_2$
(C) $\underset{(milk\ of\ lime)}{Ca(OH)_2} + Cl_2 \xrightarrow{hot}$	(3) Bleaching powder

(D) $\underset{(slaked\ lime)}{Ca(OH)_2} + Cl_2 \xrightarrow{red\ hot}$ (4) $CaCl_2 + Ca(OCl)_2$

12. Match the metals in List-I with their ore in List-II and formula in List-III :

	List-I		List-II	List-III	
(A)	Lithium	(P)	Kieserite	(U)	$LiAlSi_2O_6$
(B)	Sodium	(Q)	Spodumene	(V)	$NaNO_3$
(C)	Calcium	(R)	Flurospar	(W)	$MgSO_4 \cdot H_2O$
(D)	Magnesium	(S)	Chile saltpetre	(X)	CaF_2

13. Match the matrix :

	List-I		List-II	List-III	
(A)	$M(OH)_2$	(P)	Solubility increases	(U)	Beryl
(B)	MCO_3	(Q)	Thermal stability increses	(V)	milkof Magnesia
(C)	MSO_4	(R)	Solubility decreases	(W)	Celeslite
(D)	MH_2	(S)	Thermal stability decreases	(X)	Witherite

A. Which of the following is correct combination about alkaline earth metal hydroxides?
1) A,P,V 2) A,Q,X 3) A,Q,W 4) D,R,X

B. Which of the following is correct combination about alkaline earth metal sulphates?
1) C,P,X 2) C,S,V 3) C,R,W 4) C,Q,V

C. Which of the following is incorrect combination?
1) B,Q,X 2) D,S,U 3) C,R,W 4) A,P,V

14. Match the matrix :

	List-I	List-II	List-III
(A)	$Metal + NH_3 \longrightarrow$	(P) Deep blue black solution	(U)Gives apple green colour in flame test
(B)	$Metal\ nitirate \xrightarrow{\Delta}$	(Q) Evolve reddish brown coloured gas	(V) It's carbonate is mild abrasive in tooth paste
(C)	$MO + C + Cl_2 \xrightarrow{\Delta}$	(R) Central atom undergoes SP^3 Hybridization in solid state	(W) In solid state it has $3c-4e^-$ bonds
(D)	$M + X_2 \longrightarrow$	(S) As a constituent of sorel cement	(X)The aqueous solution of it's hydroxide is an

antacid

A. The correct combination for the element which is used to remove air from vacuum pump
1) A,P,U 2) C,R,W 3) D,S,X 4) B,Q,V

B. The correct combination for the element which is used for making window of x-ray tubes
1) B,Q,U 2) C,R,W 3) D,S,X 4) A,Q,V

C. The correct combination for the element which is used in incendiary bomb and signals
1) A,P,U 2) B,Q,V 3) C,R,W 4) D,S,X

15. Match the matrix :

	List-I	**List-II**	**List-III**
(A)	Alkali metal with lead	(P) White metal	(U) Forms insoluble sulphate
(B)	Liquid alkali metal	(Q) Coolant in fast breeder nuclear reactor	(V) Given yellow colour in flame test
(C)	Alkali metal chloride	(R) Fertilizer	(W) It's bicarbonate existing as dimer due to intermolecular H-bond
(D)	Alkaline earth metal with copper	(S) Making high strength springs	(X) It's oxide is amphoteri in nature

A. The correct combination about sodium
1) B,Q,V 2) A,Q,V 3) C,R,W 4) D,S,X

B. The correct combination for element which act as strong reducing agent
1) C,R,W 2) A,P,U 3) D,S,X 4) A,Q,X

C. The correct combination for element whose hydroxide is used in making soft soaps
1) A,P,V 2) B,Q,U 3) C,R,W 4) D,S,X

16. Match the matrix :

	List-I	**List-II**	**List-III**
(A)	$CaCO_3$	(P) Density	(U) Diamagnetic
(B)	$Ca(OH)_2$	(Q) Caustic	(V) Calcite
(C)	CaO	(R)Manufacture of high quality paper	(W)Resonance in anion
(D)	$CaSO_4$	(S) Used in white washing	(X) Alabaster

A. Gypsum on heating to 200^0C produces the compound **x** incorrect combination about **x** is

1) D,P,X 2) D,W,X 3) D,Q,W 4) D,S,X

B. Which of the following is incorrect combination about Gossage process

1) B,Q,U 2) A,Q,X 3) A,R,W 4) B,Q,X

C. In the manufacture of Na_2CO_3 from $NaOH$, the correct combination is

1) D,P,X 2) B,S,V 3) A,P,X 4) C,Q,U

17. Match the matrix :

	List-I		**List-II**		**List-III**
(A)	$Mg(OH)_2$	(P)	Dimer	(U)	Milk of Magnesia
(B)	$BeCl_2$	(Q)	Hydrolith	(V)	H_2
(C)	CaH_2	(R)	Antacid	(W)	Sp^2
(D)	$BaSO_4$	(S)	Water insoluble	(X)	Barytes

18. Match the matrix :

	List-I		**List-II**		**List-III**
(A)	Li_3N	(P)	Automobile air bags	(U)	Submarine
(B)	$LiCl$	(Q)	Ether soluble	(V)	Diamagnetic
(C)	KO_2	(R)	Paramagnetic	(W)	Coloured Compound
(D)	Rb_2O_3	(S)	Coloured compound	(X)	Humidity control

19. Match the matrix :

	List-I		**List-II**		**List-III**
(A)	Li	(P)	Super oxide	(U)	Metallic radii : 1.86 A^0
(B)	Na	(Q)	Photo voltaic cell	(V)	Crimson red flame
(C)	K	(R)	Most –ve value of $E^0_{reduction}$	(W)	Ion has highest Conductance in aq. solution
(D)	Cs	(S)	Thermally stable carbonate	(X)	Eighth most abundant element in the earth's crust

20. Match List-I with List-II :

List-I (Compounds)	**List-II (Use of Compounds)**
(A) Magnesium oxide	(1) Fertilizer
(B) Barium sulphate	(2) Purgative
(C) Calcium cyanamide	(3) As a constituent of sorel cement
(D) Magnesium sulphate	(4) As a constituent of lithopone
	(5) Refractory material

21. Match the matrix :

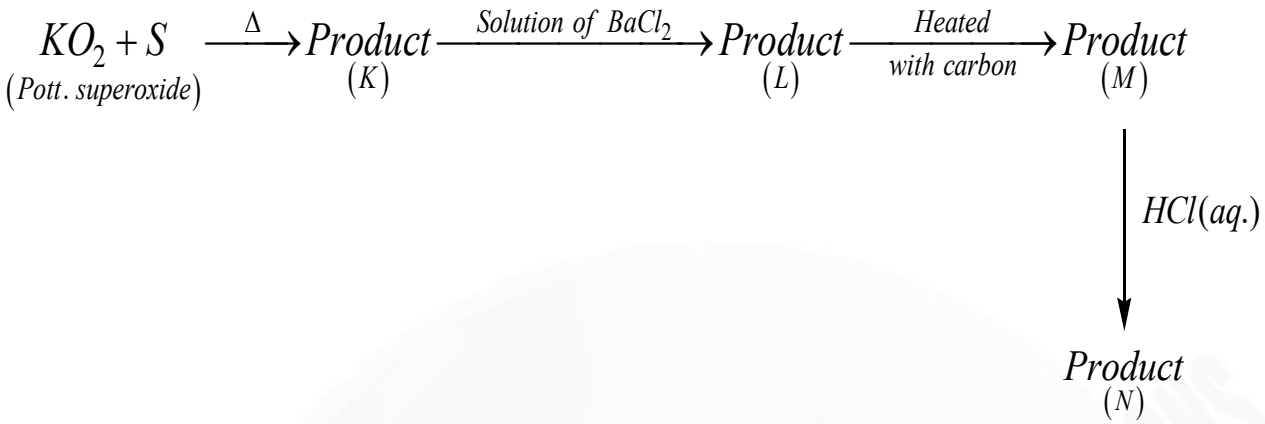
Column-I	Column-II
(A) Li	(1) Produce colour on flame
(B) Mg	(2) Produce blue solution in $liq.NH_3$
(C) Na	(3) Produce nitride directly with air
(D) Ca	(4)Produce peroxide with excess of O_2 (main product)
	(5) Produce H_2 with water (Hot / Cold)

22. Match the matrix :

Column-I (Reactions)	Column-II (Underline Reagent in given Reaction)
(A) **Substance-1** $+NaOH \xrightarrow{\Delta} NaCl + NH_3(G) + H_2O$	(1) CO_2
(B) $Gas(G) + \underset{Excess}{CO_2} + H_2O \longrightarrow$ **Substance-2**	(2) $NaHCO_3$
(C) **Substance-2** $+NaCl \longrightarrow$ **Substance-3** $+NH_4Cl$	(3) NH_4Cl
(D) **Substance-3** $\xrightarrow{\Delta} Na_2CO_3 + H_2O +$ **Substance-4**	(4) NH_4HCO_3

TYPE - 2:

23. Consider given reaction sequence for given question.



List-I (Products in above Reaction)	**List-II (Correct about product)**
(A) Product - ***K***	(1) Gas at room temperature
(B) Product - ***L***	(2) Water soluble sulphate
(C) Product - ***M***	(3) Water insoluble sulphate
(D) Product - ***N***	(4) Used to prepare lithopone with $ZnSO_4$

Select correct code for your answer.

	P	Q	R	S
(A)	2	3	1	4
(B)	2	3	4	1
(C)	1	3	4	2
(D)	2	1	4	3

24. Match List-I with List-II :

List-I (Elements)	**List-II (Characteristic)**
(A) *Li*	(1) ns^2np^6 configuration in dipositive ion
(B) *Be*	(2) Most electro positive in List-I
(C) *K*	(3) No characteristic colour on Bunsen flame
(D) *Ca*	(4) Produces hydrated perchlorate $(MClO_4 \cdot 3H_2O)$

Select correct code for your answer.

	P	Q	R	S
(A)	1	2	3	4
(B)	2	3	4	1
(C)	4	3	2	1
(D)	4	1	2	3

25. Match List-I with List-II :

List-I (Electrolysis of)	**List-II (Product)**
(A) *Aq. solution of NaCl (brine)*	(1) H_2 at cathode
(B) Fused *NaCl*	(2) H_2 at anode
(C) Fused CaH_2	(3) Cl_2 at anode
(D) Fused $MgCl_2 + KCl$	(4) *Na* at cathode

Select correct code for your answer.

	P	Q	R	S
(A)	1	4	2	3
(B)	3	4	1	2
(C)	1	3	4	2
(D)	2	4	1	3

EXERCISE-5

ASSERTION – REASONING AND STATEMENT TYPE QUESTIONS :

Directions:

Each question has 5 choices (a), (b), (c), (d) and (e) out of which ONLY ONE is correct.

a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
b) Statement-1 is True, Statement-2 is True, Statement-2 is NOT a correct explanation for Statement-1.
c) Statement-1 is True, Statement-2 is False.
d) Statement-1 is False, Statement-2 is True.
e) Statement-1 and Statement-2 both are False.

1. Statement -1: In Castner-Kellner cell $Na^{\oplus}$ is reduced at mercury cathode.

Statement -2: Standard reduction potential of hydrogen is higher than sodium.

2. Statement -1: Potassium and caesium are used in photo-electric cells.
Statement -2: Potassium and caesium emit electrons on exposure to light above certain minimum frequency.

3. Statement -1: Beryllium does not impart any characteristic colour to Bunsen flame.
Statement -2: Due to its very high ionization energy, beryllium requires a large amount of energy for excitation of the electrons.

4. Statement -1: In fused state, calcium chloride cannot be used to dry alcohol or NH_3.
Statement -2: $Anhy.\ CaCl_2$ is not a good desiccant.

5. Statement -1: Diagonal relationship is shown between Be and Al.
Statement -2: Ionization potential of Be is almost the same as that of Al.

6. Statement -1: $BeCl_2$ fumes in moist air.
Statement -2: $BeCl_2$ reacts with moisture to form HCl gas.

7. Statement -1: Calcium carbide on hydrolysis gives methane.
Statement -2: Calcium carbide contains C_2^{2-} anion.

8. Statement -1: $MgCO_3$ is soluble in water when a current of CO_2 is passed.
Statement -2: The solubility of $MgCO_3$ is due to the formation of $Mg(HCO_3)_2$.

9. Statement -1: Lithium's reaction with water is less vigorous than that of sodium.
Statement -2: Lithium has small size and very high hydration energy.

10. Statement -1: LiF and CsI have low solubility in water.
Statement -2: Both have high lattice enthalpy.

11. Statement -1: The alkali metals can form ionic hydrides which contain the hydride ion H^-.
Statement -2: The alkali metals have low electro-negativity; their hydrides conduct electricity when fused and liberate hydrogen at the anode.

12. Statement -1: Among the alkali metals, caesium salts exhibit the maximum electrical conductance in aqueous solutions.
Statement -2: Bigger the radius of the hydrated cation, higher is the electrical conductance of the aqueous solutions.

13. Statement -1: Sodium thiosulphate is used in photography.
Statement -2: Sodium thiosulphate is photosensitive.

14. Statement -1: All alkali metals do not form superoxides when heated in excess of air or oxygen.
Statement -2: Superoxide reacts with CO producing white powder and liberating oxygen.

15. Statement -1: Beryllium and magnesium do not impart characteristic colour to the Bunsen-burner flame.
Statement -2: Both Beryllium and magnesium have high ionization energy.

16. Statement -1: $Be(OH)_2$ dissolves in excess of $NaOH$.
Statement -2: $Be(OH)_2$ is an amphoteric compound.

17. Statement -1: The fluorides of alkaline earth metals are almost insoluble in water.
Statement -2: The lattice energies of the fluorides of alkaline earth metals are very high.

18. Statement -1: The alkali metals are ordinary stored under non-reactive oil.
Statement -2: Alkali metals are prevented by air reduction.

19. Statement -1: $Ca(OH)_2$ can be used to distinguish solution of Na_2CO_3 and solution of $NaHCO_3$ present in separate test tubes.
Statement -2: $Ca(HCO_3)_2$ is soluble in water but $CaCO_3$ is not soluble in water.

20. Statement -1: Solubility of MgO, CaO, SrO, BaO decreases down the group.
Statement -2: Basic strength of oxides increases down the group.

21. Statement -1: BaO is an amphoteric oxide.
Statement -2: BaO reacts with HCl solution to produce $BaCl_2$ solution.

22. Statement -1: Li and Mg both produce nitride with nitrogen.
Statement -2: Li and Mg both have outermost electron in *s*-subshell.

23. Statement -1: Caesium and potassium are used as a cathode in photoelectric cell.
Statement -2: The electrons emitted by the irradiation of light on metal are called photoelectron.

24. Statement -1: Na_2O is diamagnetic but Na_2O_2 is paramagnetic.
Statement -2: Na_2O contains oxide ion but Na_2O_2 contains peroxide ion.

25. Statement -1: If $NaOH$ and $NaCl$ is added to the mixture containing Ni^{2+}, Al^{3+}, Zn^{2+}, Fe^{3+} only Fe^{3+} and Al^{3+} get participated.
Statement -2: Solubility products of $Ni(OH)_2$ and $Zn(OH)_2$ are more than those of $Fe(OH)_3$ and $Al(OH)_3$.

26. Statement -1: $K_{sp}: order\ BaSO_4 < SrSO_4 < CaSO_4$; $K_{sp} = Solubility\ product$.
Statement -2: Ba^{2+} having high cationic charge density, so covalent character is highest in $BaSO_4$.

27. Statement -1: Magnesium is more malleable and ductile than sodium, because
Statement -2: First ionization energy of sodium is higher than that of Mg.

28. Statement -1: Magnesium is extracted by the electrolysis of fused mixture of $MgCl_2$ and $NaCl$.

Statement -2: Sodium chloride acts as a reducing agent.

29. Statement -1: Of the various chlorides of alkaline earth metals $BeCl_2$ is covalent in nature, where as $MgCl_2$ and $CaCl_2$ are ionic compounds.

Statement -2: Be is the first member of Group-II.

30. Statement -1: Both Be and Al an form complexes such as BeF_4^{2-} and AlF_6^{3-} respectively. BeF_4^{2-} is not formed.

Statement -2: In case of Be, no vacant d-orbitals are present in its outermost shell.

31. Statement -1: Beryllium does not form peroxide because

Statement -2: Be^{2+} ion being of very small size cannot form a stable lattice with larger peroxide ion.

PASSAGES :

1	B, C, A	**2**	A, C	**3**	D, C, C	**4**	B, D, A, A	**5**	C, C, D, C
6	D, B, C, A	**7**	D, B, A	**8**	B, B	**9**	A, B, A	**10**	A, B, A
11	C, A, B	**12**	A, D, A	**13**	B, C, A	**14**	C, B, C	**15**	B, C, B
16	D, C, D, B	**17**	C, A, D	**18**	D, D, D	**19**	A, B, C, D	**20**	D, C, D

MULTI MATRIX :

1. A – 2, 3; B – 2, 3, 4; | C – 1; D – 1, 3, 4;

2. A – 2, 3, 4, 5; B – 1, 2, 3, 4, 5; C – 1, 2, 4, 5; D – 1, 3, 4, 5;

3. A – 1, 2, 4, 5; B – 3, 5; C – 1, 2, 3, 5 D – 1, 2, 3, 5;

4. A – 1, 3; B – 4; C – 2; D – 1, 3, 5;

5. A – 1, 2, 3, 4; B – 1, 3; C – 1, 3, 4 D – 1, 2, 3, 4, 5;

6. A – 1, 2, 4; B – 1, 2; C – 1, 2, 3 D – 1, 2;

7. A – 1, 3, 4; B – 1, 2; C – 1, 3, 4 D – 1, 3, 4;

8. A – 1; B – 1, 2, 4, 5; C – 5; D – 2, 3;

9. A – 4; B – 2; C – 1; D – 3;

10. A – 1, 3, 4; B – 1, 2, 3; C – 1, 3; D – 1, 2, 4;

11. A – 3; B – 4; C – 2; D – 1;

12. A – Q, U; B – S, V; C – R, X; D – P, W;

13. A – 1; B – 3; C – 2;

14. A – 1; B – 2; C – 2;

15. A – 1; B – 2; C – 3;

16. A – 3; B – 2; C – 4;

17. A – R, U; B – P, W; C – Q, V; D – S, X;

18. A – P, W; B – Q, X; C – R, U; D – S, V;

19. A – R, V; B – S, U; C – A, X; D – Q, W;

20. A – 3, 5; B – 4; C – 1; D – 2;

21. A – 1, 2, 3, 5; B – 3, 5; C – 1, 2, 4, 5; D – 1, 2, 3, 5;

22. A – 3; B – 4; C – 2; D – 1;

23. B

24. C

25. A

ASSERTION & REASONING :

1	B	2	A	3	A	4	C	5	A
6	A	7	D	8	A	9	A	10	C
11	A	12	C	13	C	14	B	15	A
16	B	17	A	18	C	19	D	20	D
21	D	22	B	23	B	24	D	24	D
26	C	27	C	28	C	29	B	30	A
31	A								