Date: 16/10/2021

Q1. Write the formulae of sodium tetrahydroxoaluminate (III) and sodium metaaluminate.

Q2. Why are potassium and caesium rather than lithium used in photoelectric cells?

Q3. (a) Magnesium and beryllium do not give colour to flame whereas othe alkaline earth metals do so. Why?

(b) Potassium carbonate cannot be prepared by Solvay process. Why?

Q4. Give reasons:

(a) The mobilities of the alkali metal ions in aqueous solution are:

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

(b) Lithium is the only alkali metal which forms nitride easily.

(c) E° for $M^{2+}(aq) + 2e^- \longrightarrow M(s)$ (where M = Ca, Sr. Ba) is nearly constant.

Q5. (a) Li_2CO_3 decomposes at lower temperature whereas Na_2CO_3 at higher temperature. Explain.

(b) What happens when

(i) calcium nitrate is heated? (ii) chlorine reacts with slaked lime?

Q6. Among the alkali metal ions, which has the maximum hydration enthalpy?

Q7. Arrange the following in the increasing order of their tendency towards hydrolysis:

$$BeCl_2, \quad CaCl_2, \quad SrCl_2, \quad BaCl_2, \quad MgCl_2$$

Q8. Al_2O_3 is amphoteric in nature, why?

Q9. A chemical *A* is used for the preparation of washing soda to recover ammonia. When CO_2 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*?

Q10. When water is added to compound *A* of calcium, solution of compoud *B* is formed. When carbon dioxide is passed into the solution, it turns milky due to the formation of compound *C*. If excess of carbon dioxide is passed into the solution, milkiness disappears due to the formation of compound *D*. Identify the compounds *A*, *B*, *C* and *D*. Explain why the milkiness disappears in the last step?

Q11. (a) Why does hydrogen occur in a diatomic form rather than in a monoatomic form under normal conditions?

(b) What is the role of hexametaphosphate in water softening process?

(c) Lakes freeze from top towards bottom. Explain.

Q12. (a) Account for the following:

(i) Calcium is preferred over sodium to remove last traces of moisture from alcohol.

(ii) Bleaching powder is a mixed salt.

(iii) Sodium carbonate solution is alkaline in nature.

(b) Complete the following reactions:

(i) $MgCl_2 \cdot 6H_2O \xrightarrow{\Delta}$ (ii) $Mg(HCO_3)_2 \xrightarrow{\Delta}$

Q13. (a) Why are alkali metals soft and have low melting points?

(b) Why is the density of potassium less than sodium?

(c) What is magnesia cement? Give its composition.

(d) $Be(OH)_2$ dissolves in NaOH but $Mg(OH)_2$ does not, why?

(e) Complete the following reaction:

$$BeO + 2NaOH \longrightarrow$$

Q14. (a) Account for the following:

(i) Lithium reacts with water gently while sodium and potassium reacts with water vigorously.

(ii) KOH is a stronger base than NaOH.

(iii) LiF is a almost insoluble in water whereas LiCl is soluble.

(b) Complete the following reactions:

(i) $2Ca(OH)_2 + 2Cl_2 \longrightarrow$ (ii) $2Ca(NO_3)_2(s) \xrightarrow{\Delta}$

Q15. (a) Account for the following:

(i) K, Rb and Cs form superoxide in preference to oxides and peroxides.

(ii) The solubilities of carbonates decrease down the magnesium group.

(iii) Potassium superoxide is used in breathing equipments.

(b) Complete the following reactions:

(i) $Na_2O_2 + 2H_2O \longrightarrow$ (ii) $Ca(OH)_2 + 2Cl_2 \longrightarrow$

Q16. (a) The stability of peroxide and supeoxide of alkali metals increases while moving down the group. Explain.

(b) Aqueous solution of borax is used as cleansing agent. Why?

(c) Boronfluoride exists as BF_3 but boron hybride does not exists as BH_3. Explain.

(d) BeO is insoluble but $BeSO_4$ is soluble in water.

(e) Complete the following reaction:

$$4C_2H_5Cl + 4Na — Pb \longrightarrow$$

Q17. (a) Account for the following:

(i) Water is liquid while H_2S is a gas at ordinary temperature.

(ii) H_2O_2 is a better oxidising agent than H_2O.

(iii) The crystalline salts of alkaline earth metals contain more water crystallisation than the corresponding alkali metal.

(b) Complete the following reactions:

(i) $Na_2B_4O_7 \xrightarrow{\text{Water}}$ (ii) $Na_2CO_3 + Fe_2O_3 \xrightarrow{\Delta}$

Q18. (a) Why $BeSO_4$ and $MgSO_4$ readily soluble in water while $CaSO_4$, $SrSO_4$ and $BaSO_4$ are insoluble?

(b) In the Solvay process, can we obtain sodium carbonate directly by treating the solution containing $(NH_4)_2CO_3$ with sodium chloride? Explain.

(c) Why beryllium carbonate is kept in the atmosphere of carbon dioxide?

(d) The carbonate of lithium decomposes easily on heating to form lithium oxide and CO_2. Why?

(e) Complete the following reactions:

(i) $O_2^{2-} + H_2O \longrightarrow$ (ii) $O_2^{-} + H_2O \longrightarrow$

Q19. (a) Beryllium chloride exists as $BeCl_2 \cdot 4H_2O$ due to solvation (hydration). What is hydrated cation? Does it behave as an acid or base, explain?

(b) BeO is amphoteric in nature. Why?

(c) Compare the solubility and thermal stability of the nitrates of alkali metals and alkaline earth metals.

(d) A metal *M* reacts with N_2 give a compound *A* (M_3N). *A* on heating at high temperature gives back *M* and *A* on reacting with H_2O gives a gas *B* which turns $CuSO_4$ solution to blue on passing through it. What are *M* and *B*?

Q20. (a) Account for the following:

(i) $BeSO_4$ and $MgSO_4$ readily soluble in water while $CaSO_4$, $SrSO_4$ and $BaSO_4$ are insoluble.

(ii) BeH_2 exists as a polymer.

(iii) Ca^{2+} and Mg^{2+} play crucial role in biological activity.

(b) Complete the following reactions:

(i) $Mg_2C_3 + 4H_2O \longrightarrow$ (ii) $Mg_3N_2(s) + 6H_2O(l) \longrightarrow$

Q21. (a) Account for the following:

(i) Alkali metals are good reducing agents.

(ii) PbO_2 is soluble in NaOH as well as in HCl.

(iii) Sodium oxide solution cannot be stored in Zn or Al vessel.

(b) Complete the following reactions:

(i) $SiO_2 + 2NaOH \longrightarrow$ (ii) $Ca(OH)_2 + SO_2 \longrightarrow$

Q22. (a) What is the nature of CO when it reacts with NaOH?

(b) Although Li^+ is far smaller than the other metal ions but it moves through a solution less rapidly than the others. Why?

(c) Baking soda or baking powder are different or same?

(d) Aqueous Na_2CO_3 is alkaline in nature. Explain.

(e) Complete the following reaction:

$$2Na_2O_2 + 2CO_2 \longrightarrow$$

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S1. $Na^+[Al(OH)_4]^-$ = Sodium tetrahydroxoaluminate (III).

$NaAlO_2$ = Sodium metaaluminate.

S2. Potassium and caesium have much lower ionisation enthalpy than that of lithium. As a result, these metals on exposure to light, easily emit electrons but lithium does not. Hence, potassium and caesium rather than lithium are used in photoelectrice cells.

S3. (a) Be and Mg-atoms, due to their small size and high effective nuclear charge, bind their electrons more strongly. Therefore, they have high ionisation energies and hence, they need large amount of energy for excitation of their valence electrons to higher energy levels. As such a large energy is not abailable in Bunsen flame, hence they do not impart any colour to the flame. While other alkaline earth metals impart a characteristic colour to the flame due to easy excitation of electrons to higher energy leveis because of their low ionisation energies.

(b) Potassium carbonate cannot be prepared by Solvay process because it is more soluble than sodium bicarbonate. Thus, it does not get precipitated when CO_2 gas is passed through a concentrated solution of KCl which is saturated with ammonia.

S4. (a) Smaller the size of the ion, more highly it is hydrated and hence, greater is the mass of hydrated ion and hence, lower is the ionic mobility. Since, the extent of hydration decreases in the order: $Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$,therefore, the ionic mobility increases in the reverse order: $Li^+ < Na^+ < K^+ < Rb^+ < Cs^+$.

(b) Because of the high lattice energy of lithium, it forms lithium nitride when burnt in air or nitrogen. While the other alkali metals do not form their corresponding nitrides because their lattice energies decrease as their sizes increase from Na to Cs.

(c) E^o of any M^{2+}/M depends upon three factors: (i) enthalpy of vaporization (ii) ionization enthalpy (iii) enthalpy of hydration. Since, the combined effect of these factors is approximately same for Ca, Sr and Ba, therefore, their electrode potentials are nearly same.

S5. (a) Na_2CO_3 is an ionic compound whereas Li_2CO_3 is a covalent compound. Lattice energy of Na_2CO_3 is higher thant that of Li_2CO_3. Therefore, Li_2CO_3 is decomposes at lower temperature.

(b) (i) $$2Ca(NO_3)_2\ s \xrightarrow{\Delta} 2CaO\ s + 4NO_2(g) + O_2(g)$$

(ii) $$\underset{\text{Slaked lime}}{2Ca(OH)_2} + 2Cl_2 \xrightarrow{\Delta} CaCl_2 + \underset{\text{Bleaching powder}}{Ca(OCl)_2} + 2H_2O$$

S6. The hydration enthalpies of alkali metal ions decrease with increase in ionic radii, *i.e.*,

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

Because of the smallest size, Li^+ has maximum degree of hydration.

S7. As the ionic character increases their tendency towards hydrolysis increases. Hence, the correct order is:

$$BeCl_2 < MgCl_2 < CaCl_2 < BaCl_2 < SrCl_2$$

S8. Al_2O_3 dissolves both in alkalies and acids liberating water molecules.

$$Al_2O_3 + 2NaOH \xrightarrow{\Delta} \underset{\text{Sodium meta aluminate}}{2NaAlO_2} + H_2O$$

$$Al_2O_3 + 6HCl \xrightarrow{\Delta} \underset{\text{Aluminium chloride}}{2AlCl_3} + 3H_2O$$

Thus, the above reactions suggest that Al_2O_3 is amphoteric in nature.

S9. To recover NH_3 in solvay ammoina-soda process, $Ca(OH)_2$ is used.

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

On passing CO_2 through $Ca(OH)_2$, it turns milky due to the formation of $CaCO_3$.

$$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3\downarrow + H_2O$$

$Ca(OH)_2$ (*A*) is used for white washing.

S10. Appearance of milkiness on passing CO_2 in the solution of compound *B* indicates that compound *B* is lime water and compound *C* is $CaCO_3$. Since, compound *B* is obtained by adding H_2O to compound *A*, therefore, compound A is quicklime, CaO.

The reactions are as follows:

(a) $$\underset{\substack{\text{Calcium oxide}\\(A)}}{CaO} + H_2O \longrightarrow \underset{\substack{\text{Lime water}\\(B)}}{Ca(OH)_2}$$

(b) $$\underset{(B)}{Ca(OH)_2} + CO_2 \longrightarrow \underset{\substack{\text{Calcium carbonate}\\\text{(Milkiness)}\\(C)}}{CaCO_3} + H_2O$$

(c) When excess of CO_2 is passed, milkiness disappears due to the formation of soluble calcium bicarbonate (*D*).

$$\underset{\substack{\text{Milkiness}\\(C)}}{CaCO_3} + CO_2 + H_2O \longrightarrow \underset{\substack{\text{Calcium bicarbonate}\\\text{(soluble in } H_2O)\\(D)}}{Ca(HCO_3)_2}$$

S11. (a) H-atom has only one valence electron and requires only one electron to achieve stable inert gas configuration. For this, it shares its single electron with electron of other H-atom to form a stable diatomic molecule.

(b) The trade name for sodium hexametaphosphate is calgon. When calgon is added to hard water, the Ca^{2+} and Mg^{2+} ions present in it combine with calgon to form soluble complex of calcium and magnesium salts. This results in the removal of Ca and Mg ions from hard water. Now, water is softened and Na^+ ions are released into water.

$$\underset{\text{[From hard water]}}{2CaCl_2} + \underset{\text{Sodium hexamelaphosphate}}{Na_2[Na_4(PO_3)_6]} \longrightarrow \underset{\text{Complex salt (Water soluble)}}{Na_2[Ca_2(PO_3)_6]} + 4NaCl$$

$$\underset{\text{[From hard water]}}{2MgSO_4} + \underset{\text{Sodium hexamelaphosphate}}{Na_2[Na_4(PO_3)_6]} \longrightarrow \underset{\text{(Soluble)}}{Na_2[Mg_2(PO_3)_6]} + 4Na_2SO_4$$

(c) During severe winter, the temperature of take water keeps on decreasing. Since, cold water is heavier, therefore it moves towards bottom of the lake and warm water moves from the bottom. This process continues till the temperature of entire take water becomes 277 K. As the density of water is maximum at 277 K, further decrease in the temperature of the surface water will decrease its density. As a result, the temperature of surface water keeps on decreasing and ultimately it freezes.

S12. (a) (i) Both Na and Ca react with water to form their respective hydroxides. While Na readily reacts with alcohol to form sodium ethoxide but Ca reacts very slowly. Thus, when Ca is used, it will react more readily with water than with alcoho.

$$2C_2H_5OH + 2Na \longrightarrow 2C_2H_5ONa + H_2\uparrow$$

Therefore, Ca is preferred over Na to remove last traces of moisture from alcohol.

(ii) Bleaching powder [represented as Ca(OCl) or $CaOCl_2$] is a mixed salt of calcium hypochlorite $[Ca(ClO)_2]$ and calcium chloride, $(CaCl_2)$ mixed in 1 : 1 ratio.

In the presence of cobalt chloride, it decomposes into $CaCl_2 + O_2$.

$$2CaOCl_2 \xrightarrow{CoCl_2} 2CaCl_2 + O_2$$

(iii) Na_2CO_3 is a salt of weak acid, carbonic acid (H_2CO_3) and a strong base, NaOH, therefore it undergoes hydrolysis to produce strong base NaOH and Hence, its aqueous solution is alkaline in nature.

$$Na_2CO_3\,(s) + H_2O\,(l) \longrightarrow 2NaOH\,(aq) + H_2CO_3\,(aq)$$

(b) (i) $$MgCl_2 \cdot 6H_2O \xrightarrow{\Delta} MgO + 2HCl + 5H_2O$$

(ii) $$\underset{\text{Magnesium bicarbonate}}{Mg(HCO_3)_2} \xrightarrow{\Delta} \underset{\text{White ppt.}}{MgCO_3\downarrow} + H_2O + CO_2$$

S13. (a) Alkali metals have only valence electron per metal atom. As a result, the binding energy of alkali metal ions in the close packed metal lattices are weak. Therefore, these are soft and have low melting points.

(b) This is due to abnormal increase in the atomic size of potassium.

(c) When a saturated solution of magnesium chloride is mixed with magnesium oxide, it sets to a hard mass. The hard mass is known as magnesia cement. Its composition is $MgCl_2 \cdot 5MgO \cdot H_2O$.

(d) $Be(OH)_2$ is amphoteric and therefore, it dissolves in NaOH forming sodium beryllate

$$Be(OH)_2 + 2NaOH \longrightarrow Na_2BeO_2 + 2H_2O$$

On the other hand, $Mg(OH)_2$ is basic and does not dissolve in NaOH.

(e) $$BeO + 2NaOH \longrightarrow \underset{\text{Sodium beryllate}}{Na_2BaO_2} + H_2O$$

S14. (a) (i) Li has most negative standard reduction potential due to very high enthalpy of hydration. Thus, reaction of Li with water will be most exothermic. But surprisingly Li reacts with water gently, whereas Na and K react with water vigourously.

The explanation is in kinetics and not in thermodynamics of the reaction. No doubt, maximum energy is evolved with Li but its fusion, vaporisation and ionisation consume most of the evolved energy. As a result, reaction proceeds slowly. Na or K have low melting points and molten metal spreads over water exposing a larger surface to water, making the reaction vigorous.

(ii) KOH is a stronger base than NaOH. Due to large size of K, K — O bond is weaker than Na — O bond. KOH has more concentration of OH than NaOH, hence is a stronger base than NaOH.

(iii) Difference in lattice enthalpy and hydration enthalpy of LiCl is higher *i.e.*, -42 kJ mol^{-1} [$-887 - (-845)$] than that of LiF *i.e.*, -16 kJ mol^{-1} [$-1021 - (-1005)$], hence LiF is insoluble in water while LiCl is soluble. In other words, LiF is insoluble in water because of much higher lattice energy (-1005 kJ mol^{-1}) than that of LiCl (-845 kJ mol^{-1}).

(b) (i) $$2Ca(OH)_2 + 2Cl_2 \longrightarrow CaCl_2 + \underset{\text{Bleaching powder}}{Ca(OCl)_2} + 2H_2O$$

(ii) $$2Ca(NO_3)_2(s) \xrightarrow{\Delta} 2CaO(g) + 4NO_2(g) + O_2(g)$$

S15. (a) (i) K^+, Rb^+ and Cs^+ are large cations and superoxide ion (O_2^-) is larger than oxide (O^{2-}) and peroxide (O_2^{2-}) ions. Due to higher lattice energies, a large cation stabilises a large anion, therefore, these metals form superoxides in preference to oxides and peroxides.

(ii) The lattice energy of group 2 (*i.e.*, magnesium group) metal carbonates is almost constant due to large size of carbonate ion. Thus, their solubility is decided by hydration energy which decreases on moving down the group due to increase in the size of cation.

Hence, solubility of carbonates decreases down the magnesium gtroup.

(iii) Potassium superoxide is used in breathing equipements such as oxygen maks. Such oxygen masks are used in rescue work in mines and in other areas where the air is so deficient in oxygen that an artificial atmosphere must be generated. The moisture of the breathe reacts with superoxide to liberate oxygen and at the sametime, the potassium hydroxide formed removes CO_2 as it is exhaled therby allowing the atmosphere in the mask to be continuously regenerated

(b) (i) $$Na_2O_2(s) + 2H_2O(l) \longrightarrow 2NaOH(aq) + H_2O_2(l)$$

(ii) $$2Ca(OH)_2 + 2Cl_2 \longrightarrow CaCl_2 + \underset{\text{Bleaching powder}}{Ca(OCl)_2} + 2H_2O$$

S16. (a) The stability of peroxides and supeoxides increases as the size of metal ion increases, *i.e.*,

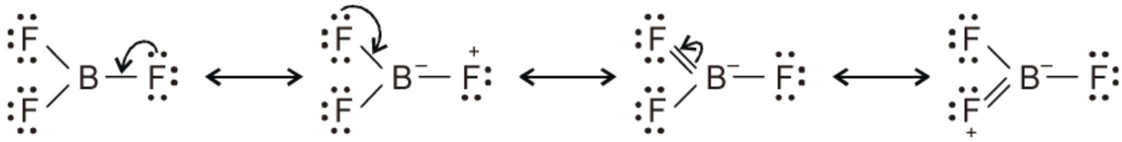
$$KO_2 < RbO_2 < CsO_2$$

This is due to the stabilisation of larger anions by larger cations through lattice energy effect while moving down the group.

(b) The aqueous solution of borax is alkaline due to hydrolysis and used as a cleansing agent.

$$\underset{\text{Borax}}{Na_2B_4O_7 \cdot 7H_2O} \longrightarrow \underset{\text{(Strong alkali)}}{2NaOH} + \underset{\text{(Weak acid)}}{4H_3BO_3}$$

(c) Due to $p\pi - p\pi$ back bondingg, the lone pair of electrons of F is donated to the B-atom. This delocalisation reduces the deficiency of electrons on B therby increasing the stability of BF_3 molecule



Due to absence of lone pair of electrons on H-atom, this compensation does not occur in BH_3. In other words electron deficiency of B stays and to reduce its electron deficiency BH_3 dimerises to from B_2H_6.

(d) Because of smaller size, higher ionisation energy and higher electronegativity, BeO is essentially covalent and hence is insoluble in water. In contrast, $BeSO_4$ isd ionic. Further, due to small size of Be^{2+}, hydration energy of $BeSO_4$ is much higher than its lattice energy and hence, $BeSO_4$ is soluble in water.

(e) $$4C_2H_5Cl + 4Na - Pb \longrightarrow (C_2H_5)_4Pb + 3Pb + 4NaCl$$

S17. (a) (i) Water superheated steam passed over red hot coke or coal at 1270 K in presence of Ni as catalyst, a mixture of CO and H_2 is produced which is known as water gas.

(ii) In H_2O_2, the peroxide ion (O_2^{2-}) is unstable, has tendency to pass into stable oxidation state (O^{2-}). Hence, H_2O_2 is a good oxidising agent while H_2O is stable.

(iii) Alkaline earth metal salts have M^{2+} ions which have very high polarising power compared to polarising power of monovalent metal ion (M^+) of alkali metal. Due to high polarising power of M^{2+}, if associate more water of crystallisation than M^+.

(b) (i) $$\underset{\text{Borax}}{Na_2B_4O_7 \cdot 10H_2O} \xrightarrow{\text{Water}} 2NaOH + H_2B_4O_7 + 8H_2O$$

(ii) $$Na_2CO_3 + Fe_2O_3 \xrightarrow{\Delta} 2NaFeO_2 + CO_2$$

S18. (a) The lattice energy of alkaline earth metal sulphates is almost constant due to large size of sulphate ion. Thus, their solubility is decided by hydration energy which decreases on moving down the group.

The greater hydration enthalpies of Be^{2+} and Mg^{2+} ions overcome the lattice enthalpy factor and therefore, their sulphates are soluble in water.

However, hydration enthalpy is low for Ca^{2+} and Sr^{2+} ions and cannot overcome the lattice energy factor.

(b) No, $(NH_4)_2CO_3$ reacts with NaCl as

$$(NH_4)_2CO_3 + 2NaCl \rightleftharpoons Na_2CO_3 + 2NH_4Cl$$

Because the products obtained (Na_2CO_3 and NH_4Cl) are highly soluble and the equilibrium will not shift in forward direction. That's why, in the Solvay process, we cannot obtain sodium carbonate directly by treating the solution containing $(NH_4)_2CO_3$ with sodium chloride.

(c) BeO is more stable than $BeCO_3$ due to small size and high polarising power of Be^{2+}. Thus, when $BeCO_3$ is kept in an atmosphere of CO_2, a reversible process takes place and stability of $BeCO_3$ increases.

$$BeCO_3 \rightleftharpoons BeO + CO_2$$

(d) The thermal stability of carbonates increases down the group. Hence, Li_2CO_3 is least stable. Due to small size of Li^+, strong polarising power distorts the electron cloud of CO_3^{2-} ion. High lattice energy of Li_2O than Li_2CO_3 also favours the decomposition of Li_2CO_3.

(e) (i) O_2^{2-} represents a peroxide ion which react with water to form H_2O_2.

$$O_2^{2-} + H_2O \longrightarrow 2OH^- + \underset{\text{Hydrogen peroxide}}{H_2O_2}$$

(ii) O_2^- represents a superoxide ion which react with water to form H_2O_2 and O_2.

$$2O_2^- + 2H_2O \longrightarrow 2OH^- + \underset{\text{Hydrogen peroxide}}{H_2O_2} + O_2$$

S19. (a) Hydrated cation is $[Be(H_2O)_4]^{2+}$.

$$[Be(H_2O)_4]^{2+} + H_2O \longrightarrow [Be(H_2O)_3(OH)]^+ + H_3O^+$$

Hydrated cation is H^+ ion donor, hence it behaves as an acid (Lory-Bonsted protonic concept).

(b) Due to smal size and high ionisation enthalpy of Be, BeO is amphoteric, *i.e.*, dissolves in both acids and bases

$$BeO + 2HCl \longrightarrow BaCl_2 + H_2O$$

$$BeO + 2NaOH \longrightarrow Na_2BeO_2 + H_2O$$

(c) Nitrates of alkali metals and alkaline earth metals:

(i) Alkali metal and alkaline earth metal nitrates are highly soluble in water.

(ii) Alkali metal nitrates on strong heating decomposes to nitries (except $LiNO_3$).

On heating further at higher temperature, the products are oxides.

$$2NaNO_3 \xrightleftharpoons{500°C} 2NaNO_2 + O_2$$

$$4NaNO_3 \xrightleftharpoons{800°C} 2Na_2O + 5O_2 + 2N_2$$

$$2LiNO_3 \xrightarrow{\Delta} Li_2O + 2NO_2 + *O_2$$

Alkaline earth metal nitrates on heating decompose into their corresponding oxide with the evolution of mixture of NO_2 and O_2 (except $Be(NO_3)_2$).

$$2Mg(NO_3)_2 \xrightarrow{\Delta} 2MgO + 4NO_2 + O_2$$

(d) The formula of *A* is M_3N suggests that *M* is a monovalent metal.

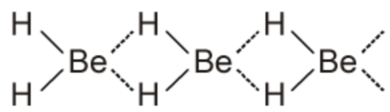
$$\underset{(M)}{6Li} + N_2 \longrightarrow \underset{\substack{(A)\\ \text{Lithium nitride}}}{2Li_3N} \xrightarrow{\Delta} 6Li + N_2$$

$$\underset{(A)}{Li_3N} + 3H_2O \longrightarrow 3LiOH + \underset{(B)}{NH_3}$$

$$CuSO_4 + \underset{(B)}{4NH_3} \longrightarrow \underset{\text{(Blue solution)}}{[Cu(NH_3)_4]SO_4}$$

S20. (a) (i) Due to their small size, Be^{2+} and Mg^{2+} have higher hydration enthalpies than their corresponding lattice enthalpies. Thereby, $BeSO_4$ and $MgSO_4$ are soluble in water. While other sulphates of this group are insoluble.

(ii) In BeH_2, three centre-two electron bonds are formed in which a 'banana-shaped' molecular orbital covers three atoms Be ... H ... Be and contains two electrons. The monomeric molecule BeH_2, if formed with normal bonds, would have only four electrons in the outer shell of the beryllium atom and would be electron deficient. Hence, it exists as a polymer.



(iii) Mg^{2+} ions are concentrated in animal cells and Ca^{2+} are concentrated in the body fluids outside the cell. Mg^{2+} is important in chlorophyll in the green parts of plants.

Ca^{2+} is important in bones asnd teeth as apatile $[Ca_3(PO_4)_2]$ and the enamel on teeth as fluorapatite $[3(Ca_3(PO_4)_2] \cdot CaF_2]$. Ca^{2+} ions are important in blood clotting, and are required to trigger the contraction of muscles and to maintain the regular beating of heart.

(b) (i) $$\underset{\text{Bleaching powder}}{Mg_2C_3 + 4H_2O} \longrightarrow 2Mg(OH)_2 + CH_3 — C \equiv CH$$

(ii) $$Mg_3^{2+}N_2^{3-}(s) + 6H_2O\,(l) \xrightarrow{\Delta} 3Mg^{2+}(OH^-)_2 + 2NH_3\,(g)$$

S21. (a) (i) Due to their lower ionisation enthalpy and strong tendency to lose the single valence electron, alkali metals are strong reducing agents.

(ii) PbO_2 is an amphoteric oxide. It reacts with both acids and bases.

$$PbO_2 + 2NaOH \longrightarrow \underset{\text{Sodium plumbhate (IV)}}{Na_2PbO_3} + H_2O$$

$$PbO_2 + 4HCl \longrightarrow 2H_2O + PbCl_4$$

(iii) Zn or Al reacts with $Na_2O(aq)$ solution to evolve He gas, so Na_2O is not kept in Zn or Al vessel.

$$Zn + Na_2O + H_2O \longrightarrow Na_2NaO_2 + H_2$$

$$2Al + Na_2O + 3H_2O \longrightarrow 2NaAlO_2 + 3H_2$$

(b) (i) $$SiO_2 + 2NaOH \longrightarrow Na_2SiO_3 + 2H_2O$$

(ii) $$Ca(OH)_2 + SO_2 \longrightarrow \underset{\text{Milky}}{CaSO_3\downarrow} + O_2\,(g)$$

S22. (a)

$$\underset{\text{(Acid)}}{CO} + \underset{\text{(Base)}}{NaOH} \longrightarrow \underset{\text{(Salt)}}{HCOONa}$$

(b) Smaller the size of cation, larger the charge (greater the charge density), hence greater the hydration. The dense charge of Li^+ attracts several layers of water molecules around it. They increase the effective size of the ion, thus showing it down.

(c) Baking soda and baking powder are different.

Baking soda is $NaHCO_3$ and baking powder is a mixture of $NaHCO_3$, $Ca(HPO_4)_2$, starch and potassium hydrogen tartarate.

(d) Na_2CO_3 is a salt of weak acid (H_2CO_3) and strong base ($NaOH$) $\cdot$ CO_3^{2-} is hydrolysed forming free OH^- ion, thus it is alkaline in nature.

$$Na_2CO_3 + 2H_2O \rightleftharpoons \underset{\text{(Strong base)}}{2NaOH} + \underset{\text{(Weak acid)}}{H_2CO_3}$$

Thus, $$CO_3^{2-} + 2H_2O \rightleftharpoons 2OH^- + H_2CO_3$$

(e) $$2Na_2O_2 + 2CO_2 \longrightarrow 2N_2CO_3 + O_2$$