UNIT-10
The s-Block Elements

NCERT–Examplar Problems with Solutions

SECTION-I: *Multiple Choice Questions (Type-I)*

Note: In the following questions, only one option is correct.

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

(i) Na

(ii) K

(iii) Rb

(iv) Cs

Ans. (iv)

Melting point decreases down the alkali metals, as the strength of the metallic bond decreases. The softness also decreases down the group.

2. Alkali metals react with water vigorously to form hydroxides and dihydrogen. Which of the following alkali metals reacts with water least vigorously?

(i) Li

(ii) Na

(iii) K

(iv) Cs

Ans. (i)

The atomic size increases down the group, electropositivity also increases down the group. Hence, the reactivity towards water increases from Li to Cs.

3. The reducing power of a metal depends on various factors. Suggest the factor which makes Li, the strongest reducing agent in aqueous solution.

(i) Sublimation enthalpy

(ii) Ionisation enthalpy

(iii) Hydration enthalpy

(iv) Electron gain enthalpy

Ans. (iii)

Due to small size and high charge to radius ratio, Li^+ is the most heavily hydrated, hence Li is the strongest reducing agent.

$$Li(s) \longrightarrow Li^+(aq) + e^-$$

4. Metal carbonates decompose on heating to give metal oxide and carbon dioxide. Which of the metal carbonates is most stable thermally?

(i) $MgCO_3$ (ii) $CaCO_3$ (iii) $SrCO_3$ (iv) $BaCO_3$

Ans. (iv)

The stability of the oxo salts increases down the group due to stabilization of large cation by large anion $BaCO_3$ is thermally most stable.

5. Which of the carbonates given below is unstable in air and is kept in CO_2 atmosphere to avoid decomposition?

(i) $BeCO_3$

(ii) $MgCO_3$

(iii) $CaCO_3$

(iv) $BaCO_3$

Ans. (i)

$BeCO_3$ is unstable and decompose to give BeO and CO_2. To slow down its decomposition, we store $BeCO_3$ in an atmosphere of CO_2 (Le-Chatelier's principle).

$$BeCO_3(s) \rightleftharpoons BeO(s) + CO_2(s)$$

6. Metals form basic hydroxides. Which of the following metal hydroxide is the least basic?

(i) $Mg(OH)_2$

(ii) $Ca(OH)_2$

(iii) $Sr(OH)_2$

(iv) $Ba(OH)_2$

Ans. (i)

Atomic size, electropositivity and metallic character increases down the group. The strength of M – OH bond decreases, hence basicity increases down the group.

7. 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

(i) $BeCl_2$

(ii) $MgCl_2$

(iii) $CaCl_2$

(iv) $SrCl_2$

Ans. (i)

$BeCl_2$ is the most covalent due to small size of Be^{2+} and high polarizing power of Be^{2+} (Fajan rules).

8. The order of decreasing ionization enthalpy in alkali metals is

(i) Na > Li > K > Rb

(ii) Rb < Na < K < Li

(iii) Li > Na > K > Rb

(iv) K < Li < Na < Rb

Ans. (iii)

As the atomic size increases, ionization enthalpy decreases.

9. 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 water is due to

(i) Ionic nature of lithium fluoride

(ii) High lattice enthalpy

(iii) High hydration enthalpy for lithium ion

(iv) Low ionisation enthalpy of lithium atom

Ans. (ii)

Due to small size of Li^+ and F^-, the lattice enthalpy is very high and this lattice enthalpy is much higher than the hydration enthalpy.

10. Amphoteric hydroxides react with both alkalies and acids. Which of the following group 2 metal hydroxides is soluble in sodium hydroxide?

(i) $Be(OH)_2$

(ii) $Mg(OH)_2$

(iii) $Ca(OH)_2$

(iv) $Ba(OH)_2$

Ans. (i)

$Be(OH)_2$ is soluble in NaOH due to the formation of sodium beryllate. $Be(OH)_2$ is amphoteric

$$Be(OH)_2 + 2NaOH \longrightarrow Na_2[Be(OH)_4]$$

Sodium beryllate (soluble)

11. In the synthesis of sodium carbonate, the recovery of ammonia is done by treating NH_4Cl with $Ca(OH)_4$. The by-product obtained in this process is

(i) $CaCl_2$

(ii) NaCl

(iii) NaOH

(iv) $NaHCO_3$

Ans. (i)

The by product is calcium chloride

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

12. When sodium is dissolved in liquid ammonia, a solution of deep blue colour is obtained. The colour of the solution is due to

(i) ammoniated electron

(ii) sodium ion

(iii) sodium amide

(iv) ammoniated sodium ion

Ans. (i)

The colour is due to presence of ammoniated electron

$$Na + (x+y)NH_3 \longrightarrow \underset{\text{ammoniated sodium ion}}{Na^+(NH_3)_x} + \underset{\text{ammoniated electron}}{e^-(NH_3)_y}$$

13. By adding gypsum to cement

(i) setting time of cement becomes less

(ii) setting time of cement increases

(iii) colour of cement becomes light

(iv) shining surface is obtained

Ans. (ii)

The addition of gypsum increases the setting time of the cement

14. Dead burnt plaster is

(i) $CaSO_4$

(ii) $CaSO_4.½H_2O$

(iii) $CaSO_4.H_2O$

(iv) $CaSO_4.2H_2O$

Ans. (i)

$$\underset{\text{Gypsum}}{CsSO_4.2H_2O} \xrightarrow{\text{heat}} \underset{\text{plaster of Paris}}{CaSO_4.\frac{1}{2}H_2O} + \frac{3}{2}H_2O$$

$$CaSO_3.\frac{1}{2}H_2O \xrightarrow[\text{heat}]{\text{strong}} \underset{\text{dead burnt plaster}}{CaSO_4} + \frac{1}{2}H_2O$$

15. Suspendsion of slaked lime in water is known as

(i) lime water

(ii) quick lime

(iii) milk of lime

(iv) aqueous solution of slaked lime

Ans. (iii)

Suspension of slaked lime in water is called **milk of lime** and the clear solution of slaked lime in water is called **lime water.**

16. Which of the following elements does not form hydride by direct heating with dihydrogen?

(i) Be

(ii) Mg

(iii) Sr

(iv) Ba

Ans. (i)

In group 2, Be is smallest in size with high ionization enthalpy. So, Be is the least reactive and does not form hydride.

17. The formula of soda ash is

(i) $Na_2CO_3.10H_2O$

(ii) $Na_2CO_3.2H_2O$

(iii) $Na_2CO_3.H_2O$

(iv) Na_2CO_3

Ans. (iv)

$Na_2CO_3.10H_2O \longrightarrow$ washing soda

$Na_2CO_3.H_2O \longrightarrow$ crystals of washing soda

$Na_2CO_3 \longrightarrow$ soda ash

18. A substance which give brick red flame and breaks down on heating to give oxygen and a brown gas is

(i) Magnesium nitrate

(ii) Calcium nitrate

(iii) Barium nitrate

(iv) Strontium nitrate

Ans. (ii)

The brick red colour is due to calcium present and brown fumes due to liberation of NO_2 gas.

$$2Ca(NO_3)_2 \xrightarrow{\text{Heat}} 2CaO + 4NO_2 + O_2$$

Brown fumes

19. Which of the following statements is true about $Ca(OH)_2$?

(i) It is used in the preparation of beaching powder

(ii) It is a light blue solid

(iii) It does not possess disinfectant property

(iv) It is used in the manufacture of cement

Ans. (i)

$Ca(OH)_2$ is used in the preparation of bleaching powder on reaction with chlorine

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

The bleaching powder composition is

$$Ca(OCl)_2.CaCl_2.Ca(OH)_2.2H_2O$$

20. 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?

(i) $Ca(HCO_3)_2$ (ii) CaO (iii) $Ca(OH)_2$ (iv) $CaCO_3$

Ans. (iii)

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

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

(recovery of amonia)

21. Dehydration of hydrates of halides of calcium, barium and stronatium i.e., $CaCl_26H_2O$. $BaCl_2.2H_2O$, $SrCl_2.2H_2O$, can be achieved by heating. These become wet on keeping in air. Which of the following statements is correct about these halides?

(i) act as dehydrating agent

(ii) can absorb moisture from air

(iii) tendency to form hydrate decreases from calcium to barium

(iv) all of the above

Ans. (iv)

The tendency to form hydrates decreases down the group from Ca to Ba as size increases.

They can absorb moisture from air. They are used as drying agent.

SECTION-II: *Multiple Choice Questions (Type II)*

Note: In the following questions two or more options may be correct.

22. Metallic elements are described by their standard electrode potential, fusion enthalpy, atomic size, etc. The alkali metals are characterized by which of the following properties?

(i) High boiling point

(ii) High negative standard electrode potential

(iii) High density

(iv) Large atomic size

Ans. (ii), (iv)

Alkali metals have a large size and high negative electrode potential. It means alkali metals are strong reducing agent.

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

(i) Na_2CO_3

(ii) $NaHCO_3$

(iii) NaOH

(iv) NaCl

Ans. (i), (iii)

Na_2CO_3 and NaOH are used in textile industry.

24. Which of the following compounds are readily soluble in water?

(i) $BeSO_4$

(ii) $MgSO_4$

(iii) $BaSO_4$

(iv) $SrSO_4$

Ans. (i), (ii)

$BeSO_4$ and $MgSO_4$ are soluble in water due to their high hydration energy which compensate for their lattice energy.

25. When Zeolite, which is hydrated sodium aluminium silicate is treated with hard water, the sodium ions are exchanged with which of the following ion(s)?

(i) H^+ ions

(ii) Mg^{2+} ions

(iii) Ca^{2+} son

(iv) SO_4^{2-} ions

Ans. (ii), (iii)

$Na_2Al_2Si_2O_8.xH_2O$ or Na_2Z (Zeolites)

$Na_2Z + M^{2+} \longrightarrow MZ + 2Na^+$

(M = Mg, Ca)

26. Identify the correct formula of halides of alkaline earth metals from the following:

(i) $BaCl_2.2H_2O$

(ii) $BaCl_2.4H_2O$

(iii) $CaCl_2.6H_2O$

(iv) $SrCl_2.4H_2O$

Ans. (i), (iii)

The tendency to form hydrate decreases from calcium to barium

$Ca \longrightarrow CaCl_2.6H_2O$ $Sr \longrightarrow SeCl_2.4H_2O$

$Ba \longrightarrow BaCl_2.2H_2O$

27. Choose the correct statements from the following:

(i) Beryllium is not readily attacked by acids because of the presence of an oxide film on the surface of the metal

(ii) Beryllium sulphate is readily soluble in water as the greater hydration enthalpy of Be^{2+} overcomes the lattice enthalpy factor

(iii) Beryllium exhibits coordination number more than four

(iv) Beryllium oxide is purely acidic in nature.

Ans. (i), (ii)

Be form a protective film of BeO on its surface. $BeSO_4$ is also soluble in water due to small size, high hydration enthalpy of Be^{2+} which compensates for high lattice enthalpy of $BeSO_4$. Due to absence of d-orbitals Be has a maximum covalency of four.

28. Which of the following are the correct reasons for anomalous behavior of lithium?

(i) Exceptionally small size of its atom

(ii) Its high polarizing power

(iii) It has high degree of hydration

(iv) Exceptionally low ionization enthalpy

Ans. (i), (ii), (iii)

Due to its exceptionally small size, Li^+ has high polarizing power and has very high degree of hydration. Li^+ is most heavily hydrated in group-1.

SECTION-III: *Short Answer Type*

29. How do you account for the strong reducing power of lithium in aqueous solution?

Ans. The reducing power is expressed in term of electrode potential. More negative the electrode potential is, stronger the reducing agent is (more the tendency to lose electrons)

(i) enthalpy of sublimation

(ii) enthalpy of ionization and

(iii) hydration enthalpy

Due to high charge to radius ratio. Li^+ has highest hydration enthalpy. This makes lithium the strongest reducing agent.

30. When heated in air, the alkali metals form various oxides. Mention the oxides formed by Li, Na and K.

Ans. Li form Lithium oxide only

$$4Li + O_2 \longrightarrow 2Li_2O$$

Na form both sodium oxide and sodium peroxide

$$4Na + O_2 \longrightarrow 2Na_2O$$

$$2Na + O_2 \longrightarrow Na_2O_2$$
(sodium peroxide)

K form potassium oxide as well as potassium superoxide

$$4K + O_2 \longrightarrow 2K_2O$$

$$K + O_2 \longrightarrow KO_2$$
(potassium superoxide)

Na form Na_2O_2 and K form KO_2 due to stablisation of large cation by large anion.

31. Complete the following reactions

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

Ans. (i) $O_2^{2-} + 2H_2O \longrightarrow 2OH^- + K_2O_2$
peroxide ion

(ii) $2O_2^- + 2H_2O \longrightarrow 2OH^- + H_2O_2 + O_2$
superoxide ion

32. Lithium resembles magnesium in some of its properties. Mention two such properties and give reason for this resemblance.

Ans. (i) Li and Mg both reacts with N_2 to form respective nitrides. This is due to high lattice enthalpies of these nitrides.

$$6Li + N_2 \longrightarrow 2Li_3N$$

$$3Mg + N_2 \longrightarrow Mg_3N_2$$

(ii) Li and Mg both form fluorides which are insoluble in water due to high lattice enthalpy

$$2Li + F_2 \longrightarrow 2LiF$$

$$Mg + F_2 \longrightarrow MgF_2$$

33. Name an element from group 2 which forms an amphoteric oxide and a water soluble sulphate.

Ans. Beryllium (Be)

BeO is amphoteric reacts with acid as well as with base

$$BeO + 2HCl \longrightarrow BeCl_2 + H_2O$$
(base)

$$BeO + 2NaOH + H_2O \longrightarrow \underset{\text{sodium beryllate}}{Na_2[Be(OH)_4]}$$
(acid)

34. Discuss the trend of the following:

(i) Thermal stability of carbonates of group 2 elements

(ii) The solubility and the nature of oxides of group 2 elements.

Ans. (i) **Thermal stability** of carbonates of group-2 elements increases down the group due to stabilisation of large cation by large anion

$BeCO_3 < MgCO_3 < CaCO_3 < SrCO_3 < BaCO_3$
Least stable most stable

(ii) Down the group-2 atomic size increases reactivity towards oxygen increases due to increase in size of group-2 element, lattice enthalpy of M – O decreases. Hence, solubility down the group-2 increases for oxides

BeO < MgO < CaO < SrO < BaO
Least soluble most soluble

Down the group-2, atomic size increases, the metallic character increases hence the basicity of oxides increases down the group.

BeO < MgO < CaO < SrO < BaO
Least basic Most basic

In fact, BeO is amphoteric.

35. Why are $BeSO_4$ and $MgSO_4$ readily soluble in water while $CaSO_4$, $SrSO_4$ and $BaSO_4$ are insoluble?

Ans. $BeSO_4$ and $MgSO_4$ are readily soluble in water due to high hydration enthalpy of Be^{2+} and Mg^{2+}. This high hydration enthalpy compensates for lattice enthalpy.

In case of $CaSO_4$, $SrSO_4$ and $BaSO_4$, the hydration enthalpy is low due to large size of the M^{2+} and is not able to overcome the lattice enthalpy. Hence, $CaSO_4$, $SrSO_4$ and $BaSO_4$ are insoluble in water.

36. All compounds of alkali metals are easily soluble in water but lithium compounds are more soluble in organic solvents. Explain.

Ans. Due to small size, high electronegativity and high ionization enthalpy, the lithium compounds are more covalent. Hence, the lithium compounds are more soluble in organic solvents.

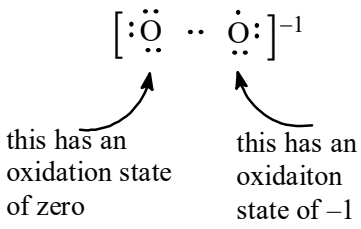
37. In the Solvay process, can we obtain sodium carbonate directly by treating the solution containing $(NH)_2CO_3$ with sodium chloride? Explain.

Ans. Na_2CO_3 cannot be obtained by reacting $(NH_4)_2CO_3$ directly with NaCl. This is because Na_2CO_3 and NH_4Cl both are soluble in water

$$(NH_4)_2CO_3 + 2NaCl \longrightarrow \underbrace{Na_2CO_3 + 2NH_4Cl}_{\text{both are soluble in water}}$$

38. Write Lewis structure of O_2^- ion and find out oxidation state of each oxygen atom? What is the average oxidation state of oxygen in this ion?

Ans. The Lewis structure of the superoxide ion O_2^- is



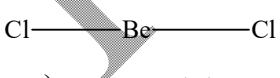
The average oxidation state of oxygen in O_2^- is $\frac{0-1}{2} = -\frac{1}{2}$

39. Why do beryllium and magnesium not impart colour to the flame in the flame test?

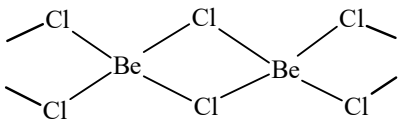
Ans. Due to their small size and high ionization enthalpy, the wavelength of the light absorbed for the excitation of electron falls outside the visible region, hence Be and Mg do not impart colour to the flame in the flame test.

40. What is the structure of $BeCl_2$ molecule in gaseous and solid state?

Ans.



(Linear) gaseous state



(Polymeric structure with bridged Cl atom solid state)

SECTION-IV: *Matching Type*

Note: In some of the following questions, one option of left column may be correlated to more than one option in the right column.

41. Match the elements given in column I with the properties mentioned in column II.

	Colum-I		Column-II
(i)	**Li**	**(a)**	**Insoluble sulphate**
(ii)	**Na**	**(b)**	**Strongest monoacidic base**
(iii)	**Ca**	**(c)**	**Most negative E° value among alkali metals**
(iv)	**Ba**	**(d)**	**Insoluble oxalate**
		(e)	**$6s^2$ outer electronic configuration**

Ans. (i) (ii) (iii) (iv)

(c) (b) (d) (a), (e)

42. Match the compounds given in column I with their uses mentioned in column II.

	Column-I		Column-II
(i)	**$CaCO_3$**	**(a)**	**Dentistry, ornamental work**
(ii)	**$Ca(OH)_2$**	**(b)**	**Manufacture of sodium carbonate from caustic soda**
(iii)	**CaO**	**(c)**	**manufacture of high quality paper**
(iv)	**$CaSO_4$**	**(d)**	**used in white washing.**

Ans. (i) (ii) (iii) (iv)

(c) (d) (b) (d)

43. Match the elements given in Column I with the colour they impart to the flame given in column II.

	Column-I		Column-II
(i)	**Cs**	**(a)**	**Apple green**
(ii)	**Na**	**(b)**	**Violet**
(iii)	**K**	**(c)**	**Brick red**
(iv)	**Ca**	**(d)**	**Yellow**
(v)	**Sr**	**(e)**	**Crimson red**
(vi	**Ba**	**(f)**	**Blue**

Ans. (i) (ii) (iii) (iv) (v) (vi)

(f) (d) (b) (c) (e) (a)

SECTION-V: *Assertion and Reason Type*

Note: In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

44. Assertion(A): The carbonate of lithium decomposes easily on heating to form lithium oxide and CO_2.

Reason (R): Lithium being very small in size polarizes large carbonate ion leading to the formation of more stable Li_2O and CO_2.

(i) Statements A and R both are correct and R is the correct explanation of A.

(ii) A and R both are correct but R is not the correct explanation of A

(iii) A is correct but R is not correct

(iv) A and R both are false.

Ans. (i) Li_2CO_3 is highly covalent and decompose to give more stable Li_2O (due to high lattice enthalpy)

$$Li_2CO_3 \longrightarrow Li_2O + CO_2$$

45. Assertion(A): Beryllium carbonate is kept in the atmosphere of carbon dioxide.

Reason (R): Beryllium carbonate is unstable and decomposes to give beryllium oxide and carbon dioxide.

(i) Statements A and R both are correct and R is the correct explanation of A.

(ii) A and R both are correct but R is not the correct explanation of A

(iii) A is correct but R is not correct

(iv) A and R both are false.

Ans. (i) We store $BeCO_3$ in atmosphere of CO_2 to slow down or prevent decomposition of $BeCO_3$ (Le Chatelier principle)

$$BeCO_3(s) \rightleftharpoons BeO(s) + CO_2(g)$$

Atmosphere of CO_2 will shift the equilibrium in the backward direction.

SECTION-VI: *Long answer Type*

46. The s-block elements are characterized by their larger atomic sizes, lower ionization enthalpies, invariable + 1 oxidation state and solubilities of their oxosalts. In the light of these features describe the nature of their oxides, halides and oxosalts.

Ans. Oxides

(i) Alkali metals all form oxides of formula M_2O by reacting metal directly with O_2,

$$4M + O_2 \longrightarrow 2M_2O$$

(ii) The reactivity towards O_2 increase down the group

(iii) In addition to normal oxides, Na form Na_2O_2 and K form KO_2.

(iv) The bascity of oxides increases down the group Li_2O is the least basic and Cs_2O is the most basic.

Halides

All alkali metals form halides of formula MX. These halide are ionic with high melting point and conducts electricity in the molten state.

All alkali metal fluoride are soluble in H_2O except LiF due to high lattice enthalpy of LiF.

Out of the alkali metal fluorides, LiF is the most covalent.

Oxosalts

All alkali metals form oxosalts like metal carbonates, M_2CO_3, nitrates MNO_3 and sulphates, M_2SO_4.

The thermal stability of oxosalts increases down the group due to stabilization of large cation by large anion.

Oxo salts of lithium have more covalent character and decompose readily.

$$Li_2CO_3 \longrightarrow Li_2O + CO_2$$

Other alkali metal carbonates are stable.

47. Present a comparative account of the alkali and alkaline earth metals with respect to the following characteristics.

(i) Tendency to form ionic/covalent compounds

(ii) Nature of oxides and their solubility in water

(iii) Formation of oxosalts

(iv) Solubility of oxosalts

(iv) Thermal stability of oxosalts.

Ans.

		Alkali metals	**Alkaline earth metals**
(i)	Tendency to form ionic/covalent compounds	Alkali metal compounds are all ionic due to their large size and low ionization enthalpy	They also form ionic compounds. But Beryllium compounds are more covalent due to high charge to size ratio.
(ii)	Nature of oxides and their solubility in water	They form oxides which are basic in nature and all oxides dissolves in H_2O to give basic metal hydroxide.	Their oxides are less basic in nature BeO is amphoteric. Their solubility is less than group 1 oxides but solubility in water increases down.
(iii)	Formation of oxo salts	Oxo salts of alkali metals are stable and stability increases down the group.	The group oxosalts of alkaline earth metals are less stable than group-1 but stability increases down the group.
(iv)	Solubility of oxosalts	The solubility of oxosalts decreases down the group.	The solubility of oxosalts decreases down the group.
(iv)	Thermal stability of oxosalt	The thermal stability of oxosalts increases down the group.	The thermal stability of oxosalts increases down the group.

48. When a metal of group 1 was dissolved in liquid ammonia, the following observations were obtained.

(i) Blue solution was obtained initially.

(ii) On concentrating the solution, blue colour changed to bronze colour.

How do you account for the blue colour of the solution? Give the name of the product formed on keeping the solution for some time.

Ans. **(i)** The alkali metals dissolve in liquid ammonia giving deep blue solutions which are electrically conducting in nature.

$$M + (x+y)NH_3 \longrightarrow [M(NH_3)_2]^+ + [e(NH_3)_y]^-$$

The blue colour of the solution is due to the presence of ammoniated electron which absorbs energy in the visible region of light and thus impart blue colour to the solution. The solutions are paramagnetic and on standing liberate slowly the hydrogen gas

$$M^+ + e^- + NH_3 \longrightarrow MNH_2 + \tfrac{1}{2}H_2$$

Metal amide

(ii) In concentrated solution (3M) the blue colour changes to bronze due to the formation of metal cluster. This solution is diamagnetic due to absence of any unpaired electron.

49. The stability of peroxide and superoxide of alkali metals increase as we go down the group. Explain giving reasons.

Ans. The stability of the peroxide or superoxide increases down the group as the size of the metal ion increases. This is due to the stabilization of large anions.

(O_2^{2-} of O_2^-) by larger cations through lattice energy effect Na_2O_2 is more stable than Na_2O

KO_2 is more stable than K_2O.

50. When water is added to compound [A] of calcium, solution of compound [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.

Ans. A $\longrightarrow$ CaO Calcium oxide (quick lime)

B $\longrightarrow$ $Ca(OH)_2$ Calcium hydroxide (lime water)

C $\longrightarrow$ $CaCO_3$ Calcium carbonate

D $\longrightarrow$ $Ca(HCO_3)_2$ Calcium bicarbonate

The reactions involved are:

$$\underset{(A)}{CaO} + H_2O \longrightarrow \underset{(B)}{Ca(OH)_2}$$

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

$$CaCO_3 + H_2O + \underset{\text{excess}}{CO_2} \longrightarrow \underset{\substack{(D)\\ \text{soluble}}}{Ca(HCO_3)_2}$$

The milkiness disappears on passing CO_2 in excess due to formation of calcium bicarbonate.

51. Lithium hydride can be used to prepare other useful hydrides. Beryllium hydride is one of them. Suggest a route for the preparation of beryllium hydride starting from lithium hydride. Write chemical equations involved in the process.

Ans. Step-(i):

Reacting LiH with AlH_3 to form mixed hydride called lithium aluminum hydride, $LiAlH_4$

$$LiH + AlH_3 \longrightarrow LiAlH_4$$

Step-(ii):

$LiAlH_4$ then reduces $BeCl_2$ to BeH_2

$$2BeCl_2 + LiAlH_4 \longrightarrow \underset{\text{Beryllium hydride}}{2BeH_2} + LiCl + AlCl_3$$

52. An element of group 2 forms covalent oxide which is amphoteric in nature and dissolves in water to give an amphoteric hydroxide. Identify the element and write chemical reactions of the hydroxide of the element which an alkali and an acid.

Ans. The element is beryllium Be

$Be(OH)_2$ is amphoteric in nature

$Be(OH)_2$ reacts with acid as well as with alkali

$$\underset{\text{(base)}}{Be(OH)_2} + 2HCl \longrightarrow BeCl_2 + 2H_2O$$

$$\underset{\text{(acid)}}{Be(OH)_2} + 2NaOH \longrightarrow \underset{\text{sodium beryllate}}{Na_2[Be(OH)_4]}$$

53. Ions of an element of group 1 participate in the transmission of nerve signals and transport of sugars and aminoacids into cells. This element imparts yellow colour to the flame in flame test and forms an oxide and a perioxide with oxygen. Identify the element and write chemical reaction to show the formation of its peroxide. Why does the element impart colour to the flame.

Ans. The element is sodium, Na

Formation of sodium peroxide

$$2Na + O_2 \longrightarrow \underset{\text{Excess}}{} \underset{\text{sodium peroxide}}{Na_2O_2}$$

Sodium impart yellow colour to the flame. This is because the heat from the flame excites the outermost orbital electrons to a higher energy level. When the excited electron comes back to the ground state, there is a emission of radiation in the visible region (the wavelength λ = 589.2 H in the case of sodium and gives yellow colour).

