14

s-Block Elements

Topic 1 Group I Elements

Objective Questions I (Only one correct option)

1. The temporary hardness of a water sample is due to compound X. Boiling this sample converts X to compound Y. X and Y, respectively, are **(2019 Main, 12 April II)**

(a) $Mg(HCO_3)_2$ and $Mg(OH)_2$
(b) $Ca(HCO_3)_2$ and $Ca(OH)_2$
(c) $Mg(HCO_3)_2$ and $MgCO_3$
(d) $Ca(HCO_3)_2$ and CaO

2. The incorrect statement is **(2019 Main, 12 April II)**

(a) lithium is the strongest reducing agent among the alkali metals.
(b) lithium is least reactive with water among the alkali metals.
(c) $LiNO_3$ decomposes on heating to give $LiNO_2$ and O_2.
(d) LiCl crystallise from aqueous solution as LiCl $2H_2O$.

3. The metal that gives hydrogen gas upon treatment with both acid as well as base is **(2019 Main, 12 April I)**

(a) magnesium (b) mercury
(c) zinc (d) iron

4. The correct statements among (a) to (d) are: **(2019 Main, 8 April II)**

1. Saline hydrides produce H_2 gas when reacted with H_2O.
2. Reaction of $LiAlH_4$ with BF_3 leads to B_2H_6.
3. PH_3 and CH_4 are electron rich and electron precise hydrides, respectively.
4. HF and CH_4 are called as molecular hydrides.

(a) (1), (2), (3) and (4) (b) (1), (2) and (3) only
(c) (3) and (4) only (d) (1), (3) and (4) only

5. The strength of 11.2 volume solution of H_2O_2 is [Given that molar mass of
H 1 g mol ^{1} and O 16 g mol ^{1}] **(2019 Main, 8 April II)**

(a) 1.7% (b) 34% (c) 13.6% (d) 3.4%

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

(a) $Li^+ > Na^+ > K^+ > Cs^+ > Rb^+$
(b) $Na^+ > Li^+ > K^+ > Rb^+ > Cs^+$
(c) $Na^+ > Li^+ > K^+ > Cs^+ > Rb^+$
(d) $Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$

7. The correct statement(s) among I to III with respect to potassium ions that are abundant within the cell fluids is/are **(2019 Main, 12 Jan II)**

I. They activate many enzymes.
II. They participate in the oxidation of glucose to produce ATP.
III. Along with sodium ions, they are responsible for the transmission of nerve signals.

(a) I, and III only (b) I, II and III
(c) I and II only (d) III only

8. A metal on combustion in excess air forms X. X upon hydrolysis with water yields H_2O_2 and O_2 along with another product. The metal is **(2019 Main, 12 Jan I)**

(a) Li (b) Mg (c) Rb (d) Na

9. The hardness of a water sample (in terms of equivalents of $CaCO_3$) containing is
(Molar mass of $CaSO_4$ 136 g mol ^{1}) **(2019 Main, 12 Jan I)**

(a) 100 ppm (b) 10 ppm (c) 50 ppm (d) 90 ppm

10. The hydride that is not electron deficient is **(2019 Main, 11 Jan II)**

(a) AlH_3 (b) B_2H_6 (c) SiH_4 (d) GaH_3

11. The correct statements among (a) to (d) regarding H_2 as a fuel are : **(2019 Main, 11 Jan I)**

I. It produces less pollutants than petrol.
II. A cylinder of compressed dihydrogen weights ~ 30 times more than a petrol tank producing the same amount of energy.
III. Dihydrogen is stored in tanks of metal alloys like $NaNi_5$.
IV. On combustion, values of energy released per gram of liquid dihydrogen and LPG are 50 and 142 kJ, respectively.

(a) I, II and III only (b) II, III and IV only
(c) II and IV only (d) I and III only

12. NaH is an example of **(2019 Main, 11 Jan I)**

(a) metallic hydride (b) electron-rich hydride
(c) saline hydride (d) molecular hydride

13. Sodium metal on dissolution in liquid ammonia gives a deep blue solution due to the formation of **(2019 Main, 10 Jan II)**

(a) sodium ammonia complex (b) sodium ion-ammonia complex
(c) sodamide (d) ammoniated electrons

14. The total number of isotopes of hydrogen and number of radioactive isotopes among them, respectively, are **(2019 Main, 10 Jan I)**

(a) 2 and 1 (b) 3 and 2 (c) 2 and 0 (d) 3 and 1

15. The chemical nature of hydrogen peroxide is **(2019 Main, 10 Jan I)**
(a) oxidising and reducing agent in both acidic and basic medium
(b) oxidising and reducing agent in acidic medium, but not in basic medium
(c) reducing agent in basic medium, but not in acidic medium
(d) oxidising agent in acidic medium, but not in basic medium

16. The metal that forms nitride by reacting directly with N_2 of air, is **(2019 Main, 9 Jan II)**
(a) Rb (b) K (c) Cs (d) Li

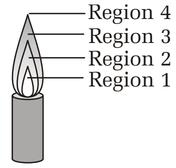
17. What is reason of temporary hardness of water? **(2019 Main, 9 Jan II)**
(a) Na_2SO_4 (b) $CaCl_2$ (c) NaCl (d) $Ca(HCO_3)_2$

18. The isotopes of hydrogen are **(2019 Main, 9 Jan I)**
(a) deuterium and tritium only
(b) protium and deuterium only
(c) protium, deuterium and tritium
(d) tritium and protium only

19. Hydrogen peroxide oxidises $[Fe(CN)_6]^4$ to $[Fe(CN)_6]^3$ in acidic medium but reduces $[Fe(CN)_6]^3$ to $[Fe(CN)_6]^4$ in alkaline medium. The other products formed are, respectively. **(2018 Main)**
(a) $(H_2O + O_2)$ and H_2O (b) $(H_2O + O_2)$ and $(H_2O + OH\ )$
(c) H_2O and $(H_2O + O_2)$ (d) H_2O and $(H_2O + OH\ )$

20. Both lithium and magnesium display several similar properties due to the diagonal relationship; however, the one which is incorrect is **(2017 Main)**
(a) Both form basic carbonates
(b) Both form soluble bicarbonates
(c) Both form nitrides
(d) nitrates of both Li and Mg yield NO_2 and O_2 on heating

21. The hottest region of Bunsen flame shown in the figure given below is **(2016 Main)**



(a) region 2 (b) region 3 (c) region 4 (d) region 1

22. Which one of the following statements about water is false? **(2016 Main)**
(a) Water can act both as an acid and as a base
(b) There is extensive intramolecular hydrogen bonding in the condensed phase
(c) Ice formed by heavy water sinks in normal water
(d) Water is oxidised to oxygen during photosynthesis

23. The main oxides formed on combustion of Li, Na and K in excess of air respectively are **(2016 Main)**
(a) LiO_2, Na_2O_2 and K_2O (b) Li_2O_2, Na_2O_2 and KO_2
(c) Li_2O, Na_2O_2 and KO_2 (d) Li_2O , Na_2O and KO_2

24. Which of the following atoms has the highest first ionisation energy? **(2016 Main)**
(a) Na (b) K (c) Sc (d) Rb

25. Hydrogen peroxide in its reaction with KIO_4 and NH_2OH respectively, is acting as a **(2014 Adv.)**
(a) reducing agent, oxidising agent
(b) reducing agent, reducing agent
(c) oxidising agent, oxidising agent
(d) oxidising agent, reducing agent

26. In which of the following reactions H_2O_2 acts as a reducing agent? **(2014 Main)**

I. $H_2O_2 \quad 2H \quad 2e \qquad 2H_2O$
II. $H_2O_2 \quad 2e \qquad O_2 + 2H$
III. $H_2O_2 \quad 2e \qquad 2OH$
IV. $H_2O_2 + 2OH \quad 2e \qquad O_2 + 2H_2O$

(a) I and II (b) III and IV (c) I and III (d) II and IV

27. A sodium salt of an unknown anion when treated with $MgCl_2$ gives white precipitate only on boiling. The anion is **(2004, 1M)**
(a) SO_4^2 (b) HCO_3 (c) CO_3^2 (d) NO_3

28. A dilute aqueous solution of Na_2SO_4 is electrolysed using platinum electrodes. The products at the anode and cathode are respectively **(1996, 1M)**
(a) O_2, H_2 (b) $S_2O_8^{2-}$, Na (c) O_2, Na (d) $S_2O_8^{2-}$, H_2

29. Hydrolysis of one mole of peroxodisulphuric acid produces **(1996, 1M)**
(a) two moles of sulphuric acid
(b) two moles of peroxomono sulphuric acid
(c) one mole of sulphuric acid and one mole of peroxomono sulphuric acid
(d) one mole of sulphuric acid, one mole of peroxomono sulphuric acid and one mole of hydrogen peroxide

30. The species that do not contain peroxide ions, is **(1992, 1M)**
(a) PbO_2 (b) H_2O_2 (c) SrO_2 (d) BaO_2

31. The metallic lustre exhibited by sodium metal is explained by **(1987, 1M)**
(a) diffusion of sodium ions
(b) oscillation of loose electron
(c) excitation of free protons
(d) existence of body centred cubic lattice

32. A solution of sodium sulphate in water is electrolysed using inert electrodes. The products at cathode and anode are respectively **(1987, 1M)**
(a) H_2, O_2 (b) O_2, H_2 (c) O_2, Na (d) O_2, SO_2

33. Nitrogen dioxide cannot be obtained by heating **(1985, 1M)**
(a) KNO_3 (b) $Pb(NO_3)_2$ (c) $Cu(NO_3)_2$ (d) $AgNO_3$

34. The oxide that gives H_2O_2 on treatment with a dilute acid is **(1985, 1M)**
(a) PbO_2 (b) Na_2O_2
(c) MnO_2 (d) TiO_2

35. Molecular formula of Glauber's salt is **(1985, 1M)**
(a) $MgSO_4 \ 7H_2O$ (b) $CuSO_4 \ 5H_2O$
(c) $FeSO_4 \ 7H_2O$ (d) $Na_2SO_4 \ 10H_2O$

36. Heavy water is **(1983, 1M)**
(a) H_2O^{18}
(b) water obtained by repeated distillation
(c) D_2O
(d) water at 4°C

37. A solution of sodium metal in liquid ammonia is strongly reducing due to the presence of **(1981, 1M)**
(a) sodium atoms (b) sodium hydride
(c) sodium amide (d) solvated electrons

38. The temporary hardness of water is due to calcium bicarbonate can be removed by adding **(1979, 1M)**
(a) $CaCO_3$ (b) $Ca(OH)_2$ (c) $CaCl_2$ (d) HCl

Objective Questions II

(One or more than one correct option)

39. The pair(s) of reagents that yield paramagnetic species is/are
(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

40. The compound(s) formed upon combustion of sodium metal in excess air is (are) **(2007, 2M)**
(a) Na_2O_2 (b) Na_2O (c) NaO_2 (d) NaOH

41. Sodium nitrate decomposes above 800°C to give **(1998, 2M)**
(a) N_2 (b) O_2
(c) NO_2 (d) Na_2O

42. Highly pure dilute solution of sodium in liquid ammonia **(1998, 2M)**
(a) shows blue colour
(b) exhibits electrical conductivity
(c) produces sodium amide
(d) produces hydrogen gas

43. When zeolite, which is hydrated sodium aluminium silicate, is treated with hard water, the sodium ions are exchanged with **(1990, 1M)**
(a) H^+ ions (b) SO_4^{2-} ions (c) Mg^{2+} ions (d) OH ions

44. Sodium sulphate is soluble in water, whereas barium sulphate is sparingly soluble because **(1989, 1M)**
(a) the hydration energy of sodium sulphate is more than its lattice energy
(b) the lattice energy of barium sulphate is more than its hydration energy
(c) the lattice energy has no role to play in solubility
(d) the hydration energy of sodium sulphate is less than its lattice energy

Assertion and Reason

Read the following questions and answer as per the direction given below :

(a) Statement I is correct; Statement II is correct; Statement II is the correct explanation of Statement I
(b) Statement I is correct; Statement II is correct; Statement II is not the correct explanation of Statement I
(c) Statement I is correct; Statement II is incorrect
(d) Statement I is incorrect; Statement II is correct

45. **Statement I** Alkali metals dissolve in liquid ammonia to give blue solution.
Statement II Alkali metals in liquid ammonia give solvated species of the type $[M(NH_3)_n]$ (M alkali metals). **(2007, 3M)**

46. **Statement I** LiCl is predominantly a covalent compound.
Statement II Electronegativity difference between Li and Cl is too small. **(1998, 2M)**

47. **Statement I** The alkali metals can form ionic hydrides which contain the hydride ion, H .
Statement II The alkali metals have low electronegativity, their hydrides conduct electricity when fused and liberate hydrogen gas at the anode. **(1994, 2M)**

Fill in the Blanks

48. Hydrogen gas is liberated by the action of aluminium with concentrated solution of ……… . **(1987, 1M)**

49. Sodium dissolved in liquid ammonia conducts electricity because of …… **(1985, 1M)**

50. The adsorption of hydrogen by palladium is commonly known as …… **(1983, 1M)**

51. Iodine reacts with hot NaOH solution. The products are NaI and …… **(1980, 1M)**

True/False

52. Sodium when burnt in excess of oxygen gives sodium oxide. **(1987, 1M)**

Subjective Questions

53. A white solid is either Na_2O or Na_2O_2. A piece of red litmus paper turns white when it is dipped into a freshly made aqueous solution of the white solid.
(i) Identify the substance and explain with balanced equation.
(ii) Explain what would happen to the red litmus if the white solid were the other compound. **(1999, 4M)**

54. Hydrogen peroxide acts both as an oxidising and as a reducing agent in alkaline solution towards certain first row transition metal ions. Illustrate both these properties of H_2O_2 using chemical equations. **(1998, 4M)**

55. Element A burns in nitrogen to give an ionic compound B. Compound B reacts with water to give C and D. A solution of C becomes 'milky' on bubbling carbon dioxide gas. Identify A, B, C and D. **(1997, 3M)**

56. Complete and balance the following chemical reaction.
Anhydrous potassium nitrate is heated with excess of metallic potassium
$KNO_3(s) \quad K(s) \quad \ldots \ \ldots$ **(1992, 1M)**

57. Give reasons in one or two sentences for the following:
"H_2O_2 is a better oxidising agent than H_2O." **(1986, 1M)**

58. Sodium carbonate is prepared by Solvay process but the same process is not extended to the manufacture of potassium carbonate, explain. **(1981, 1M)**

59. Water is a liquid, while H_2S is a gas at ordinary temperature. Explain . **(1978, 1M)**

Topic 2 Group II Elements

Objective Questions I (Only one correct option)

1. In comparison to boron, berylium has **(2019 Main, 12 April II)**
(a) lesser nuclear charge and lesser first ionisation enthalpy
(b) greater nuclear charge and lesser first ionisation enthalpy
(c) greater nuclear charge and greater first ionisation enthalpy
(d) lesser nuclear charge and greater first ionisation enthalpy

2. The correct sequence of thermal stability of the following carbonates is **(2019 Main, 12 April I)**
(a) $BaCO_3$ $CaCO_3$ $SrCO_3$ $MgCO_3$
(b) $MgCO_3$ $CaCO_3$ $SrCO_3$ $BaCO_3$
(c) $MgCO_3$ $SrCO_3$ $CaCO_3$ $BaCO_3$
(d) $BaCO_3$ $SrCO_3$ $CaCO_3$ $MgCO_3$

3. A hydrated solid X on heating initially gives a monohydrated compound Y.
Y upon heating above 373 K leads to an anhydrous white powder Z. X and Z, respectively, are **(2019 Main, 10 April II)**
(a) baking soda and soda ash
(b) washing soda and soda ash
(c) baking soda and dead burnt plaster
(d) washing soda and dead burnt plaster

4. The alloy used in the construction of aircrafts is **(2019 Main, 10 April I)**
(a) Mg-Zn (b) Mg-Mn (c) Mg-Sn (d) Mg-Al

5. The structures of beryllium chloride in the solid state and vapour phase, respectively are **(2019 Main, 9 April II)**
(a) dimeric and dimeric (b) chain and chain
(c) dimeric and chain (d) chain and dimeric

6. Magnesium powder burns in air to give **(2019 Main, 9 April I)**
(a) MgO and Mg_3N_2 (b) $Mg(NO_3)_2$ and Mg_3N_2
(c) MgO only (d) MgO and $Mg(NO_3)_2$

7. The covalent alkaline earth metal halide ($X = \text{Cl, Br, I}$) is **(2019 Main, 8 April II)**
(a) SrX_2 (b) CaX_2 (c) MgX_2 (d) BeX_2

8. Match the following items in Column I with the corresponding items in Column II. **(2019 Main, 11 Jan II)**

	Column I		Column II
(i)	Na_2CO_3 $10H_2O$	A.	Portland cement ingredient
(ii)	$Mg(HCO_3)_2$	B.	Castner-Kellner process
(iii)	NaOH	C.	Solvay process
(iv)	$Ca_3Al_2O_6$	D.	Temporary hardness

(a) (i) - (D); (ii) - (A); (iii) - (B); (iv) - (C)
(b) (i) - (B); (ii) - (C); (iii) - (A); (iv) - (D)
(c) (i) - (C); (ii) - (B); (iii) - (D); (iv) - (A)
(d) (i) - (C); (ii) - (D); (iii) - (B); (iv) - (A)

9. The amphoteric hydroxide is **(2019 Main, 11 Jan I)**
(a) $Be(OH)_2$ (b) $Ca(OH)_2$ (c) $Sr(OH)_2$ (d) $Mg(OH)_2$

10. The metal used for making X-ray tube window is **(2019 Main, 10 Jan I)**
(a) Na (b) Be (c) Mg (d) Ca

11. The alkaline earth metal nitrate that does not crystallise with water molecules, is **(2019 Main, 9 Jan I)**
(a) $Ca(NO_3)_2$ (b) $Sr(NO_3)_2$
(c) $Ba(NO_3)_2$ (d) $Mg(NO_3)_2$

12. Which one of the following alkaline earth metal sulphates has its hydration enthalpy greater than its lattice enthalpy? **(2015 Main)**
(a) $CaSO_4$ (b) $BeSO_4$
(c) $BaSO_4$ (d) $SrSO_4$

13. The following compounds have been arranged in order of their increasing thermal stabilities. Identify the correct order.

K_2CO_3 (I), $MgCO_3$ (II), $CaCO_3$ (III), $BeCO_3$ (IV)

(a) I < II < III < IV (b) IV < II < III < I **(1996, 1M)**
(c) IV < II < I < III (d) II < IV < III < I

14. The oxidation state of the most electronegative element in the products of the reaction, BaO_2 with dil. H_2SO_4 are **(1991, 1M)**
(a) 0 and –1 (b) –1 and –2
(c) –2 and 0 (d) –2 and –1

15. Calcium is obtained by **(1980, 1M)**
(a) electrolysis of molten $CaCl_2$
(b) electrolysis of solution of $CaCl_2$ in water
(c) reduction of $CaCl_2$ with carbon
(d) roasting of limestone

Objective Questions II
(One or more than one correct option)

16. The reagent(s) used for softening the temporary hardness of water is(are) **(2010)**
(a) $Ca_3(PO_4)_2$ (b) $Ca(OH)_2$
(c) Na_2CO_3 (d) NaOCl

17. $MgSO_4$ on reaction with NH_4OH and Na_2HPO_4 forms a white crystalline precipitate. What is its formula? **(2006, 3M)**
(a) $Mg(NH_4)PO_4$ (b) $Mg_3(PO_4)_3$
(c) $MgCl_2$ $MgSO_4$ (d) $MgSO_4$

18. The material used in solar cells contains **(1993, 1M)**
(a) Cs (b) Si (c) Sn (d) Ti

Fill in the Blank

19. Anhydrous $MgCl_2$ is obtained by heating the hydrated salt with …… **(1980 , 1M)**

True/False

20. $MgCl_2$ $6H_2O$ on heating gives anhydrous $MgCl_2$. **(1982, 1M)**

Subjective Questions

21. Identify (X) in the following synthetic scheme and write their structures.

$Ba\overset{*}{C}O_3 + H_2SO_4 \quad X$ (gas) (C* denotes C^{14}) **(2001, 1M)**

22. Give reasons for the following in one or two sentences only :
"$BeCl_2$ can be easily hydrolysed." **(1999, 2M)**

23. The crystalline salts of alkaline earth metals contain more water of crystallisation than the corresponding alkali metal salts. Why? **(1997, 2M)**

24. Calcium burns in nitrogen to produce a white powder which dissolves in sufficient water to produce a gas *A* and an alkaline solution. The solution on exposure to air produces a thin solid layer of *B* on the surface. Identify the compounds *A* and *B*. **(1996, 3M)**

25. Arrange the following in increasing order of basic strength :

MgO, SrO, K_2O, NiO, Cs_2O **(1991, 1M)**

Answers

Topic 1

1. (a)	**2.** (c)	**3.** (c)	**4.** (a)
5. (d)	**6.** (d)	**7.** (b)	**8.** (c)
9. (a)	**10.** (c)	**11.** (a)	**12.** (c)
13. (d)	**14.** (d)	**15.** (a)	**16.** (d)
17. (d)	**18.** (c)	**19.** (c)	**20.** **(a)**
21. (a)	**22.** (b)	**23.** (c)	**24.** (c)
25. (a)	**26.** (d)	**27.** (b)	**28.** (a)
29. (c)	**30.** (a)	**31.** (b)	**32.** (a)
33. (a)	**34.** (b)	**35.** (d)	**36.** (c)
37. (d)	**38.** (b)	**39.** (a, b, c)	**40.** (a, b)
41. (a, b, d)	**42.** (a, b)	**43.** (a, d)	**44.** (a, b)
45. (b)	**46.** (c)	**47.** (a)	**48.** NaOH
49. solvated electrons		**50.** occlusion	**51.** $NaIO_3$
52. F			

Topic 2

1. (d)	**2.** (b)	**3.** (b)	**4.** (d)
5. (c)	**6.** (a)	**7.** (d)	**8.** (d)
9. (a)	**10.** (b)	**11.** (c)	**12.** (b)
13. (b)	**14.** (d)	**15.** (a)	**16.** (b, c, d)
17. (a)	**18.** (b)	**19.** dry HCl	**20.** F

Hints & Solutions

Topic 1 Group I Elements

1. The temporary hardness of a water sample is due to compound *X* [i.e. $Mg(HCO_3)_2$]. Boiling of this sample converts *X*[i.e. $Mg(HCO_3)_2$] to compound *Y*[i.e. $Mg(OH)_2$]. Generally, temporary hardness is due to presence of magnesium and calcium hydrogen carbonates. It can be removed by boiling. During boiling, the soluble $Mg(HCO_3)_2$ is converted into insoluble $Mg(OH)_2$ and $Ca(HCO_3)_2$ changed to insoluble $CaCO_3$. These precipitates can be removed by filteration.

$$Mg(HCO_3)_2 \quad \overset{\text{Heating}}{} \quad Mg(OH)_2 \quad 2CO_2$$

$$Ca(HCO_3)_2 \quad \overset{\text{Heating}}{} \quad CaCO_3 \quad H_2O \quad CO_2$$

2. Statement (c) is incorrect. $LiNO_3$(Lithium nitrate) on heating gives a mixture of Li_2O, NO_2 and O_2.

$$4LiNO_3 \qquad 2Li_2O \quad 4NO_2 \qquad O_2$$

Among the alkali metals, lithium is the strongest reducing agent.

3. Metal that gives hydrogen gas upon treatment with both acid as well as base is zinc. Hence, it is amphoteric in nature.
Reactions involved are as follows:

$$Zn \quad \text{Dil. NaOH} \qquad Na_2ZnO_2 \quad H_2$$

$$Zn \quad 2HCl(\text{dil.}) \qquad ZnCl_2 \quad H_2$$

4. The explanation of given statements are as follows :

1. Saline or ionic hydrides produce H_2 with H_2O.

$$M\overset{\ominus}{H} + H_2O \qquad H_2 \quad + MOH$$

Thus, statement (1) is correct.

2. $$3LiAlH_4 + 4BF_3 \quad \overset{\text{Ether}}{} \quad \underset{\text{(Diborane)}}{2B_2H_6} + 3LiF + 3AlF_3$$

Thus, statement (2) is correct.

3. PH_3 and CH_4 are covalent hydrides and in both of the hydrides, octet of P and C have been satisfied. But P in PH_3 has one lone pair of electrons and C in CH_4 does not have so PH_3 (group 15) and CH_4 (group 14) are electron rich and electron precise hydrides, respectively.

Thus, statement (3) is correct.

4. HF and CH_4 are called as molecular hydrides because of their discrete and sterically symmetrical structure.

Thus, statement (4) is also correct.

5. 11.2 volume of H_2O_2 means that 1 mL of this H_2O_2 will give 11.2 mL of oxygen at STP.

$$\underset{2 \quad 34\text{ g}}{2H_2O_2(l)} \qquad \underset{22.4\text{ L at STP}}{O_2(g)} \qquad 2H_2O(l)$$

22.4 L of O_2 at STP is produced from H_2O_2 68 g

11.2 L of O_2 at STP is produced from

$$H_2O_2 \quad \frac{68}{22.4} \quad 11.2 \quad 34\text{ g}$$

34 g of H_2O_2 is present in 1000 g of solution

$$\%\ w/w \quad \frac{34}{1000} \quad 100 \quad 3.4\%$$

6. **Key Idea** The amount of energy released when one mole of gaseous ions combine with water to form hydrated ions is called hydration enthalpy.

The correct order of hydration enthalpies of alkali metal ions is

Li Na K Rb Cs

Li possesses the maximum degree of hydration due to its small size. As a consequence of hydration enthalpy, their mobility also get affected. Cs^+ has highest and Li has lowest mobility in aqueous solution.

7. All the statements are correct. K being metallic unipositive ions work as enzyme activators. These also participate in many reactions of glycolysis and Kreb's cycle to produce ATP from glucose.

Being unipositive these are also equally responsible for nerve signal transmission along with Na . (Na ion-pump theory)

8. Metal (*A*) is rubidium (Rb). In excess of air, it forms $RbO_2(X)$. X is a superoxide that have O_2 ion. It is due to the stabilisation of large anion by large cations through lattice energy effects. $RbO_2\,(X)$ gets easily hydrolysed by water to form the hydroxide, H_2O_2 and O_2.

The reaction involved are as follows:

$$\mathrm{Rb + O_2} \qquad \underset{(X)}{\mathrm{RbO_2}}\ \text{(superoxide)}$$

$$\underset{(X)}{\mathrm{2RbO_2}} + \mathrm{2H_2O} \qquad \mathrm{2RbOH + H_2O_2 + O_2}$$

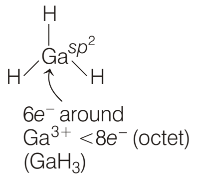
9. Hardness of water sample can be calculated in terms of ppm concentration of $CaCO_3$.

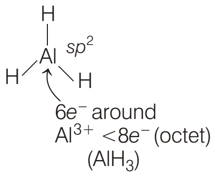
Given, molarity $10\ ^{3}$M

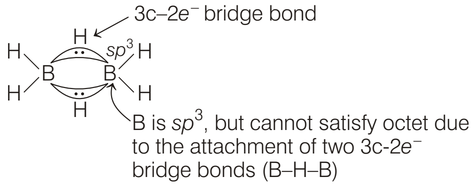
i.e. 1000 mL of solution contains $10\ ^{3}$ mole of $CaCO_3$.

$$\text{Hardness of water} \quad \text{ppm of } \mathrm{CaCO_3}$$
$$\frac{10\ ^{3}\quad 1000}{1000}\quad 10^{6}$$
$$100\,\text{ppm}$$

10. GaH_3, AlH_3 and B_2H_6 are the hydrides of group-13 (ns^2np^1), whereas SiH_4 is an hydride of group 14.

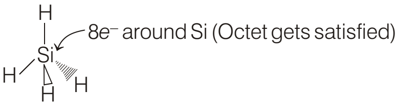






So, B_2H_6, AlH_3 and GaH_3 are electron deficient hydrides.

But, SiH_4 is an electron precise hydride of group-14 (ns^2np^2), i.e. these hydrides can have the required number of electrons to write their conventional Lewis structures.



11. (I) H_2 is a 100% pollution free fuel. So, statement (I) is correct.

(II) Molecular weight of H_2(2u).

$\frac{1}{29}$ molecular weight of butane,

C_4H_{10} (LPG) [58u].

So, compressed H_2 weighs ~30 times more than a petrol tank and statement (II) is correct.

(III) $NaNi_5$, $Ti\text{-}TiH_2$ etc. are used for storage of H_2 in small quantities. Thus, statement (III) is correct.

(IV) On combustion values of energy released per gram of liquid dihydrogen (H_2) : 142 kJ g ^{1}, and for LPG : 50 kJ g ^{1}. So, staement (IV) is incorrect.

12. $\overset{\oplus}{\mathrm{Na}}\overset{\ominus}{\mathrm{H}}$ is an example of ionic or saline hydride. These hydrides are formed when hydrogen combines with metals having less electronegativity and more electropositive character with respect to hydrogen.

Except Be and Mg, all *s*-block metals form saline hydrides.

Hydrides of *p*-block elements are covalent in nature, *viz*, electron deficient hydrides (by group-13 elements), electron-precise hydrides (by group-14 elements), and electron-rich hydrides (by group 15-17 elements). Hydrides of *d*, *f*-block metals are called interstitial or metallic hydrides.

13. Sodium metal on dissolution in liquid ammonia gives a deep blue solution due to the formation of ammoniated electrons. The reaction is represented as follows:

$$\mathrm{Na}(s) \quad (x \quad y)\,\mathrm{NH_3}(l) \qquad \underset{\substack{\text{[Ammoniated Na}\\ \text{or expanded Na]}}}{[\mathrm{Na(NH)}_x]} \quad \underset{\substack{\text{[Ammoniated}\\ \text{electrons]}}}{[e_{(\mathrm{NH_3})_y}]}$$

Ammoniated (solvated) electrons show electronic transition in visible region and the solution becomes deep blue coloured.

This deep blue solution also shows the following properties due to the presence of ammoniated electrons.

(i) It is strongly reducing in nature.

(ii) It is paramagnetic.

(iii) It is a good conductor of electricity.

14. Hydrogen has three isotopes:

	$^1_1$H	$^2_1$H	$^3_1$H
	Protium (P)	**Deuterium (D)**	**Tritium (T)**
p	1	1	1
n	0	1	2
$\frac{n}{p}$	0	1	2

Only tritium (T) is radioactive, because of its very high $\frac{n}{p}$ value, $\frac{n}{p}\quad 2$.

15. H_2O_2 can act as both oxidising and reducing agents in both acidic and basic medium.

H_2O_2 as oxidising agent

- In acidic medium: $\mathrm{H_2O_2 + 2H^+ + 2}e \qquad \mathrm{2H_2O}$

- In basic medium : $H_2O_2 + 2O\ H + 2e \qquad 2H_2O + 2O^2$

H_2O_2 as reducing agent

- In acidic medium : $H_2O_2 \qquad O_2 \quad 2H \quad 2e$

In basic medium :

$$H_2O_2 + 2OH \qquad O_2 \quad 2H_2O \quad 2e$$

16. Among the group-1 metals, only Li is able to form its nitride, Li_3N. [All alkaline earth metals of group-2 form their nitride, M_3N_2]

$$\underset{\text{(Air)}}{6Li + N_2} \qquad 2Li_3N \text{ (Ruby red solid)}$$

$$[3\overset{\text{I}}{M} + N_2 \qquad \overset{\text{II}}{M_3}N_2]$$

Li is the smallest metal ion of group-1. Smaller size of Li and larger size of nitride ion, N^3, enable Li to polarise the spherical electron cloud of N^3 and it gives higher stability to Li_3N.

17. Temporary hardness of water is due to presence of soluble $Ca(HCO_3)_2$ or $Mg(HCO_3)_2$.

Permanent hardness of water is due to the presence of $CaCl_2$ or $CaSO_4$ or $MgCl_2$ or $MgSO_4$.

Temporary hardness of water is also called carbonate hardness which can be easily removed by boiling or by treatment with $Ca(OH)_2$ (Clark's method).

18. There are three known isotopes of hydrogen, each possessing an atomic number 1 and atomic masses 1, 2 and 3 respectively. These are named as protium (^1H), deuterium (^2H or D) and tritium (^3H or T)

The most common isotope is the ordinary hydrogen usually called protium. It consists of one proton in the nucleus and an electron revolving around it.

The second isotope of hydrogen is called heavy hydrogen or deuterium. It consists of one proton and one neutron in the nucleus and an electron revolving around it. The third isotope of hydrogen is called tritium. It consists of one proton and two neutrons in the nucleus and an electron revolving around it.

19. Both reactions in their complete format are written below

(i) In acidic medium,

$$[Fe^{2+}(CN)_6]^4 + H_2\overset{1}{O_2} + 2H^+ \qquad [Fe^{3+}(CN)_6]^3 + 2H_2\overset{2}{O}$$

(ii) In alkaline medium,

$$[Fe^{3+}(CN)_6]^3 \quad H_2\overset{1}{O_2} \quad 2OH$$
$$[Fe^2 \ (CN)_6]^4 \quad O_2 \quad 2H_2O$$

Hence, H_2O (for reaction (i)) and $O_2 + H_2O$ (for reaction (ii)) are produced as by product.

20. **Mg** can form basic carbonate while **Li** cannot.

$$5\,Mg^{2+} \quad 6\,CO_3^{2-} \quad 7H_2O \qquad 4MgCO_3 \ Mg(OH)_2$$
$$5H_2O + 2\,HCO_3$$

21. Region 1 (Pre-heating zone)
Region 2 (Primary combustion zone, hottest zone)
Region 3 (Internal zone)
Region 4 (Secondary reaction zone)

22. There is extensive intermolecular H-bonding in the condensed phase.

23. $2Li + \frac{1}{2}\underset{\text{(Excess)}}{O_2(g)} \qquad Li_2O$

$2Na + \underset{\text{(Excess)}}{O_2(g)} \qquad Na_2O_2;\ K + \underset{\text{(Excess)}}{O_2(g)} \qquad KO_2$

24. Order of first ionisation energy is Sc > Na > K > Rb.

Due to poor shielding effect, removal of one electron from 4*s* orbital is difficult as compared to 3*s*-orbital.

25. **PLAN** This problem can be solved by using concept of oxidant and reductant.

Oxidant Oxidant increases the oxidation number of the species with which it is reacted.

Reductant Reductant decreases the oxidation number of the species with which it is reacted.

H_2O_2 reacts with KIO_4 in the following manner:

$$K\overset{7}{I}O_4 + H_2O_2 \qquad K\overset{5}{I}O_3 + H_2O + O_2$$

On reaction of KIO_4 with H_2O_2, oxidation state of I varies from +7 to +5, i.e. decreases. Thus, KIO_4 gets reduced hence, H_2O_2 is a reducing agent here.

With NH_2OH, it given following reaction:

$$\overset{1}{N}H_2OH + H_2O_2 \qquad \overset{3}{N_2}O_3 + H_2O$$

In the above reaction, oxidation state of N varies from –1 to +3. Here, oxidation number increases, hence H_2O_2 is acting as an oxidising agent here.

Hence, (a) is the correct choice.

26. Release of electron is known as reduction. So, H_2O_2 acts as reducing agent when it releases electrons.

Here, in reaction (II) and (IV), H_2O_2 releases two electron, hence reaction (II) and (IV) is known as **reduction**.

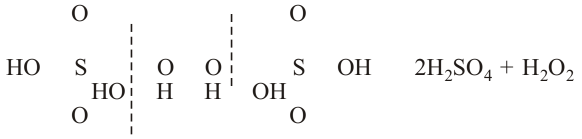
In reaction (I) and (III), two electrons are being added, so (I) and (III) represents **oxidation.**

27. $Mg(HCO_3)_2$ on boiling decomposes to give white precipitate of $MgCO_3$ as:

$$Mg(HCO_3)_2\,(aq) \quad \overset{\text{Heat}}{} \quad MgCO_3 \quad + H_2O + CO_2$$

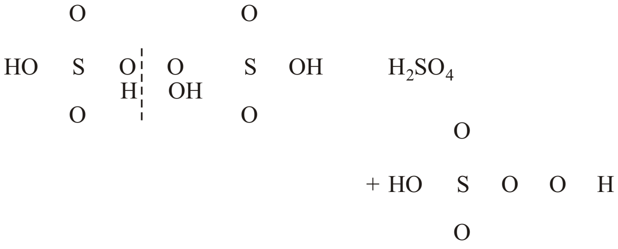
28. Electrolysis of aqueous Na_2SO_4 gives $H_2\,(g)$ at cathode and $O_2(g)$ at anode.

29. Peroxodisulphuric acid ($H_2S_2O_8$) on complete hydrolysis gives two moles of H_2SO_4 and one mole of H_2O_2 as



$$HO\ \underset{O}{\overset{O}{S}}\ \underset{HO}{}\ \underset{H}{O}\ \underset{H}{O}\ \underset{OH}{}\ \underset{O}{\overset{O}{S}}\ OH \qquad 2H_2SO_4 + H_2O_2$$

On partial hydrolysis, it gives one mole of H_2SO_4 and one mole of peroxomonosulphuric acid as



$$HO\!-\!\overset{O}{\underset{O}{S}}\!-\!O\;\;\overset{}{\underset{H}{}}\;\;O\!-\!\overset{O}{\underset{O}{S}}\!-\!OH \quad \underset{OH}{} \quad H_2SO_4 + HO\!-\!\overset{O}{\underset{O}{S}}\!-\!O\!-\!O\!-\!H$$

Peroxomonosulphuric acid

30. In PbO_2, Pb is in +4 oxidation state and oxygen is in –2 oxidation state. In all other case, peroxide ion (O_2^{2}) is present.

31. Metallic lustre of any metal is due to oscillation of free electrons present in the metal.

32. H_2O is reduced as well as oxidised giving $H_2(g)$ at cathode and $O_2(g)$ at anode.

33. KNO_3 and other nitrates of alkli metals (except $LiNO_3$) are thermally stable.

34. Sodium peroxide on treatment with dilute acid gives H_2O_2

$$Na_2O_2 + H_2SO_4 \qquad Na_2SO_4 + H_2O_2$$

35. Glauber's salt is $Na_2SO_4 \;\; 10H_2O$.

36. D_2O is commonly known as heavy water.

37. Presence of solvated electrons makes solution of alkali metal in liquid ammonia makes them strongly reducing agent.

38. Lime treatment remove bicarbonate hardness by forming insoluble $CaCO_3$ as

$$Ca(HCO_3)_2 + Ca(OH)_2 \qquad 2CaCO_3 \quad + 2H_2O$$

39. **PLAN** Paramagnetic character of species can be easily explained on the basis of presence of unpaired electrons, i.e. compounds containing unpaired electron(s) is/are paramagnetic.

Reaction of alkali metals with ammonia depends upon the physical state of ammonia whether it is in gaseous state or liquid state. If ammonia is considered as a gas then reaction will be

(a) $Na + \underset{\text{(Excess)}}{NH_3} \qquad NaNH_2 + \frac{1}{2}H_2$

($NaNH_2$ + 1/2 H_2 are diamagnetic)

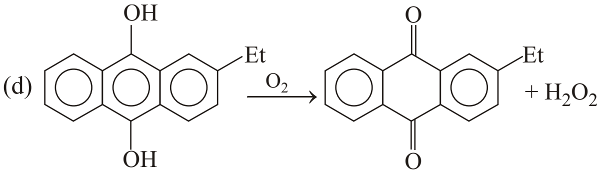
If ammonia is considered as a liquid then reaction will be

$$M \quad (x \quad y)NH_3 \qquad [M(NH_3)_x] \quad \underset{\substack{\text{Ammoniated electron}\\ \text{Blue colour}\\ \text{Paramagnetic}\\ \text{Very strong reducing agent}}}{[e(NH_3)_y]}$$

(b) $K \quad \underset{\text{(Excess)}}{O_2} \qquad \underset{\substack{\text{Potassium superoxide}\\ \text{paramagnetic}}}{KO_2(K \;\; , O_2)}$

(c) $3Cu + 8HNO_3 \qquad \underset{\text{Paramagnetic}}{3Cu(NO_3)_2} \quad \underset{\text{Paramagnetic}}{2NO} \quad 4H_2O$

(d)



2-ethylanthraquinol 2-ethylanthraquinone

Hence, option (a), (b) and (c) are correct choices.

40. When sodium metal is burnt in excess of air, mainly sodium peroxide (Na_2O_2) with little sodium oxide (Na_2O) are formed.

41. $NaNO_3$ when heated, it decomposes in two stages as:

$$NaNO_3 \quad {}^{T\,<\,500\,C} \quad NaNO_2 + \frac{1}{2}O_2$$

$$NaNO_2 \quad {}^{T\,>\,800\,C} \quad Na_2O + N_2 + O_2$$

42. In dilute solution of Na in liquid ammonia, solvated electrons are present whose emission spectrum gives blue colouration to solution.

$$Na + NH_3 \qquad Na^+ + \underset{\text{Solvated electron}}{NH_3\,(e\;\;)}$$

Also, presence of solvated electrons and solvated Na^+ ion makes solution highly conducting.

43. Zeolite acts as ion exchange resin and its Na^+ is exchanged with H^+ and Mg^{2+} ions present in hard water.

44. Solubility of a salt is influenced by two major factors, lattice energy and hydration energy. For greater solubility, there should be smaller lattice energy and greater hydration energy.

45. Both statements are correct but blue colour is due to presence of solvated electron NH_3 (e).

46. Statement I is correct. Small size of Li^+ makes it highly polarising, introduces predominant covalency in LiCl. Statement II is incorrect, there is very large difference in electronegativity of Li and Cl.

47. Alkali metal forms MH in which hydrogen is in –1 oxidation state. Both statements are correct and statement –2 is correct explanation of statement I.

48. Al + conc. $NaOH \qquad NaAlO_2 + H_2$

49. Na in liquid ammonia contain $NH_3(e\;\;)$ which possesses charge and conduct electricity.

50. Occlusion is a phenomena in which particles are physically trapped in voids.

51. I_2 disproportionate in alkali giving NaI and $NaIO_3$.

52. Sodium when burnt in excess of oxygen, gives sodium peroxide as major product.

$$Na + O_2 \qquad \underset{\text{Major}}{Na_2O_2} + \underset{\text{Minor}}{Na_2O}$$

53. The substance is Na_2O_2. When Na_2O_2 is dissolved in water, it forms NaOH and H_2O_2. In this case, NaOH is a strong base while H_2O_2 is a weak acid.

(i) $Na_2O_2 + 2H_2O \qquad 2NaOH + H_2O_2$

H_2O_2 decolourises red litmus paper due to its bleaching action which is due to its oxidising character.

$$H_2O_2 \qquad H_2O + \underset{\substack{\text{Bleaches colour}\\ \text{of red litmus}}}{[O]}$$

(ii) If the compound is Na_2O, it will hydrolyse to form NaOH.

$$Na_2O + H_2O \qquad 2NaOH$$

NaOH solution formed above will change colour of red litmus paper into blue.

54. $\underset{\text{OA}}{KMnO_4} + \underset{\text{RA}}{H_2O_2} \qquad MnO_2 + KOH + O_2$

$\underset{\text{RA}}{FeSO_4} + \underset{\text{OA}}{H_2O_2} \qquad Fe^{3+} + H_2O$

55. $\underset{A}{3M} + N_2 \qquad \underset{B}{M_3N_2}$

$\underset{B}{M_3N_2} + 6H_2O \qquad \underset{C}{3M(OH)_2} + \underset{D}{2NH_3}$

$\underset{C}{M(OH)_2} + CO_2 \qquad \underset{\text{Milkyness}}{MCO_3}$

M can be either Ca or Ba but essentially not Mg because $Mg(OH)_2$ is very sparingly soluble in water.

56. $2KNO_3(s) + 10K(s) \qquad 6K_2O(s) + N_2(g)$

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

58. In Solvay process, $NaHCO_3$ is extracted from the solution by fractional crystallisation, which is then heated to convert it into Na_2CO_3 $KHCO_3$, being more soluble than $NaHCO_3$, cannot be extracted by fractional crystallisation. Hence, Solvay process fails in production of K_2CO_3.

59. Water forms stronger intermolecular H-bonds, therefore it is liquid at room temperature while H_2S cannot form such strong intermolecular bonds, gas at room temperature.

Topic 2 Group II Elements

1. In comparison to boron, beryllium has lesser nuclear charge and greater first ionisation enthalpy.

Electronic configuration of Be(4) $1s^2, 2s^2$.

It possess completely filled *s*-orbitals. Hence, high amount of energy is required to pull the electron from the gaseous atom. Beryllium (4) lies left to the boron (5) and on moving from left to right an electron is added due to which nuclear charge increases from Be to B.

2. The correct sequence of thermal stability of carbonates is

$MgCO_3 \quad CaCO_3 \quad SrCO_3 \quad BaCO_3$

On moving down the group, i.e. from Mg to Ba, atomic radius generally increases. It is due to the addition of shell. As a result, the atomic size increases. $CO_3^{2\ }$ is a large anion. Hence, more stabilised by $Ba^{2\ }$ (large cation) and less stabilised by $Mg^{2\ }$. Therefore, $BaCO_3$ has highest thermal stability followed by $SrCO_3$, $CaCO_3$ and $MgCO_3$.

3. Baking soda ($NaHCO_3$) is not a hydrated solid. Thus, (X) is not baking soda. Thus, option (a) and (c) are incorrect. Dead burnt plaster ($CaSO_4$) is obtained from gypsum *via* the formation of plaster of Paris.

$$\underset{\text{Gypsum}}{CaSO_4 \;\; 2H_2O} \;\overset{380\text{-}393\text{ K}}{\underset{1/2\,H_2O}{\qquad}}\; \underset{\text{Plaster of Paris}}{CaSO_4 \;\; \frac{1}{2}H_2O} \;\overset{>393\text{K}}{\underset{\frac{1}{2}H_2O}{\qquad}}\; \underset{\substack{\text{Dead burnt plaster}\\ \text{(anhydrous)}}}{CaSO_4}$$

Therefore, the reaction takes place as follows :

$$\underset{\substack{\text{Washing soda}\\ (X)}}{Na_2CO_3 \;\; 10H_2O} \;\overset{<373\text{K}}{\underset{9H_2O}{\qquad}}\; \underset{\substack{\text{Monohydrate}\\ (Y)}}{Na_2CO_3 \;\; H_2O} \;\overset{>373\text{K}}{\underset{H_2O}{\qquad}}\; \underset{\substack{\text{Anhydrous white powder}\\ \text{(soda ash) } (Z)}}{Na_2CO_3}$$

4. Names of magnesium alloys are given by two letters followed by two numbers. The common alloying elements are *A* (Aluminium), *Z* (zinc), *T* (tin), *M* (manganese) etc. Numbers indicate respective nominal compositions of main alloying elements, e.g. '*AZ* 91' implies the composition of the alloy as : Al = 9%, Zn = 1% and Mg = 100 – (9 + 1) = 90%

Among the alloys given, Mg – Al (Magnalium ; Mg = 5%, Al =95%) is being light, tough and strong, hence it is used in aircrafts.

5. The structures of beryllium chloride in the solid state and vapour phase, respectively are dimeric and chain. In vapour phase at above 900°C, $BeCl_2$ is monomeric having a linear structure Cl Be Cl. The bonding in $BeCl_2$ is covalent and Be atom accommodates 2 2 4 electrons in the two *sp*-hybrid orbitals. Below 900°C, beryllium chloride in vapour phase exists as a mixture of monomer $BeCl_2$ and dimer Be_2Cl_4.

6. Magnesium powder burns in air to give MgO and Mg_3N_2. MgO does not combine with excess oxygen to give any superoxide. Mg reacts with nitrogen to form magnesium nitride (Mg_3N_2).

$Mg \quad O_2 \qquad MgO$

$3Mg \quad N_2 \qquad Mg_3N_2$

7. **Key Idea** According to Fajan's rule, degree of covalency (ionic potential), -polarisation power of the cation charge on the cation $\frac{1}{\text{size of the cation}}$.

Alkaline earth metals contains bipositive ($H^{2\ }$) ions in their compounds.

So, here

(i) Charge on cation, i.e. 2 is constant.

(ii) Halide present (X) is also constant.

So, the covalent character depends on the size of alkaline earth metal. As we move down the group, size of metal ion increases.

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

So, $Be^{2\ }$ readily forms covalent compounds like BeX_2, because of very high positive charge density over its small size, so that it readily polarises anionic spherical electron cloud.

8. (i) Washing soda (Na_2CO_3 $10H_2O$) is manufactured in Solvay process. In this method, CO_2 gas is passed through a conc. solution of NaCl saturated with NH_3. It gives ammonium carbonate followed by ammonium hydrogen carbonate.

The obtained NH_4HCO_3 is treated with solution of NaCl which result in the formation of $NaHCO_3$. The crystal obtained are heated to obtain Na_2CO_3.

$NaCl \quad NH_3 \quad CO_2 \quad H_2O \qquad NaHCO_3 \quad NH_4Cl$

$$2NaHCO_3 \;\underset{H_2O,\ CO_2}{\qquad}\; Na_2CO_3 \;\overset{\text{Crystallisation}}{\qquad}\; Na_2CO_3 \;\; 10H_2O$$

(ii) $Mg(HCO_3)_2$ and $Ca(HCO_3)_2$ cause temporary hardness to water that can be easily removed by boiling.

(iii) NaOH is manufactured by Castner-Kellner process.

In this reaction, Na amalgam flows out and treated with water to give NaOH and H_2 gas. During electrolysis, hydrogen is evolved at cathode and chlorine is evolved at anode, which are the by product of this process.

$$2NaCl(aq) \xrightarrow{\text{Electrolysis}} \begin{cases} \boxed{\text{Carbon anode}}\ 2Cl^{-} - 2e \longrightarrow Cl_2\uparrow \\ \boxed{\text{Hg cathode}}\ 2Na^{+} + 2e \end{cases}$$

$$\downarrow$$

$$2Na\ (Na/Hg)$$

$$\downarrow H_2O$$

$$2NaOH(aq) + H_2\uparrow$$

(iv) Portland cement constitutes, tricalcium aluminosilicate, $3CaO\ Al_2O_3.\ SiO_2$, i.e. $Ca_3Al_2O_6\ \ SiO_2$.

9. For group-2 metal hydroxides, basicity increases down the group, as:

$Be(OH)_2 \quad Mg(OH)_2 \quad Ca(OH)_2 \quad Sr(OH)_2 \quad Ba(OH)_2$

This is because as the size of metal atom increases, *M*—OH bond length increases or *M*—OH bond become weaker thus readily breaks to release OH ions which are responsible for the basicity of these solutions.

But $Be(OH)_2$ shows amphoteric (basic as well as acidic) character as it reacts with acid and alkali both which is shown in the following reactions. $Be(OH)_2$ as a base :

$$Be(OH)_2 \quad 2HCl \qquad BeCl_2 \quad 2H_2O$$

$Be(OH)_2$ as an acid :

$$Be(OH)_2 \quad 2NaOH \qquad Na_2[Be(OH)_4]$$

10. Among the four elements given, Na, Be, Mg and Ca, Be has highest IE value because of its smallest size and $2s^2$ valence shell configuration.

So, *X*-ray cannot cause ionisation from the material used, i.e. Be in the tube window, which may cause interference in the study.

11. A saturated aqueous solution of $\overset{\text{I}}{M}(NO_3)_2$ on crystallisation will produce hydrated crystal, $\overset{\text{II}}{M}(NO_3)_2\ nH_2O$ only when hydration enthalpy (H_{hyd}) of M^2 ion will be appreciably more negative.

Hydration of an ion depends on its size. Smaller the size of an ion, higher will be its charge density and as a result it will remain more solvated (hydrated) through ion dipole interaction.

Size of group-2 metal ions increases on going down the group. So, their ability to form hydrated crystals follows the order:

$$Be^2 \qquad Mg^2 \qquad Ca^2 \qquad Sr^2 \qquad Ba^2$$

Thus, $Ba(NO_3)_2$ is slightly or almost insoluble in water.

12. As we move down the group, size of metal increases. Be has lower size while SO_4^2 has bigger size, that's why $BeSO_4$ breaks easily and lattice energy becomes smaller but due to lower size of Be, water molecules are gathered around and hence hydration energy increases. On the other hand, rest of the metals, i.e. Ca, Ba, Sr have bigger size and that's why lattice energy is greater than hydration energy.

Time saving technique In the question of finding hydration energy only check the size of atom. Smaller sized atom has more hydration energy. Thus, in this question Be is placed upper most in the group has lesser size and not comparable with the size of sulphates. Hence, $BeSO_4$ is the right response.

13. Thermal stability of salts with common anion depends on polarising power of cation. Greater the polarising power, lower be their thermal stability. Hence,

$BeCO_3$ (IV) < $MgCO_3$ (II) < $CaCO_3$ (III) < K_2CO_3 (I)

14. The reaction involved is

$$BaO_2 + H_2SO_4 \qquad BaSO_4 + H_2O_2$$

The most electronegative atom, oxygen, in $BaSO_4$ and H_2O_2 has 2 and 1 oxidation state respectively.

15. Electrolysis of molten $CaCl_2$ gives calcium at cathode

$$Ca^{2+} + 2e \qquad Ca \quad \text{(at cathode)}$$

In case of electrolysis in aqueous medium, less electropositive H^+ is reduced at cathode rather than Ca^{2+}.

16. $Ca(OH)_2 + Ca(HCO_3)_2 \qquad 2CaCO_3 \quad + \quad \underset{\text{(Clark's method)}}{2H_2O}$

$$NaOCl + H_2 \qquad NaOH + HOCl$$

$$HO \quad + HCO_3 \qquad CO_3^2 \quad + H_2O$$

$$Ca(HCO_3)_2 + Na_2CO_3 \qquad CaCO_3 \quad + 2NaHCO_3$$

17. Magnesium ammonium phosphate is precipitated out.

$MgSO_4 + NH_4OH + Na_2HPO_4 \qquad Mg(NH_4)PO_4 \quad + Na_2SO_4$

18. Si is used in solar cells, because of its semi-conductor properties.

19. Anhydrous $MgCl_2$ is obtained by heating hydrated salt in stream of dry HCl.

20. Heating $MgCl_2\ \ 6H_2O$ brings about partial dehydration as

$$MgCl_2\ \ 6H_2O \qquad Mg(OHCl) + HCl + 5H_2O$$

21. $Ba\overset{*}{C}O_3 + H_2SO_4 \qquad BaSO_4 + H_2O + \overset{*}{C}O_2 \qquad (\overset{*}{C} \quad C^{14})$

22. Be in $BeCl_2$ is electron deficient, short of two lone pair of electrons from stable octet. H_2O has lone pair of electrons, reacts with $BeCl_2$.

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

24. *A* NH_3, *B* $CaCO_3$.

Reactions involved are :

$$3Ca + N_2 \xrightarrow{\text{Heat}} Ca_3N_2$$

$$Ca_3N_2 + 6H_2O \qquad 3Ca(OH)_2 + \underset{A}{2NH_3}$$

$$Ca(OH)_2 + \underset{\text{(From air)}}{CO_2} \qquad \underset{B}{CaCO_3} + H_2O$$

25. Basic strength (i) decreases from left to right in period and (ii) increases from top to bottom in group. Therefore,

$NiO < MgO < SrO < K_2O < Cs_2O$ Basic strength