

Chapter

The s-Block Elements



Topic-1: Group-1 Elements (Alkali Metals)



1 MCQs with One Correct Answer

- The metallic lustre exhibited by sodium is explained by
(a) diffusion of sodium ions [1987 - 1 Mark]
(b) oscillation of loose electrons
(c) excitation of free protons
(d) existence of body centered cubic lattice
- The pair of compounds which cannot exist together in solution is : [1986 - 1 Mark]
(a) NaHCO_3 and NaOH (b) Na_2CO_3 and NaHCO_3
(c) Na_2CO_3 and NaOH (d) NaHCO_3 and NaCl
- The oxide that gives hydrogen peroxide on treatment with a dilute acid is : [1985 - 1 Mark]
(a) PbO_2 (b) Na_2O_2 (c) MnO_2 (d) TiO_2
- A solution of sodium metal in liquid ammonia is strongly reducing due to the presence of [1981 - 1 Mark]
(a) sodium atoms (b) sodium hydride
(c) sodium amide (d) solvated electrons



4 Fill in the Blanks

- The electrolysis of molten sodium hydride liberates gas at the [1989 - 1 Mark]
- Sodium dissolved in liquid ammonia conducts electricity because [1985 - 1 Mark]



5 True / False

- Sodium when burnt in excess of oxygen gives sodium oxide. [1987 - 1 Mark]
- The softness of group I-A metals increases down the group with increasing atomic number. [1986 - 1 Mark]



6 MCQs with One or More than One Correct Answer

- The compound(s) formed upon combustion of sodium metal in excess air is (are) [2009 - 5M, -1]
(a) Na_2O_2 (b) Na_2O (c) NaO_2 (d) NaOH

- Highly pure dilute solution of sodium in liquid ammonia
(a) shows blue colour [1998 - 2 Marks]
(b) exhibits electrical conductivity
(c) produces sodium amide
(d) produces hydrogen gas.



9 Assertion and Reason Statement Type Questions

Each question contains **STATEMENT-1 (Assertion)** and **STATEMENT-2 (Reason)**. Each question has 4 choices (a), (b), (c) and (d) out of which **ONLY ONE** is correct. Mark your answer as

- If both Statement -1 and Statement -2 are correct, and Statement -2 is the correct explanation of the Statement -1.
- If both Statement -1 and Statement -2 are correct, but Statement -2 is not the correct explanation of the Statement -1.
- If Statement -1 is correct but Statement -2 is incorrect.
- If Statement -1 is incorrect but Statement -2 is correct.

[2007]

- Statement-1** : Alkali metals dissolve in liquid ammonia to give blue solutions.

Statement-2 : Alkali metals in liquid ammonia give solvated species of the type $[M(\text{NH}_3)_n]^+$ (M = alkali metals).



10 Subjective Problems

- Explain the difference in the nature of bonding in LiF and LiI . [1996 - 2 Marks]
- Write down the balanced equations for the reactions when:
(i) Potassium ferricyanide reacts with hydrogen peroxide in basic solution. [1989 - 1 Mark]
(ii) Carbon dioxide is passed through a concentrated aqueous solution of sodium chloride saturated with ammonia. [1988 - 1 Mark]
- Give reason of the following :
Sodium carbonate is made by Solvay process but the same process is not extended to the manufacture of potassium carbonate. [1981 - 1 Mark]



Topic-2: Group-2 Elements (Alkaline Earth Metals)



1 MCQs with One Correct Answer

- A sodium salt on treatment with MgCl_2 gives white precipitate only on heating. The anion of the sodium salt is [2004S]
(a) HCO_3^- (b) CO_3^{2-} (c) NO_3^- (d) SO_4^{2-}
- The set representing the correct order of first ionization potential is [2001S]
(a) $\text{K} > \text{Na} > \text{Li}$ (b) $\text{Be} > \text{Mg} > \text{Ca}$
(c) $\text{B} > \text{C} > \text{N}$ (d) $\text{Ge} > \text{Si} > \text{C}$
- The following compounds have been arranged in order of their increasing thermal stabilities. Identify the correct order. [1996 - 1 Mark]

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

- $\text{I} < \text{II} < \text{III} < \text{IV}$ (b) $\text{IV} < \text{II} < \text{III} < \text{I}$
(c) $\text{IV} < \text{II} < \text{I} < \text{III}$ (d) $\text{II} < \text{IV} < \text{III} < \text{I}$
- Molecular formula of Glauber's salt is : [1985 - 1 Mark]
(a) $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ (b) $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
(c) $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ (d) $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$
 - Calcium is obtained by [1980]
(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.
 - HCl is added to following oxides. Which one would give H_2O_2 ? [1980]
(a) MnO_2 (b) PbO_2 (c) $\text{BaO}_2 \cdot 8\text{H}_2\text{O}$ (d) NO_2
 - A substance absorbs CO_2 and violently reacts with water. The substance is [1978]
(a) CaCO_3 (b) CaO (c) H_2SO_4 (d) ZnO



4 Fill in the Blanks

- Ca^{2+} has a smaller ionic radius than K^+ because it has [1993 - 1 Mark]
- Anhydrous MgCl_2 is obtained by heating hydrated salt with [1980]



5 True / False

- $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$ on heating give anhydrous MgCl_2 . [1982 - 1 Mark]



6 MCQs with One or More than One Correct Answer

- MgSO_4 on reaction with NH_4OH and Na_2HPO_4 forms a white crystalline precipitate. What is its formula? [2006 - 5M, -1]
(a) $\text{Mg}(\text{NH}_4)\text{PO}_4$ (b) $\text{Mg}_3(\text{PO}_4)_2$
(c) $\text{MgCl}_2 \cdot \text{MgSO}_4$ (d) MgSO_4
- The species that do not contain peroxide ions are [1992 - 1 Mark]
(a) PbO_2 (b) H_2O_2 (c) SrO_2 (d) BaO_2



10 Subjective Problems

- Give reason of the following:
 BeCl_2 can be easily hydrolysed. [1999 - 2 Marks]
- Work out the following using chemical equation:
Chlorination of calcium hydroxide produces bleaching powder. [1998 - 2 Marks]
- Arrange the following sulphates of alkaline earth metals in order of decreasing thermal stability : BeSO_4 , MgSO_4 , CaSO_4 , SrSO_4 [1997 - 1 Mark]
- The crystalline salts of alkaline earth metals contain more water of crystallisation than the corresponding alkali metal salts. [1997 - 2 Marks]
- 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. Identify *A*, *B*, *C* and *D*. [1997 - 3 Marks]
- Mg_3N_2 when reacted with water gives off NH_3 but HCl is not obtained from MgCl_2 on reaction with water at room temperature. [1995 - 2 Marks]
- Complete and balance the following reactions :
 $\text{Ca}_5(\text{PO}_4)_3\text{F} + \text{H}_2\text{SO}_4 + \text{H}_2\text{O}$
Heat \rightarrow + $5\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ + [1994-1 Mark]
- Give briefly the isolation of magnesium from sea water by the Dow process. Give equations for the steps involved. [1993 - 3 Marks]
- Write down the balanced equations for the reactions when: Carbon dioxide is passed through a suspension of lime stone in water. [1991 - 1 Mark]



Answer Key

Topic-1 : Group-1 Elements (Alkali Metals)

- (b) 2. (a) 3. (b) 4. (d) 5. (Hydrogen, anode) 6. (of solvated electrons)
- (False) 8. (True) 9. (a, b) 10. (a, b) 11. (b)

Topic-2 : Group-2 Elements (Alkaline Earth Metals)

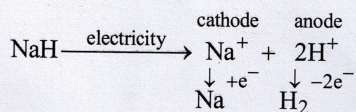
- (a) 2. (b) 3. (b) 4. (d) 5. (a) 6. (c) 7. (b) 8. (higher effective nuclear charge)
- (Anhydrous HCl) 10. (False) 11. (a) 12. (a)

Hints & Solutions

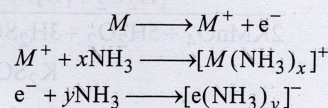


Topic-1: Group-1 Elements (Alkali Metals)

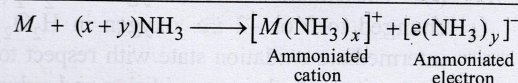
- (b) When light falls on sodium surface, valence e^- gets excited and then returns back. The emission of photons creates a metallic lustre on the surface.
- (a) Acidic and basic salts cannot exist together.
Since NaHCO_3 is an acid salt of H_2CO_3 , it reacts with NaOH to form Na_2CO_3 and H_2O .
$$\text{NaHCO}_3 + \text{NaOH} \rightarrow \text{Na}_2\text{CO}_3 + \text{H}_2\text{O}$$
- (b) $\text{Na}_2\text{O}_2 + \text{H}_2\text{SO}_4$ (20% ice cold) $\longrightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O}_2$
- (d) The free ammoniated electrons make the solution of Na in liquid NH_3 a very powerful reducing agent.
The ammonical solution of an alkali metal is rather favoured as a reducing agent than its aqueous solution because in aqueous solution the alkali metal being highly electropositive evolves hydrogen from water (thus H_2O acts as an oxidising agent) while its solution in ammonia is quite stable, provided no catalyst (transition metal) is present.
- Hydrogen, anode.**



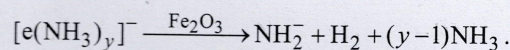
- of solvated electrons.
- False :** Sodium when burnt in excess of oxygen gives sodium peroxide (Na_2O_2) and not sodium oxide.
$$4\text{Na} + \text{O}_2 \text{ (limited)} \rightarrow 2\text{Na}_2\text{O}; \quad 2\text{Na} + \text{O}_2 \text{ (excess)} \rightarrow \text{Na}_2\text{O}_2$$
- True :** The metallic bonding decreases with increase in atomic size and thus, the tendency to show metallic bonding among alkali metals decreases from Li to Cs. Close packing of atoms in crystal lattice decreases from Li to Cs, resulting in an increase in softness.
- (a, b) $4\text{Na} + \text{O}_2 \text{ (limited)} \xrightarrow{\Delta} 2\text{Na}_2\text{O}$
$$2\text{Na} + \text{O}_2 \text{ (excess)} \xrightarrow{\Delta} \text{Na}_2\text{O}_2$$
- (a, b) Blue colour is due to the presence of solvated (ammoniated) electrons, while electrical conductance is due to the presence of ions.



on adding



Note: Sodium in liquid ammonia forms NaNH_2 only in presence of a catalyst like Pt black, iron oxide, etc.



- (b) Statement-1 is correct. Statement-2 is also correct but not the correct explanation because blue colour of the solution is due to the solvated electrons.
- LiF has more ionic character while LiI has more covalent character. The latter is due to the greater polarizability of larger iodide ion than that of fluoride ion.
- (iv) $2\text{K}_3[\text{Fe}(\text{CN})_6] + \text{H}_2\text{O}_2 + 2\text{KOH} \rightarrow 2\text{K}_4[\text{Fe}(\text{CN})_6] + 2\text{H}_2\text{O} + \text{O}_2$
(iii) $\text{NaCl} + \text{NH}_4\text{OH} + \text{CO}_2 \rightarrow \text{NH}_4\text{Cl} + \text{NaHCO}_3$
- Potassium carbonate cannot be manufactured by Solvay process, since, unlike sodium hydrogen carbonate, potassium hydrogen carbonate is rather too soluble in water to be precipitated like NaHCO_3 .



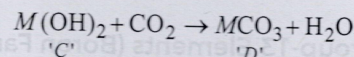
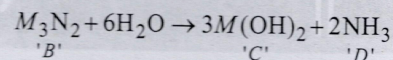
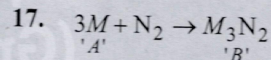
Topic-2: Group-2 Elements (Alkaline Earth Metals)

- (a) $\text{MgCl}_2 + 2\text{NaHCO}_3 \longrightarrow \text{MgHCO}_3 + 2\text{NaCl}$
(soluble)
$$\text{MgHCO}_3 \xrightarrow{\text{heat}} \text{MgCO}_3 \downarrow + \text{H}_2\text{O} + \text{CO}_2$$
- (b) In going from top to bottom in a group, the first ionization potential decreases, thus
 $\text{Be} > \text{Mg} > \text{Ca}$
- (b) The increasing thermal stability is
$$\text{BeCO}_3 < \text{MgCO}_3 < \text{CaCO}_3 < \text{K}_2\text{CO}_3$$

(IV) (II) (III) (I)
Increasing size of cation decreases its polarization ability towards carbonate, making the compound more stable.
- (d) Glauber's salt is $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$.
- (a) Ca is obtained by electrolysis of molten mixture of CaCl_2 mixed with CaF_2 .

6. (c) Peroxide can produce hydrogen peroxide
 $\text{BaO}_2 \cdot 8\text{H}_2\text{O} + \text{H}_2\text{SO}_4 \longrightarrow \text{BaSO}_4 + \text{H}_2\text{O}_2 + 8\text{H}_2\text{O}$
7. (b) $\text{CaO} + \text{H}_2\text{O} \xrightarrow{\text{Hissing sound}} \text{Ca(OH)}_2 + \text{Heat}$
 $\text{CaO} + \text{CO}_2 \longrightarrow \text{CaCO}_3$
8. **higher effective nuclear charge.**
9. **Anhydrous HCl**
 \therefore All the water of crystallisation cannot be removed by heating hydrated MgCl_2 . HCl checks the hydrolysis of MgCl_2 by its own water of crystallization.
10. **False :** Although 4 molecules of water of crystallisation are removed by heating, the remaining two react with MgCl_2 as per the equation given below :
 $\text{MgCl}_2 + 2\text{H}_2\text{O} \rightarrow \text{MgO} + 2\text{HCl} + \text{H}_2\text{O}$
 In order to avoid this to happen, $\text{MgCl}_2 \cdot 2\text{H}_2\text{O}$ is dehydrated in presence of HCl gas, which checks, (being in excess) the hydrolysis of MgCl_2 by its own water of crystallisation.
11. (a) $\text{Mg}^{2+} + \text{NH}_3 + \text{HPO}_4^{2-} \longrightarrow \text{Mg(NH}_4\text{)PO}_4$
12. (a) H_2O_2 (hydrogen peroxide); SrO_2 and BaO_2 (Barium peroxide) contain peroxide ions (O_2^{2-}).
13. BeCl_2 is hydrolysed due to high polarising power and presence of vacant p -orbitals in Be-atom.
 $(\text{Be} = 1s^2, 2s^2 2p_x^0 2p_y^0 2p_z^0)$
14. $3\text{Ca(OH)}_2 + 2\text{Cl}_2 \rightarrow \text{Ca(OC}l)_2 \cdot \text{Ca(OH)}_2 \cdot \text{CaCl}_2 \cdot 2\text{H}_2\text{O}$
 Bleaching powder
 (a mixture of $\text{Ca(OC}l)_2$ and basic chloride)
15. $\text{SrSO}_4 > \text{CaSO}_4 > \text{MgSO}_4 > \text{BeSO}_4$ (Based upon size of cation or ionic character)
16. Smaller the size of cation, higher will be hydration tendency because **hydration energy of cation is inversely proportional to size of cation.**
 The size of alkaline earth metal ions are smaller than the

size of alkali metal ions. So, in crystalline form, the salts of alkaline earth metals have more water molecules than those of alkali metals.

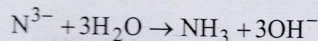


M may be either Ca or Ba.

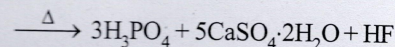
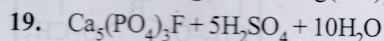
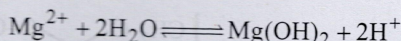
It is not magnesium because Mg(OH)_2 has very low solubility in water.

If we consider Ba as M then A is **Ba**, B is **Ba_3N_2** , C is **Ba(OH)_2** , D is **BaCO_3** .

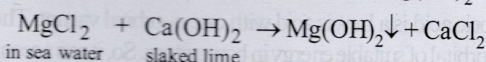
18. N^{3-} being smaller in size and high charge present on it make it more susceptible to hydrolysis :



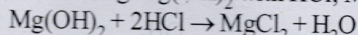
Cl^- being a weak conjugate base does not undergo hydrolysis. Mg^{2+} get hydrolysed as :



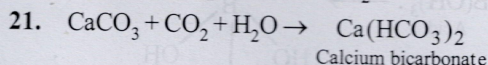
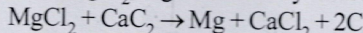
20. In sea water, Mg exists as MgCl_2 .
 On treating sea water with slaked lime, Mg(OH)_2 is obtained.



On reacting Mg(OH)_2 with HCl, MgCl_2 is obtained.



From MgCl_2 , Mg is obtained by reduction of MgCl_2 with CaC_2 .



Suspension of lime stone is CaCO_3 .