CHAPTER

8

The s-Block Elements

Section-A JEE Advanced/ IIT-JEE

A Fill in the Blanks

1. Anhydrous $MgCl_2$ is obtained by heating hydrated salt with ..... *(1980)*
2. The absorption of hydrogen by palladium is commonly known as ..... . *(1983 - 1 Mark)*
3. Sodium dissolved in liquid ammonia conducts electricity because ..... . *(1985 - 1 Mark)*
4. The electrolysis of molten sodium hydride liberates ..... gas at the ..... . *(1989 - 1 Mark)*
5. Ca^{2+} has a smaller ionic radius than K^+ because it has ..... *(1993 - 1 Mark)*

B True / False

1. $MgCl_2.6H_2O$ on heating give anhydrous $MgCl_2$. *(1982 - 1 Mark)*
2. The softness of group I-A metals increases down the group with increasing atomic number. *(1986 - 1 Mark)*
3. Sodium when burnt in excess of oxygen gives sodium oxide. *(1987 - 1 Mark)*

C MCQs with One Correct Answer

1. A substance absorbs CO_2 and voilently reacts with water. The substance is *(1978)*
   (a) $CaCO_3$ (b) CaO
   (c) H_2SO_4 (d) ZnO
2. HCl is added to following oxides. Which one would give H_2O_2? *(1980)*
   (a) MnO_2 (b) PbO_2
   (c) $BaO_2.8H_2O$ (d) NO_2
3. 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.
4. 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
5. Heavy water is *(1983 - 1 Mark)*
   (a) $H_2{}^{18}O$
   (b) water obtained by repeated distillation
   (c) D_2O
   (d) water at 4°C
6. The hydration energy of Mg^{++} is larger than that of :
   (a) Al^{3+} (b) Na^+ *(1984 - 1 Mark)*
   (c) Be^{++} (d) Mg^{3+}
7. 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
8. Molecular formula of Glauber's salt is : *(1985 - 1 Mark)*
   (a) $MgSO_4.7H_2O$ (b) $CuSO_4.5H_2O$
   (c) $FeSO_4.7H_2O$ (d) $Na_2SO_4.10H_2O$
9. Hydrogen gas will not reduce : *(1985 - 1 Mark)*
   (a) heated cupric oxide (b) heated ferric oxide
   (c) heated stannic oxide (d) heated aluminium oxide
10. 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
11. 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
12. The volume strength of 1.5 N H_2O_2 solution is
    (a) 4.8 (b) 8.4 *(1991 - 1 Mark)*
    (c) 3.0 (d) 8.0
13. 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)
    (a) I < II < III < IV (b) IV < II < III < I
    (c) IV < II < I < III (d) II < IV < III < I
14. The set representing the correct order of first ionization potential is *(2001S)*
    (a) K > Na > Li (b) Be > Mg > Ca
    (c) B > C > N (d) Ge > Si > C

15. 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-}

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

D MCQs with One or More Than One Correct

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

2. 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

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

4. The species present in solution when CO_2 is dissolved in water are *(2006 - 5M, –1)*
(a) $CO_2, H_2CO_3, HCO_3^-, CO_3^{2-}$
(b) H_2CO_3, CO_3^{2-}
(c) CO_3^{2-}, HCO_3^-
(d) CO_2, H_2CO_3

5. $MgSO_4$ on reaction with NH_4OH and Na_2HPO_4 forms a white crystalline precipitate. What is its formula? *(2006 - 5M, –1)*
(a) $Mg(NH_4)PO_4$ (b) $Mg_3(PO_4)_2$
(c) $MgCl_2.MgSO_4$ (d) $MgSO_4$

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

7. 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

E Subjective Problems

1. Give reasons for the following :
(*i*) Sodium carbonate is made by Solvay process but the same process is not extended to the manufacture of potassium carbonate. *(1981 - 1 Mark)*
(*ii*) Hydrogen peroxide is a better oxidising agent than water. *(1986 - 1 Mark)*
(*iii*) Magnesium oxide is used for the lining of steel making furnace. *(1987 - 1 Mark)*
(*iv*) Why is sodium chloride added during electrolysis of fused anhydrous magnesium chloride? *(1987 - 1 Mark)*
(*v*) Hydrogen peroxide acts as an oxidising as well as a reducing agent. *(1992 - 1 Mark)*
(*vi*) The crystalline salts of alkaline earth metals contain more water of crystallisation than the corresponding alkali metal salts. *(1997 - 2 Marks)*
(*vii*) $BeCl_2$ can be easily hydrolysed. *(1999 - 2 Marks)*

2. How will you prepare bleaching powder from slaked lime *(1982 - 1 Mark)*

3. Write down the balanced equations for the reactions when:
(*i*) Calcum phosphate is heated with a mixture of sand and carbon; *(1985 - 1 Mark)*
(*ii*) An alkaline solution of potassium ferricyanide is reacted with hydrogen peroxide. *(1982 - 1 Mark)*
(*iii*) Carbon dioxide is passed through a concentrated aqueous solution of sodium chloride saturated with ammonia. *(1988 - 1 Mark)*
(*iv*) Potassium ferricyanide reacts with hydrogen peroxide in basic solution. *(1989 - 1 Mark)*
(*v*) Carbon dioxide is passed through a suspension of lime stone in water. *(1991 - 1 Mark)*

4. Give briefly the isolation of magnesium from sea water by the Dow process. Give equations for the steps involved. *(1993 - 3 Marks)*

5. Complete and balance the following reactions :

$$Ca_5(PO_4)_3F + H_2SO_4 + H_2O \xrightarrow{\text{Heat}} \ldots\ldots + 5CaSO_4.2H_2O + \ldots\ldots$$

(1994 - 1 Mark)

6. A 5.0 cm^3 solution of H_2O_2 liberates 0.508 g of iodine from an acidified KI solution. Calculate the strength of H_2O_2 solution in terms of volume strength at STP. *(1995 - 2 Marks)*

7. Explain the difference in the nature of bonding in LiF and LiI. *(1996 - 2 Marks)*

8. To a 25ml H_2O_2 solution, excess of acidified solution of potassium iodide was added. The iodine liberated required 20 ml of 0.3 N sodium thiosulphate solution. Calculate the volume strength of H_2O_2 solution. *(1997 - 5 Marks)*

9. Give reactions for the oxidation of hydrogen peroxide with potassium permanganate in acidic medium. *(1997 - 1 Mark)*

10. 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)*

11. 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)*

12. Work out the following using chemical equation:
Chlorination of calcium hydroxide produces bleaching powder. *(1998 - 2 Marks)*

13. 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 - 4 Marks)*

H Assertion & Reason Type Questions

1. Read the following statement and explanation and answer as per the options given below :
Statement : The alkali metals can form ionic hydrides which contain the hydride ion H^-.
Explanation : The alkali metals have low electronegativity; their hydrides conduct electricity when fused and liberate hydrogen at the anode. *(1994 - 2 Marks)*
(a) Both S and E are true and E is the correct explanation of S.
(b) Both S and E are true but E is not the correct explanation of S.
(c) S is true but E is false.
(d) S is false but E is true

2. This question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason) and has 4 choices (a), (b), (c) and (d) out of which ONLY ONE is correct. *(2007)*
STATEMENT-1 : Alkali metals dissolve in liquid ammonia to give blue solutions. because
STATEMENT-2 : Alkali metals is liquid ammonia give solvated species of the type $[M(NH_3)_n]^+$ (M = alkali metals).
(a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
(b) Statement-1 is True, Statement-2 is True; Statement-2 is not correct explanation for Statement-1
(c) Statement-1 is True, Statement-2 is False
(d) Statement-1 is False, Statement-2 is True.

Section-B JEE Main / AIEEE

1. KO_2 (potassium super oxide) is used in oxygen cylinders in space and submarines because it **[2002]**
(a) absorbs CO_2 and increases O_2 content
(b) eliminates moisture
(c) absorbs CO_2
(d) produces ozone.

2. The metallic sodium disolves in liquid ammonia to form a deep blue coloured solution. The deep blue colour is due to formation of: **[2002]**
(a) solvated electron, $e(NH_3)_x^-$
(b) solvated atomic sodium, $Na(NH_3)_y$
(c) $(Na^+ + Na^-)$
(d) $NaNH_2 + H_2$

3. A metal M readily forms its sulphate MSO_4 which is water-soluble. It forms its oxide MO which becomes inert on heating. It forms an insoluble hyroxide $M(OH)_2$ which is soluble in NaOH solution. Then M is **[2002]**
(a) Mg (b) Ba
(c) Ca (d) Be.

4. In curing cement plasters water is sprinkled from time to time. This helps in **[2003]**
(a) developing interlocking needle-like crystals of hydrated silicates
(b) hydrating sand and gravel mixed with cement
(c) converting sand into silicic acid
(d) keeping it cool

5. The substance **not** likely to contain $CaCO_3$ is
(a) calcined gypsum (b) sea shells **[2003]**
(c) dolomite (d) a marble statue

6. The solubilities of carbonates decrease down the magnesium group due to a decrease in **[2003]**
(a) hydration energies of cations
(b) inter-ionic attraction
(c) entropy of solution formation
(d) lattice energies of solids

7. Which one of the following processes will produce hard water ? **[2003]**
(a) Saturation of water with $MgCO_3$
(b) Saturation of water with $CaSO_4$
(c) Addition of Na_2SO_4 to water
(d) Saturation of water with $CaCO_3$

8. One mole of magnesium nitride on the reaction with an excess of water gives : **[2004]**
(a) two moles of ammonia
(b) one mole of nitric acid
(c) one mole of ammonia
(d) two moles of nitric acid

9. Which of the following species is diamagnetic in nature?
(a) H_2^- (b) H_2^+ *[2005]*
(c) H_2 (d) He_2^+

10. Based on lattice energy and other considerations which one of the following alkali metal chlorides is expected to have the highest melting point ? [2005]
(a) RbCl (b) KCl
(c) NaCl (d) LiCl

11. Which of the following statements in relation to the hydrogen atom is correct ? [2005]
(a) 3s, 3p and 3d orbitals all have the same energy
(b) 3s and 3p orbitals are of lower energy than 3d orbital
(c) 3p orbital is lower in energy than 3d orbital
(d) 3s orbital is lower in energy than 3p orbital

12. The ionic mobility of alkali metal ions in aqueous solution is maximum for [2006]
(a) Li^+ (b) Na^+
(c) K^+ (d) Rb^+

13. In context with the industrial preparation of hydrogen from water gas ($CO + H_2$), which of the following is the correct statement? [2008]
(a) CO and H_2, are fractionally separated using differences in their densities
(b) CO is removed by absorption in aqueous Cu_2Cl_2 solution
(c) H_2 is removed through occlusion with pd
(d) CO is oxidised to CO_2 with steam in the presence of a catalyst followed by absorption of of CO_2 in alkali

14. Which of the following on thermal decomposition yields a basic as well as acidic oxide ? [2012]
(a) $NaNO_3$ (b) $KClO_3$
(c) $CaCO_3$ (d) NH_4NO_3

15. Very pure hydrogen (99.9) can be made by which of the following processes ? [2012]
(a) Reaction of methane with steam
(b) Mixing natural hydrocarbons of high molecular weight
(c) Electrolysis of water
(d) Reaction of salts like hydrides with water

16. In which of the following reactions H_2O_2 acts as a reducing agent? [JEE M 2014]
(a) $H_2O_2 + 2H^+ + 2e^- \rightarrow 2H_2O$
(b) $H_2O_2 + 2e^- \rightarrow O_2 + 2H^+$
(c) $H_2O_2 + 2e^- \rightarrow 2OH^-$
(d) $H_2O_2 + 2OH^- - 2e^- \rightarrow O_2 + 2H_2O$

17. Which one of the following alkaline earth metal sulphates has its hydration enthalpy greater than its lattice enthalpy ? [JEE M 2015]
(a) $BaSO_4$ (b) $SrSO_4$
(c) $CaSO_4$ (d) $BeSO_4$

18. The molecular formula of a commercial resin used for exchanging ions in water softening is $C_8H_7SO_3^-Na^+$ (Mol. wt. 206. What would be the maximum uptake of Ca^{2+} ions by the resin when expressed in mole per gram resin ? [JEE M 2015]
(a) $\frac{2}{309}$ (b) $\frac{1}{412}$
(c) $\frac{1}{103}$ (d) $\frac{1}{206}$

19. From the following statements regarding H_2O_2, choose the incorrect statement : [JEE M 2015]
(a) It has to be stored in plastic or wax lined glass bottles in dark
(b) It has to be kept away from dust
(c) It can act only as an oxidizing agent
(d) It decomposes on exposure to light

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

21. Which of the following atoms has the highest first ionization energy? [JEE M 2016]
(a) K (b) Sc
(c) Rb (d) Na

22. The main oxides formed on combustion of Li, Na and K in excess of air are, respectively: [JEE M 2016]
(a) Li_2O_2, Na_2O_2 and KO_2 (b) Li_2O, Na_2O_2 and KO_2
(c) Li_2O, Na_2O and KO_2 (d) LiO_2, Na_2O_2 and K_2O