

Chapter 7. Equilibrium

- The equilibrium constants of the following are

$$\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3; \quad K_1$$

$$\text{N}_2 + \text{O}_2 \rightleftharpoons 2\text{NO}; \quad K_2$$

$$\text{H}_2 + \frac{1}{2}\text{O}_2 \rightleftharpoons \text{H}_2\text{O}; \quad K_3$$

The equilibrium constant (K) of the reaction :

$$2\text{NH}_3 + \frac{5}{2}\text{O}_2 \xrightleftharpoons{K} 2\text{NO} + 3\text{H}_2\text{O}$$
will be
(a) $K_2K_3^3/K_1$ (b) K_2K_3/K_1
(c) $K_2^3K_3/K_1$ (d) $K_1K_3^3/K_2$
(NEET 2017, 2007, 2003)
- Concentration of the Ag^+ ions in a saturated solution of $\text{Ag}_2\text{C}_2\text{O}_4$ is $2.2 \times 10^{-4} \text{ mol L}^{-1}$. Solubility product of $\text{Ag}_2\text{C}_2\text{O}_4$ is
(a) 2.66×10^{-12} (b) 4.5×10^{-11}
(c) 5.3×10^{-12} (d) 2.42×10^{-8}
(NEET 2017)
- A 20 litre container at 400 K contains $\text{CO}_{2(g)}$ at pressure 0.4 atm and an excess of SrO (neglect the volume of solid SrO). The volume of the container is now decreased by moving the movable piston fitted in the container. The maximum volume of the container, when pressure of CO_2 attains its maximum value, will be
(Given that : $\text{SrCO}_{3(s)} \rightleftharpoons \text{SrO}_{(s)} + \text{CO}_{2(g)}$, $K_p = 1.6 \text{ atm}$)
(a) 10 litre (b) 4 litre
(c) 2 litre (d) 5 litre
(NEET 2017)
- The percentage of pyridine ($\text{C}_5\text{H}_5\text{N}$) that forms pyridinium ion ($\text{C}_5\text{H}_5\text{N}^+\text{H}$) in a 0.10 M aqueous pyridine solution (K_b for $\text{C}_5\text{H}_5\text{N} = 1.7 \times 10^{-9}$) is
(a) 0.0060% (b) 0.013%
(c) 0.77% (d) 1.6%
(NEET-II 2016)
- The solubility of $\text{AgCl}_{(s)}$ with solubility product 1.6×10^{-10} in 0.1 M NaCl solution would be
(a) $1.26 \times 10^{-5} \text{ M}$ (b) $1.6 \times 10^{-9} \text{ M}$
(c) $1.6 \times 10^{-11} \text{ M}$ (d) zero.
(NEET-II 2016)
- Which of the following fluoro-compounds is most likely to behave as a Lewis base?
(a) BF_3 (b) PF_3 (c) CF_4 (d) SiF_4
(NEET-II 2016)
- MY and NY_3 , two nearly insoluble salts, have the same K_{sp} values of 6.2×10^{-13} at room temperature. Which statement would be true in regard to MY and NY_3 ?
(a) The salts MY and NY_3 are more soluble in 0.5 M KY than in pure water.
(b) The addition of the salt of KY to solution of MY and NY_3 will have no effect on their solubilities.
(c) The molar solubilities of MY and NY_3 in water are identical.
(d) The molar solubility of MY in water is less than that of NY_3 .
(NEET-I 2016)
- If the equilibrium constant for $\text{N}_{2(g)} + \text{O}_{2(g)} \rightleftharpoons 2\text{NO}_{(g)}$ is K , the equilibrium constant for $\frac{1}{2}\text{N}_{2(g)} + \frac{1}{2}\text{O}_{2(g)} \rightleftharpoons \text{NO}_{(g)}$ will be
(a) $\frac{1}{2}K$ (b) K
(c) K^2 (d) $K^{1/2}$ (2015)
- What is the pH of the resulting solution when equal volumes of 0.1 M NaOH and 0.01 M HCl are mixed?
(a) 2.0 (b) 7.0
(c) 1.04 (d) 12.65 (2015)
- Aqueous solution of which of the following compounds is the best conductor of electric current?
(a) Hydrochloric acid, HCl
(b) Ammonia, NH_3
(c) Fructose, $\text{C}_6\text{H}_{12}\text{O}_6$
(d) Acetic acid, $\text{C}_2\text{H}_4\text{O}_2$ (2015)

11. Which one of the following pairs of solution is not an acidic buffer?
 (a) CH_3COOH and CH_3COONa
 (b) H_2CO_3 and Na_2CO_3
 (c) H_3PO_4 and Na_3PO_4
 (d) HClO_4 and NaClO_4 (2015)
12. The K_{sp} of Ag_2CrO_4 , AgCl , AgBr and AgI are respectively, 1.1×10^{-12} , 1.8×10^{-10} , 5.0×10^{-13} , 8.3×10^{-17} . Which one of the following salts will precipitate last if AgNO_3 solution is added to the solution containing equal moles of NaCl , NaBr , NaI and Na_2CrO_4 ?
 (a) AgBr (b) Ag_2CrO_4
 (c) AgI (d) AgCl (2015, Cancelled)
13. Which of the following statements is correct for a reversible process in a state of equilibrium?
 (a) $\Delta G^\circ = -2.30 RT \log K$
 (b) $\Delta G^\circ = 2.30 RT \log K$
 (c) $\Delta G = -2.30 RT \log K$
 (d) $\Delta G = 2.30 RT \log K$ (2015, Cancelled)
14. If the value of equilibrium constant for a particular reaction is 1.6×10^{12} , then at equilibrium the system will contain
 (a) mostly products
 (b) similar amounts of reactants and products
 (c) all reactants
 (d) mostly reactants. (2015, Cancelled)
15. Which of the following salts will give highest pH in water?
 (a) KCl (b) NaCl
 (c) Na_2CO_3 (d) CuSO_4 (2014)
16. Using the Gibb's energy change, $\Delta G^\circ = +63.3 \text{ kJ}$, for the following reaction,

$$\text{Ag}_2\text{CO}_3(s) \rightleftharpoons 2\text{Ag}^+(aq) + \text{CO}_3^{2-}(aq)$$
 the K_{sp} of $\text{Ag}_2\text{CO}_3(s)$ in water at 25°C is ($R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$)
 (a) 3.2×10^{-26} (b) 8.0×10^{-12}
 (c) 2.9×10^{-3} (d) 7.9×10^{-2} (2014)
17. For the reversible reaction,

$$\text{N}_{2(g)} + 3\text{H}_{2(g)} \rightleftharpoons 2\text{NH}_{3(g)} + \text{heat}$$
 The equilibrium shifts in forward direction
 (a) by increasing the concentration of $\text{NH}_{3(g)}$
 (b) by decreasing the pressure
 (c) by decreasing the concentrations of $\text{N}_{2(g)}$ and $\text{H}_{2(g)}$
 (d) by increasing pressure and decreasing temperature. (2014)
18. For a given exothermic reaction, K_p and K'_p are the equilibrium constants at temperatures T_1 and T_2 , respectively. Assuming that heat of reaction is constant in temperature range between T_1 and T_2 , it is readily observed that
 (a) $K_p > K'_p$ (b) $K_p < K'_p$
 (c) $K_p = K'_p$ (d) $K_p = \frac{1}{K'_p}$ (2014)
19. KMnO_4 can be prepared from K_2MnO_4 as per the reaction,

$$3\text{MnO}_4^{2-} + 2\text{H}_2\text{O} \rightleftharpoons 2\text{MnO}_4^- + \text{MnO}_2 + 4\text{OH}^-$$
 The reaction can go to completion by removing OH^- ions by adding
 (a) CO_2 (b) SO_2 (c) HCl (d) KOH (NEET 2013)
20. Which of these is least likely to act as a Lewis base?
 (a) BF_3 (b) PF_3 (c) CO (d) F^- (NEET 2013)
21. Accumulation of lactic acid ($\text{HC}_3\text{H}_5\text{O}_3$), a monobasic acid in tissues leads to pain and a feeling of fatigue. In a 0.10 M aqueous solution, lactic acid is 3.7% dissociates. The value of dissociation constant, K_a , for this acid will be
 (a) 1.4×10^{-5} (b) 1.4×10^{-4}
 (c) 3.7×10^{-4} (d) 2.8×10^{-4} (Karnataka NEET 2013)
22. At 100°C the K_w of water is 55 times its value at 25°C . What will be the pH of neutral solution? ($\log 55 = 1.74$)
 (a) 7.00 (b) 7.87 (c) 5.13 (d) 6.13 (Karnataka NEET 2013)
23. The values of K_{sp} of CaCO_3 and CaC_2O_4 are 4.7×10^{-9} and 1.3×10^{-9} respectively at 25°C . If the mixture of these two is washed with water, what is the concentration of Ca^{2+} ions in water?
 (a) $5.831 \times 10^{-5} \text{ M}$ (b) $6.856 \times 10^{-5} \text{ M}$
 (c) $3.606 \times 10^{-5} \text{ M}$ (d) $7.746 \times 10^{-5} \text{ M}$ (Karnataka NEET 2013)
24. The dissociation constant of a weak acid is 1×10^{-4} . In order to prepare a buffer solution with a $\text{pH} = 5$, the $[\text{Salt}]/[\text{Acid}]$ ratio should be

- (a) 4 : 5 (b) 10 : 1 (c) 5 : 4 (d) 1 : 10
(Karnataka NEET 2013)
25. pH of a saturated solution of Ba(OH)_2 is 12. The value of solubility product (K_{sp}) of Ba(OH)_2 is
(a) 3.3×10^{-7} (b) 5.0×10^{-7}
(c) 4.0×10^{-6} (d) 5.0×10^{-6}
(2012)
26. Equimolar solutions of the following substances were prepared separately. Which one of these will record the highest pH value?
(a) BaCl_2 (b) AlCl_3 (c) LiCl (d) BeCl_2
(2012)
27. Buffer solutions have constant acidity and alkalinity because
(a) these give unionised acid or base on reaction with added acid or alkali
(b) acids and alkalies in these solutions are shielded from attack by other ions
(c) they have large excess of H^+ or OH^- ions
(d) they have fixed value of pH. (2012)
28. Given that the equilibrium constant for the reaction,
$$2\text{SO}_{2(g)} + \text{O}_{2(g)} \rightleftharpoons 2\text{SO}_{3(g)}$$
has a value of 278 at a particular temperature. What is the value of the equilibrium constant for the following reaction at the same temperature?
$$\text{SO}_{3(g)} \rightleftharpoons \text{SO}_{2(g)} + \frac{1}{2} \text{O}_{2(g)}$$

(a) 1.8×10^{-3} (b) 3.6×10^{-3}
(c) 6.0×10^{-2} (d) 1.3×10^{-5}
(Mains 2012)
29. Given the reaction between 2 gases represented by A_2 and B_2 to give the compound $AB_{(g)}$.
$$A_{2(g)} + B_{2(g)} \rightleftharpoons 2AB_{(g)}$$
At equilibrium, the concentration of $A_2 = 3.0 \times 10^{-3} \text{ M}$, of $B_2 = 4.2 \times 10^{-3} \text{ M}$, of $AB = 2.8 \times 10^{-3} \text{ M}$
If the reaction takes place in a sealed vessel at 527°C , then the value of K_c will be
(a) 2.0 (b) 1.9 (c) 0.62 (d) 4.5
(Mains 2012)
30. The value of ΔH for the reaction
$$X_{2(g)} + 4Y_{2(g)} \rightleftharpoons 2XY_{4(g)}$$
is less than zero. Formation of $XY_{4(g)}$ will be favoured at
(a) high temperature and high pressure
(b) low pressure and low temperature
(c) high temperature and low pressure
(d) high pressure and low temperature
(2011)
31. A buffer solution is prepared in which the concentration of NH_3 is 0.30 M and the concentration of NH_4^+ is 0.20 M. If the equilibrium constant, K_b for NH_3 equals 1.8×10^{-5} , what is the pH of this solution? ($\log 2.7 = 0.43$)
(a) 9.08 (b) 9.43 (c) 11.72 (d) 8.73
(2011)
32. Which of the following is least likely to behave as Lewis base?
(a) H_2O (b) NH_3 (c) BF_3 (d) OH^-
(2011)
33. For the reaction, $\text{N}_{2(g)} + \text{O}_{2(g)} \rightleftharpoons 2\text{NO}_{(g)}$, the equilibrium constant is K_1 . The equilibrium constant is K_2 for the reaction,
$$2\text{NO}_{(g)} + \text{O}_{2(g)} \rightleftharpoons 2\text{NO}_{2(g)}$$
What is K for the reaction,
$$\text{NO}_{2(g)} \rightleftharpoons \frac{1}{2} \text{N}_{2(g)} + \text{O}_{2(g)}$$

(a) $\frac{1}{2K_1K_2}$ (b) $\frac{1}{4K_1K_2}$
(c) $\left[\frac{1}{K_1K_2}\right]^{1/2}$ (d) $\frac{1}{K_1K_2}$ (2011)
34. In qualitative analysis, the metals of group I can be separated from other ions by precipitating them as chloride salts. A solution initially contains Ag^+ and Pb^{2+} at a concentration of 0.10 M. Aqueous HCl is added to this solution until the Cl^- concentration is 0.10 M. What will the concentrations of Ag^+ and Pb^{2+} be at equilibrium?
(K_{sp} for $\text{AgCl} = 1.8 \times 10^{-10}$, K_{sp} for $\text{PbCl}_2 = 1.7 \times 10^{-5}$)
(a) $[\text{Ag}^+] = 1.8 \times 10^{-7} \text{ M}$, $[\text{Pb}^{2+}] = 1.7 \times 10^{-6} \text{ M}$
(b) $[\text{Ag}^+] = 1.8 \times 10^{-11} \text{ M}$, $[\text{Pb}^{2+}] = 8.5 \times 10^{-5} \text{ M}$
(c) $[\text{Ag}^+] = 1.8 \times 10^{-9} \text{ M}$, $[\text{Pb}^{2+}] = 1.7 \times 10^{-3} \text{ M}$
(d) $[\text{Ag}^+] = 1.8 \times 10^{-11} \text{ M}$, $[\text{Pb}^{2+}] = 1.7 \times 10^{-4} \text{ M}$
(Mains 2011)
35. If pH of a saturated solution of Ba(OH)_2 is 12, the value of its K_{sp} is
(a) $4.00 \times 10^{-6} \text{ M}^3$ (b) $4.00 \times 10^{-7} \text{ M}^3$
(c) $5.00 \times 10^{-6} \text{ M}^3$ (d) $5.00 \times 10^{-7} \text{ M}^3$
(2010)

- 36.** What is $[H^+]$ in mol/L of a solution that is 0.20 M in CH_3COONa and 0.10 M in CH_3COOH ? K_a for $CH_3COOH = 1.8 \times 10^{-5}$
 (a) 3.5×10^{-4} (b) 1.1×10^{-5}
 (c) 1.8×10^{-5} (d) 9.0×10^{-6} (2010)
- 37.** In which of the following equilibrium K_c and K_p are not equal?
 (a) $2NO_{(g)} \rightleftharpoons N_{2(g)} + O_{2(g)}$
 (b) $SO_{2(g)} + NO_{2(g)} \rightleftharpoons SO_{3(g)} + NO_{(g)}$
 (c) $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$
 (d) $2C_{(s)} + O_{2(g)} \rightleftharpoons 2CO_{2(g)}$ (2010)
- 38.** In a buffer solution containing equal concentration of B^- and HB , the K_b for B^- is 10^{-10} . The pH of buffer solution is
 (a) 10 (b) 7 (c) 6 (d) 4 (2010)
- 39.** The reaction,
 $2A_{(g)} + B_{(g)} \rightleftharpoons 3C_{(g)} + D_{(g)}$
 is begun with the concentrations of A and B both at an initial value of 1.00 M. When equilibrium is reached, the concentration of D is measured and found to be 0.25 M. The value for the equilibrium constant for this reaction is given by the expression
 (a) $[(0.75)^3(0.25)] \div [(1.00)^2(1.00)]$
 (b) $[(0.75)^3(0.25)] \div [(0.50)^2(0.75)]$
 (c) $[(0.75)^3(0.25)] \div [(0.50)^2(0.25)]$
 (d) $[(0.75)^3(0.25)] \div [(0.75)^2(0.25)]$ (Mains 2010)
- 40.** The dissociation constants for acetic acid and HCN at $25^\circ C$ are 1.5×10^{-5} and 4.5×10^{-10} respectively. The equilibrium constant for the equilibrium
 $CN^- + CH_3COOH \rightleftharpoons HCN + CH_3COO^-$
 would be
 (a) 3.0×10^{-5} (b) 3.0×10^{-4}
 (c) 3.0×10^4 (d) 3.0×10^5 (2009)
- 41.** Which of the following molecules acts as a Lewis acid?
 (a) $(CH_3)_2O$ (b) $(CH_3)_3P$
 (c) $(CH_3)_3N$ (d) $(CH_3)_3B$ (2009)
- 42.** The ionization constant of ammonium hydroxide is 1.77×10^{-5} at 298 K. Hydrolysis constant of ammonium chloride is
 (a) 6.50×10^{-12} (b) 5.65×10^{-13}
 (c) 5.65×10^{-12} (d) 5.65×10^{-10} (2009)
- 43.** What is the $[OH^-]$ in the final solution prepared by mixing 20.0 mL of 0.050 M HCl with 30.0 mL of 0.10 M $Ba(OH)_2$?
 (a) 0.40 M (b) 0.0050 M
 (c) 0.12 M (d) 0.10 M (2009)
- 44.** The dissociation equilibrium of a gas AB_2 can be represented as :
 $2AB_{2(g)} \rightleftharpoons 2AB_{(g)} + B_{2(g)}$
 The degree of dissociation is x and is small compared to 1. The expression relating the degree of dissociation (x) with equilibrium constant K_p and total pressure P is
 (a) $(2K_p/P)^{1/2}$ (b) (K_p/P)
 (c) $(2K_p/P)$ (d) $(2K_p/P)^{1/3}$ (2008)
- 45.** If the concentration of OH^- ions in the reaction
 $Fe(OH)_{3(s)} \rightleftharpoons Fe^{3+}_{(aq)} + 3OH^-_{(aq)}$
 is decreased by $1/4$ times, then equilibrium concentration of Fe^{3+} will increase by
 (a) 64 times (b) 4 times
 (c) 8 times (d) 16 times (2008)
- 46.** Equal volumes of three acid solutions of pH 3, 4 and 5 are mixed in a vessel. What will be the H^+ ion concentration in the mixture?
 (a) 3.7×10^{-3} M (b) 1.11×10^{-3} M
 (c) 1.11×10^{-4} M (d) 3.7×10^{-4} M (2008)
- 47.** The value of equilibrium constant of the reaction
 $HI_{(g)} \rightleftharpoons \frac{1}{2}H_{2(g)} + \frac{1}{2}I_{2(g)}$
 is 8.0. The equilibrium constant of the reaction
 $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$ will be
 (a) 16 (b) $1/8$ (c) $1/16$ (d) $1/64$ (2008)
- 48.** The values of K for the reactions,
 $X \rightleftharpoons Y + Z$... (i)
 $A \rightleftharpoons 2B$... (ii)
 are in the ratio 9 : 1. If degree of dissociation of X and A be equal, then total pressure at equilibrium (i) and (ii) are in the ratio
 (a) 36 : 1 (b) 1 : 1 (c) 3 : 1 (d) 1 : 9 (2008)
- 49.** A weak acid, HA , has a K_a of 1.00×10^{-5} . If 0.100 mol of this acid is dissolved in one litre of water, the percentage of acid dissociated at equilibrium is closest to

- (a) 1.00% (b) 99.9%
(c) 0.100% (d) 99.0% (2007)
50. Calculate the pOH of a solution at 25°C that contains 1×10^{-10} M of hydronium ions, *i.e.* H_3O^+ .
(a) 4.000 (b) 9.000 (c) 1.000 (d) 7.000 (2007)
51. For the reaction:

$$\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightleftharpoons \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}),$$
 $\Delta H_r = -170.8 \text{ kJ mol}^{-1}$. Which of the following statements is not true?
 (a) The reaction is exothermic.
 (b) At equilibrium, the concentrations of $\text{CO}_2(\text{g})$ and $\text{H}_2\text{O}(\text{l})$ are not equal.
 (c) The equilibrium constant for the reaction is given by $K_p = \frac{[\text{CO}_2]}{[\text{CH}_4][\text{O}_2]}$.
 (d) Addition of $\text{CH}_4(\text{g})$ or $\text{O}_2(\text{g})$ at equilibrium will cause a shift to the right. (2006)
52. Which of the following pairs constitutes a buffer?
 (a) HCl and KCl
 (b) HNO_2 and NaNO_2
 (c) NaOH and NaCl
 (d) HNO_3 and NH_4NO_3 (2006)
53. The hydrogen ion concentration of a 10^{-8} M HCl aqueous solution at 298 K ($K_w = 10^{-14}$) is
 (a) 1.0×10^{-8} M (b) 1.0×10^{-6} M
 (c) 1.0525×10^{-7} M (d) 9.525×10^{-8} M (2006)
54. At 25°C, the dissociation constant of a base, BOH , is 1.0×10^{-12} . The concentration of hydroxyl ions in 0.01 M aqueous solution of the base would be
 (a) $1.0 \times 10^{-5} \text{ mol L}^{-1}$ (b) $1.0 \times 10^{-6} \text{ mol L}^{-1}$
 (c) $2.0 \times 10^{-6} \text{ mol L}^{-1}$ (d) $1.0 \times 10^{-7} \text{ mol L}^{-1}$ (2005)
55. H_2S gas when passed through a solution of cations containing HCl precipitates the cations of second group of qualitative analysis but not those belonging to the fourth group. It is because
 (a) presence of HCl decreases the sulphide ion concentration
 (b) solubility product of group II sulphides is more than that of group IV sulphides
 (c) presence of HCl increases the sulphide ion concentration
 (d) sulphides of group IV cations are unstable in HCl. (2005)
56. Equilibrium constants K_1 and K_2 for the following equilibria:

$$\text{NO}(\text{g}) + \frac{1}{2}\text{O}_2 \xrightleftharpoons{K_1} \text{NO}_2(\text{g})$$
 and

$$2\text{NO}_2(\text{g}) \xrightleftharpoons{K_2} 2\text{NO}(\text{g}) + \text{O}_2(\text{g})$$
 are related as
 (a) $K_2 = 1/K_1^2$ (b) $K_2 = K_1^2$
 (c) $K_2 = 1/K_1$ (d) $K_2 = K_1/2$ (2005)
57. The solubility product of a sparingly soluble salt AX_2 is 3.2×10^{-11} . Its solubility (in moles/L) is
 (a) 5.6×10^{-6} (b) 3.1×10^{-4}
 (c) 2×10^{-4} (d) 4×10^{-4} (2004)
58. The rapid change of pH near the stoichiometric point of an acid-base titration is the basis of indicator detection. pH of the solution is related to ratio of the concentrations of the conjugate acid (HIn) and base (In^-) forms of the indicator by the expression
 (a) $\log \frac{[\text{In}^-]}{[\text{HIn}]} = \text{p}K_{\text{In}} - \text{pH}$
 (b) $\log \frac{[\text{HIn}]}{[\text{In}^-]} = \text{p}K_{\text{In}} - \text{pH}$
 (c) $\log \frac{[\text{HIn}]}{[\text{In}^-]} = \text{pH} - \text{p}K_{\text{In}}$
 (d) $\log \frac{[\text{In}^-]}{[\text{HIn}]} = \text{pH} - \text{p}K_{\text{In}}$ (2004)
59. In Haber process 30 litres of dihydrogen and 30 litres of dinitrogen were taken for reaction which yielded only 50 % of the expected product. What will be the composition of gaseous mixture under the aforesaid condition in the end?
 (a) 20 litres ammonia, 20 litres nitrogen, 20 litres hydrogen
 (b) 10 litres ammonia, 25 litres nitrogen, 15 litres hydrogen
 (c) 20 litres ammonia, 10 litres nitrogen, 30 litres hydrogen
 (d) 20 litres ammonia, 25 litres nitrogen, 15 litres hydrogen (2003)
60. The reaction quotient (Q) for the reaction

$$\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$$
 is given by

$$Q = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3}$$
. The reaction will proceed from right to left if
 (a) $Q = K_c$ (b) $Q < K_c$
 (c) $Q > K_c$ (d) $Q = 0$
 where K_c is the equilibrium constant. (2003)

61. Which one of the following statements is not true?
 (a) Among halide ions, iodide is the most powerful reducing agent.
 (b) Fluorine is the only halogen that does not show a variable oxidation state.
 (c) HOCl is a stronger acid than HOBr.
 (d) HF is a stronger acid than HCl. (2003)
62. The solubility product of AgI at 25°C is $1.0 \times 10^{-16} \text{ mol}^2 \text{ L}^{-2}$. The solubility of AgI in 10^{-4} N solution of KI at 25°C is approximately (in mol L^{-1})
 (a) 1.0×10^{-16} (b) 1.0×10^{-12}
 (c) 1.0×10^{-10} (d) 1.0×10^{-8} (2003)
63. Reaction $\text{BaO}_{2(s)} \rightleftharpoons \text{BaO}_{(s)} + \text{O}_{2(g)}$; $\Delta H = +ve$. In equilibrium condition, pressure of O_2 depends on
 (a) increase mass of BaO_2
 (b) increase mass of BaO
 (c) increase temperature on equilibrium
 (d) increase mass of BaO_2 and BaO both. (2002)
64. Solubility of MX_2 type electrolytes is 0.5×10^{-4} mole/lit., then find out K_{sp} of electrolytes.
 (a) 5×10^{-12} (b) 25×10^{-10}
 (c) 1×10^{-13} (d) 5×10^{-13} (2002)
65. Which has highest pH?
 (a) CH_3COOK (b) Na_2CO_3
 (c) NH_4Cl (d) NaNO_3 (2002)
66. Solution of 0.1 N NH_4OH and 0.1 N NH_4Cl has pH 9.25. Then find out pK_b of NH_4OH .
 (a) 9.25 (b) 4.75 (c) 3.75 (d) 8.25 (2002)
67. In HS^- , I^- , $\text{R} - \text{NH}_2$, NH_3 order of proton accepting tendency will be
 (a) $\text{I}^- > \text{NH}_3 > \text{R} - \text{NH}_2 > \text{HS}^-$
 (b) $\text{NH}_3 > \text{R} - \text{NH}_2 > \text{HS}^- > \text{I}^-$
 (c) $\text{R} - \text{NH}_2 > \text{NH}_3 > \text{HS}^- > \text{I}^-$
 (d) $\text{HS}^- > \text{R} - \text{NH}_2 > \text{NH}_3 > \text{I}^-$ (2001)
68. Ionisation constant of CH_3COOH is 1.7×10^{-5} and concentration of H^+ ions is 3.4×10^{-4} . Then find out initial concentration of CH_3COOH molecules.
 (a) 3.4×10^{-4} (b) 3.4×10^{-3}
 (c) 6.8×10^{-4} (d) 6.8×10^{-3} (2001)
69. Solubility of M_2S salt is 3.5×10^{-6} then find out solubility product.
 (a) 1.7×10^{-6} (b) 1.7×10^{-16}
 (c) 1.7×10^{-18} (d) 1.7×10^{-12} (2001)
70. Correct relation between dissociation constants of a dibasic acid is
 (a) $K_{a1} = K_{a2}$ (b) $K_{a1} > K_{a2}$
 (c) $K_{a1} < K_{a2}$ (d) $K_{a1} = \frac{1}{K_{a2}}$ (2000)
71. For any reversible reaction, if we increase concentration of the reactants, then effect on equilibrium constant
 (a) depends on amount of concentration
 (b) unchange
 (c) decrease
 (d) increase. (2000)
72. Conjugate acid of NH_2^- is
 (a) NH_4OH (b) NH_4^+
 (c) NH_2^- (d) NH_3 (2000)
73. Which statement is wrong about pH and H^+ ?
 (a) pH of neutral water is not zero.
 (b) Adding 1 N solution of CH_3COOH and 1 N solution of NaOH , pH will be seven.
 (c) $[\text{H}^+]$ of dilute and hot H_2SO_4 is more than concentrated and cold H_2SO_4 .
 (d) Mixing solution of CH_3COOH and HCl , pH will be less than 7. (2000)
74. Equilibrium constant K_p for following reaction $\text{MgCO}_{3(s)} \rightleftharpoons \text{MgO}_{(s)} + \text{CO}_{2(g)}$
 (a) $K_p = P_{\text{CO}_2}$
 (b) $K_p = P_{\text{CO}_2} \times \frac{P_{\text{CO}_2} \times P_{\text{MgO}}}{P_{\text{MgCO}_3}}$
 (c) $K_p = \frac{P_{\text{CO}_2} + P_{\text{MgO}}}{P_{\text{MgCO}_3}}$
 (d) $K_p = \frac{P_{\text{MgCO}_3}}{P_{\text{CO}_2} \times P_{\text{MgO}}}$ (2000)
75. The strongest conjugate base is
 (a) SO_4^{2-} (b) Cl^-
 (c) NO_3^- (d) CH_3COO^- (1999)
76. The concentration of $[\text{H}^+]$ and concentration of $[\text{OH}^-]$ of a 0.1 aqueous solution of 2% ionised weak acid is [ionic product of water = 1×10^{-14}]
 (a) $2 \times 10^{-3} \text{ M}$ and $5 \times 10^{-12} \text{ M}$

- (b) 1×10^{-3} M and 3×10^{-11} M
 (c) 0.02×10^{-3} M and 5×10^{-11} M
 (d) 3×10^{-2} M and 4×10^{-13} M (1999)
- 77.** The solubility of a saturated solution of calcium fluoride is 2×10^{-4} moles per litre. Its solubility product is
 (a) 22×10^{-11} (b) 14×10^{-4}
 (c) 2×10^{-2} (d) 32×10^{-12} (1999)
- 78.** If K_1 and K_2 are the respective equilibrium constants for the two reactions,
 $\text{XeF}_{6(g)} + \text{H}_2\text{O}_{(g)} \rightarrow \text{XeOF}_{4(g)} + 2\text{HF}_{(g)}$
 $\text{XeO}_{4(g)} + \text{XeF}_{6(g)} \rightarrow \text{XeOF}_{4(g)} + \text{XeO}_3\text{F}_{2(g)}$,
 the equilibrium constant of the reaction,
 $\text{XeO}_{4(g)} + 2\text{HF}_{(g)} \rightarrow \text{XeO}_3\text{F}_{2(g)} + \text{H}_2\text{O}_{(g)}$,
 will be
 (a) K_1/K_2 (b) $K_1 \cdot K_2$
 (c) $K_1/(K_2)^2$ (d) K_2/K_1 (1998)
- 79.** A physician wishes to prepare a buffer solution at pH = 3.85 that efficiently resists changes in pH yet contains only small concentration of the buffering agents. Which of the following weak acids together with its sodium salt would be best to use?
 (a) 2, 5-Dihydroxy benzoic acid ($\text{p}K_a = 2.97$)
 (b) Acetoacetic acid ($\text{p}K_a = 3.58$)
 (c) *m*-Chlorobenzoic acid ($\text{p}K_a = 3.98$)
 (d) *p*-Chlorocinnamic acid ($\text{p}K_a = 4.41$) (1997)
- 80.** The hydride ion H^- is stronger base than its hydroxide ion OH^- . Which of the following reaction will occur if sodium hydride (NaH) is dissolved in water?
 (a) $\text{H}^- + \text{H}_2\text{O} \rightarrow \text{no reaction}$
 (b) $\text{H}^-_{(aq)} + \text{H}_2\text{O} \rightarrow \text{H}_2\text{O}$
 (c) $\text{H}^-_{(aq)} + \text{H}_2\text{O}_{(l)} \rightarrow \text{OH}^- + \text{H}_2$
 (d) None of these. (1997)
- 81.** The solubility product of CuS, Ag_2S and HgS are 10^{-31} , 10^{-44} and 10^{-54} respectively. The solubilities of these sulphides are in the order
 (a) $\text{HgS} > \text{Ag}_2\text{S} > \text{CuS}$
 (b) $\text{CuS} > \text{Ag}_2\text{S} > \text{HgS}$
 (c) $\text{Ag}_2\text{S} > \text{CuS} > \text{HgS}$
 (d) $\text{AgS} > \text{HgS} > \text{CuS}$ (1997)
- 82.** The equilibrium constant for the reaction $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$ is K , then the equilibrium constant for the equilibrium $2\text{NH}_3 \rightleftharpoons \text{N}_2 + 3\text{H}_2$ is
 (a) \sqrt{K} (b) $\sqrt{\frac{1}{K}}$ (c) $\frac{1}{K}$ (d) $\frac{1}{K^2}$ (1996)
- 83.** The ionic product of water at 25°C is 10^{-14} . Its ionic product at 90°C will be,
 (a) 1×10^{-14} (b) 1×10^{-16}
 (c) 1×10^{-20} (d) 1×10^{-12} (1996)
- 84.** If α is dissociation constant, then the total number of moles for the reaction,
 $2\text{HI} \rightarrow \text{H}_2 + \text{I}_2$ will be
 (a) 1 (b) $1 - \alpha$
 (c) 2 (d) $2 - \alpha$ (1996)
- 85.** The pH value of $N/10$ NaOH solution is
 (a) 12 (b) 13 (c) 10 (d) 11 (1996)
- 86.** Which of the following is not a Lewis acid?
 (a) SiF_4 (b) C_2H_4 (c) BF_3 (d) FeCl_3 (1996)
- 87.** The pH value of blood does not appreciably change by a small addition of an acid or a base, because the blood
 (a) can be easily coagulated
 (b) contains iron as a part of the molecule
 (c) is a body fluid
 (d) contains serum protein which acts as buffer. (1995)
- 88.** The pH value of a 10 M solution of HCl is
 (a) equal to 1 (b) equal to 2
 (c) less than 0 (d) equal to 0 (1995)
- 89.** The solubility of AgCl will be minimum in
 (a) 0.01 M CaCl_2 (b) pure water
 (c) 0.001 M AgNO_3 (d) 0.01 M NaCl (1995)
- 90.** In liquid-gas equilibrium, the pressure of vapours above the liquid is constant at
 (a) constant temperature
 (b) low temperature
 (c) high temperature
 (d) none of these. (1995)
- 91.** Which one of the following is most soluble?
 (a) Bi_2S_3 ($K_{sp} = 1 \times 10^{-70}$)
 (b) Ag_2S ($K_{sp} = 6 \times 10^{-51}$)
 (c) CuS ($K_{sp} = 8 \times 10^{-37}$)
 (d) MnS ($K_{sp} = 7 \times 10^{-16}$) (1994)

92. At 80°C , distilled water has $[\text{H}_3\text{O}^+]$ concentration equal to 1×10^{-6} mole/litre. The value of K_w at this temperature will be
 (a) 1×10^{-12} (b) 1×10^{-15}
 (c) 1×10^{-6} (d) 1×10^{-9} (1994)
93. According to Le Chatelier's principle, adding heat to a solid and liquid in equilibrium will cause the
 (a) temperature to increase
 (b) temperature to decrease
 (c) amount of liquid to decrease
 (d) amount of solid to decrease. (1993)
94. 0.1 M solution of which one of these substances will act basic?
 (a) Sodium borate
 (b) Ammonium chloride
 (c) Calcium nitrate
 (d) Sodium sulphate (1992)
95. Which one of the following information can be obtained on the basis of Le Chatelier principle?
 (a) Dissociation constant of a weak acid
 (b) Entropy change in a reaction
 (c) Equilibrium constant of a chemical reaction
 (d) Shift in equilibrium position on changing value of a constraint. (1992)
96. Aqueous solution of acetic acid contains
 (a) CH_3COO^- and H^+
 (b) CH_3COO^- , H_3O^+ and CH_3COOH
 (c) CH_3COO^- , H_3O^+ and H^+
 (d) CH_3COOH , CH_3COO^- and H^+ (1991)
97. K_1 and K_2 are equilibrium constant for reactions (i) and (ii)

$$\text{N}_{2(g)} + \text{O}_{2(g)} \rightleftharpoons 2\text{NO}_{(g)} \quad \dots(i)$$

$$\text{NO}_{(g)} \rightleftharpoons \frac{1}{2}\text{N}_{2(g)} + \frac{1}{2}\text{O}_{2(g)} \quad \dots(ii)$$

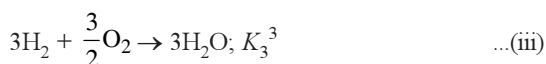
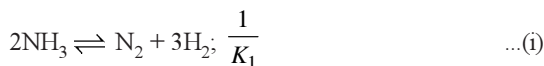
 (a) $K_1 = \left(\frac{1}{K_2}\right)^2$ (b) $K_1 = K_2^2$
 (c) $K_1 = \frac{1}{K_2}$ (d) $K_1 = (K_2)^0$ (1989)
98. The compound whose water solution has the highest pH is
 (a) NaCl (b) NaHCO_3
 (c) Na_2CO_3 (d) NH_4Cl (1988)

Answer Key

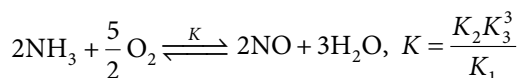
1. (a) 2. (c) 3. (d) 4. (b) 5. (b) 6. (b) 7. (d) 8. (d) 9. (d) 10. (a)
 11. (d) 12. (b) 13. (a) 14. (a) 15. (c) 16. (b) 17. (d) 18. (a) 19. (a) 20. (a)
 21. (b) 22. (d) 23. (d) 24. (b) 25. (b) 26. (a) 27. (a) 28. (c) 29. (c) 30. (d)
 31. (b) 32. (c) 33. (c) 34. (c) 35. (d) 36. (d) 37. (d) 38. (d) 39. (b) 40. (c)
 41. (d) 42. (d) 43. (d) 44. (d) 45. (a) 46. (d) 47. (d) 48. (a) 49. (a) 50. (a)
 51. (c) 52. (b) 53. (c) 54. (d) 55. (a) 56. (a) 57. (c) 58. (d) 59. (b) 60. (c)
 61. (d) 62. (b) 63. (c) 64. (d) 65. (b) 66. (b) 67. (c) 68. (d) 69. (b) 70. (b)
 71. (b) 72. (d) 73. (b) 74. (a) 75. (d) 76. (a) 77. (d) 78. (d) 79. (b) 80. (d)
 81. (b) 82. (c) 83. (d) 84. (c) 85. (b) 86. (b) 87. (d) 88. (c) 89. (a) 90. (a)
 91. (d) 92. (a) 93. (d) 94. (a) 95. (d) 96. (b) 97. (a) 98. (c)

EXPLANATIONS

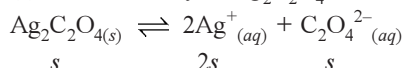
1. (a) : From the given equations,



By adding equations (i), (ii) and (iii), we get



2. (c) : Let solubility of $\text{Ag}_2\text{C}_2\text{O}_4$ be s mol L^{-1}



$$K_{sp} = (2s)^2(s) \Rightarrow 4s^3$$

$$K_{sp} = 4 \times (1.1 \times 10^{-4})^3 \quad (\because [\text{Ag}^+] = 2s = 2.2 \times 10^{-4})$$

$$K_{sp} \approx 5.3 \times 10^{-12}$$

3. (d) : $\text{SrCO}_{3(s)} \rightleftharpoons \text{SrO}_{(s)} + \text{CO}_{2(g)}; K_p = 1.6 \text{ atm}$

$$K_p = \frac{p_{\text{CO}_2} \times p_{\text{SrO}}}{p_{\text{SrCO}_3}}$$

$$\Rightarrow 1.6 = p_{\text{CO}_2} \quad (\because p_{\text{SrO}} = p_{\text{SrCO}_3} = 1)$$

\therefore Maximum pressure of $\text{CO}_2 = 1.6 \text{ atm}$

Let the maximum volume of the container when pressure of CO_2 is 1.6 atm be $V \text{ L}$

During the process, $PV = \text{constant}$

$$\therefore 0.4 \times 20 = 1.6 \times V$$

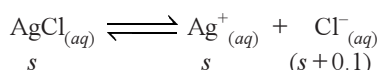
$$\Rightarrow V = \frac{0.4 \times 20}{1.6} = 5 \text{ L}$$

4. (b) : $\text{C}_5\text{H}_5\text{N} + \text{H}_2\text{O} \rightleftharpoons \text{C}_5\text{H}_5\text{NH}^+ + \text{OH}^-$
0.10 M

$$\alpha = \sqrt{\frac{K_b}{C}} = \sqrt{\frac{1.7 \times 10^{-9}}{0.10}} = 1.30 \times 10^{-4}$$

\therefore Percentage of pyridine that forms pyridinium ion $= 1.30 \times 10^{-4} \times 100 = 0.013\%$

5. (b) : Let s be the solubility of AgCl in moles per litre.



$(\because 0.1 \text{ M NaCl solution also provides } 0.1 \text{ M Cl}^- \text{ ion})$

$$K_{sp} = [\text{Ag}^+][\text{Cl}^-]; 1.6 \times 10^{-10} = s(s + 0.1)$$

$$1.6 \times 10^{-10} = s(0.1) \quad (\because s \ll 0.1)$$

$$s = \frac{1.6 \times 10^{-10}}{0.1} = 1.6 \times 10^{-9} \text{ M}$$

6. (b) : $\text{BF}_3 \rightarrow$ Lewis acid (incomplete octet)

$\text{PF}_3 \rightarrow$ Lewis base (presence of lone pair on P atom)

$\text{CF}_4 \rightarrow$ Complete octet

$\text{SiF}_4 \rightarrow$ Lewis acid (empty d -orbital in Si-atom)

7. (d) : For $MY : K_{sp} = s_1^2$

$$\Rightarrow s_1 = \sqrt{K_{sp}} = \sqrt{6.2 \times 10^{-13}} = 7.87 \times 10^{-7} \text{ mol L}^{-1}$$

For $NY_3 : K_{sp} = 27s_2^4$

$$\Rightarrow s_2 = \sqrt[4]{\frac{6.2 \times 10^{-13}}{27}} = 3.89 \times 10^{-4} \text{ mol L}^{-1}$$

Hence, molar solubility of MY in water is less than that of NY_3 .

8. (d) : If the reaction is multiplied by $\frac{1}{2}$, then new equilibrium constant, $K' = K^{1/2}$.

9. (d) : One mole of NaOH is completely neutralised by one mole of HCl .

Hence, 0.01 mole of NaOH will be completely neutralised by 0.01 mole of HCl .

$\Rightarrow \text{NaOH left unneutralised} = 0.1 - 0.01 = 0.09 \text{ mol}$
As equal volumes of two solutions are mixed,

$$[\text{OH}]^- = \frac{0.09}{2} = 0.045 \text{ M}$$

$$\Rightarrow \text{pOH} = -\log(0.045) = 1.35$$

$$\therefore \text{pH} = 14 - 1.35 = 12.65$$

10. (a) : HCl is a strong acid and dissociates completely into ions in aqueous solution.

11. (d) : Acidic buffer is a mixture of a weak acid and its salt with a strong base. HClO_4 is a strong acid.

12. (b) :

Salt	K_{sp}	Solubility
Ag_2CrO_4	$1.1 \times 10^{-12} = 4s^3$	$s = \sqrt[3]{\frac{K_{sp}}{4}} = 0.65 \times 10^{-4}$
AgCl	$1.8 \times 10^{-10} = s^2$	$s = \sqrt{K_{sp}} = 1.34 \times 10^{-5}$
AgBr	$5 \times 10^{-13} = s^2$	$s = \sqrt{K_{sp}} = 0.71 \times 10^{-6}$
AgI	$8.3 \times 10^{-17} = s^2$	$s = \sqrt{K_{sp}} = 0.9 \times 10^{-8}$

Solubility of Ag_2CrO_4 is highest thus, it will be precipitated at last.

13. (a)

14. (a) : The value of K is high which means reaction proceeds almost to completion *i.e.*, the system will contain mostly products.

15. (c) : Na_2CO_3 which is a salt of NaOH (strong base) and H_2CO_3 (weak acid) will produce a basic solution with pH greater than 7.

$$\begin{aligned} 16. (\text{b}) : \Delta G^\circ &= -2.303RT \log K_{sp} \\ 63.3 \times 10^3 \text{ J} &= -2.303 \times 8.314 \times 298 \log K_{sp} \\ 63.3 \times 10^3 \text{ J} &= -5705.84 \log K_{sp} \\ \log K_{sp} &= -\frac{63.3 \times 10^3}{5705.84} = -11.09 \end{aligned}$$

$$K_{sp} = \text{antilog}(-11.09) = 8.128 \times 10^{-12}$$

17. (d) : As the forward reaction is exothermic and leads to lowering of pressure (produces lesser number of gaseous moles) hence, according to Le Chatelier's principle, at high pressure and low temperature, the given reversible reaction will shift in forward direction to form more product.

$$18. (\text{a}) : \log \frac{K'_p}{K_p} = -\frac{\Delta H}{2.303R} \left[\frac{1}{T_2} - \frac{1}{T_1} \right]$$

For exothermic reaction, $\Delta H = -\text{ve}$ *i.e.* heat is evolved. The temperature T_2 is higher than T_1 .

Thus, $\left(\frac{1}{T_2} - \frac{1}{T_1} \right)$ is negative.

so, $\log K'_p - \log K_p = -\text{ve}$ or $\log K_p > \log K'_p$
or $K_p > K'_p$

19. (a) : HCl and SO_2 are reducing agents. So they can reduce MnO_4^- .
 CO_2 is neither oxidising nor reducing agent, it will provide only acidic medium. It can shift the reaction in forward direction and the reaction can go to completion.

20. (a) : BF_3 is Lewis acid (e^- pair acceptor).

21. (b) : Degree of dissociation, $\alpha = \frac{3.7}{100} = 0.037$

According to Ostwald's formula,

$$K_a = \alpha^2 C = (0.037)^2 \times 0.10 = 1.369 \times 10^{-4} \approx 1.4 \times 10^{-4}$$

22. (d) : We know that, at 25°C , $K_w = 1 \times 10^{-14}$

At 100°C , $K_w = 55 \times 10^{-14}$

$$[\text{H}^+] = \sqrt{55 \times 10^{-14}}$$

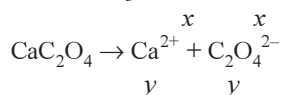
$$\text{pH} = -\log [\text{H}^+]$$

$$\text{pH} = -\log \left[\sqrt{55 \times 10^{-14}} \right]$$

$$= \frac{1}{2} [-\log(55 \times 10^{-14})] = \frac{1}{2} [-\log 55 + 14 \log 10]$$

$$= \frac{1}{2} [-1.74 + 14] = \frac{1}{2} [12.26] = 6.13$$

23. (d) : $\text{CaCO}_3 \rightarrow \text{Ca}^{2+} + \text{CO}_3^{2-}$



Now, $[\text{Ca}^{2+}] = x + y$

$$\text{and } x(x+y) = 4.7 \times 10^{-9} \quad \dots(\text{i})$$

$$y(x+y) = 1.3 \times 10^{-9} \quad \dots(\text{ii})$$

Dividing equation (i) and (ii) we get

$$\frac{x}{y} = 3.6$$

$$\therefore x = 3.6y$$

Putting this value in equation (ii), we get

$$y(3.6y + y) = 1.3 \times 10^{-9}$$

On solving, we get $y = 1.68 \times 10^{-5}$

$$\text{and } x = 3.6 \times 1.68 \times 10^{-5} = 6.048 \times 10^{-5}$$

$$\therefore [\text{Ca}^{2+}] = (x+y) = (1.68 \times 10^{-5}) + (6.048 \times 10^{-5})$$

$$\therefore [\text{Ca}^{2+}] = 7.728 \times 10^{-5} \text{ M}$$

24. (b) : $\text{pH} = \text{p}K_a + \log \frac{[\text{Salt}]}{[\text{Acid}]}$

$$5 = -\log K_a + \log \frac{[\text{Salt}]}{[\text{Acid}]} \quad [\because \text{p}K_a = -\log K_a]$$

$$5 = -\log [1 \times 10^{-4}] + \log \frac{[\text{Salt}]}{[\text{Acid}]}$$

$$5 = 4 + \log \frac{[\text{Salt}]}{[\text{Acid}]}$$

$$5 - 4 = \log \frac{[\text{Salt}]}{[\text{Acid}]}$$

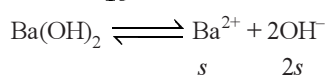
$$1 = \log \frac{[\text{Salt}]}{[\text{Acid}]}$$

$$\frac{[\text{Salt}]}{[\text{Acid}]} = 10 = 10 : 1$$

25. (b) : pH of solution = 12

$$[\text{H}^+] = 10^{-12}$$

$$[\text{OH}^-] = \frac{10^{-14}}{10^{-12}} = 10^{-2}$$



$$2s = 10^{-2} \Rightarrow s = \frac{10^{-2}}{2}$$

$$K_{sp} = (s)(2s)^2 = 4s^3$$

$$= 4 \times \left(\frac{10^{-2}}{2} \right)^3 = \frac{4}{8} \times 10^{-6} = 5 \times 10^{-7}$$

26. (a) : BaCl₂ is made up of Ba(OH)₂ and HCl.

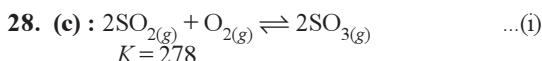
AlCl₃ is made up of Al(OH)₃ and HCl.

LiCl is made up of LiOH and HCl.

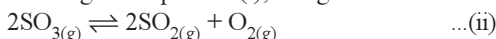
BeCl₂ is made up of Be(OH)₂ and HCl.

Ba(OH)₂ is strongest base among the given options thus have maximum pH.

27. (a)



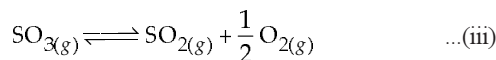
By reversing the equation (i), we get



Equilibrium constant for this reaction is

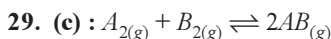
$$K' = \frac{1}{K} = \frac{1}{278}$$

By dividing the equation (ii) by 2, we get desired equation,

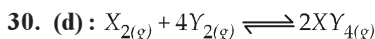


Equilibrium constant for this reaction

$$K'' = \sqrt{K'} = \sqrt{\frac{1}{K}} = \sqrt{\frac{1}{278}} = 0.0599 \approx 0.06 \text{ or } 6 \times 10^{-2}$$

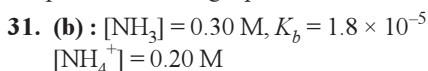


$$K_c = \frac{[AB]^2}{[A_2][B_2]} = \frac{(2.8 \times 10^{-3})^2}{(3.0 \times 10^{-3})(4.2 \times 10^{-3})} = \frac{2.8 \times 2.8}{4.2 \times 3.0} = 0.62$$



$$\Delta n_g = -\text{ve and } \Delta H = -\text{ve}$$

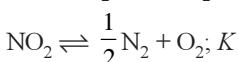
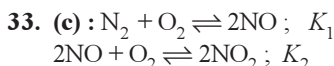
The reaction is favoured in forward direction at low temperature and high pressure.



$$\text{pOH} = \text{p}K_b + \log \frac{[\text{salt}]}{[\text{base}]} = 4.74 + \log \frac{0.2}{0.3} = 4.56$$

$$\text{pH} = (14 - 4.56) = 9.43$$

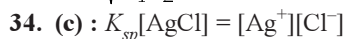
32. (c) : BF₃ is an electron deficient species and acts as Lewis base.



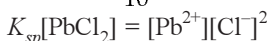
$$K_1 = \frac{[\text{NO}]^2}{[\text{N}_2][\text{O}_2]}; K_2 = \frac{[\text{NO}_2]^2}{[\text{NO}]^2[\text{O}_2]}$$

$$K = \frac{[\text{N}_2]^{1/2}[\text{O}_2]}{[\text{NO}_2]} = \sqrt{\frac{[\text{N}_2][\text{O}_2] \times [\text{NO}]^2[\text{O}_2]}{[\text{NO}]^2 \times [\text{NO}_2]^2}}$$

$$K = \sqrt{\frac{1}{K_1 K_2}}$$



$$[\text{Ag}^+] = \frac{1.8 \times 10^{-10}}{10^{-1}} = 1.8 \times 10^{-9} \text{ M}$$



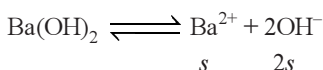
$$[\text{Pb}^{2+}] = \frac{1.7 \times 10^{-5}}{10^{-1} \times 10^{-1}} = 1.7 \times 10^{-3} \text{ M}$$

35. (d) : We Know, $\text{pH} + \text{pOH} = 14$

Here, $12 + \text{pOH} = 14$

$$\text{pOH} = 2$$

$$[\text{OH}^-] = 10^{-2}$$

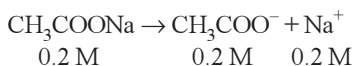
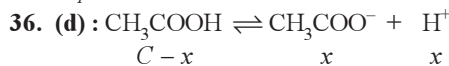


$$2S = [\text{OH}^-] = 10^{-2}$$

$$s = \frac{10^{-2}}{2} = 5 \times 10^{-3} \text{ M}$$

$$K_{sp} = [\text{Ba}^{2+}][\text{OH}^-]^2 = (5 \times 10^{-3})(10^{-2})^2$$

$$K_{sp} = 5 \times 10^{-7}$$



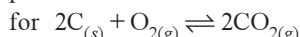
$$\begin{array}{ccc} C-x & x & x \\ 0.2 \text{ M} & 0.2 \text{ M} & 0.2 \text{ M} \end{array} \quad \left\{ \begin{array}{l} \text{acetic acid is a} \\ \text{weak acid so,} \\ \text{dissociation is} \\ \text{minimum.} \end{array} \right.$$

$$\begin{aligned} \therefore [\text{H}^+] &= \frac{K_a[\text{CH}_3\text{COOH}]}{[\text{CH}_3\text{COO}^-]} \\ &= \frac{1.8 \times 10^{-5} \times 10^{-1}}{2 \times 10^{-1}} = 9 \times 10^{-6} \text{ M} \end{aligned}$$

37. (d) : K_p and K_c are related by the equation,

$$K_p = K_c(RT)^{\Delta n_g}$$

where Δn_g = difference in the no. of moles of products and reactants in the gaseous state.



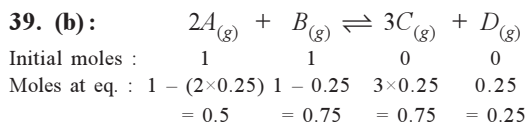
$$\Delta n_g = 2 - (1) = 1 \neq 0$$

38. (d) : We know, $\text{pOH} = \text{p}K_b + \log \frac{[\text{B}^-]}{[\text{HB}]}$

Since, $[\text{B}^-] = [\text{HB}]$ (given)

$$\therefore \text{pOH} = \text{p}K_b \Rightarrow \text{pOH} = 10$$

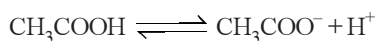
$$\therefore \text{pH} = 14 - 10 = 4$$



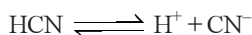
Equilibrium constant, $K = \frac{[C]^3[D]}{[A]^2[B]}$

$\therefore K = \frac{(0.75)^3(0.25)}{(0.5)^2(0.75)}$

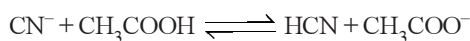
40. (c): Given,



$$K_1 = \frac{[\text{CH}_3\text{COO}^-][\text{H}^+]}{[\text{CH}_3\text{COOH}]} = 1.5 \times 10^{-5}$$



$$K_2 = \frac{[\text{CN}^-][\text{H}^+]}{[\text{HCN}]} = 4.5 \times 10^{-10}$$



$$K = \frac{[\text{HCN}][\text{CH}_3\text{COO}^-]}{[\text{CN}^-][\text{CH}_3\text{COOH}]}$$

$$K = \frac{K_1}{K_2} = \frac{1.5 \times 10^{-5}}{4.5 \times 10^{-10}} \approx 0.3 \times 10^5$$

or $K = 3 \times 10^4$

41. (d): Lewis acids are electron deficient compounds, since $(\text{CH}_3)_3\text{B}$ is electron deficient (due to incomplete octet of B), it acts as a Lewis acid.

42. (d): NH_4Cl is a salt of strong acid and weak base, so hydrolysis constant is

$$K_h = \frac{K_w}{K_b}$$

Given, $K_b(\text{NH}_4\text{OH}) = 1.77 \times 10^{-5}$

$$K_w = 10^{-14}$$

$\therefore K_h = \frac{10^{-14}}{1.77 \times 10^{-5}} = 0.565 \times 10^{-9}$

or $K_h = 5.65 \times 10^{-10}$

43. (d): Millimoles of H^+ produced = $20 \times 0.05 = 1$

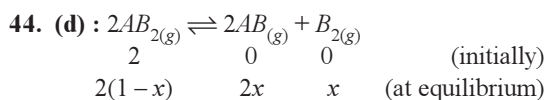
Millimoles of OH^- produced = $30 \times 0.1 \times 2 = 6$

(\because Each $\text{Ba}(\text{OH})_2$ gives 2OH^- .)

\therefore Millimoles of OH^- remaining in solution = $6 - 1 = 5$

Total volume of solution = $20 + 30 = 50$ mL

$\therefore [\text{OH}^-] = \frac{5}{50} = 0.1 \text{ M}$



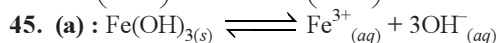
Amount of moles at equilibrium = $2(1-x) + 2x + x = 2+x$

$$K_p = \frac{[p_{AB}]^2 [p_{B_2}]}{[p_{AB_2}]^2}$$

$$K_p = \frac{\left(\frac{2x}{2+x} \times P\right)^2 \times \left(\frac{x}{2+x} \times P\right)}{\left(\frac{2(1-x)}{2+x} \times P\right)^2} = \frac{4x^3 \times P}{2+x} \times \frac{1}{4(1-x)^2}$$

$$K_p = \frac{4x^3 \times P}{2} \times \frac{1}{4} \quad (\because 1-x \approx 1 \text{ \& } 2+x \approx 2)$$

$$x = \left(\frac{8K_p}{4P}\right)^{1/3} \Rightarrow x = \left(\frac{2K_p}{P}\right)^{1/3}$$



$$K = \frac{[\text{Fe}^{3+}][\text{OH}^-]^3}{[\text{Fe}(\text{OH})_3]}$$

$K = [\text{Fe}^{3+}][\text{OH}^-]^3$ (activity of solid is taken unity)

Concentration of OH^- ion in the reaction is decreased by $1/4$ times then equilibrium concentration of Fe^{3+} will be increased by 64 times in order to keep the value of K constant.

46. (d): $\text{pH} = -\log[\text{H}^+]$

or $[\text{H}^+] = 10^{-\text{pH}}$; $[\text{H}^+]$ of soln. 1 = 10^{-3}

$[\text{H}^+]$ of soln. 2 = 10^{-4} ; $[\text{H}^+]$ of soln. 3 = 10^{-5}

Total concentration of $[\text{H}^+]$

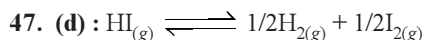
$$= 10^{-3}(1 + 1 \times 10^{-1} + 1 \times 10^{-2})$$

$$\Rightarrow 10^{-3} \left(\frac{1}{1} + \frac{1}{10} + \frac{1}{100} \right) \Rightarrow 10^{-3} \left(\frac{100 + 10 + 1}{100} \right)$$

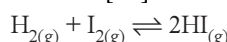
$$\Rightarrow 10^{-3} \left(\frac{111}{100} \right) = 1.11 \times 10^{-3}$$

So, H^+ ion concentration in mixture of equal volume

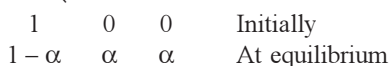
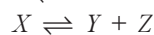
of these acid solution = $\frac{1.11 \times 10^{-3}}{3} = 3.7 \times 10^{-4} \text{ M}$



i.e. $K = \frac{[\text{H}_2]^{1/2} [\text{I}_2]^{1/2}}{[\text{HI}]} = 8$



$$K' = \frac{[\text{HI}]^2}{[\text{H}_2][\text{I}_2]} = \left(\frac{1}{8}\right)^2 \Rightarrow K' = \frac{1}{64}$$



Total no. of moles at equilibrium = $1 - \alpha + 2\alpha = 1 + \alpha$

Similarly,



1 0 Initially

$1 - \alpha$ 2α At equilibrium

Total no. of moles at equilibrium = $1 - \alpha + 2\alpha = 1 + \alpha$

$$\therefore K_{p1} = \frac{p_Y \times p_Z}{p_X} = \frac{\frac{\alpha}{1+\alpha} \times P_1 \times \frac{\alpha}{1+\alpha} \times P_1}{\frac{1-\alpha}{1+\alpha} \times P_1}$$

$$K_{p2} = \frac{(p_B)^2}{p_A} = \frac{\left(\frac{2\alpha}{1+\alpha} \times P_2\right)^2}{\frac{1-\alpha}{1+\alpha} \times P_2}$$

$$\text{Now } \frac{K_{p1}}{K_{p2}} = \frac{P_1}{4P_2} \Rightarrow \frac{P_1}{P_2} = \frac{36}{1} = 36:1$$

49. (a) : For a weak acid, degree of dissociation,

$$\alpha = \sqrt{\frac{K_a}{C}} = \sqrt{\frac{1 \times 10^{-5}}{0.1}} = 10^{-2} \quad \text{i.e. } 1.00\%$$

50. (a) : Given, $[\text{H}_3\text{O}^+] = 1 \times 10^{-10}$ or, $\text{pH} = 10$

Now at 25°C , $\text{pH} + \text{pOH} = \text{p}K_w = 14$

or, $\text{pOH} = 14 - \text{pH} = 14 - 10 = 4$

51. (c) : $\text{CH}_{4(g)} + 2\text{O}_{2(g)} \rightleftharpoons \text{CO}_{2(g)} + 2\text{H}_2\text{O}_{(l)}$

$$K_p = \frac{P_{\text{CO}_2}}{P_{\text{CH}_4} \cdot P_{\text{O}_2}^2}$$

52. (b) : HNO_2 and NaNO_2 are examples of acidic buffer.

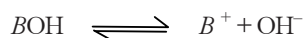
53. (c) : $10^{-8} \text{ M HCl} = 10^{-8} \text{ M H}^+$

Also from water, $[\text{H}^+] = 10^{-7}$

Total $[\text{H}^+] = 10^{-7} + 0.10 \times 10^{-7} = 1.1 \times 10^{-7}$

54. (d) : $C = 0.01 \text{ M}$

$K_b = 1 \times 10^{-12}$ at 25°C



C 0 0

at eq. $C - C\alpha$ $C\alpha$ $C\alpha$

$[\text{OH}^-] = C\alpha$

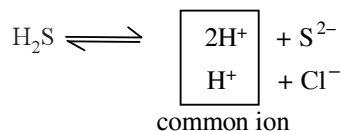
$$[\text{OH}^-] = \sqrt{K_b C} = \sqrt{1 \times 10^{-12} \times 10^{-2}}$$

$$[\text{OH}^-] = 10^{-7} \text{ mol L}^{-1}$$

55. (a) : The cation of group II are precipitated as their sulphides.

Solubility product of sulphide of group II radicals are very low. Therefore, even with low conc. of S^{2-} ions, the ionic product exceeds the value of their solubility product and the radical of group II gets precipitated. The low conc. of S^{2-} ions is obtained

by passing H_2S gas through the solution of the salt in the presence of dil. HCl which suppresses degree of ionisation of H_2S by common ion effect.



Note: Solubility product of group IV radicals are quite high.

It is necessary to suppress the conc. of S^{2-} ions, otherwise radical of group IV will also get precipitated along with group II radicals.

$$\text{56. (a) : } K_1 = \frac{P_{\text{NO}_2}}{P_{\text{NO}} \cdot (P_{\text{O}_2})^{1/2}} \quad \dots(1)$$

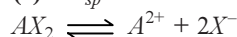
$$K_2 = \frac{(P_{\text{NO}})^2 \cdot P_{\text{O}_2}}{(P_{\text{NO}_2})^2} \quad \dots(2)$$

taking square root on both sides in eq. 2.

$$\Rightarrow \sqrt{K_2} = \frac{P_{\text{NO}} \cdot (P_{\text{O}_2})^{1/2}}{P_{\text{NO}_2}}$$

$$\Rightarrow \sqrt{K_2} = \frac{1}{K_1} ; \Rightarrow K_2 = \frac{1}{K_1^2}$$

57. (c) : $K_{sp} = 3.2 \times 10^{-11}$

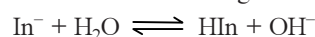


$$K_{sp} = s \times (2s)^2 = 4s^3; \quad \text{i.e., } 3.2 \times 10^{-11} = 4s^3$$

$$\text{or, } s^3 = 0.8 \times 10^{-11} = 8 \times 10^{-12}$$

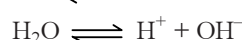
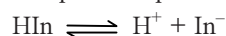
$$\therefore s = 2 \times 10^{-4}$$

58. (d) : Let us consider the formation of a salt of a weak acid and a strong base.



$$K_h = \frac{[\text{HIn}][\text{OH}^-]}{[\text{In}^-]} \quad \dots(i)$$

Other equations present in the solution are



$$K_{\text{In}} = \frac{[\text{H}^+][\text{In}^-]}{[\text{HIn}]} \quad \dots(ii)$$

$$K_w = [\text{H}^+][\text{OH}^-] \quad \dots(iii)$$

From (ii) and (iii),

$$\frac{K_w}{K_{\text{In}}} = \frac{[\text{HIn}][\text{OH}^-]}{[\text{In}^-]} = K_h \quad \dots(iv)$$

$$[\text{OH}^-] = \frac{K_w [\text{In}^-]}{K_{\text{In}} [\text{HIn}]}$$

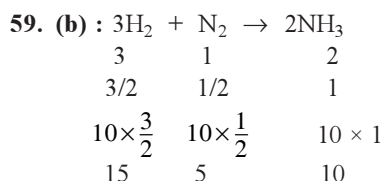
$$\log [\text{OH}^-] = \log K_w - \log K_{\text{In}} + \log \frac{[\text{In}^-]}{[\text{HIn}]}$$

$$-\text{pOH} = -\text{p}K_w + \text{p}K_{\text{In}} + \log \frac{[\text{In}^-]}{[\text{HIn}]}$$

$$\text{p}K_w - \text{pOH} = \text{p}K_{\text{In}} + \log \frac{[\text{In}^-]}{[\text{HIn}]}$$

$$\text{or, pH} = \text{p}K_{\text{In}} + \log \frac{[\text{In}^-]}{[\text{HIn}]}$$

$$\text{i.e. } \log \frac{[\text{In}^-]}{[\text{HIn}]} = \text{pH} - \text{p}K_{\text{In}}$$

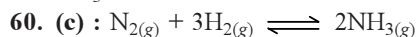


Composition of gaseous mixture under the aforesaid condition in the end

$$\text{H}_2 = 30 - 15 = 15 \text{ litres}$$

$$\text{N}_2 = 30 - 5 = 25 \text{ litres}$$

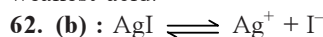
$$\text{NH}_3 = 10 \text{ litres}$$



$$K_c = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3}; \quad \Delta n = 2 - 4 = -2$$

Thus the reaction will shift in forward direction when $Q > K_c$.

61. (d) : Due to strong hydrogen-fluorine bond, proton is not given off easily and hence, HF is weakest acid.



$$1.0 \times 10^{-16} = s \times s$$

$$\text{Solubility of } \text{Ag}^+ = 1.0 \times 10^{-8} \text{ mol L}^{-1}$$

$$\text{Solubility of AgI in KI solution} = 1.0 \times 10^{-8} \times 10^{-4} \\ = 1.0 \times 10^{-12} \text{ mol L}^{-1}$$

63. (c) : Pressure of O_2 does not depend on concentration terms of other reactants (because both are in solid state), since this is an endothermic reaction. If the temperature be raised dissociation of BaO_2 would occur, more O_2 is produced at equilibrium, pressure of O_2 increases.

64. (d) : If s is the solubility of the electrolyte MX_2

$$C_{\text{M}^{2+}} = s, C_{\text{X}^-} = 2s$$

$$\text{Solubility product, } K_{\text{sp}} = s \times (2s)^2 = 4s^3;$$

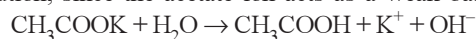
$$s = 0.5 \times 10^{-4} \text{ mole/litre}$$

$$\therefore K_{\text{sp}} = 4 \times (0.5 \times 10^{-4})^3; K_{\text{sp}} = 5 \times 10^{-13}$$

65. (b) : NH_4OH is a weak base but HCl is a strong acid in solution, so pH of NH_4Cl solution is comparatively low.

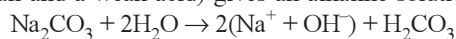
NaNO_3 is a salt of strong base and strong acid, so pH of the solution will be 7.

Hydrolysis of potassium acetate (a salt of a weak acid and a strong alkali) gives a weakly alkaline solution, since the acetate ion acts as a weak base.



The pH of this solution ≈ 8.8 .

Hydrolysis of sodium carbonate (a salt of strong alkali and a weak acid) gives an alkaline solution



The pH of this solution is > 10 .

66. (b) : Solution of 0.1 N NH_4OH and 0.1 N NH_4Cl is a buffer solution.

According to Henderson equation, the pH of a basic buffer,

$$\text{pH} = 14 - \text{p}K_b - \log \frac{C_{\text{salt}}}{C_{\text{base}}}$$

$$\Rightarrow \text{p}K_b = 14 - \text{pH} - \log \frac{C_{\text{salt}}}{C_{\text{base}}}$$

$$\Rightarrow \text{p}K_b = 14 - 9.25 - \log \frac{0.1}{0.1}$$

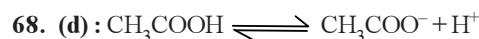
$$\Rightarrow \text{p}K_b = 14 - 9.25 = 4.75$$

$$\therefore \text{p}K_b \text{ of } \text{NH}_4\text{OH} = 4.75$$

67. (c) : Proton accepting tendency is known as the strength of basicity.

In $\text{R}-\ddot{\text{N}}\text{H}_2$, N has lone pair of electron which intensify due to electron releasing R-group and increase the tendency to donate lone pair of electrons to H^+ .

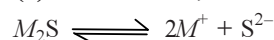
Secondly as the size of the ion increases there is less attraction for H^+ to form weaker bonds with H – atom and are less basic. The order of the given series: $\text{RNH}_2 > \text{NH}_3 > \text{HS}^- > \text{I}^-$.



$$K_{\text{ion}} = \frac{[\text{CH}_3\text{COO}^-][\text{H}^+]}{[\text{CH}_3\text{COOH}]}$$

$$[\text{CH}_3\text{COOH}] = \frac{3.4 \times 10^{-4} \times 3.4 \times 10^{-4}}{1.7 \times 10^{-5}} = 6.8 \times 10^{-3}$$

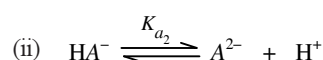
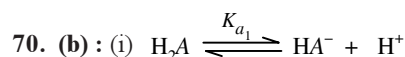
69. (b) : For reaction,



$$\text{Solubility} = 3.5 \times 10^{-6}$$

$$\text{Solubility product, } K_{\text{sp}} = [\text{M}^+]^2 [\text{S}^{2-}]$$

$$= (2s)^2 s = 4s^3 = 4 \times (3.5 \times 10^{-6})^3 = 1.7 \times 10^{-16}$$



In the 1st step H^+ ion comes from neutral molecule, while in the 2nd step the H^+ ion comes from negatively charged ions. The presence of -ve charge makes the removal H^+ ion difficult. Thus, $K_{a1} > K_{a2}$.

71. (b) : For a reaction, $A + B \rightleftharpoons C + D$.

$$K_{eq} = \frac{[C][D]}{[A][B]}$$

Increase in conc. of reactants will proceed the equilibrium in the forward direction giving more products. So that the equilibrium constant value remains constant and independent of concentration.

72. (d) : $NH_2^- + H^+ \rightarrow NH_3$ (conjugate acid)

Substance + H^+ \rightarrow conjugate acid

Substance - H^+ \rightarrow conjugate base.

73. (b) : After mixing 1 N solution of CH_3COOH (weak acid) and 1 N NaOH (strong base), the resulting solution will have free OH^- ions. Thus pH will be higher than 7.

74. (a) : $K_p = P_{CO_2}$

Solids do not exert pressure, so their partial pressure is taken as unity.

75. (d) : $CH_3COOH \rightleftharpoons CH_3COO^- + H^+$
Weak acid Conjugate base

As CH_3COOH is the weakest acid, so its conjugate base (CH_3COO^-) is the strongest base. H_2SO_4 , HCl , HNO_3 are strong acids, so their conjugate bases are weak.

76. (a) : $[H^+] = C\alpha = 0.1 \times 0.02 = 2 \times 10^{-3} M$
(As degree of dissociation = 2% = 0.02)

$$\text{Hence } [OH^-] = \frac{10^{-14}}{2 \times 10^{-3}} = 5 \times 10^{-12} M$$

77. (d) : For CaF_2 , decomposition is as follows:

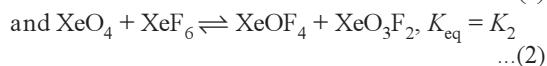
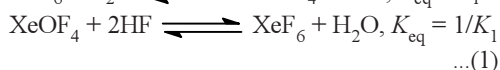
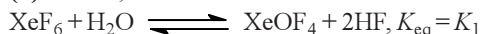


$$\Rightarrow K_{sp} = [Ca^{2+}][F^-]^2 = s \times (2s)^2$$

$$\text{or, } K_{sp} = 4s^3 \Rightarrow K_{sp} = 4s^3 = 4 \times (2 \times 10^{-4})^3$$

$$\Rightarrow K_{sp} = 32 \times 10^{-12}$$

78. (d) : Given,



The reaction, $XeO_4 + 2HF \rightleftharpoons XeO_3F_2 + H_2O$, can be obtained by adding eq. (1) and eq. (2).

So, the equilibrium constant for the above reaction can be obtained by multiplying the equilibrium constants of eq. (1) and eq. (2).

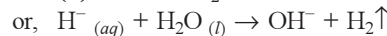
Hence, the value is $= \frac{K_2}{K_1}$

79. (b) : $pH = pK_a + \log \frac{[Salt]}{[Acid]}$

For small concentration of buffering agent and for maximum buffer capacity $[Salt]/[Acid] \approx 1$

i.e., $pH = pK_a$.

80. (d) : $NaH + H_2O \rightarrow NaOH + H_2$



Hydride ions will abstract proton from NaOH and hydrogen gas will evolve as a result of it.

81. (b) : The greater the solubility product, the greater is the solubility.

82. (c) : The equilibrium constant for the reverse reaction will be $1/K$.

83. (d) : At high temperature, the value of ionic product increases.

84. (c) : Total number of moles $= 2(1 - \alpha) + 2\alpha = 2$

85. (b) : Since NaOH is a strong base, therefore it completely ionises. Thus, the hydroxyl ion concentration is equal to that of the base itself. We know that concentration of OH^- in $N/10$ NaOH $= 0.1 = 10^{-1}$. Therefore value of

$$H_3O^+ = \frac{K_w}{[OH^-]} = \frac{1 \times 10^{-14}}{10^{-1}} = 1 \times 10^{-13}$$

$$pH = -\log [H_3O^+] = -\log [1 \times 10^{-13}] = 13$$

86. (b) : In BF_3 and $FeCl_3$ molecules, the central atoms have incomplete octet and in SiF_4 , the central atom has empty *d*-orbitals. Hence, according to Lewis concept, these are Lewis acids.

87. (d) : The pH value of the blood is maintained constant by buffer solution present in the blood itself. Buffer solutions resist the change in pH values.

88. (c) : Since HCl is a strong acid and it completely ionises, therefore H_3O^+ ions concentration is equal that of the acid itself *i.e.* $[H_3O^+] = [HCl] = 10 M$.

$$\text{Therefore } pH = -\log [H_3O^+] = -\log [10] = -1$$

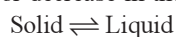
89. (a) : There are greater number of particles (*i.e.* ions) compared to others. Hence, solubility will be minimum.

90. (a) : Vapour pressure is directly related to temperature. Greater is the temperature, greater will be the vapour pressure. So to keep it constant, temperature should be constant.

91. (d) : Higher the value of solubility product, greater is the solubility.

92. (a) : $[\text{H}_3\text{O}^+] = [\text{OH}^-] = 1 \times 10^{-6}$ mole/litre
 $K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = [1 \times 10^{-6}] \times [1 \times 10^{-6}] = 1 \times 10^{-12}$

93. (d) : When solid and liquid are in equilibrium, the increase in temperature results in increase in volume of liquid or decrease in the amount of solid.



With increase in temperature equilibrium shifts in forward direction.

94. (a) : Sodium borate is a salt formed from strong base (NaOH) and weak acid (H_3BO_3). Hence, sodium borate will act basic.

95. (d) : According to Le Chatelier's principle, if an equilibrium is subjected to a change in

concentration, pressure or temperature, etc. equilibrium shift in such a way so as to undo the effect of a change imposed.

96. (b) : $\text{CH}_3\text{COOH} + \text{H}_2\text{O} \rightleftharpoons \text{CH}_3\text{COO}^- + \text{H}_3\text{O}^+$

97. (a) : Reaction (ii) is the reversible reaction of (i) and is half of the reaction (i). Thus, rate constant can be given as:

$$K_2 = \sqrt{\frac{1}{K_1}} \quad \text{or} \quad K_1 = \left[\frac{1}{K_2} \right]^2$$

98. (c) : NH_4Cl and NaHCO_3 are acidic in nature and NaCl is neutral. Only Na_2CO_3 is basic and thus have highest pH.

