I –CHEMISTRY
CHEMICAL EQUILIBRIUM & IONIC EQUILIBRIUM

1. One mole of nitrogen is mixed with three moles of hydrogen in a 4 litre container. If 0.0025 mole of nitrogen is converted to ammonia by the following reaction

   $N_{2\,(g)} + 3H_{2\,(g)} \rightleftharpoons 2NH_{3\,(g)}$ the equilibrium constant (K_c) for the following reaction is

   $\frac{1}{2}N_{2\,(g)} + \frac{3}{2}H_{2\,(g)} \rightleftharpoons NH_{3\,(g)}$

   a) 1.48×10^{-5} litre mol^{-1} b) 3.82×10^{-3} litre mol^{-1}
   c) 38.2×10^{-3} litre mol^{-1} d) 14.8×10^{-5} litre mol^{-1}

2. Standard entropy of X_2, $Y_2$and XY_3 are 60, 40 and 50 JK^{-1} mol^{-1}, respectively. For the reaction, $\frac{1}{2}X_2 + \frac{3}{2}Y_2 \rightarrow XY_3$, $\Delta H = -30$ kJ, to be at equilibrium, the temperature will be

   a) 1000 K b) 1250 K c) 500 K d) 750 K

3. Five moles of sulphur dioxide and five moles of oxygen are allowed to react to form sulphur trioxide in a closed vessel. When the equilibrium is reached, it is found that 60% of sulphur dioxide is used up. the total number of moles of sulphur dioxide, oxygen and sulphur trioxide in the vessel now is

   a) 8.5 b) 10.0 c) 9.0 d) 10.5

4. Equilibrium constants K_1 and K_2 for the following equilibria:

   $NO_{(g)} + \frac{1}{2}O_2 \xrightleftharpoons{K_2} NO_{2\,(g)}$ and $2NO_{2\,(g)} \xrightleftharpoons{K_1} 2NO_{(g)} + O_{2\,(g)}$ are related as:

   a) $K_2 = 1/K_1^2$ b) $K_2 = K_1^2$ c) $K_2 = 1/K_1$ d) $K_2 = K_1/2$

5. The reaction $X + Y \rightleftharpoons Z + W$ proceeds to right hand side upto 99.9%. The equilibrium constant K of the reaction will be

   a) 10^4 b) 10^5 c) 10^6 d) 10^8

6. At equilibrium, the concentration of $N_2 = 3 \times 10^{-3}$ M, $O_2 = 4.2 \times 10^{-3}$ M and NO $= 2.8 \times 10^{-3}$ M in a sealed tube at 800 K. The value of K_c for the reaction;

   $N_{2\,(g)} + O_{2\,(g)} \rightleftharpoons 2NO_{(g)}$ is

   a) 0.207 b) 0.222 c) 0.622 d) none

7. For reaction: $2NOCl_{(g)} \rightarrow 2NO_{(g)} + Cl_{2\,(g)}$, K_c at 427^0 C is 3×10^{-6} L mol^{-1}. The value of K_p is nearly

   a) 7.50×10^{-5} b) 2.50×10^{-5} c) 2.50×10^{-4} d) 1.75×10^{-4}

8. Consider the reactions, $NO_2 \rightleftharpoons \frac{1}{2}N_2 + O_2$, K_1 $N_2O_4 \rightleftharpoons 2NO_2$, K_2 Give the equilibrium constant for the formation N_2O_4 from N_2 and O_2.

a) $\frac{1}{K_1^2} + \frac{1}{K_2}$ b) $\frac{1}{2K_1} + \frac{1}{K_2}$ c) $\sqrt{\frac{1}{K_1K_2}}$ d) $\frac{K_2}{K_1}$

9. One mole of a compound AB reacts with one mole of a compound CD according to the equation; AB + CD → AD + CB. When equilibrium had been established it was found that 3/4 mole each of reactants AB and CD had been converted to Ad and CB. There is no change is volume. The equilibrium constant for the reaction is

a) 9/16 b) 1/9 c) 16/9 d) 9

10. If S_1, S_2, S_3 and S_4 are the solubilities of AgCl in water, in 0.01 M $CaCl_2$, in 0.01 M NaCl and in 0.05 M $AgNO_3$ respectively at a certain temperature, the correct order of solubilities is

a) $S_1 > S_2 > S_3 > S_4$ b) $S_1 > S_3 > S_2 > S_4$

c) $S_1 > S_2 = S_3 > S_4$ d) $S_1 > S_3 > S_4 > S_2$.

11. 0.01 mole of lime (CaO) was dissolved in 100 cm^3 of water. Assuming the base is completely ionized in the solution, the pH of the solution will be

a) 1.3 b) 13.3 c) 12.3 d) 12.0

12. 0.01 M H_2SO_4 is ionized to the extent of 95%. The pH of the solution will be

a) between 0 and 0.5 b) between 0.5 and 1.0

c) between 1.0 and 1.5 d) between 1.5 and 2.0

13. The pH of an aqueous solution of Ba $(OH)_2$ is 10. If the K_{sp} of Ba $(OH)_2$ is 1 x 10^{-9}, then the conc. of Ba^{+2} ions in the solution in mol L^{-1} is

a) 1 x 10^{-2} b) 1 x 10^{-4} c) 1 x 10^{-1} d) 1 x 10^{-5}

14. A solution of an acid has pH = 4.70. Find out the concentration of OH^- ions (pK_w = 14)

a) 5 x 10^{-10} M b) 4 x 10^{-10} M c) 2 x 10^{-5} M d) 9 x 10^{-4} M

15. The solubility product of AgI at 25^0 C is 1.0 x 10^{-16} mol^2 L^{-2}. The solubility of AgI in 10^{-4} N solution of KI at 25^0 C is approximately (in mol L^{-1})

a) 1.0 x 10^{-16} b) 1.0 x 10^{-12} c) 1.0 x 10^{-10} d) 1.0 x 10^{-8}

16. The pK_a of acetic acid is 4.74. The concentration of CH_3COOH is 0.01 M. The pH of CH_3COOH is

a) 3.37 b) 4.37 c) 4.74 d) 0.474

17. On adding 0.1 M solution each of Ag^+, Ba^{2+}, Ca^{2+} ions in a Na_2SO_4 solution, species first precipitated is (K_{sp} $BaSO_4$ = 10^{-11}, K_{sp} $CaSO_4$ = 10^{-6}, K_{sp} Ag_2SO_4 = 10^{-5})

a) Ag_2SO_4 b) $BaSO_4$ c) $CaSO_4$ d) all of these

18. At 25^0 C, the value of pK_b (K_b being the dissociation constant of the base) for NH_3 in aqueous solution is 4.7. What is the pH of a 0.1 M aqueous solution of NH_4Cl with 0.01 M NH_3 (approx)?

a) 8.3 b) 9 c) 9.5 d) 10

19. A solution has 0.05 m Mg^{2+} ions and 0.05 M NH_3. Calculate the concentration of NH_4Cl required to prevent the formation of $Mg(OH)_2$ in this solution. K_{sp} of $Mg(OH)_2 = 9.0 \times 10^{-12}$ and ionization constant of $NH_3 = 1.8 \times 10^{-5}$.

a) 0.05 M b) 0.067 M c) 2.0×10^6 M d) 1.8×10^{-10} M

20. What is the equilibrium expression for the reaction, $P_4(s) + 5O_2(g) \rightleftharpoons P_4O_{10}(s)$?

a) $K_c = \frac{1}{[O_2]^5}$ b) $K_c = [O_2]^5$ c) $K_c = \frac{[P_4O_{10}]}{5[P_4][O_2]}$ d) $K_c = \frac{[P_4O_{10}]}{[P_4][O_2]^5}$

21. The value of K_c for the reaction, $3O_2(g) \rightleftharpoons 2O_3(g)$ is 2.0×10^{-50} at 25^0C. If the eq2uilibtrium concentration of O_2 in air at 25^0 C is 1.6×10^{-2}, what is the concentration of O_3?

a) $2.0 \times 10^{-50} \times (1.6 \times 10^{-2})^3$ b) 2.86×10^{-28}

c) $(1.6 \times 10^{-2})^4$ d) Both (a) and (b)

22. Equilibrium constants K_1 and K_2 for the following equilibria

$NO(g) + \frac{1}{2}O \overset{K_1}{\rightleftharpoons} NO_2(g)$ and, $2NO_2(g) \overset{K_2}{\rightleftharpoons} 2NO(g) + O_2(g)$ are related as

a) $K_1 = \frac{1}{K_2}$ b) $K_2 = \frac{1}{K_1}$ c) $K_2 = \frac{1}{K_1^2}$ d) $K_1 = \frac{1}{K_2^2}$

23. What is the effect of pressure by doubling the volume on the following system at 500^0 C?

$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

a) Shift to product side b) Shift to reactant side

c) Liquifaction of HI d) No effect

24. The ionisation constant of acetic acid is 1.74×10^{-5}. The degree of dissociation of acetic acid in its 0.05 M solution and its pH are respectively

a) 1.86×10^{-2}, 4 b) 1.24×10^{-3}, 3 c) 1.24×10^{-3}, 4 d) 1.86×10^{-2}, 3

25. NaOH(aq), HCl(aq) and NaCl(aq) concentration of each is 10^{-3} M. Their pH will be respectively

a) 10, 6, 2 b) 11, 3, 7 c) 10, 2, 6 d) 3, 4, 7

26. pH of a solution of a strong acid is 5.0. What will be the pH of the solution obtained after diluting the given solution 100 times?

a) 5.8 b) 6.7 c) 9.3 d) 13

27. K_a for CH_3COOH is 1.8×10^{-5} and K_b for NH_4OH is 1.8×10^{-5}. The pH of ammonium acetate will be

a) 7.005 b) 4.75 c) 7.0 d) between 6 and 7

28. In Haber's process, 30 L of dihydrogen and 30 L 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 at the end?

a) 10 L NH_3, 25 L N_2, 15 L H_2 b) 20 L NH_3, 20 L N_2, 20 L H_2
c) 20 L NH_3, 25 L N_2, 15 L H_2 d) 20 L NH_3, 10 L N_2, 30 L H_2

29. Conjugate acid of a weak base is always stronger. The decreasing order of basic strength of the following conjugate bases is OH^-, RO^-, CH_3COO^-, Cl^-

a) $RO^- > OH^- > CH_3COO^- > Cl^-$ b) $OH^- > RO^- > CH_3COO^- > Cl^-$
c) $Cl^- > RO^- . OH^- > CH_3COO^-$ d) $CH_3COO^- > RO^- > OH^- > Cl^-$

30. What mole of $Ca(OH)_2$ is dissolved in 250 mL aqueous solution to give a solution of pH 10.65, assuming full dissociation?

a) 0.47×10^{-4} b) 0.48×10^{-4} c) 0.56×10^{-4} d) 0.68×10^{-4}

31. Solubility product constant (K_{sp}) of slats of types MX, MX_2 and M_3X at temperature T are
4.0×10^{-8}, 3.2×10^{-14} and 2.7×10^{-15}, respectively. Solubilities (mol dm^{-3}) of the slats at temperature T are in the order

a) $MX > MX_2 > M_3X$ b) $M_3X > MX_2 > MX$
c) $MX_2 > M_3X > MX$ d) $MX > M_3X > MX_2$

32. A reaction mixture containing 0.050 atm N_2, 3.0 atm H_2 and 0.050 atm NH_3 is heated to 450^0 C. The value of K_p is 4.28×10^{-5} atm^{-2}. $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$
The correct statement (s) is/are

a) reaction goes towards the left
b) reaction goes towards the right
c) N_2 and H_2 combine to form ammonia
d) ammonia gas decomposes into H_2 and N_2

33. The pH of a 0.1 molar solution of the acid HQ is 3. The value of the ionisation constant, K_a of the acid is

a) 3×10^{-1} b) 1×10^{-3} c) 1×10^{-5} d) 1×10^{-7}

34. Phosphorus pentachloride dissociates as follows, in a closed reaction vessel,
$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$
If Total pressure, at equilibrium, of the reaction mixture is p and degree of dissociation of PCl_5 is z, the partial pressure of PCl_3 will be

a) $\left(\frac{x}{x+1}\right)$ p b) $\left(\frac{2x}{1-x}\right)$ p c) $\left(\frac{x}{x-1}\right)$ p d) $\left(\frac{x}{1-x}\right)$ p

35. The solubility product of a slat having general formula MX_2, in water is 4×10^{-12}. The concentration of M^{2+} ions in the aqueous solution of the salt is

a) 4.0×10^{-10} M b) 1.6×10^{-4} M c) 1.0×10^{-4} M d) 2.0×10^{-6} M

36. For the reaction, $CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$, the K_p/K_c is equal to

a) 1/RT b) RT c) $\sqrt{RT}$ d) 1.0

37. At a certain temperature, the dissociation constants of formic acid and acetic acid are 1.8×10^{-4} and 1.8×10^{-5} respectively. The concentration of acetic acid solution in

a) 0.01 M b) 0.04 M c) 0.05 M d)0.08 M

38. The self ionization constant of pure formic acid K = $[HCOOH_2^+]$ $[HCOO^-]$ is 10^{-6} at room temperature. Taking the density of formic acid as 1.22 g/cm^3, percentage of formic acid molecules in pure formic acid that are converted into formate ions is

a) 0.4% b) 0.04%
c) 0.004% d) none of these is correct

39. If to 100 mL of 0.1 M acetic acid solution, 0.82 g of sodium acetate is added, the pH of the solution (assume no dilution factor) becomes

a) 3.75 b) 4.75 c) 5.25 d) 5.75

40. 100ml of 0.12M HCl and 100ml of 0.1M sodium hydroxide solutions are mixed together. What is the p^H of the resulting solution is

a) 2 b) 12 c) 10 d) 4

41. At 425^{0}C, for the gaseous reaction $H_2 + I_2 \rightleftharpoons 2HI$; K_c = 64. What weight of HI will be formed at equilibrium, if 1 mole of H_2 and 1 mole of iodine are placed in a 1 litre vessel at 425^0 C

a) 2048g b) 204.8 g c) 20.48g d) 2.048

42. In a system: A (s) $\rightleftharpoons$ 2B (g) + 3C (g)
If the concentration of C at equilibrium is increased by a factor of 2, it will cause the equilibrium concentration of B to change to

a) $\frac{1}{2\sqrt{2}}$ times the original value b) $2\sqrt{2}$ times the original value
c) $\frac{1}{2}$ of its original value d) $\frac{1}{4}$ of its original value

43. For which of the following sparingly soluble salt, the solubility (S) and solubility product (K_{sp}) are related by the expression: S = $\left[\frac{K_{sp}}{4}\right]^{1/3}$

a) $BaSO_4$ b) $Ca_3(PO_4)_2$ c) Hg_2Cl_2 d) Ag_3PO_4

44. A mixture of SO_2, SO_3 and O_2 is taken in a 10 litre flask at a temperature at which

K_c = 100 for the reaction $2SO_2 + O_2 \rightleftharpoons 2\ SO_3$

If the number of moles of SO_3 in the flask is double the number of moles of SO_2, the number of moles of O_2 in the flask is

a) 0.2 b) 0.4 c) 4 d) 2.0

45. Solution of 0.1 M NH_4OH and 0.1 M NH_4Cl has pH 9.25. Then pK_b of NH_4OH is

a) 9.25 b) 4.75 c) 3.75 d) 8.25

46. 100 mL of 0.2 N HCl is added to 100 mL of 0.18 N NaOH and the whole volume is made one litre. The pH of the resulting solution is

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

47. The first and second dissociation constants of an acid, H_2A, are 1.0×10^{-5} and 5.0×10^{-10} respectively. The overall dissociation constant of the acid will be

a) 0.2×10^{5} b) 5.0×10^{-5} c) 5.0×10^{-15} d) 5.0×10^{15}

48. The solubility products of MA, MB, MC and MD are 1.8×10^{-10}, 4×10^{-3}, 4×10^{-8} and 6×10^{-5} respectively. If a 0.01 M solution of MX is added drop wise to a mixture containing A^-, B^-, C^- and D^- ions, then the one to be precipitated first will be

a) MA b) MB c) MC d) MD

49. Silver ions are added to the solution with $[Br^-] = [Cl^-] = [CO_3^{2-}] = [AsO_4^{3-}] = 0.1M$

Which compound will precipitate at the lowest $[Ag^+]$?

a) $AgBr(K_{sp} = 5\times10^{-13})$ I b) $AgCl(K_{sp} = 1.8\times10^{-10})$

c) $Ag_2CO_3(K_{sp} = 8.1\times10^{-12})$ d) $Ag_3AsO_4(K_{sp} = 10^{-22})$

50. The solubility of $PbCl_2$ in water is 0.01M at 25^0C. It's solubility in 0.1M NaCl will be

a) 2×10^{-3}M b) 1×10^{-4}M

c) 1.6×10^{-2}M d) 4×10^{-4}M