Chemical Equilibrium -1

1. In which of the following attainment of "equilibrium state" can be recognized with the help of constancy in colour

1) Decomposition of $CaCO_3$

2) Reaction between N_2 & O_2

3) Decomposition of N_2O_4

4) Decomposition of PCl_5

2. In the case of $CaCO_3 \rightleftarrows CaO + CO_2$, attainment of equilibrium state is noticed with the help of constancy in

1) Concentration of $CaCO_3$ 2) Concentration of CO_2

3) Pressure of CaO 4) All of these

3. At low temperature, Nitrogen dioxide, a reddish brown gas gets associated to form the colourless dinitrogen tetroxide as in the reaction $2NO_{2(g)} \rightleftarrows N_2O_{4(g)}$. Then at equilibrium

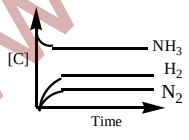
1) There would be an increase in colour intensity

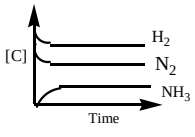
2) The mixture would become colourless

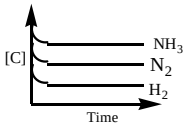
3) There would be a decrease in colour intensity

4) There would be no change in colour intensity

4. Which of the following is correct for $N_2+3H_2 \rightleftarrows 2NH_3$

1) 

2) 

3) 

4) All

5. **$Fe^{+3}_{(aq)} + SCN^{-}_{(aq)} \rightleftharpoons [Fe(SCN)]^{+2}_{(aq)}$ is an example to**

1) Heterogeneous equilibrium

2) Homogeneous equilibrium

3) Reversible process that never attains equilibrium state

4) Irreversible process that attains equilibrium state

6. **Which of the following is an irreversible reaction?**

1) $PCl_5 \rightarrow PCl_3 + Cl_2$ 2) $2SO_2 + O_2 \rightarrow 2SO_3$

3) $N_2 + 3H_2 \rightarrow 2NH_3$ 4) $2KClO_3 \rightarrow 2KCl + 3O_2$

7. **An example of an irreversible reaction**

1) $CH_3COOC_2H_5 + H_2O \rightarrow CH_3COOH + C_2H_5OH$

2) $N_2 + O_2 \rightarrow 2NO$

3) $NH_4HS \rightarrow NH_3 + H_2S$

4) $BaCl_{2(aq)} + K_2SO_{4(aq)} \rightarrow BaSO_{4(s)} + 2KCl_{(aq)}$

8. **Which of the following is a characteristic property of equilibrium?**

1) Number of moles of reactants and products is always equal.

2) Catalyst affects the equilibrium state.

3) It never proceeds to completion.

4) Rate of forward and backward reactions are not equal.

9. **When a system is in equilibrium state**

1) The concentration of products is equal to the concentration of the reactants.

2) The ratio of the product of Molar concentrations of products and reactants is constant.

3) Number of moles of reactants and products is the same.

4) The ratio of rate constants of the forward and backward reaction is always unity.

10. **Attainment of equilibrium can be noticed with the help of constancy of which of the following physical properties?**

1) Intensity of colour 2) Density 3) Pressure 4) All the above

11. Change in volume of the system does not alter the number of moles in which of the following equilibrium?

1) $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$ 2) $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

3) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ 4) $SO_2Cl_2(g) \rightleftharpoons SO_2(g) + Cl_2(g)$

12. At equilibrium state

1) ΔH = negative 2) ΔG = negative 3) ΔG = zero 4) ΔG is positive

13. A catalyst

1) Alters the equilibrium constant

2) Increases the equilibrium concentration of products

3) Helps establishing the equilibrium quickly

4) Decreases the equilibrium concentration of products

14. Gas phase homogeneous equilibrium is involved in one of the following

1) Acid hydrolysis of Ester

2) Synthesis of ammonia by Haber's process

3) Dissociation of lime stone in a closed vessel

4) Dissociation of lime stone in a open vessel

15. The following are some statements about chemical equilibrium.

A) The rate of forward reaction is equal to the rate of backward reation.

B) The chemical equilibrium can be established from reactant side only.

C) The concentration of the reactants and products remain same with time.

The correct statements are

1) A and B 2) A and C 3) B and C 4) All A, B, C

16. The reaction is reversible if it is carried out

1) At constant pressure

2) At constant temperature

3) In an open vessel

4) In a closed vessel

17. In the lime-kiln; the reaction $CaCO_{3(s)} \Leftrightarrow CaO_{(s)} + CO_{2(g)}$

1) Attains a state of equilibrium after some time

2) Stops after some time

3) Does not take place at all

4) Goes to completion eventually

Hint: Lime kyln is a open vessel.

18. When H_2 and I_2 are mixed and equilibrium is attained, then

1) Amount of HI formed is equal to the amount of H_2 dissociated

2) HI dissociation stops

3) The reaction stops completely

4) Both forward and backward reactions proceed with same rate

19. $CaCO_3 \rightleftharpoons CaO + CO_2$ **reaction in a lime kiln goes to completion because**

1) It is a heterogeneous reaction.

2) Backward reaction is very slow.

3) CO_2 formed escapes out.

4) K_C (or) K_P has no unit.

20. When the rate of formation of reactants is equal to the rate of formation of products, this is known as,

1) Chemical reaction 2) Chemical equilibrium

3) Chemical kinetics 4) Chemical energetics

21. For the reaction: Cu(s) + $2Ag^+$ (aq) $\rightleftharpoons$ Cu^{2+}(aq) + 2Ag(s), the equilibrium constant is given by

1) $\frac{[Cu^{2+}][Ag]^2}{[Cu][Ag^+]^2}$ 2) $\frac{[Cu^{2+}][Ag]^2}{[Cu][Ag^+]^2}$ 3) $\frac{[Cu^{2+}]}{[Ag^+]^2}$ 4) $\frac{[Ag^+]^2}{[Cu^{2+}]}$

Hint: The molar concentration of a solid is unity.

22. As per law of mass action, for $NH_4HS_{(s)} \rightleftarrows NH_{3(g)} + H_2S_{(g)}$ ratio of rate constants of forward (K_f) & backword (K_b) reactions at equilibrium equals to

1) $[NH_4HS]$ 2) $P_{NH3}+P_{H2S}$ 3) $[H_2S] + [NH_3]$ 4) $[NH_3]\,[H_2S]$

Hint: $K_f/K_b = K_C = [NH_3]\,[H_2S]$ $\because [NH_4HS_{(s)}] = 1$

23. Law of mass action is not applicable to C (graphite $\rightleftarrows$) C (diamond) because

1) It is a physical equilibrium
2) It is a Homogenious chemical equilibrium
3) It is a Heterogenious chemical equilibrium
4) Both forms are crystalline

24. Units of K_C for $xA_{(g)} \rightleftarrows yB_{(g)}$ is $lit^2\text{-}mol^{-2}$, then the values of x & y can be

1) 1, 2 2) 3, 2 3) 2, 3 4) 3, 1

Hint: units of $K_c = (moles/lit)^{\Delta n}$,given $(lit^2\text{-}mol^{-2})$ i.e $\Delta n = -2$

25. Unit of K_P for $NH_4COONH_{2(s)} \rightleftarrows 2NH_{3\,(g)} + CO_{2\,(g)}$ is

1) No units 2) atm^2 3) atm^3 4) atm^{-3}

Hint: units of $K_P = (atm)^{\Delta n}$,for this $\Delta n = (2+1)-0 = 3$

26. K_C for $H_2+I_2 \rightleftarrows 2HI$ is 'K', then for $HI \rightleftarrows 1/2\ H_2 + 1/2\ I_2$, it is

1) K^2 2) $\sqrt{K}$ 3) $\frac{1}{\sqrt{K}}$ 4) $\frac{1}{K^2}$

Hint: K_C for $H_2+I_2 \rightleftarrows 2HI$ is 'K', then , K_C for $2HI \rightleftarrows H_2+I_2$ is 1/K, then for $HI \rightleftarrows 1/2\ H_2 + 1/2\ I_2$, $K_C = \frac{1}{\sqrt{K}}$

27. Law of mass action cannot be applied to

1) $2HI_{(g)} \rightleftharpoons H_{2(g)} + I_{2(g)}$

2) $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$

3) $S_{Rhombic} \rightleftharpoons S_{Monoclinic}$

4) $CaCO_{3(s)} \rightleftharpoons CaO_{(s)} + CO_{2(g)}$

Hint: Law of mass action not applicable for a physical equilibrium.

28. Law of mass action is applicable to

1) Homogeneous chemical equilibrium only

2) Heterogeneous chemical equilibrium only

3) Both homogeneous and Heterogeneous chemical equilibria

4) Physical equilibrium

29. At a given temperature, for a reversible reaction, if the concentration of reactants is doubled then the equilibrium constant will

1) Be doubled 2) Be halved 3) Change to 1/3 4) Remain same

Hint: K_C is independent of Concentration of reactants and products.

30. If $N_2+3H_2 \rightleftharpoons 2NH_3$... (I) &

$N_2+3H_2 \rightleftharpoons 2NH_3$.... (II) are in equilibrium at same temperature, then

1) K_C of I = K_C of II 2) K_C of I = K_P of II

3) K_C of I < K_C of II 4) K_P of II > K_P of I

Hint: K_C depends on Temperature. As temperature is same K_C of I = K_C of II

31. The active mass of 5.6 lit of CO_2 at STP in moles/lit is

1) 5.6 / 22.4 2) 8 / 5.6 3) 32 / 5.6 4) 0.25 / 5.6

Hint: No. of moles in 5.6lit=5.6/22.4= 0.25

Active mass of a gas= Molarity= moles/volume in lit =0.25/5.6 mole/lit (or) 1/22.4mole/lit.

32. The reaction $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$ is carried out in a 1 litre flask. If the same reaction is carried out in a 2 litre flask at the same temperature, the equilibrium constant will be

1) Same 2) Doubled 3) Halved 4) Decreased

Hint: At a given temperature the value of K_C is independent of concentration, pressure, volume of vessel and catalyst.

33. The relationship between Kp and Kc is given by

1) $K_C = K_P(RT)^{\Delta n}$ 2) $K_P = K_C(RT)^{\Delta n}$

3) $K_C = K_P + (R\,T)^{\Delta n}$ 4) $K_P = K_C + RT\,\Delta n$

34. For the equilibrium reaction,

$3Fe_{(s)} + 4H_2O_{(g)} \Leftrightarrow Fe_3O_{4(s)} + 4H_{2(g)}$ **the relation between Kp and Kc is**

1) $K_P > K_C$ 2) $K_P < K_C$ 3) $K_P = K_C \times (RT)^{-2}$ 4) $K_P = K_C$

Hint: $\Delta n=0$

35. For which of the following reactions, $Kp\,(RT)^2 = Kc$

1) $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$

2) $N_{2(g)} + 3H_{2(g)} \Leftrightarrow 2NH_{3(g)}$

3) $2SO_{2(g)} + O_{2(g)} \Leftrightarrow 2SO_{3(g)}$

4) $H_{2(g)} + I_{2(g)} \Leftrightarrow 2HI_{(g)}$

Hint: Given $Kp\,(RT)^2 = Kc$ i.e. $Kp = Kc(RT)^{-2}$ $\therefore \Delta n=-2$

37. The ionisation constant of H_2CO_3 as an acid in aqueous solution at room temperature is X. If the first and second ionisation constants of H_2CO_3 are X_1 and X_2 respectively then

1) $X=X_1/X_2$ 2) $X=X_2/X_1$

3) $X = X_1X_2$ 4) $X = 1/X_1X_2$

Hint: When two or more equations are added their equilibrium constant values are multiplied

38. In which of the following cases, does the reaction go farthest to completion

1) $K = 10^3$ 2) $K = 10^{-2}$ 3) $K = 10^{-5}$ 4) $K = 10^2$

39. The units of equilibrium constant Kc for the following system

$H_{2(g)} + I_{2(g)} \Leftrightarrow 2HI_{(g)}$ is

1) $mole^{-1}$ lit 2) mol^{-2} liter 3) $mole\ lit^{-1}$ 4) No units

Hint: $\because \Delta n = 0$

40. $H_{2(g)} + I_{2(g)} \Leftrightarrow 2HI_{(g)}$**, In this reaction,**

1) $K_p = 2\ K_c$ 2) $K_p = K_c$ 3) $K_p > K_c$ 4) $K_p < K_c$

Hint: $K_P = K_C(RT)^{\Delta n}$ as $\Delta n = 0$, $K_p = K_c$

41. For the Chemical reaction

$A_{2\ (g)} + B_{2\ (g)} \rightleftarrows 2AB_{\ (g)}$ the amount of AB at equilibrium is affected by

1) Temperature and pressure 2) Temperature only

3) Pressure only 4) Temperature, pressure and Catalyst

42. The following are some statements about equilibrium constant.

A) The value of K is affected by temperature

B) The equilibrium constant gives idea about the extent of completion of reaction

C) The equilibrium constant is affected by volume and pressure

The correct combination is.

1) A and B 2) B and C

3) C and A 4) All

43. For reactions involving gaseous reactants and products the equilibrium constant K_P is written in terms is

1) The pressure of the gases

2) The molar volumes of the gases

3) The partial pressures of the gases

4) The mole fraction of the gases

44. The following are some statements about active masses.

A) Active mass of pure liquids and solids are taken as unity.

B) Active mass of electrolytes is taken as Normality

C) For 'dilute solutions of non-electrolytes, the active mass can be taken as molarity.

The correct combination is

1) A and B 2) B and C

3) A and C 4) A, B, C

45. Which one of the following has greater active mass

1) 200 gm of lime stone in 2 lit vessel

2) 90 gm of CS_2 liquid in 100 ml vessel

3) 56 gm of N_2 gas in 0.5 lit vessel

4) 1 mole of O_2 gas at STP

Hint: Active mass of 56 gm of N_2 gas in 0.5 lit vessel=(56/28)/0.5 =4moles/lit

Active mass of 1 mole of O_2 gas at STP=1/22.4 mole/lit

Active mass of a pure solid or liquid =1

46. Which of the following expression is true for the system $2SO_{2(g)} + O_{2(g)} \Leftrightarrow 2SO_{3(g)}$ **?**

1) $K_p(K_c)^{-1} < 1$ 2) $K_p(K_c)^{-1} > 1$

3) $K_p(K_c)^{-1} = 1$ 4) $K_p = K_c$

47. For the reaction $2NO_{2\,(g)} \rightleftharpoons N_2O_{4\,(g)}$ **K_P / K_C is**

1) RT 2) $(RT)^{-1}$ 3) $(RT)^{-1/2}$ 4) $(RT)^{1/2}$

Hint: $\Delta n = 1-2=-1$, $K_P / K_{C=}(RT)^{-1}$

48. The following are some statements about units of Kc and Kp.

A) Kp has always units.

B) Kc has no units at all times.

C) If n = 0, then Kp and Kc have no units.

The correct set is

1) A and B 2) C only

3) C and A 4) A, B, C

49. If K_1 and K_2 are the equilibrium constants of equilibria A and B respectively, then the relationship between the two constants is

A) $SO_2(g)+\frac{1}{2}O_2(g) \Leftrightarrow SO_3(g) \rightarrow K_1$

B) $2SO_3(g) \Leftrightarrow 2SO_2(g)+O_2(g) \rightarrow K_2$

1) $K_1 = K_2$ 2) $K_1 = \frac{1}{K_2}$ 3) $K_2 = K_1^2$ 4) $K_1^2 = \frac{1}{K_2}$

Hint: The equation (A)is inverted and multiplied by two toget Equation (B). Thus $K_2 = 1/K_1^2$

50. The equilibrium constant of a reaction is

1) Which has only numerical value and carries no units

2) With or without units depending upon the stoichiometric coefficients of the species involved in a chemical equation

3) Whose value always depends upon the units in which the concentrations of species involved in chemical reaction

4) Independent of temperature

51. The equilibrium constant for the reaction A $\rightleftharpoons$ B is K. The equilibrium constant for the reaction mA $\rightleftharpoons$ mB is

1) mK 2) K/m 3) K^m 4) m^K

Hint: As equation is multiplied with m, the value of K becomes K^m

52. The equilibrium constants of a reaction at 298 K and 308 K are 1.0 x10^{-2} and 2 x 10^{-2} respectively, the reaction is

1) Exothermic 2) Endothermic

3) May be endothermic or exothermic 4) Cannot be predicted

Hint: as the value of K increases with increase in temperature, the reaction is an Endothermic process.

53. The equilibrium constant of the reaction (K_c) $2SO_2 + O_2 \rightleftarrows 2SO_3$ when the reaction is conducted in a one litre vessel was found to be 2.5 x10^{-2} . If the reaction is conducted at the same temperature in a 2 litre vessel the value of K_c is

1) 1.25X10^{-2} 2) 2.5 x10^{-2} 3) 6. 25x10^{-4} 4) 40

Hint: The value of K_C is independent of volume of the vessel.

54. In the system $CaF_2(s) \rightleftarrows Ca^{2+}(aq) + 2F^-(aq)$, increasing the concentration of Ca^{2+} four times; the equilibrium concentration of F^- will be changed to

1) One half of its initial value 2) Twice the initial value

3) 1/4th of its initial value 4) Thrice of its initial value

Hint: $K_c = [Ca^{2+}][F^-]^2$ As K is constant at a given temperature $[f^-]^2 = 1/[Ca^{+2}] = 1/4$ and $[F^-] = 1/2$.

55. If the equilibrium constant for the reaction $2AB \rightleftarrows A_2 + B_2$ is 25. What is the equilibrium constant for $4AB \rightleftarrows 2A_2 + 2B_2$

1) 5 2) 625 3) 50 4) 12.5

Hint; If whole equation is multiplied with two K becomes squre.Thus $K=(25)^2=625$

56. The equilibrium constant for the reaction

N_2 (g) + O_2 (g) $\rightleftarrows$ 2NO (g) is 4 x10^{-4} at 2000 K. In presence of a catalyst the equilibrium is attained three times faster. The equilibrium constant in presence of the catalyst at 2000 K

1) 40×10^{-4} 2) 4×10^{-4} 3) 1.2×10^{-3} 4) 6.4×10^{-11}

57. With increase in temperature, the value of equilibrium constant

1) Increases 2) Decreases

3) May increase or decrease 4) Remains constant

58. For an exothermic reaction, the Equilibrium constant

1) Increases with increase of temperature

2) Decreases with increase of temperature

3) Increases with increase of pressure

4) Decreases with increase of pressure

59. For the equilibrium, $PCl_5 \rightleftharpoons PCl_3 + Cl_2$; temperature remaining constant

1) K_c will increase with increase in volume

2) K_c will increase with decrease in volume

3) K_c will not change with the change in volume

4) K_c may increase or decrease with the change in volume depending upon its numerical value

60. For the equilibrium N_2 (g) + $3H_2$ (g) $\rightleftharpoons$ $2NH_3$ (g) at 1000^0 C the equilibrium constant is very low, then which of the following is correct at equilibrium?

1) $[H_2]$ is very high but not $[N_2]$ 2) $[H_2]$ is low

3) $[N_2]$ is low 4) $[NH_3]$ is very low

Hint: Lower value of K represents very low concentration of products at equilibrium.

KEY

1) 3 2) 2 3) 4 4) 2 5) 2 6) 4 7) 4 8) 3 9) 2 10) 4

11) 1 12) 3 13) 3 14) 2 15) 2 16) 4 17) 4 18) 4 19) 3 20) 2

21)3 22) 4 23) 1 24) 4 25) 3 26) 3 27) 3 28) 3 29) 4 30) 1

31)4 32) 1 33) 2 34) 4 35) 2 36) 2 37) 3 38) 1 39) 4 40) 2

41) 2 42) 1 43)3 44) 4 45) 3 46) 1 47) 2 48) 2 49) 4 50)2

51)3 52) 2 53)2 54) 1 55)2 56)2 57)3 58)2 59)3 60)4