CHAPTER 6

Equilibrium

Law of Chemical Equilibrium, Equilibrium Const. and Its Application

1. $3O_2(g) \rightleftharpoons 2O_3(g)$ for the given reaction at 298 K, K_c is found to be 3.0×10^{-59}. If the concentration of O_2 at equilibrium is 0.040 M, then concentration of O_3 in M is: *(2022)*

a. 1.2×10^{21} b. 4.38×10^{-32}

c. 1.9×10^{-63} d. 2.4×10^{31}

2. The equilibrium constants of the following are:

$N_2 + 3H_2 \rightleftharpoons 2NH_3$ K_1

$N_2 + O_2 \rightleftharpoons 2NO$ K_2

$H_2 + \frac{1}{2}O_2 \rightarrow H_2O$ K_3

The equilibrium constant (K) of the reaction: *(2017-Delhi)*

$2NH_3 + \frac{5}{2}O_2 \overset{K}{\rightleftharpoons} 2NO + 3H_2O$, will be:

a. $K_2^3 K_3 / K_1$ b. $K_1 K_3^3 / K_2$

c. $K_{\ddot{u}} K^3 / K$ d. $K_2 K_3 / K_1$

3. If the equilibrium constant for

$N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$ is K, the equilibrium constant for

$\frac{1}{2}N_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons NO(g)$ will be: *(2015 Re)*

a. K^2 b. $K^{1/2}$

c. $\frac{1}{2}K$ d. K

4. If the value of an equilibrium constant for a particular reaction is 1.6×10^{12}, then at equilibrium the system will contain: *(2015)*

a. Mostly reactants

b. Mostly products

c. Similar amounts of reactants and products

d. All reactants

Relation Between K,Q and G, Factors Affecting Equilibria

5. Hydrolysis of sucrose is given by the following reaction:
Sucrose + $H_2O \rightleftharpoons$ Glucose + Fructose
If the equilibrium constant (K_c) is 2×10^{13} at 300 K, the value of $\Delta_r G^o$ at the same temperature will be : *(2020)*

a. 8.314 J mol^{-1} $K^{-1} \times 300$ K $\times$ ln (2×10^{13})

b. 8.314 J mol^{-1} $K^{-1} \times 300$ K $\times$ ln (3×10^{13})

c. –8.314 J mol^{-1} $K^{-1} \times 300$ K $\times$ ln (4×10^{13})

d. –8.314 J mol^{-1} $K^{-1} \times 300$ K $\times$ ln (2×10^{13})

6. Which one of the following conditions will favour maximum formation of the product in the reaction,
$A_2(g) + B_2(g) \rightleftharpoons X_2(g)\ \Delta_r H = -X$ kJ *(2018)*

a. Low temperature and high pressure

b. Low temperature and low pressure

c. High temperature and low pressure

d. High temperature and high pressure

7. Which one of the following statements is not correct? *(2017-Delhi)*

a. Coenzymes increase the catalytic activity of enzyme

b. Catalyst does not initiate any reaction

c. The value of equilibrium constant is changed in the presence of a catalyst in the reaction at equilibrium

d. Enzymes catalyse mainly bio-chemical reactions

8. A 20 litre container at 400 K contains $CO_2(g)$ at pressure 0.4 atm and an excess of SrO (neglect the volume of solid SrO). The volume of the containers 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: *(2017-Delhi)*

(Given that: $SrCO_3(s) \rightleftharpoons SrO(s) + CO_2(g)$ $K_p = 1.6$ atm)

a. 2 litre b. 5 litre

c. 10 litre d. 4 litre

9. Consider the nitration of benzene using mixed conc. H_2SO_4 and HNO_3. If a larger amount of $KHSO_4$ is added to the mixture, the rate of nitration will be: *(2016-I)*

a. Doubled b. Increase

c. Decrease d. Unchanged

10. Which of the following statements is correct for a reversible process in a state of equilibrium? *(2015)*

a. $\Delta G^o = -2.303\ RT \log K$ b. $\Delta G^o = 2.303\ RT \log K$

c. $\Delta G = -2.303\ RT \log K$ d. $\Delta G = 2.303\ RT \log K$

11. For a given exothermic reaction, K_p and K'_p are the equilibrium constants at temperature 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 *(2014)*

a. $K_p > K'_p$ b. $K_p < K'_p$

c. $K_p = K'_p$ d. $K_p = \frac{1}{K'_p}$

12. For the reversible reaction,

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ + Heat. The equilibrium shifts in forward direction: *(2014)*

a. By decreasing the pressure

b. By decreasing the concentrations of $N_2(g)$ and $H_2(g)$

c. By increasing pressure and decreasing temperature

d. By increasing the concentration of $NH_3(g)$

13. $KMnO_4$ can be prepared from K_2MnO_4 as per the reaction:

$3MnO_4^{2-} + 2H_2O \rightleftharpoons 2MnO_4^- + MnO_2 + 4OH^-$

The reaction can go to completion by removing OH^- ions by adding: *(2013)*

a. HCl b. KOH

c. CO_2 d. SO_2

Acids, Bases and Salts

14. Conjugate base for Bronsted acids H_2O and HF are: *(2019)*

a. OH^- and H_2F^+, respectively

b. H_3O^+ and F^-, respectively

c. OH^- and F^-, respectively

d. H_3O^+ and H_2F^+, respectively

15. Which of the following fluoro-compounds is most likely to behave as a Lewis base? *(2016-II)*

a. CF_4 b. SiF_4

c. BF_3 d. PF_3

16. Which of these is least likely to act as a Lewis base? *(2013)*

a. CO b. F^-

c. BF_3 d. PF_3

Ionization of Acids & Bases, pH Scale, Hydrolysis

17. The pK_b of dimethylamine and pK_a of acetic acid are 3.27 and 4.77 respectively at T(K). The correct option for the pH of dimethylammonium acetate solution is: *(2021)*

a. 5.50 b. 7.75

c. 6.25 d. 8.50

18. Which among the following salt solutions is basic in nature? *(2020-Covid)*

a. Ammonium sulphate b. Ammonium nitrate

c. Sodium acetate d. Ammonium chloride

19. Following solutions were prepared by mixing different volumes of NaOH and HCl of different concentrations: *(2018)*

A. $60\ mL \frac{M}{10} HCl + 40\ mL \frac{M}{10} NaOH$

B. $55\ mL \frac{M}{10} HCl + 45\ mL \frac{M}{10} NaOH$

C. $75\ mL \frac{M}{5} HCl + 25\ mL \frac{M}{5} NaOH$ `

D. $100\ mL \frac{M}{10} HCl + 100\ mL \frac{M}{10} NaOH$

pH of which one of them will be equal to 1?

a. B b. A

c. C d. D

20. The percentage of pyridine (C_5H_5N) that forms pyrimidine ion ($C_5H_5N^+H$) in a 0.10 M aqueous pyridine solution (K_b for $C_5H_5N = 1.7 \times 10^{-9}$) is: *(2016-II)*

a. 0.77% b. 1.6%

c. 0.0060% d. 0.013%

21. What is the pH of the resulting solution when equal volumes of 0.1 M NaOH and 0.01 M HCl are mixed? *(2015 Re)*

a. 2.0 b. 7.0

c. 1.04 d. 12.65

22. Aqueous solution of which of the following compounds is the best conductor of electric current? *(2015 Re)*

a. Hydrochloric acid, HCl b. Ammonia, NH_3

c. Fructose, $C_6H_{12}O_6$ d. Acetic acid, $C_2H_4O_2$

23. Which of the following salts will give highest pH in water? *(2014)*

a. NaCl b. Na_2CO_3

c. $CuSO_4$ d. KCl

Buffer Solutions

24. The pH of the solution containing 50 mL each of 0.10 M sodium acetate and 0.01 M acetic acid is *(2022)*

[Given pK_a of $CH_3COOH = 4.57$]

a. 2.57 b. 5.57

c. 3.57 d. 4.57

25. Which will make basic buffer? *(2019)*

a. 50 mL of 0.1 M NaOH + 25 mL of 0.1 M CH_3COOH

b. 100 mL of 0.1 M CH_3COOH + 100 mL of 0.1 M NaOH

c. 100 mL of 0.1 M HCl + 200 mL of 0.1 M NH_4OH

d. 100 mL of 0.1 M HCl + 100 mL of 0.1 M NaOH

26. Which one of the following pairs of solution is not an acidic buffer? *(2015 Re)*

a. H_3PO_4 and Na_3PO_4

b. $HClO_4$ and $NaClO_4$

c. CH_3COOH and CH_3COONa

d. H_2CO_3 and Na_2CO_3

Solubility Equilibria of Sparingly Soluble Salts

27. Find out the solubility of $Ni(OH)_2$ in 0.1 M NaOH. Given that the ionic product of $Ni(OH)_2$ is 2×10^{-15}. *(2020)*

a. 2×10^{-8} M b. 1×10^{-13} M

c. 1×10^{8} M d. 2×10^{-13} M

28. HCl was passed through a solution of $CaCl_2$, $MgCl_2$ and NaCl. Which of the following compounds crystalliess? *(2020)*

a. Only NaCl b. Only $MgCl_2$

c. NaCl, $MgCl_2$ and $CaCl_2$ d. Both $MgCl_2$ and $CaCl_2$

29. The solubility product for a salt of the type AB is 4×10^{-8}. What is the molarity of its standard solution? *(2020-Covid)*

a. 16×10^{-16} mol/L b. 2×10^{-16} mol/L

c. 4×10^{-4} mol/L d. 2×10^{-4} mol/L

30. pH of a saturated solution of $Ca(OH_2)$ is 9. The solubility product (K_{sp}) of $Ca(OH)_2$ is: *(2019)*

a. 0.5×10^{-15} b. 0.25×10^{-10}

c. 0.125×10^{-15} d. 0.5×10^{-10}

31. The solubility of $BaSO_4$ in water is 2.42×10^{-3} gL^{-1} at 298 K. The value of its solubility product (K_{sp}) will be *(2018)*

(Given molar mass of $BaSO_4$ = 233 g mol^{-1})

a. 1.08×10^{-10} mol^2 L^{-2} b. 1.08×10^{-12} mol^2 L^{-2}

c. 1.08×10^{-8} mol^2 L^{-2} d. 1.08×10^{-14} mol^2 L^{-2}

32. Concentration of the Ag^+ ions in a saturated solution of $Ag_2C_2O_4$ is 2.2×10^{-4} mol L^{-1}. Solubility product of $Ag_2C_2O_4$ is: *(2017-Delhi)*

a. 5.3×10^{-12} b. 2.42×10^{-8}

c. 2.66×10^{-12} d. 4.5×10^{-11}

33. The solubility of AgCl(s) with solubility product 1.6×10^{-10} in 0.1 M NaCl solution would be: *(2016-II)*

a. 1.6×10^{-11} M b. Zero

c. 1.26×10^{-5} M d. 1.6×10^{-9} M

34. MY and NY_3, two nearly insoluble salts, have the same K_{sp} values of 6.2×10^{-13} at room temperature, which statements would be true in regard to MY and NY_3? *(2016-I)*

a. The addition of the salt of KY to solution of MY and NY_3 will have no effect on their solubilities

b. The molar solubilities of MY and NY_3 in water are identical

c. The molar solubility of MY in water is less than that of NY_3

d. The salts MY and NY_3 are more soluble in 0.5 M KY than in pure water

35. 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? *(2015)*

a. AgCl b. AgBr

c. Ag_2CrO_4 d. AgI

36. Using the Gibb's energy change, ΔG^o = + 63.3 kJ, for the following reaction,

$$Ag_2CO_3(s) \rightleftharpoons 2Ag^+(aq) + CO_3^{2-}(aq)$$

the K_{sp} of $Ag_2CO_3(s)$ in water at 25°C is (R = 8.314 J K^{-1} mol^{-1}) *(2014)*

a. 3.2×10^{-26} b. 8.0×10^{-12}

c. 2.9×10^{-3} d. 7.9×10^{-2}

37. Identify the correct order of solubility in aqueous medium: *(2013)*

a. $Na_2S > CuS > ZnS$

b. $Na_2S > ZnS > CuS$

c. $CuS > ZnS > Na_2S$

d. $ZnS > Na_2S > CuS$

Answer Key

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
b	c	b	b	d	a	c	b	c	a	a	c	c	c	d	c	b
18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
c	c	d	d	a	b	b	c	b	d	a	d	a	a	a	d	c
35	36	37														
c	b	b														