

Equilibrium

1. For a weak acid HA, the percentage of dissociation is nearly 1% at equilibrium. If the concentration of acid is 0.1 mol L^{-1} , then the correct option for its K_a at the same temperature is: **(2023)**
 - (a) 1×10^{-4}
 - (b) 1×10^{-6}
 - (c) 1×10^{-5}
 - (d) 1×10^{-3}
2. An acidic buffer is prepared by mixing: **(2023)**
 - (a) weak acid and its salt with strong base
 - (b) equal volumes of equimolar solutions of weak acid and weak base
 - (c) strong acid and its salt with strong base
 - (d) strong acid and its salt with base (The pK_a of acid = pK_b of the base)
3. 0.01 M acetic acid solution is 1% ionised, then pH of this acetic acid solution is: **(2022)**
 - (a) 1
 - (b) 3
 - (c) 2
 - (d) 4
4. K_H value for some gases at the same temperature 'T' are given: **(2022)**

Gas	$K_H/k \text{ bar}$
Ar	40.3
CO_2	1.67
HCHO	1.83×10^{-5}
CH_4	0.413

Where K_H is Henry's Law constant in water. The order of their solubility in water is:

 - (a) $\text{HCHO} < \text{CH}_4 < \text{CO}_2 < \text{Ar}$
 - (b) $\text{Ar} < \text{CO}_2 < \text{CH}_4 < \text{HCHO}$
 - (c) $\text{Ar} < \text{CH}_4 < \text{CO}_2 < \text{HCHO}$
 - (d) $\text{HCHO} < \text{CO}_2 < \text{CH}_4 < \text{Ar}$
5. K_p for the following reaction is 3.0 at 1000 K.
 $\text{CO}_2(\text{g}) + \text{C}(\text{s}) \rightleftharpoons 2\text{CO}(\text{g})$
 What will be the value of K_c for the reaction at the same temperature? **(2022)**
 (Given: $R = 0.083 \text{ L bar K}^{-1} \text{ mol}^{-1}$)
 - (a) 3.6
 - (b) 0.36
 - (c) 3.6×10^{-2}
 - (d) 3.6×10^{-3}
6. 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 $\text{CH}_3\text{COOH} = 4.57$]
 - (a) 5.57
 - (b) 3.57
 - (c) 4.57
 - (d) 2.57
7. $3\text{O}_2(\text{g}) \rightleftharpoons 2\text{O}_3(\text{g})$
 For the above 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) 4.38×10^{-32}
 - (b) 1.9×10^{-63}
 - (c) 2.4×10^{31}
 - (d) 1.2×10^{21}
8. 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
9. Find out the solubility of $\text{Ni}(\text{OH})_2$ in 0.1 M NaOH. Given that the ionic product of $\text{Ni}(\text{OH})_2$ is 2×10^{-15} . **(2020)**
 - (a) $2 \times 10^{-8} \text{ M}$
 - (b) $1 \times 10^{-13} \text{ M}$
 - (c) $1 \times 10^8 \text{ M}$
 - (d) $2 \times 10^{-13} \text{ M}$
10. HCl was passed through a solution of CaCl_2 , MgCl_2 and NaCl. Which of the following compound(s) crystallise(s)? **(2020)**
 - (a) Only NaCl
 - (b) Only MgCl_2
 - (c) NaCl, MgCl_2 and CaCl_2
 - (d) Both MgCl_2 and CaCl_2

11. Which among the following salt solutions is basic in nature? **(2020 covid Re-NEET)**
 (a) Ammonium sulphate
 (b) Ammonium nitrate
 (c) Sodium acetate
 (d) Ammonium chloride
12. The solubility product for a salt of the type AB is 4×10^{-8} . What is the molarity of its standard solution? **(2020 Covid Re-NEET)**
 (a) $16 \times 10^{-16} \text{ mol/L}$
 (b) $2 \times 10^{-16} \text{ mol/L}$
 (c) $4 \times 10^{-4} \text{ mol/L}$
 (d) $2 \times 10^{-4} \text{ mol/L}$
13. Hydrolysis of sucrose is given by the following reaction.
 $\text{Sucrose} + \text{H}_2\text{O} \rightleftharpoons \text{Glucose} + \text{Fructose}$
 If the equilibrium constant (K_c) is 2×10^{13} at 300 K, the value of $\Delta_r G^\circ$ at the same temperature will be :
 (a) $8.314 \text{ J mol}^{-1} \text{ K}^{-1} \times 300 \text{ K} \times \ln (2 \times 10^{13})$
 (b) $8.314 \text{ J mol}^{-1} \text{ K}^{-1} \times 300 \text{ K} \times \ln (3 \times 10^{13})$
 (c) $-8.314 \text{ J mol}^{-1} \text{ K}^{-1} \times 300 \text{ K} \times \ln (4 \times 10^{13})$
 (d) $-8.314 \text{ J mol}^{-1} \text{ K}^{-1} \times 300 \text{ K} \times \ln (2 \times 10^{13})$
14. pH of a saturated solution of $\text{Ca}(\text{OH})_2$ is 9. The solubility product (K_{sp}) of $\text{Ca}(\text{OH})_2$ is: **(2019)**
 (a) 0.5×10^{-15}
 (b) 0.25×10^{-10}
 (c) 0.125×10^{-15}
 (d) 0.5×10^{-10}
15. 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
16. 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
17. Which one of the following conditions will favour maximum formation of the product in the reaction,
 $\text{A}_2(\text{g}) + \text{B}_2(\text{g}) \rightleftharpoons \text{X}_2(\text{g}) \quad \Delta_r H = -X \text{ kJ}$ **(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
18. The solubility of BaSO_4 in water is $2.42 \times 10^{-3} \text{ g L}^{-1}$ at 298 K. The value of its solubility product (K_{sp}) will be: **(2018)**
 (Given molar mass of $\text{BaSO}_4 = 233 \text{ g mol}^{-1}$)
 (a) $1.08 \times 10^{-10} \text{ mol}^2 \text{ L}^{-2}$
 (b) $1.08 \times 10^{-12} \text{ mol}^2 \text{ L}^{-2}$
 (c) $1.08 \times 10^{-8} \text{ mol}^2 \text{ L}^{-2}$
 (d) $1.08 \times 10^{-14} \text{ mol}^2 \text{ L}^{-2}$
19. Following solutions were prepared by mixing different volumes of NaOH and HCl of different concentrations : **(2018)**
 (A) $60 \text{ mL } \frac{M}{10} \text{ HCl} + 40 \text{ mL } \frac{M}{10} \text{ NaOH}$
 (B) $55 \text{ mL } \frac{M}{10} \text{ HCl} + 45 \text{ mL } \frac{M}{10} \text{ NaOH}$
 (C) $75 \text{ mL } \frac{M}{5} \text{ HCl} + 25 \text{ mL } \frac{M}{5} \text{ NaOH}$
 (D) $100 \text{ mL } \frac{M}{10} \text{ HCl} + 100 \text{ mL } \frac{M}{10} \text{ NaOH}$
 pH of which one of them will be equal to 1?
 (a) B
 (b) A
 (c) C
 (d) D
20. The equilibrium constants of the following are : **(2017-Delhi)**
 $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3 \quad K_1$
 $\text{N}_2 + \text{O}_2 \rightleftharpoons 2\text{NO} \quad K_2$
 $\text{H}_2 + \frac{1}{2}\text{O}_2 \rightarrow \text{H}_2\text{O} \quad K_3$
 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) $K_2^3 K_3 / K_1$
 (b) $K_1 K_3^3 / K_2$
 (c) $K_2 K_3^3 / K_1$
 (d) $K_2 K_3 / K_1$
21. Concentration of 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 Ag_2CO_3 is: **(2017-Delhi)**
 (a) 5.3×10^{-12}
 (b) 2.42×10^{-8}
 (c) 2.66×10^{-12}
 (d) 4.5×10^{-11}
22. 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
23. The standard equilibrium constant K_p at 298 K for the reaction, $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ is 5.8×10^5 . The value of standard equilibrium constant, if the concentration of gases is expressed in terms of mol L^{-1} , will be: **(2017-Gujarat)**
 [Given : $R = 0.08314 \text{ L bar K}^{-1} \text{ mol}^{-1}$]
 (a) 3.99×10^9
 (b) 3.51×10^6
 (c) 3.84×10^7
 (d) 3.56×10^8
24. Consider the following reaction for which the change in enthalpy is positive
 $2A(g) + B(g) \rightleftharpoons C(g) + D(g)$
 Which of the following will not affect the equilibrium? **(2017-Gujarat)**
 (a) Presence of catalyst
 (b) Change in concentration of reactants
 (c) Change in pressure
 (d) Change in temperature
25. For the reaction $CO(g) + Cl(g) \rightleftharpoons COCl_2(g)$ $\frac{K_p}{K_c}$ is equal to: **(2017-Gujarat)**
 (a) $(RT)^2$
 (b) $\frac{1}{RT}$
 (c) RT
 (d) $\sqrt{RT}$
26. 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
27. The solubility of $AgCl(s)$ with solubility product 1.6×10^{-10} in 0.1 M NaCl solution would be: **(2016-II)**
 (a) $1.6 \times 10^{-11} \text{ M}$
 (b) Zero
 (c) $1.26 \times 10^{-5} \text{ M}$
 (d) $1.6 \times 10^{-9} \text{ M}$
28. 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%
29. 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
30. 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 of NY_3
 (d) The salts MY and NY_3 are more soluble in 0.5 M KY than in pure water
31. 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
32. 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
33. 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
34. The K_{sp} of Ag_2CrO_4 , $AgBr$ 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 Na₂CrO₄ ?
(2015)
- (a) AgCl
(b) AgBr
(c) Ag₂CrO₄
(d) AgI
35. 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
36. Aqueous solution of which of the following compounds is the best conductor of electric current? (2015 Re)
(a) Hydrochloric acid, HCl
(b) Ammonia, NH₃
(c) Fructose, C₆H₁₂O₆
(d) Acetic acid, C₂H₄O₂
37. Which of the following statements is correct for a reversible process in a state of equilibrium? (2015)
(a) $\Delta G^\circ = -2.303 RT \log K$
(b) $\Delta G^\circ = 2.303 RT \log K$
(c) $\Delta G = -2.303 RT \log K$
(d) $\Delta G = 2.303 RT \log K$
38. Which of the following salts will give highest pH in water? (2014)
(a) NaCl
(b) Na₂CO₃
(c) CuSO₄
(d) 4KCl
39. Using the Gibb's energy change, $\Delta G^\circ = +63.3 \text{ kJ}$, for the following reaction,
 $\text{Ag}_2\text{CO}_3(\text{s}) \rightleftharpoons 2\text{Ag}^+(\text{aq}) + \text{CO}_3^{2-}(\text{aq})$
The K_{sp} of Ag₂CO₃(s) in water at 25°C is ($R = 5.314 \text{ JK}^{-1} \text{ mol}^{-1}$) (2014)
(a) 3.2×10^{-26}
(b) 8.0×10^{-12}
(c) 2.9×10^{-3}
(d) 7.9×10^{-2}
40. For the reversible reaction,
 $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g}) + \text{Heat}$.
The equilibrium shifts in forward direction: (2014)
(a) By decreasing the pressure
(b) By decreasing the concentration of N₂(g) and H₂(g)
(c) By Increasing pressure and decreasing temperature
(d) By increasing the concentration of NH₃(g)
41. Which of these is least likely to act as a Lewis base? (2013)
(a) CO
(b) F⁻
(c) BF₃
(d) PF₃
42. KMnO₄ can be prepared from K₂MnO₄ 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: (2013)
(a) HCl
(b) KOH
(c) CO₂
(d) SO₂

Answer Key

S1. Ans. (c)

S2. Ans. (a)

S3. Ans. (d)

S4. Ans. (b)

S5. Ans. (c)

S6. Ans. (a)

S7. Ans. (a)

S8. Ans. (b)

S9. Ans. (d)

S10. Ans. (a)

S11. Ans. (c)

S12. Ans. (d)

S13. Ans. (d)

S14. Ans. (a)

S15. Ans. (c)

S16. Ans. (c)

S17. Ans. (a)

S18. Ans. (a)

S19. Ans. (c)

S20. Ans. (c)

S21. Ans. (a)

S22. Ans. (c)

S23. Ans. (d)

S24. Ans. (a)

S25. Ans. (b)

S26. Ans. (d)

S27. Ans. (c)

S28. Ans. (d)

S29. Ans. (c)

S30. Ans. (c)

S31. Ans. (b)

S32. Ans. (b)

S33. Ans. (b)

S34. Ans. (c)

S35. Ans. (d)

S36. Ans. (a)

S37. Ans. (a)

S38. Ans. (b)

S39. Ans. (b)

S40. Ans. (c)

S41. Ans. (c)

S42. Ans. (c)

Solutions

- S1. Ans.(c)
 $K_a = C\alpha^2$
 $K_a = (0.1) \times (0.01)^2$
 $K_a = 1 \times 10^{-5}$
- S2. Ans.(a)
 Acidic buffer is prepared by mixing weak acid and its salt with strong base.
- S3. Ans.(d)
 For weak acid (i.e., CH_3COOH)
 $[\text{H}^+] = C\alpha$
 $= 0.01 \times \frac{1}{100} = 10^{-4} \text{ M}$
 $\text{pH} = -\log \text{H}^+ = -\log 10^{-4} = 4$
- S4. Ans.(b)
 According to Henry's Law,
 $p = K_H x$
 Where 'p' is partial pressure of gas in vapour phase.
 'K_H' is Henry's Law constant.
 'x' is mole fraction of gas in liquid.
 Higher the value of K_H at a given pressure, lower is the solubility of the gas in the liquid.
 $\therefore$ Solubility: $\text{Ar} < \text{CO}_2 < \text{CH}_4 < \text{HCHO}$
- S5. Ans.(c)
 $\text{CO}_2(\text{g}) + \text{C}(\text{s}) \rightleftharpoons 2\text{CO}(\text{g})$
 $\Delta n_g = 2 - 1 = 1$
 $K_p = K_c(\text{RT})^{\Delta n_g}$
 $K_p = K_c(\text{RT})$
 $[\therefore K_p = 3]$
 $K_c = \frac{K_p}{\text{RT}} = \frac{3}{0.083 \times 1000}$
 $= 0.036$
 $= 3.6 \times 10^{-2}$
- S6. Ans.(a)
 It is a mixture of weak acid and salt of its conjugate base. Hence, it is acidic buffer.
 $\text{pH} = \text{p}K_a + \log \frac{[\text{Salt}]}{[\text{Acid}]}$
 $= 4.57 + \log \left(\frac{0.1}{0.01} \right)$
 $= 4.57 + 1$
 $= 4.57$
- S7. Ans.(a)
 $3\text{O}_2(\text{g}) \rightleftharpoons 2\text{O}_3(\text{g})$
 $K_c = \frac{[\text{O}_3]^2}{[\text{O}_2]^3}$
 $[\text{O}_3]^2 = K_c[\text{O}_2]^3 = 3 \times 10^{-59} \times (0.04)^3$
 $[\text{O}_3]^2 = 1.9 \times 10^{-63} = 19 \times 10^{-64}$
 $[\text{O}_3] = 4.38 \times 10^{-32}$
 Concentration of O₃ at equilibrium = $4.38 \times 10^{-32} \text{ M}$
- S8. Ans.(b)
 $\text{pH} = \frac{1}{2} [p^{k_w} + p^{k_a} - p^{k_b}]$
 $= 7 + \frac{1}{2} p^{k_a} - \frac{1}{2} p^{k_b}$
 $= 7 + \frac{1}{2} \times 4.77 - \frac{1}{2} \times 3.27$
 $= 7.75$
- S9. Ans.(d)
 Let the solubility of $\text{Ni}(\text{OH})_2$ is s
 $\underset{s}{\text{Ni}(\text{OH})_2} \rightleftharpoons \underset{s}{\text{Ni}^{2+}} + 2\underset{2s}{\text{OH}^-}$
 $\text{NaOH} \rightarrow \text{Na} + \text{OH}^-$
 0.1 0.1 0.1
 As K_{sp} is small $2s \ll 0.10$
 Therefore $(0.10 + 2s) \approx 0.10$
 So total $[\text{OH}]^- = 0.10$
 Ionic product = $[\text{Ni}^{2+}] [\text{OH}^-]^2$
 $2 \times 10^{-15} = s(0.10)^2$
 $s = 2 \times 10^{-13} \text{ M}$
- S10. Ans.(a)

When HCl is passed through the mixture of CaCl_2 , MgCl_2 and NaCl , Cl^- ion concentration increases. As CaCl_2 and MgCl_2 are more stable than NaCl . Hence ionic product $[\text{Na}^+][\text{Cl}^-]$ becomes more than solubility product. Thus, precipitation of NaCl occurs (due to common ion effect)

S11. Ans.(c)

Acetic acid, CH_3COOH , will react with sodium hydroxide, NaOH , to produce sodium acetate, CH_3COONa , and water.

Sodium acetate is a salt of strong base and Weak acid therefore its salt solution is basic in nature.

S12. Ans.(d)

For salt AB

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

$$s = \sqrt{K_{sp}}$$

$$s = \sqrt{4 \times 10^{-8}}$$

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

S13. Ans.(d)

$$\text{Given : } K = 2 \times 10^{13}$$

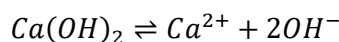
$$\Delta G = \Delta G^\circ + RT \ln Q$$

$$\text{At equilibrium } \Delta G = 0, Q = K_{eq}$$

$$\text{So } \Delta_r G^\circ = -RT \ln K_{eq}$$

$$\Delta_r G^\circ = -8.314 \text{ J mol}^{-1} \text{ K}^{-1} \times 300 \text{ K} \times \ln (2 \times 10^{13})$$

S14. Ans.(a)



$$\text{pH} + \text{pOH} = 14$$

$$\text{pH} = 9, \text{ thus } \text{pOH} = 14 - 9 = 5$$

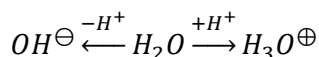
$$[\text{OH}^-] = 10^{-5} \text{ M}$$

$$\text{Thus } [\text{Ca}^{2+}] = \frac{10^{-5}}{2}$$

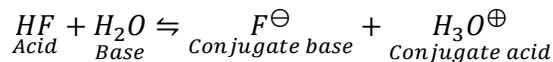
$$\text{So, } K_{sp} = [\text{Ca}^{2+}][\text{OH}^-]^2$$

$$= \frac{10^{-5}}{2} (10^{-5})^2 = 0.5 \times 10^{-15}$$

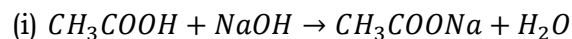
S15. Ans.(c)



Conjugate base Conjugate acid



S16. Ans.(c)



$$\text{Initial } 25 \text{ mL} \quad 50 \text{ mL} \quad 0$$

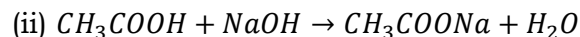
$$\times 0.1 \text{ M} \quad \times 0.1 \text{ M}$$

$$= 2.5 \text{ mmol} = 5 \text{ mmol}$$

$$\text{Final} \quad 0 \quad 2.5 \text{ mmol} \quad 2.5 \text{ mmol}$$

This is basic solution due to NaOH .

This is not basic buffer.



$$\text{Initial } 100 \text{ mL} \quad 100 \text{ mL} \quad 0$$

$$\times 0.1 \text{ M} \quad \times 0.1 \text{ M}$$

$$= 10 \text{ mmol} = 10 \text{ mmol}$$

$$\text{Final} \quad 0 \quad 0 \quad 10 \text{ mmol}$$

Hydrolysis of salt takes place.

This is not basic buffer.



$$\text{Initial} \quad 100 \text{ mL} \quad 200 \text{ mL} \quad 0$$

$$\times 0.1 \text{ M} \quad \times 0.1 \text{ M}$$

$$= 10 \text{ mmol} = 20 \text{ mmol}$$

$$\text{Final} \quad 0 \quad 10 \text{ mmol} \quad 10 \text{ mmol}$$

This will make basic buffer.



$$\text{Initial} \quad 100 \text{ mL} \quad 100 \text{ mL} \quad 0$$

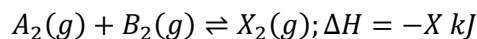
$$\times 0.1 \text{ M} \quad \times 0.1 \text{ M}$$

$$= 10 \text{ mmol} = 10 \text{ mmol}$$

$$\text{Final} \quad 0 \quad 0 \quad 10 \text{ mmol}$$

$\Rightarrow$ This is Neutral solution.

S17. Ans.(a)



On increasing pressure, equilibrium shifts in a direction where pressure decreases i.e. forward direction.

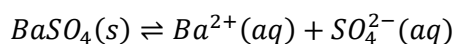
On decreasing temperature, equilibrium shifts in forward direction as it is exothermic direction.

So, high pressure and low temperature favours maximum formation of product.

S18. Ans.(a)

$$\text{Solubility of } \text{BaSO}_4, s = \frac{2.42 \times 10^{-3}}{233} (\text{mol L}^{-1})$$

$$= 1.04 \times 10^{-5} (\text{mol L}^{-1})$$



$$K_{sp} = [\text{Ba}^{2+}][\text{SO}_4^{2-}] = s^2$$

$$= (1.04 \times 10^{-5})^2$$

$$= 1.08 \times 10^{-10} \text{mol}^2 \text{L}^{-2}$$

S19. Ans.(c)

$$M_{\text{eq}} \text{ of HCl} = 75 \times \frac{1}{5} \times 1 = 15$$

$$- M_{\text{eq}} \text{ of NaOH} = 25 \times \frac{1}{5} \times 1 = 5$$

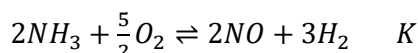
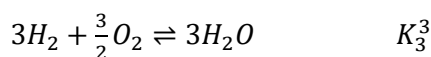
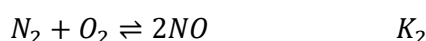
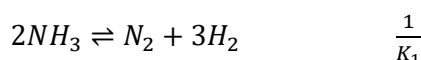
$$- M_{\text{eq}} \text{ of HCl in resulting solution} = 10$$

$$- \text{Molarity of } [\text{H}^+] \text{ in resulting mixture}$$

$$= \frac{10}{100} = \frac{1}{10}$$

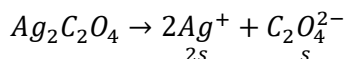
$$\text{pH} = -\log[\text{H}^+] = -\log\left[\frac{1}{10}\right] = 1.0$$

S20. Ans.(c)



$$K = \frac{K_2 K_3^3}{K_1}$$

S21. Ans.(a)



$$K_{sp} = [\text{Ag}^+]^2 [\text{C}_2\text{O}_4^{2-}]$$

$$= (2s)^2 (s) ; [\text{Ag}^+ = 2.2 \times 10^{-4}]$$

$$= (2.2 \times 10^{-4})^2 (1.1 \times 10^{-4});$$

$$[2s = 2.2 \times 10^{-4}]$$

$$= 4.84 \times 10^{-8} \times 1.1 \times 10^{-4}$$

$$= 5.3 \times 10^{-12}$$

S22. Ans.(c)

The value of equilibrium constant is not changed in the presence of a catalyst in the reaction at equilibrium. The catalyst only increases the rates of reaction, it does not affect the equilibrium constant.

S23. Ans.(d)

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

$$K_c = \frac{K_p}{(RT)^{\Delta n}} = \frac{5.8 \times 10^5}{(0.08314 \times 298)^{2-4}}$$

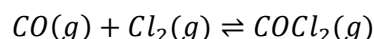
$$= \frac{5.8 \times 10^5}{(0.08314 \times 298)^{-2}}$$

$$= 3.56 \times 10^8$$

S24. Ans.(a)

Presence of catalyst does not affect the equilibrium of the reaction. Catalyst only affect the rate of reaction.

S25. Ans.(b)



$$\Delta n = -1$$

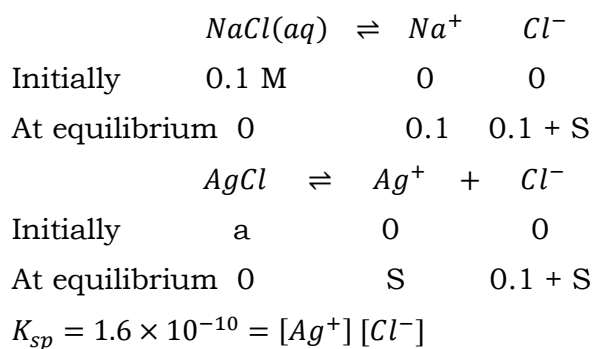
$$K_p = K_c (RT)^{\Delta n_g}$$

$$\frac{K_p}{K_c} = \frac{1}{RT}$$

S26. Ans.(d)

Among the 4 options PF_3 will behave as a Lewis base due to presence of lone pair of electrons in p-orbitals.

S27. Ans.(d)



$$K_{sp} = 1.6 \times 10^{-10} = [\text{Ag}^+] [\text{Cl}^-]$$

$$= S(0.1 + S)$$

$$1.6 \times 10^{-10} = S \times 0.1$$

$$S = 1.6 \times 10^{-9} \text{M}$$

S28. Ans.(d)

Pyrimidine is a very weak base so

$$K_b = c\alpha^2$$

$$\alpha = \sqrt{\frac{K_b}{c}}$$

$$= \sqrt{\frac{1.7 \times 10^{-9}}{0.9}}$$

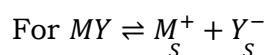
$$= 1.3 \times 10^{-4}$$

$$\% \alpha = 0.013\%$$

S29. Ans.(c)

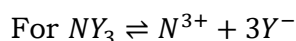
If large amount of KHSO_4 would be added then concentration of NO_2^+ will decrease, rate of nitration will also decrease.

S30. Ans.(c)



$$K_{sp} = 6.2 \times 10^{-13}$$

$$S = 7.9 \times 10^{-7} \text{ mol L}^{-1}$$



$$K_{sp} = 27S^4 \Rightarrow S = \left(\frac{K_{sp}}{27}\right)^{1/4}$$

$$S = 3.89 \times 10^{-4} \text{ mol L}^{-1}$$

So, solubility of NY_3 is more than solubility of MY in pure water. And addition of KY decrease the solubility because of common ion effect.

S31. Ans.(b)

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

S32. Ans.(b)

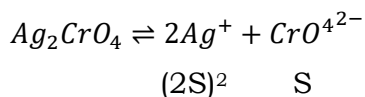
HClO_4 and NaClO_4 will not make a buffer solution because a buffer solution is formed by the mixture of a weak acid and its conjugate base and HClO_4 is not a weak acid.

S33. Ans.(b)

Such big equilibrium constant indicates large concentration of products so equilibrium is mostly towards product.

S34. Ans.(c)

According to solubility law:



$$1.1 \times 10^{-12} = 4S^3$$

$$\text{Ag}_2\text{CrO}_4 = S \sim 10^{-3}$$

$$\text{AgCl} = S \sim 10^{-5}$$

$$\text{AgBr} = S \sim 10^{-6}$$

$$\text{AgI} = S \sim 10^{-8}$$

So, Ag_2CrO_4 will be the most soluble.

S35. Ans.(d)

$\therefore$ 1 mole of NaOH is completely neutralized by 1 mole of HCl .

So, 0.01 mole is neutralized by 0.01 mole of HCl .

Left $\text{NaOH} = 0.09$ mole

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

$$p^{\text{OH}} = -\log[\text{OH}^-] = 1.35$$

$$p\text{H} = 14 - p^{\text{OH}} = 14 - 1.35 = 12.65$$

S36. Ans.(a)

HCl is strong acid and dissociated completely into ions in aq. Solution.

S37. Ans.(a)

$$\therefore \Delta G = \Delta G^\circ + 2.303 RT \log Q$$

At equilibrium

$$\Delta G = 0$$

$$Q = K_{eq}$$

$$\text{So, } \Delta G^\circ = (-)2.303 RT \log K_{eq}$$

S38. Ans.(b)

Highest pH is shown by alkali

So, Na_2CO_3 being salt of a strong base and weak acid will exhibit highest pH.

$\text{NaCl} \rightarrow$ neutral pH = 7

$\text{CuSO}_4 \rightarrow$ Acidic pH < 7

$\text{KCl} \rightarrow$ Neutral pH = 7

S39. Ans.(b)

$$\therefore \Delta G^\circ = -2.303 RT \log K_{sp}$$

$$63.3 \times 10^3 \text{ J} = -2.303 \times 8.314 \times 298 \log K_{sp}$$

$$K_{sp} = 8.128 \times 10^{-12}$$

S40. Ans.(c)

On increasing pressure, equilibrium shifts in forward direction, where number of moles decreases, it is an example of exothermic reaction therefore decreasing temperature favours the forward direction.

S41. Ans.(c)

Lewis base species are those which are electron deficient and does require electron to complete their octet. BF_3 is an electron deficient species and is a Lewis acid.

S42. Ans.(c)

HCl and SO_2 are reducing agents so they can reduce MnO_4^- .

CO_2 is neither oxidizing nor reducing agent it will provide only acidic medium and shift the direction in forward reaction towards completion.