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 it's salt with strong base
   (b) equal volumes of equimolar solutions of weak acid and weak base
   (c) strong acid and it's salt with strong base
   (d) strong acid and it's 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 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) HCHO < CH_4 < CO_2 < Ar
   (b) Ar < CO_2 < CH_4 < HCHO
   (c) Ar < CH_4 < CO_2 < HCHO
   (d) HCHO < CO_2 < CH_4 < Ar

5. K_p for the following reaction is 3.0 at 1000 K.
   $CO_2(g) + C(s) \rightleftharpoons 2CO(g)$
   What will be the value of K_c for the reaction at the same temperature? **(2022)**
   (Given: R = 0.083 L bar K^{-1} 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 CH_3COOH = 4.57]
   (a) 5.57
   (b) 3.57
   (c) 4.57
   (d) 2.57

7. $3O_2(g) \rightleftharpoons 2O_3(g)$
   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 $Ni(OH)_2$ 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

10. HCl was passed through a solution of $CaCl_2$, $MgCl_2$ and NaCl. Which of the following compound(s) crystallies(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) 16×10^{-16} mol/L
(b) 2×10^{-16} mol/L
(c) 4×10^{-4} mol/L
(d) 2×10^{-4} mol/L

13. Hydrolysis of sucrose is given by the following reaction.
$\text{Sucrose} + H_2O \rightleftharpoons \text{Glucose} + \text{Fructose}$
If the equilibrium constant (K_c) is 2×10^{13} at 300 K, the value of $\Delta_rG°$ at the same temperature will be :
(a) $8.314\, J\, mol^{-1}K^{-1} \times 300\, K \times \ln(2 \times 10^{13})$
(b) $8.314\, J\, mol^{-1}K^{-1} \times 300\, K \times \ln(3 \times 10^{13})$
(c) $-8.314\, J\, mol^{-1}\, K^{-1} \times 300\, K \times \ln(4 \times 10^{13})$
(d) $-8.314\, J\, mol^{-1}\, K^{-1} \times 300\, K \times lb(2 \times 10^{13})$

14. 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}

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,
$A_2(g) + B_2(g) \rightleftharpoons X_2(g)\ \Delta_rH = -X\, kJ$ **(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

18. 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} $mol^2\, L^{-2}$

19. Following solutions were prepared by mixing different volumes of NaOH and HCl of different concentrations : **(2018)**
(A) $60mL \frac{M}{10} HCl + 40mL \frac{M}{10} NaOH$
(B) $55mL \frac{M}{10} HCl + 45mL \frac{M}{10} NaOH$
(c) $75mL \frac{M}{5} HCl + 25mL \frac{M}{5} NaOH$
(d) $100mL \frac{M}{10} HCl + 100mL \frac{M}{10} NaOH$
pH of which one of them will be equal to 1?
(a) B
(b) A
(c) C
(d) D

20. The equilibrium constants of the following are : **(2017-Delhi)**
$N_2 + 3H_2 \rightleftharpoons 2NH_3 \qquad K_1$
$N_2 + O_2 \rightleftharpoons 2NO \qquad K_2$
$H_2 + \frac{1}{2}O_2 \rightarrow H_2O \qquad K_3$
The equilibrium constant (K) of the reaction:
$2NH_3 + \frac{5}{2}O_2 \overset{K}{\rightleftharpoons} 2NO + 3H_2O$, will be:
(a) $K_2^3 K_3/K_1$
(b) $K_1 K_3^3/K_2$
(c) $K_2 K_3^3/K_1$
(d) $K_2 K_3/K_1$

21. Concentration of Ag^+ ions in a saturated solution of $Ag_2C_2O_4$ is 2.2×10^{-4} mol L^{-1}. Solubility product of Ag_2CO_4 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 L bar K^{-1} 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) 1.6×10^{-11} M
(b) Zero
(c) 1.26×10^{-5} M
(d) 1.6×10^{-9} 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 = 1.7×10^{-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 Na_2CrO_4 ? **(2015)**

(a) AgCl
(b) AgBr
(c) Ag_2CrO_4
(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, NH_3
(c) Fructose, $C_6H_{12}O_6$
(d) Acetic acid, $C_2H_4O_2$

37. Which of the following statements is correct for a reversible process in a state of equilibrium? **(2015)**
(a) $\Delta G° = -2.303\ RT \log K$
(b) $\Delta G° = 2.303\ RT \log K$
(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) Na_2CO_3
(c) $CuSO_4$
(d) 4KCl

39. Using the Gibb's energy change, $\Delta G°$ = +63.3 kJ, for the following reaction,
$Ag_2CO_3(s) \rightleftharpoons 2Ag^+(aq) + CO_3^-(aq)$
The K_{sp} of Ag_2CO_3(s) in water at 25°C is (R = 5.314 $JK^{-1}\ mol^{-1}$) **(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,
$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) + Heat.$
The equilibrium shifts in forward direction: **(2014)**
(a) By decreasing the pressure
(b) By decreasing the concentration of N_2(g) and H_2(g)
(c) By Increasing pressure and decreasing temperature
(d) By increasing the concentration of NH_3(g)

41. Which of these is least likely to act as a Lewis base? **(2013)**
(a) CO
(b) F^-
(c) BF_3
(d) PF_3

42. $KMnO_4$ 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

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)

$[H^+] = C\alpha$

$= 0.01 \times \frac{1}{100} = 10^{-4}$ M

pH = – log 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.

∴ Solubility: Ar < CO_2 < CH_4 < HCHO

S5. Ans.(c)

$CO_2(g) + C(s) \rightleftharpoons 2CO(g)$

$\Delta n_g = 2 - 1 = 1$

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

$K_p = K_c(RT)$

[∵ $K_p = 3$]

$K_c = \frac{K_p}{RT} = \frac{3}{0.083 \times 1000}$

= 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.

$pH = pK_a + \log \frac{[Salt]}{[Acid]}$

$= 4.57 + \log\left(\frac{0.1}{0.01}\right)$

= 4.57 + 1

= 4.57

S7. Ans.(a)

$3O_2(g) \rightleftharpoons 2O_3(g)$

$K_c = \frac{[O_3]^2}{[O_2]^3}$

$[O_3]^2 = K_c[O_2]^3 = 3 \times 10^{-59} \times (0.04)^3$

$[O_3]^2 = 1.9 \times 10^{-63} = 19 \times 10^{-64}$

$[O_3] = 4.38 \times 10^{-32}$

Concentration of O_3 at equilibrium = 4.38×10^{-32} M

S8. Ans.(b)

$pH = \frac{1}{2}[P^{k_w} + P^{k_a} - P^{k_b}]$

$= 7 + \frac{1}{2}P^{k_a} - \frac{1}{2}p^{k_b}$

$= 7 + \frac{1}{2} \times 4.77 - \frac{1}{2} \times 3.27$

= 7.75

S9. Ans.(d)

Let the solubility of $Ni(OH)_2$ is s

$\underset{s}{Ni(OH)_2} \rightleftharpoons \underset{s}{Ni^{2+}} + \underset{2s}{2OH^-}$

$NaOH \rightarrow Na + OH^-$

0.1 0.1 0.1

As K_{sp} is small 2s <<0.10

Therefore (0.10 + 2s) ≈ 0.10

So total $[OH]^-$ = 0.10

Ionic product = $[Ni^{2+}]\,[OH^-]^2$

$2 \times 10^{-15} = s(0.10)^2$

$s = 2 \times 10^{-13}$ 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 $[Na^+]$ $[Cl^-]$ 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

$K_{sp} = (s)2$

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

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

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

S13. Ans.(d)

Given : K = 2×10^{13}

$\Delta G = \Delta G° + RT\ lnQ$

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

So $\Delta_r G° = -RT\ lnK_{eq}$

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

S14. Ans.(a)

$Ca(OH)_2 \rightleftharpoons Ca^{2+} + 2OH^-$

$pH + pOH = 14$

pH = 9, thus pOH = 14 – 9 = 5

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

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

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

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

S15. Ans.(c)

$OH^{\ominus} \xleftarrow{-H^+} H_2O \xrightarrow{+H^+} H_3O^{\oplus}$

Conjugate base Conjugate acid

$\underset{Acid}{HF} + \underset{Base}{H_2O} \leftrightharpoons \underset{Conjugate\ base}{F^{\ominus}} + \underset{Conjugate\ acid}{H_3O^{\oplus}}$

S16. Ans.(c)

(i) $CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$

Initial 25 mL 50 mL 0

× 0.1 M × 0.1 M

= 2.5 mmol = 5 mmol

Final 0 2.5 mmol 2.5 mmol

This is basic solution due to NaOH.

This is not basic buffer.

(ii) $CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$

Initial 100 mL 100 mL 0

× 0.1 M × 0.1 M

= 10 mmol = 10 mmol

Final 0 0 10 mmol

Hydrolysis of salt takes place.

This is not basic buffer.

(iii) $HCl + NH_4OH \rightarrow NH_4Cl + H_2O$

Initial 100 mL 200 mL 0

× 0.1 M × 0.1 M

= 10 mmol = 20 mmol

Final 0 10 mmol 10 mmol

This will make basic buffer.

(iv) $HCl + NaOH \rightarrow NaCl + H_2O$

Initial 100 mL 100 mL 0

× 0.1 M × 0.1 M

= 10 mmol = 10 mmol

Final 0 0 10 mmol

⇒ This is Neutral solution.

S17. Ans.(a)

$A_2(g) + B_2(g) \rightleftharpoons X_2(g); \Delta H = -X\ kJ$

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)

Solubility of $BaSO_4$, $s = \frac{2.42 \times 10^{-3}}{233} (mol\ L^{-1})$

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

$BaSO_4(s) \rightleftharpoons Ba^{2+}(aq) + SO_4^{2-}(aq)$

$K_{sp} = [Ba^{2+}][SO_4^{2-}] = s^2$

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

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

S19. Ans.(c)

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

– M_{eq} of NaOH $= 25 \times \frac{1}{5} \times 1 = 5$
– M_{eq} of HCl in resulting solution = 10
– Molarity of $[H^+]$ in resulting mixture $= \frac{10}{100} = \frac{1}{10}$
  pH$= -\log[H^+] = -log\left[\frac{1}{10}\right] = 1.0$

S20. Ans.(c)

$2NH_3 \rightleftharpoons N_2 + 3H_2$	$\frac{1}{K_1}$
$N_2 + O_2 \rightleftharpoons 2NO$	K_2
$3H_2 + \frac{3}{2}O_2 \rightleftharpoons 3H_2O$	K_3^3
$2NH_3 + \frac{5}{2}O_2 \rightleftharpoons 2NO + 3H_2$	K

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

S21. Ans.(a)

$Ag_2C_2O_4 \rightarrow \underset{2s}{2Ag^+} + \underset{s}{C_2O_4^{2-}}$

$K_{sp} = [Ag^+]^2[C_2O_4$

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

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

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

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

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

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)

$CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$

$\Delta n = -1$

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

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

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)

	$NaCl(aq)$	$\rightleftharpoons$	Na^+		Cl^-
Initially	0.1 M		0		0
At equilibrium	0		0.1		0.1 + S
	$AgCl$	$\rightleftharpoons$	Ag^+	$+$	Cl^-
Initially	a		0		0
At equilibrium	0		S		0.1 + S

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

$= S(0.1 + S)$

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

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

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)

For $MY \rightleftharpoons \underset{S}{M^+} + \underset{S}{Y^-}$

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

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

For $NY_3 \rightleftharpoons N^{3+} + 3Y^-$

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

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

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:

$Ag_2CrO_4 \rightleftharpoons 2Ag^+ + CrO4^{2-}$

(2S)² S

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

$Ag_2CrO_4 = S \sim 10^{-3}$

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

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

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

So, Ag_2CrO_4 will be the most soluble.

S35. Ans.(d)

$\because$ 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 NaOH = 0.09 mole

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

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

$pH = 14 - p^{OH} = 14 - 1.35 = 12.65$

S36. Ans.(a)

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

S37. Ans.(a)

$\because \ \Delta G = \Delta G° + 2.303\ RT \log Q$

At equilibrium

$\Delta G = 0$

$Q = K_{eq}$

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

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.

NaCl → neutral pH = 7

$CuSO_4$ → Acidic pH < 7

KCl → Neutral pH = 7

S39. Ans.(b)

$\because \ \Delta G° = -2.303\ RT \log K_{sp}$

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

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

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.