Chapter

8 Ionic Equilibrium

Single Correct Option Type Questions

Q.1 In our body, carbon dioxide (CO_2) combines with water (H_2O) to form carbonic acid.
$H_2O + CO_2 \rightarrow H_2CO_3$
Carbonic acid undergoes dissociation as,
$H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$
During the physical and mental stress, the rate of respiration increases, which results in the decrease in concentration of CO_2 in the blood. What will be the effect on pH of human blood during the stress ?
(A) Decreases (B) Remains same (C) Increases (D) Cannot be predicted

Q.2 An aqueous solution of 0.01 M CH_3COOH has van't Hoff factor of 1.01. If pH = – log [H^+], pH of 0.01 M CH_3COOH solution would be -
(A) 2 (B) 3 (C) 4 (D) 5

Q.3 The pK_b value of ammonium hydroxide is 4.75. An aqueous solution of ammonium hydroxide is titrated with HCl. The pH of the solution at the point where half of the ammonium hydroxide has been neutralised will be
(A) 9.25 (B) 8.25 (C) 7.50 (D) 4.75

Q.4 Solubility of calcium phosphate (molecular mass, M) in water is W g per 100 mL at 25°C. Its soubility product at 25°C will be approximately -
(A) $10^9\left(\frac{W}{M}\right)^5$ (B) $10^7\left(\frac{W}{M}\right)^5$ (C) $10^5\left(\frac{W}{M}\right)^5$ (D) $10^3\left(\frac{W}{M}\right)^5$

Q.5 100 ml 0.1 M H_3PO_4 is titrated with 150 ml 0.1 M NaOH. The pH of final solution is
(Given : $K_1 = 10^{-3}$, $K_2 = 10^{-8}$, $K_3 = 10^{-12}$)
(A) 3 (B) 8 (C) 12 (D) 10

Q.6 What will be the approximate pH ion concentration when a 200 ml 0.02 M CH_3COOH is added with 100 ml 0.01 M HCl and 200 ml of 0.02 M NaOH (K_a $CH_3COOH = 2 \times 10^{-5}$).
(log 3 = 0.477)
(A) 5 (B) 6 (C) 4 (D) 7

Q.7 When 0.22 mole of CH_3NH_2 (ionization constant, $K_b = 10^{-6}$) is mixed with 0.02 mole HCl and the volume is made up to 1 litre, find the [H^+] of resulting solution at 25°C.
(A) 10^{-5} M (B) 2×10^{-9} M (C) 2×10^{-5} M (D) 10^{-9} M

Q.8 The solubility product of AgI at 25°C is 1.0×10^{-16} mol^2 L^{-2}. The solubility of AgI in 10^{-4} N solution of KI at 25°C is approximately (in mol L^{-1})
(A) 1.0×10^{-12} (B) 1.0×10^{-10} (C) 1.0×10^{-8} (D) 1.0×10^{-16}

Q.9 150 ml of 0.1 M NaOH solution is mixed with 100 ml of 0.1 M H_2CO_3 solution. If K_{a_1} and K_{a_2} of H_2CO_3 are 10^{-7} and 10^{-13} respectively, then pOH of the resulting solution will be
(A) 13 (B) 7 (C) 1 (D) 2

Q.10 10 ml of 0.2 M acid is added to 250 ml of a buffer solution with pH = 6.34 and the pH of the solution becomes 6.32 . The buffer capacity of the solution is :
(A) 0.1 (B) 0.2 (C) 0.3 (D) 0.4

Q.11 Which of the following is the correct nature of a solution obtained by mixing 100 ml of 0.10 M HA and 100 ml of 0.1 M NaOH ?
(I) Neutral, if HA is a strong acid
(II) Basic if HA is a weak acid
(III) Neutral if HA is a weak acid
(A) I only (B) I and II only (C) I and III only (D) II and III only

Q.12 When solid $AgNO_3$ is slowly added to a solution that has 0.0001 M each in NaCl, NaBr and NaI? The K_{sp} of AgCl = 1.7×10^{-10}, K_{sp} of AgBr = 3.3×10^{-13} and K_{sp} of AgI = 1.5×10^{-16}. The concentration of Ag^+ required to initiate the precipitation of AgCl is :
(A) 1.7×10^{-6} M (B) 1.7×10^{-4} M (C) 1.7×10^{-8} M (D) 1.7×10^{-9} M

Q.13 $AgNO_3$(s) is slowly added to a solution which 0.1 M in Cl^- and 0.1 M in Br^-. The % of Br^{-1} ions precipitated when AgCl ion starts precipitating is ?
$K_{sp}(AgCl) = 1 \times 10^{-10}$ and $K_{sp}(AgBr) = 1 \times 10^{-13}$.
(A) 0.1 (B) 0.01 (C) 99.9 (D) 99.99

Q.14 The pH of a solution obtained by mixing 2 ml of H_2SO_4 of pH= 2 and 3 ml of KOH of pH = 12 is ? (log 2 = 0.3)
(A) 10.30 (B) 3.70 (C) 11.30 (D) 12.70

Q.15 10 ml of $\frac{M}{10}$ H_2SO_4 is added to 40 ml of $\frac{M}{10}$ NH_4OH solution. The pH of the resulting solution is ?
(pK_b NH_4OH = 4.76)
(A) 4.46 (B) 9.54 (C) 9.24 (D) 4.76

Q.16 The equilibrium constant K_p for the reaction:
$H_2(g) + CO_2(g) \rightleftharpoons H_2O(g) + CO(g)$
is 16. Initially 0.4 mole of H_2 and 0.4 mole of CO_2 are present in a 5 L flask. The equilibrium concentration of $CO_2(g)$ is:
(A) 0.08 M (B) 0.016 M (C) 0.32 M (D) 0.064 M

Statement Based Questions

Q.17 **Statement-1:** pH of a neutral solution is always equal to $pK_W/2$ at any temperature.
Statement-2: A neutral solution at any temperature will have same concentration of [H^+] and [OH^-] ion in the expression for K_W.
(A) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1.
(C) Statement-1 is True, Statement-2 is False.
(D) Statement-1 is False, Statement-2 is True.

Q.18 **Statement-1:** The pH of pure water is less than 7 at 60° C
Statement-2: As the temperature increases, pure water becomes slightly acidic
(A) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1.
(C) Statement-1 is True, Statement-2 is False.
(D) Statement-1 is False, Statement-2 is True.

Multiple Correct Option Type Questions

Q.19 Let us consider the ionization of HCl in the aqueous solution of CH_3COOH.
$CH_3COOH + HCl \rightleftharpoons CH_3COOH_2^+ + Cl^-$
Select the correct statement(s) among the following -
(A) Cl^- is the conjugate base of HCl
(B) CH_3COOH is the conjugate base of $CH_3COOH_2^+$
(C) $CH_3COOH_2^+$ is the conjugate base of CH_3COOH
(D) None of these

Q.20 Which among the following represent the conjugate acid/base pairs ?
(A) H_3O^+/H_2O (B) H_2SO_4/SO_4^{2-}
(C) HCO_3^-/CO_3^{2-} (D) All are conjugate acid/base pairs

Q.21 Which among the following species act both as an acid as well as a base ?
(A) SO_4^{2-} (B) HSO_4^- (C) PO_4^{3-} (D) NH_3

Q.22 If you have saturated solution of CaF_2 then -
(A) $[Ca^{2+}] = \sqrt{K_{sp}}$ (B) $[Ca^{2+}] = 2\,[F^-]$ (C) $2[Ca^{2+}] = [F^-]$ (D) $[Ca^{2+}] = [K_{sp/4}]^{1/3}$

Q.23 A solution contains 0.01 M conc. each of Zn^{+2}, Mg^{+2} and M_n^{+2} ions. They are to be precipitated as their sulphide by passing H_2S gas into the solution and the solution is saturated with 0.1M H_2S
(Given : $K_{sp}(ZnS) = 10^{-18}$, $K_{sp}(MnS) = 10^{-22}$, $K_{sp}(MgS) = 10^{-12}$, $K_a(H_2S) = 10^{-21}$). Identify which is/are correct statement
(A) Only MnS is precipitated in pH range of 1 to 3. (B) ZnS is precipitated when the pH > 3.
(C) MgS gets precipitated when pH > 6. (D) MgS get precipitated when pH < 3.

Q.24 $H_3PO_4(aq) \rightleftharpoons H^+(aq) + H_2PO_4^-(aq),\ K_{a_1}$
$H_2PO_4^-(aq) \rightleftharpoons H^+(aq) + HPO_4^{2-}(aq),\ K_{a_2}$
$HPO_4^{2-}(aq) \rightleftharpoons H^+(aq) + PO_4^{3-}(aq),\ K_{a_3}$
Which is/are incorrect statement(s) ?
(A) $K_{a_1} > K_{a_2} > K_{a_3}$
(B) $pH(H_2PO_4^-) \approx \frac{pK_{a_1} + K_{a_2}}{2}$
(C) Both $H_2PO_4^-$ and HPO_4^{2-} are more acidic than H_3PO_4
(D) Only HPO_4^{2-} is amphiprotic anion in the solution

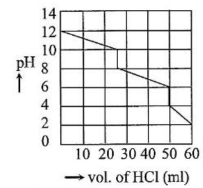
Q.25 Which of the following statement(s) is/are **CORRECT** ?
(A) pH of 10^{-8} MHCl(aq) solution is 8 at 25°C
(B) Autoprotolysis constant of water increases with temperature
(C) 100 ml of solution of 0.05 M $Ca(OH)_2$ will have pH = 13 at 25°C
(D) pH of 0.1 M solutions in correct order HCl < NH_4Cl < NaCl < NaCN

Q.26 Which of the following statement(s) is/are **INCORRECT** for 0.1 M NaA (aq) solution at 25°C ?
(Given : $K_a(HA) = 10^{-5}$)
(A) Degree of hydrolysis of A^-(aq) is 10^{-4} (B) pOH of solution is 5
(C) Solution is acidic (D) pH of solution = $\frac{1}{2}[pK_w - pK_a - \log C]$

Q.27 The solubility of a sparingly soluble salt $A_x B_y$ in water at 25°C = 1.4×10^{-4} M. The solubility product is 1.1×10^{-11}. The possibilities are
(A) x = 1, y = 2 (B) x = 2, y = 1 (C) x = 1, y = 3 (D) x = 3, y = 1

Q.28 The variation of pH during the titration of 0.5 N Na_2CO_3 with 0.5 N HCl is shown in the given graph. The following table indicates the colour and pH ranges of different indicators

Indicator	Range of colour change	Colour in acid	Colour in base
Thymol blue	1.2 to 2.8	Red	Yellow
Bromocresol red	4.2 to 6.3	Red	Yellow
Bromothymol blue	6.0 to 7.6	Yellow	Blue
Cresolphethalein	8.2 to 9.8	Colourless	Red



Based on the graph and the table, which of the following statements are true ?
(A) The first equivalence point can be detected by cresolphthalein
(B) The complete neutralisation can be detected by bromothymol
(C) The seconds equivalence point can be detected by bromocresol red
(D) The volume of HCl required for the first equivalence point is half the volume of HCl required for the second equivalence point

Q.29 Which of the following mixtures can be regarded as buffer ?
(A) 500 mL 0.2 (M) CH_3COOH + 1000 mL 0.2 (M) NaOH
(B) 500 mL 0.2 (M) CH_3COOH + 300 mL 0.2 (M) NaOH
(C) 500 mL 0.2 (M) CH_3COOH + 500 mL 0.2 (M) NaOH
(D) 500 mL 0.2 (M) CH_3COOH + 500 mL 0.2 (M) NH_4OH

Q.30 Which of the following mixture is/are buffers ?

(A) 100 ml of 0.1 M $Ca(CH_3COO)_2$ & 100 ml of 0.1 M HCl
(B) 100 ml of 0.1 M $(PhNH_3)_2SO_4$ & 50 ml 0.1 M $Ca(OH)_2$
(C) 100 ml of 0.1 M $(NH_4)_2SO_4$ & 100 ml of 0.1 M NH_4OH
(D) 100 ml of 0.1 M borax solution ($Na_2B_4O_7.10H_2O$) & 25 ml of 0.05 M H_2SO_4

Q.31 Buffer solution of A of a weak monoprotic acid and its sodium salt in the concentration ratio m : n has pH = X. Buffer solution B of the same acid and its sodium salt in the concentration ratio n : m has pH = Y. If Y – X = 1 and X + Y = 9.5 then,

(A) $pK_a = 4.75$ (B) $\frac{m}{n} = 2.36$ (C) $\frac{m}{n} = 3.162$ (D) $pK_a = 5.25$

Q.32 Which of the following mixture represent a buffer ?

(A) 100 ml of 2 M HCN & 100 ml of 1 M NaOH
(B) 100 ml of 2 M CH_3COONa & 100 ml of 1 M HCl
(C) 100 ml of 0.2 M NH_4OH & 100 ml of 0.1 M H_2SO_4
(D) 100 ml of 0.5 M $C_6H_5NH_2$ & 100 ml of 0.2 M H_2SO_4

Passage Based Questions

Passage # 1 (Ques. 33 - 35)

The dissociation of weak electrolyte (weak acid) is expressed in terms of Ostwald dilution law. Stronger is the acid, weaker is its conjugate base. The dissociation constants of an acid (K_a) and its conjugate base (K_b) are related by the given relation :

$K_w = K_a \times K_b$

At 25°C, K_w (Ionic product of water) = 10^{-14}

Phosphoric acid is a weak acid. It is used in fertilizer, food, detergent and toothpaste. Structure of phosphoric acid is :

O
↑
HO–P–OH ($pK_{a_1} = 2.12, pK_{a_2} = 7.21, pK_{a_3} = 12.32$)
|
OH

Aqueous solution of phosphoric acid with a density of 1 g mL^{-1} containing 0.05 % by weight of phosphoric acid is used to impart tart taste to many soft drinks.

Phosphate ion is an interfering radical in qualitative analysis. It should be removed for analysis beyond third group of qualitative analysis.

Q.33 The basicity of phosphoric acid is -

(A) 1 (B) 2 (C) 3 (D) 4

Q.34 The state of hybridization of phosphorous in phosphoric acid is -

(A) sp (B) sp^2 (C) sp^3 (D) sp^3d

Q.35 What is the molarity of phosphoric acid used in soft drink ?

(A) 5.1×10^{-3} (B) 1.5×10^{-3} (C) 3.1×10^{-3} (D) 2.1×10^{-3}

Passage # 2 (Ques. 36 - 37)

Acid – base indicators are either weak organic acid or weak organic bases. Indicator change in dilute solution when the hydronium ion concentration reaches a particular value. For example, phenolphthalein is a colourless substance in any aqueous solution with a pH less then 8.3. In between the pH range 8.3 to 10, transition of colour (colourless to pink) takes place and if pH of solution is greater than 10 solution is dark pink considering an acid indictor HIn, the equilibrium involving it and its conjugate base In^- can be represented as :

$$\underset{\text{acidic form}}{HIn} \rightleftharpoons H^+ + \underset{\text{basic form}}{In^-}$$

pH of solution can be computed as :

$$pH = pK_{In} + \log\frac{[In^-]}{[HIn]}$$

In general, transition of colour take place in between the pH range $pK_{In} \pm 1$.

Q.36 What is the equilibrium constant for the reaction ?

HB (aq) + NaA (aq) $\rightleftharpoons$ HA(aq) + NaB (aq)

(A) 10 (B) 0.1 (C) 10^{-7} (D) 10^{-11}

Q.37 Calculate the pH at equivalent point when HB is titrated with NaOH

(A) 8.75 (B) 8.85 (C) 9.0 (D) None of these

Passage # 3 (Ques. 38 - 39)

The solubility of some sparingly soluble salts e.g. AgCl, AgBr, AgI, Ag_2CrO_4 etc can be appreciably increased through complexation reaction. Let's take the case of AgCl which is very feebly soluble in water (K_{sp} of AgCl = 1×10^{-10} at 25°C) but if liquid ammonia is added into this solution, its solubility increased so many folds due to the formation of complex $[Ag(NH_3)_2]^+$.

$AgCl + 2NH_3\,(aq) \rightleftharpoons [Ag(NH_3)_2]^+ + Cl^-$

A solution of Ag^+ ions at a concentration of 4.0×10^{-13} M just fails to yield a precipitate of AgCl with concentration of 1.0×10^{-3} M of Cl^- ions, when the concentration of ammonia in the solution is 2.0×10^{-2} M.

Now, answer the following questions.

Q.38 The solubility of AgCl in water (without adding NH_3) at 25°C is

(A) 10^{-4} M (B) 10^{-5} M (C) 10^{-6} M (D) 10^{-8} M

Q.39 The dissociation constant of the complex $[Ag(NH_3)_2]^+$ at 25°C is

(A) 10^{-7} (B) 10^{+7} (C) 10^{-8} (D) 10^{+8}

Passage # 4 (Ques. 40- 42)

A solution is 0.1 M in each of Ba^{2+}, Ca^{2+} and Sr^{2+} ions. Solid $(NH_4)_2SO_4$ is gradually added to the solution. Given $K_{sp}(BaSO_4) = 1.5 \times 10^{-9}$, $K_{sp}(CaSO_4) = 2.5 \times 10^{-5}$ and $K_{sp}(SrSO_4) = 7.5 \times 10^{-7}$.

Assume no change in volume during the addition of $(NH_4)_2SO_4$.

Q.40 The correct sequence of ions precipitated is

(A) $Ba^{2+}, Ca^{2+}, Sr^{2+}$ (B) $Ba^{2+}, Sr^{2+}, Ca^{2+}$ (C) $Ca^{2+}, Sr^{2+}, Ba^{2+}$ (D) $Ca^{2+}, Ba^{2+}, Sr^{-2+}$

Q.41 The concentration of the first ion precipitated when the second starts precipitating is about

(A) 0.1 M (B) 2×10^{3} M (C) 2×10^{-4} M (D) 2×10^{-5} M

Q.42 The concentration of the second ion precipitated when the third starts precipitating is about

(A) 3×10^{-4} M (B) 3×10^{-5} M (C) 0.1 M (D) 3×10^{-3} M

Passage # 5 (Ques. 43 - 44)

The solubility product of a soluble salt A_xB_y is given by; $K_{sp} = [A^{y+}]^x [B^{x-}]^y$. As soon as the product of concentration of A^{y+} and B^{x-} becomes more than its K_{sp}, the salt begins to precipitate. It may practically be noticed that AgCl is fairly soluble in water and its solubility decreases dramatically in 0.1 M NaCl or 0.1 M $AgNO_3$ solution. It may, therefore, be concluded that in presence of a common ion, the solubility of salt decreases.

Q.43 K_{sp} of SrF_2 in water is 8×10^{-10}. The solubility of SrF_2 in 0.1 M NaF aqueous solution is

(A) 8×10^{-10} (B) 2×10^{-3} (C) 2.7×10^{-10} (D) 8×10^{-8}

Q.44 Equal volume of the following two solutions are mixed. The one in which $CaSO_4$ ($K_{sp} = 2.4 \times 10^{-5}$) is precipitated is

(A) 0.02 M $CaCl_2$ + 0.0004 M Na_2SO_4 (B) 0.01 M $CaCl_2$ + 0.0004 M Na_2SO_4

(C) 0.02 M $CaCl_2$ + 0.0002 M Na_2SO_4 (D) 0.03 M $CaCl_2$ + 0.0004 M Na_2SO_4

Passage # 6 (Ques. 45 - 47)

The solubility of some sparingly soluble salts e.g. AgCl, AgBr, AgI, Ag_2CrO_4 etc can be appreciably increased through complexation reaction. Let's take the case of AgCl which is very feebly soluble in water (K_{sp} of AgCl = 1×10^{-10} at 25°C) but if liquid ammonia is added into this solution, its solubility increased so many folds due to the formation of complex $[Ag(NH_3)_2]^+$

$$AgCl + 2NH_3(aq) \rightleftharpoons [Ag(NH_3)_2]^+ + Cl^-$$

A solution of Ag^+ ions at a concentration of 4.0×10^{-13} M just fails to yield a precipitate of AgCl with concentration of 1.0×10^{-3} M of Cl^- ions, when the concentration of ammonia in the solution is 2.0×10^{-2} M.

Now, answer the following questions :

Q.45 The solubility of AgCl in water (without adding NH_3) at 25°C is

(A) 10^{-4} M (B) 10^{-5} M (C) 10^{-6} M (D) 10^{-8} M

Q.46 The dissociation constant of the complex $[Ag(NH_3)_2]^+$ at 25°C is

(A) 10^{-7} (B) 10^{+7} (C) 10^{-8} (D) 10^{+8}

Q.47 $Ag^+ + 2NH_3 \rightleftharpoons [Ag(NH_3)_2]^+$

On adding more NH_3, the above equilibrium shifts :

(A) In the forward direction (B) In the backward direction

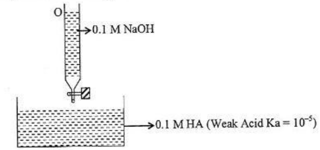
(C) The complex dissociation faster (D) None of these

Column Matching Type Questions

Q.48 Match the column when we titrate sodium carbonate solution (in beaker) with hydrochloric acid :

Column –I	Column-II
(A) At the start titration	(P) Buffer solution of HCO_3^- and CO_3^{2-}
(B) Before the first equivalent point	(Q) Buffer solution of H_2CO_3 and HCO_3^-
(C) At the first equivalent point	(R) Amphiprotic anion, $pH = 1/2(pK_{a_1} + pK_{a_2})$
(D) Between the first and second equivalent points	(S) Hydrolysis of CO_3^{2-}
	(T) $pH = \sqrt{pK_{a_1} + pK_{a_2}}$

Q.49 Consider the following experimental setup :



Column I (Expression for pH)	Column II (Extent of titration)
(A) $pk_a + \log\frac{[salt]}{[Acid]}$	(P) No titration
(B) $\frac{1}{2}(pk_a - \log C)$	(Q) Titration < 100 %
(C) $14 - \log [OH^-]$	(R) Titration = 100%
(D) $\frac{1}{2}(pk_w + pk_a + \log C)$	(S) Titration > 100%

Q.50

Column I	Column II
(A) Solubility of AgCl in water	(P) 10^{-5} M
(B) Solubility of Ag_2SO_4 in water	(Q) 1.435×10^{-6} gm/ml
(C) Solubility of Ag_2SO_4 in 0.1 M $AgNO_3$	(R) 4×10^{-13} M
(D) Solubility of Ag_2SO_4 in 0.1M Na_2SO_4	(S) 10^{-7} M

Given : $K_{SP}(AgCl) = 10^{-10}$; $K_{SP}(Ag_2SO_4) = 4 \times 10^{-15}$

Q.51

Column I	Column II
(A) 1L, 1M Na_2CO_3 + 1L, 1M H_2CO_3 [$K_{a_1}(H_2CO_3) = 10^{-6}$, $K_{a_2} = 10^{-9}$]	(P) pH = 7.5
(B) 1L, 0.2 M $(CH_3COO)_2Ca$ + 1L, 0.2 M HCl solution [$K_a(CH_3COOH) = 10^{-5}$]	(Q) pH = 1
(C) 1L, 0.2 M NH_4Cl + 1L, 0.2 M HCl solution	(R) pH = 9
(D) 1L, 0.2 M NH_4Cl + 1L, 0.1 M NaOH solution [$K_b(NH_4OH) = 10^{-5}$]	(S) pH = 5

Q.52 Match the following :

List-I	List-II
(P) 75 ml of 0.2 M CH_3COOH + 25 ml of 0.2 M NaOH	(1) 12.7
(Q) 50 ml of 0.2 M CH_3COOH + 25 ml of 0.2 M NaOH	(2) 8.72
(R) 50 ml of 0.2 M CH_3COOH + 50 ml of 0.2 M NaOH	(3) 4.74
(S) 25 ml of 0.2 M CH_3COOH + 75 ml of 0.2 M NaOH	(4) 4.44

(pK_a = 4.74; log 2 = 0.3; log 3 = 0.477; log 5 = 0.7)

Codes :

	P	Q	R	S
(A)	2	3	4	1
(B)	2	1	3	4
(C)	1	2	3	4
(D)	4	3	2	1

Q.53 Match the following

List-I	**List-II**
(P) $CH_3COOH + CH_3COONa$	(1) Basic buffer
(Q) $NH_4OH + NH_4Cl$	(2) Acidic buffer
(R) Na_2CO_3	(3) Acidic salt
(S) $CuSO_4$	(4) Basic salt

Codes:

	P	Q	R	S
(A)	2	1	4	3
(B)	2	2	4	3
(C)	1	2	3	4
(D)	4	2	1	3

Q.54 Match Column-I and Column-II.

Column I	**Column II**
(A) The volume of mixture has no effect on the equilibrium constant.	(P) Common ion effect
(B) Increasing the pressure moves the equilibrium to to the left.	(Q) pH = 4
(C) The solution has hydronium ion concentration of 0.0001 mol/litre.	(R) There is an increase in the number of moles from products to reactants.
(D) The addition of NaOH to $Ca(OH)_2$ solution precipitates $Ca(OH)_2$	(S) There is no change in number of moles

Numeric Response Type Questions

Q.55 The pH of a 0.005 M H_2SO_4 solution is _____.

Q.56 A 0.1 M solution of weak monoprotic acid ($K_a = 1 \times 10^{-5}$) is 1 % dissociated. The pH of solution is ______ .

Q.57 Calculate pH at which an acid indicator HIn with concentration 0.1 M changes its colour (K_a for HIn $= 1 \times 10^{-5}$)

Q.58 The K_{sp} of Mg $(OH)_2$ is 1×10^{-12}; 0.01 M $MgCl_2$ will precipitate at limiting pH of______ .

Q.59 Find out negative logarithm of solubility of solid $Zn(OH)_2$ at 25°C and pH = 6.

Given : $Zn(OH)_2\,(s) + aq \rightleftharpoons Zn(OH)_2\,(aq),\ K_1 = 10^{-6}$.

$Zn(OH)_2\,(aq) \rightleftharpoons Zn(OH)^+\,(aq) + OH^-\,(aq),\ K_2 = 10^{-7}$.

$Zn(OH)^+\,(aq) \rightleftharpoons Zn^{+2}\,(aq) + OH^-\,(aq),\ K_3 = 10^{-4}$.

$Zn(OH)_2\,(aq) + OH^-\,(aq) \rightleftharpoons Zn(OH)_3^-\,(aq),\ K_4 = 10^3$.

$Zn(OH)_3^-\,(aq) + OH^-\,(aq) \rightleftharpoons Zn(OH)_4^{-2}\,(aq),\ K_5 = 10$.

Q.60 Calculate the pH of 0.005 M $(CH_3COO)_2Ba$.
(Given : $K_a(CH_3COOH) = 10^{-6}$)

Q.61 If the solubility of $Cd(CN)_2$ in 0.050 M NaCN solution is $X \times 10^{-6}$. What is the value of X ?
[K_{sp} of $Cd(CN)_2 = 1.0 \times 10^{-8}\ M^3$]

Q.62 If the percentage degree of dissociation (%α) of 0.01M weak base XOH (aq) in presence of 0.1M NaOH is represented as 10^{-x} then find the value of 'x'?
Given : $K_b(XOH) = 10^{-5}$.

Q.63 An acid-base indicator which is a weak acid has a pK_a value = 5.45. At what concentration ratio of sodium acetate to acetic acid would the indicator show a colour half-way between those of its acid and conjugate base forms? pK_a of acetic acid = 4.75. [log 2 = 0.3].

Q.64 What is ratio of moles of $Mg(OH)_2$ and $Al(OH)_3$ in 1 litre. Their saturated solution (K_{SP} of $Mg(OH)_2 = 4 \times 10^{-12}$ and K_{SP} of $Al(OH)_3 = 1 \times 10^{-33}$) give answer by multiplying it with by 10^{-17}. (Both are present in same solution)

Q.65 Determine degree of dissociation of 0.05 M NH_3 at 25°C in a solution of pH = 11.

Q.66 The solubility of $Mg(OH)_2$ in a solution of $Ba(OH)_2$ is $x \times 10^{-8}$ M. 10 mL of $Ba(OH)_2$ solution requires 10 mL of 0.04 N HCl solution for complete neutralization. K_{sp} of $Mg(OH)_2$ is $1.2 \times 10^{-11}\ M^3$. The value of x is.

Q.67 Out of NaCN, NaCl, NH_4Cl, CH_3COONa, $NaHCO_3$, Na_2CO_3, Na_3PO_4, HCOONa how many aqueous solution have pH > 7.

Q.68 If 50 ml of 0.2 M NaCN is mixed with 50 ml of 0.2 M HCl then (K_b for $CN^- = 2 \times 10^{-5}$) Calculate concentration of $[H_3O^+]$ interms of molarity $\times 10^{-6}$.

Q.69 Amongst the following, the total number of compounds whose aqueous solution turns red litmus paper blue is NaCN, KCl, CH_3COONH_4, NaH_2PO_4, $ZnCl_2$, Na_3PO_4, $Fe(NO_3)_3$, Na_2CO_3, NH_4Cl, $NaHCO_3$, Na_2HPO_4.

Q.70 1 ml of 0.05 M H_2SO_4 is mixed with 999 ml of NaCl solution. The pH of the resulting solution is.

Q.71 A certain buffer solution contains equal concentration of X^{-1} and HX. The K_b for X^- is 10^{-10}. Then the pH of the buffer is.

ANSWER KEY

Single Correct Option type Questions

1. (C)	**2.** (C)	**3.** (A)	**4.** (B)	**5.** (B)	**6.** (A)	**7.** (D)
8. (A)	**9.** (A)	**10.** (D)	**11.** (B)	**12.** (A)	**13.** (C)	**14.** (C)
15. (C)	**16.** (B)					

Statement Based Questions

17. (A)	**18.** (B)

Multiple Correct Option type Questions

19. (A,B)	**20.** (A,C)	**21.** (B,D)	**22.** (C,D)	**23.** (A,B,C)	**24.** (C,D)	**25.** (B,C,D)
26. (C,D)	**27.** (A,B)	**28.** (A,C,D)	**29.** (B,D)	**30.** (A,B,D)	**31.** (A,C)	**32.** (A,B,D)

Passage Based Questions

33. (C)	**34.** (C)	**35.** (A)	**36.** (A)	**37.** (B)	**38.** (B)	**39.** (C)
40. (B)	**41.** (C)	**42.** (D)	**43.** (D)	**44.** (D)	**45.** (B)	**46.** (C)
47. (A)						

Column Matching Type Questions

48. [**A** $\rightarrow$ S; **B** $\rightarrow$ P; **C** $\rightarrow$ R; **D** $\rightarrow$ Q]

49. [**A** $\rightarrow$ Q; **B** $\rightarrow$ P; **C** $\rightarrow$ S; **D** $\rightarrow$ R]

50. [**A** $\rightarrow$ P,Q; **B** $\rightarrow$ P; **C** $\rightarrow$ R; **D** $\rightarrow$ S]

51. [**A** $\rightarrow$ P; **B** $\rightarrow$ S; **C** $\rightarrow$ Q; **D** $\rightarrow$ R]

52. [D]

53. [A]

54. [**A** $\rightarrow$ S; **B** $\rightarrow$ R; **C** $\rightarrow$ Q; **D** $\rightarrow$ P]

Numerical Response Type Questions

55. (2)	**56.** (3)	**57.** (5)	**58.** (9)	**59.** (1)	**60.** (9)	**61.** (4)
62. (1)	**63.** (3)	**64.** (4)	**65.** (2)	**66.** (3)	**67.** (6)	**68.** (7)
69. (5)	**70.** (4)	**71.** (4)				