PHYSICAL / INORGANIC
CHEMISTRY
DPP
DAILY PRACTICE PROBLEMS

DPP No. 23

Total Marks : 46

Max. Time : 51 min.

Topic : Ionic Equilibrium

Type of Questions		**M.M., Min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.6	(3 marks, 3 min.)	[18, 18]
Multiple choice objective ('–1' negative marking) Q.7 to Q.8	(4 marks, 4 min.)	[8, 8]
Subjective Questions ('–1' negative marking) Q.9 to Q.11	(4 marks, 5 min.)	[12, 15]
Match the Following (no negative marking) Q. 12	(8 marks, 10 min.)	[8, 10]

1. In which of the following cases the resulting solution is acidic.

I . $BeCl_2$ II. KCN III. Na_2CO_3 IV. C_5H_6NBr

(A) I & IV (B) I & III (C) I, III and IV (D) Only IV

2. We know that NH_3 is a stronger base than CH_4. Which of the following is correct ?

(A) NH_3 is a stronger acid than CH_4. (B) NH_3 is a weaker acid than CH_4.

(C) NH_4^+ is a weaker acid than CH_4. (D) All of these

3. In terms of K_1, K_2 and K_3 of a weak triprotic acid H_3B, the value of K_b for BH^{2-} will be :

(A) K_w/K_1 (B) K_w/K_2 (C) K_2/K_w (D) K_w/K_3

4. If a solution contains 10^{-6} M each of X^-, Y^{2-} and Z^{3-} ions, then upon addition of $AgNO_3$(s) slowly to the above solution with stirring : (Given : K_{sp} (AgX) = 9×10^{-14}, $K_{sp}(Ag_2Y) = 4.9 \times 10^{-21}$, $K_{sp}(Ag_3Z) = 5.12 \times 10^{-28}$)

(A) Ag_3Z will be the first one to precipitate out. (B) Ag_2Y will be the first one to precipitate out.

(C) AgX will be the first one to precipitate out. (D) Nothing can be said with certainity.

5. The freezing point depression of a 0.1 M aq. solution of weak acid (HX) is –0.20°C.

What is the value of equilibrium constant for the reaction?

$$HX\,(aq) \rightleftharpoons H^+(aq) + X^-\,(aq)$$

[Given : K_f for water = 1.8 kg mol^{-1} K. & Molality = Molarity]

(A) 1.46×10^{-4} (B) 1.35×10^{-3} (C) 1.21×10^{-2} (D) 1.35×10^{-4}

6. Azhar wants to prepare a saturated solution of Ag^+ ion. He has got only three samples of AgCl (K_{sp}= 1.8×10^{-10}), AgBr (K_{sp} = 5×10^{-13}) and $Ag_2\,CrO_4$ (K_{sp} = 2.4×10^{-12}), which compound he should use to have maximum $[Ag^+]$?

(A) AgCl (B) AgBr (C) Ag_2CrO_4 (D) Either of them

7. In which of the following solutions, the solubility of AgCN will be greater than that in pure water :

Given $K_{sp}(AgCN) = 4 \times 10^{-16}$, K_a (HCN) = 5×10^{-10}

(A) 0.01 M Ag NO_3 solution

(B) A buffer solution of pH = 12

(C) 0.2 M NH_3 solution

(D) A buffer solution of pH = 5

8. Acetic acid and propionic acid have K_a values 1.75×10^{-5} and 1.3×10^{-5} respectively at a certain temperature. An equimolar solution of a mixture, of the two acids is partially neutralised by NaOH. How is the ratio of the contents of acetate and propionate ions related to the K_a values and the molarity:

(A) $\left(\frac{\alpha}{1-\alpha}\right) = \frac{1.75}{1.3} \times \left(\frac{\beta}{1-\beta}\right)$, where α and β are ionised fractions of their acids

(B) The ratio is unrelated to the K_a values.

(C) The ratio is unrelated to the molarity of acid.

(D) The ratio is unrelated to the pH of the solution.

9. A certain mixture of HCl and CH_3–COOH is 0.1 M in each of the acids. 20 ml of this solution is titrated against 0.1M NaOH. By how many units does the pH change from the start to the stage when the HCl is almost completely neutralised and acetic acid remains unreacted ? K_a for acetic acid = 2×10^{-5}.

10. CH_3COOH (60 ml, 0.1M) is titrated against 0.1M NaOH solution. Calculate the pH at the addition of 10 ml of NaOH. K_a of CH_3COOH is 2×10^{-5}. [log 2 = 0.3]

11. How many salts will turn blue litmus to red when dissolved in water ?

K_2SO_4, LiCN, $C_6H_5NH_3^+Cl^-$, $C_6H_5COO^-Na^+$, $FeCl_3$, $(NH_4)_2C_2O_4$, $Al(NO_3)_3$, CH_3COONa

12.

	Column-I	**Column-II**
(A)	$NaHCO_3$ (aq.)	(p) Significant cationic hydrolysis
(B)	CH_3COONH_4 (aq.)	(q) Significant anionic hydrolysis
(C)	$K_2SO_4 . Al_2(SO_4)_3$ (aq.)	(r) Acidic (pH < 7)
(D)	NaCN (aq)	(s) Basic (pH > 7)
		(t) pH is independent of concentration

Given : $K_1 = 5 \times 10^{-7}$, $K_2 = 5 \times 10^{-11}$ for H_2CO_3

K (CH_3COOH) = 1.8×10^{-5} , K (NH_4OH) = 1.8×10^{-5}

Answer Key

DPP No. # 23

1.	(A)	**2.**	(A)	**3.**	(B)	**4.**	(B)	**5.**	(B)
6.	(C)	**7.**	(C, D)	**8.**	(A,C,D)	**9.**	(3)	**10.**	4
11.	03	**12.**	(A – q,s,t) ; (B – p,q,t) ; (C – p,r) ; (D – q,s).						

Hints & Solutions

PHYSICAL / INORGANIC CHEMISTRY

DPP No. # 23

1. Hydrolysis of cartion can form H^+. So Be^{+2}, $C_5H_6N^+$ forms acidic solution.

3. $BH^{2-} + H_2O \rightleftharpoons BH_2^- + OH^-$

$$K_b = \frac{K_w}{K_a(\text{of } BH_2^-)}$$

$$\text{i.e. } K_b = \frac{K_w}{K_2}$$

4. $[Ag^+]$ req for pptation of AgX$= \dfrac{K_{sp}}{[X^-]} = \dfrac{9 \times 10^{-14}}{10^{-6}} = 9 \times 10^{-8}$ M

$[Ag^+]$ req for pptation of $Ag_2Y = \sqrt{\dfrac{K_{sp}}{[y^-]}} = \sqrt{\dfrac{4.9 \times 10^{-21}}{10^{-6}}} = 7 \times 10^{-8}$ M

$[Ag^+]$ req for pptation of $Ag_3Z = \sqrt[3]{\dfrac{K_{sp}}{[z^-]}} = \sqrt[3]{\dfrac{5.12 \times 10^{-28}}{10^{-6}}} = 8 \times 10^{-8}$ M

clearly, $[Ag^+]$ req for pptation of Ag_2Y is minimum.

∴ Ag_2Y will be the first one to pricipitate out.

5. $\Delta T_f = i \times k_f \times m$

$0.2 = i \times 1.8 \times 0.1$

⇒ $i = 1.11$

⇒ $\alpha = 0.11$

$$k_a = \frac{c\alpha^2}{1-\alpha} = \frac{0.1 \times (0.11)^2}{(1-0.11)}$$

$= 1.35 \times 10^{-3}$ **Ans.**

6. Let the solubility of AgCl, AgBr and $Ag_2\,CrO_4$ be xM, yM and zM, then we get

$$K_{sp(AgCl)} = x^2 \quad \Rightarrow \quad x = \sqrt{1.8 \times 10^{-10}} \quad \Rightarrow \quad x = 10^{-5}\sqrt{1.8}$$

Similarly, $y = 10^{-7}\sqrt{50}$

$K_{sp}\,Ag_2CrO_4 = 4z^3 = 2.4 \times 10^{12}$

⇒ $z = (60)^{1/3} \times 10^{-4}$

∴ More (Ag^+) is needed to precipitate it.

7. In $AgNO_3$ solution, the solubility of AgCN will decrease as compared to pure water because of common ion effect of Ag^+ ion.

In NH_3 solution and buffer of pH = 5, the solubility of AgCN will increase due to complex formation in case of NH_3 solution and hydrolysis of CN^- ions in case of buffer of pH = 5.

8. In a given mixture, the ionisation of two acids can be written as: Let α, β be degree of ionisation at same concentration.

$$\underset{1-\alpha}{CH_3COOH} \rightleftharpoons \underset{\beta}{CH_3COO^-} + \underset{\alpha+\beta-x}{H^+} \qquad \underset{1-\beta}{C_2H_5COOH} \rightleftharpoons \underset{\beta}{C_2H_5COO^-} + \underset{\alpha+\beta-x}{H^+}$$

$$\therefore \quad K_{A.A} = \frac{[\alpha][\alpha+\beta-x].c}{[1-\alpha]} \qquad K_{P.A} = \frac{[\beta][\alpha+\beta-x].c}{[1-\beta]}$$

(where 'x' is equivalents of NaOH droped).

$$\therefore \quad \frac{K_{A.A}}{K_{P.A}} = \frac{\alpha}{1-\alpha} \times \frac{1-\beta}{\beta} \qquad \text{or} \qquad \frac{\alpha}{1-\alpha} = \frac{1.75}{1.3} \times \left[\frac{\beta}{1-\beta}\right]$$

Hence, A,C,D.

9. m. moles of HCl = 0.1 × 20 = 2

m. moles of CH_3COOH = 0.1 × 20 = 2

After titration of HCl by NaOH

$$[CH_3COOH] = \frac{2}{40} = \frac{1}{20}\,M$$

$$\therefore \text{pH} = \frac{1}{2}(pK_a - \log C) = \frac{1}{2}\left[5 - \log 2 - \log\left(\frac{1}{20}\right)\right] = \mathbf{3.}$$

10. When 10 ml of NaOH is added, it reacts with CH_3COOH to produce salt and water. The solution is then an acidic buffer. So, for acidic buffer,

$$\text{pH} = pK_a + \log\frac{[\text{Conjugate base}]}{[\text{Acid}]}$$

$$= 4.7 + \log\frac{10 \times 0.1}{60 \times 0.1 - 10 \times 0.1}$$

$$= 4.7 + \log\frac{1}{5} = \mathbf{4}$$

11. $C_6H_5NH_3^+Cl^-$, $FeCl_3$, $Al(NO_3)_3$.