PHYSICAL / INORGANIC CHEMISTRY

DPP

DAILY PRACTICE PROBLEMS

DPP No. 17

Total Marks : 34

Max. Time : 41 min.

Topic : Ionic Equilibrium

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.2	(3 marks, 3 min.)	[6, 6]
Subjective Questions ('–1' negative marking) Q.3 to Q.9	(4 marks, 5 min.)	[28, 35]

1. **(a)** When CO_2 dissolves in water, the following equilibrium is established

$CO_2 + 2H_2O \rightleftharpoons H_3O^+ + HCO_3^-$ for which the equilibrium constant is 3.8×10^{-7} and pH = 6. The ratio of HCO_3^- to CO_2 would be

(A) 3.8 (B) 0.38 (C) 6 (D) 13.4

(b) The pH of blood is 7.4 . What is the ratio of $\frac{[HPO_4^{2-}]}{[H_2PO_4^-]}$ in the blood . pK_a ($H_2PO_4^-$) = 7.1

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

2. **(a)** Which of the following salts undergoes anionic hydrolysis?

(A) $CuSO_4$ (B) NH_4Cl (C) $FeCl_3$ (D) Na_2CO_3

(b) The pH value will be highest for the aqueous solution of

(A) NaCl (B) Na_2CO_3 (C) NH_4Cl (D) $NaHCO_3$

(c) Which of the following salts does not undergo hydrolysis?

(A) NH_4NO_3 (B) $FeCl_3 . 6H_2O$ (C) KCl (D) KCN

3. Determine the $[S^{2-}]$ in a saturated (0.1M) H_2S solution to which enough HCl has been added to produce a $[H^+]$ of 2×10^{-4} . $K_1 = 10^{-7}$, $K_2 = 10^{-14}$.

4. (i) What concentration of H_3O^+ ions will reduce $[S^{2-}]$ ion to 4×10^{-18} M in a 0.10 M solution H_2S?

(ii) What concentration of H_3O^+ ions will reduce $[HS^-]$ ion to 2×10^{-6} M in a 0.10 M solution H_2S ?

$K_1(H_2S) = 1 \times 10^{-7}$, $K_2(H_2S) = 10^{-14}$.

5. Find the concentration of H^+ , HCO_3^- & CO_3^{2-} in a 0.01 M solution of H_2CO_3 if the pH of this is 4.18 .

K_a (H_2CO_3) = 4×10^{-7} ; K_a (HCO_3^-) = 4.8×10^{-11} .

6. What is the concentration of acetic acid which can be added to 0.5 M formic acid so that the % dissociation of neither acid is changed by the addition. K_a for acetic acid is 2×10^{-5}, K_a for formic acid = 2.4×10^{-4}.

7. Calculate the hydrolysis constant of the salt containing NO_2^- ions , K_a for HNO_2 is 5×10^{-4} .

8. Nicotine, $C_{10}H_{14}N_2$, has two basic nitrogen atoms and both can react with water to give a basic solution.

$Nic(aq) + H_2O(l) \rightleftharpoons NicH^+(aq) + OH^-(aq)$

$NicH^+(aq) + H_2O(l) \rightleftharpoons NicH_2^{2+}(aq) + OH^-(aq)$

K_{b1} is 8.0×10^{-7} and K_{b2} is 1.1×10^{-10}. Calculate the approximate pH of a 0.20 M solution.

9. A solution contains 0.10 M H_2S and 0.25 M HCl . Calculate the concentration of $[S^{2-}]$ and $[HS^-]$ ions in the solution. For H_2S, $K_{a_1} = 1.0 \times 10^{-7}$, $K_{a_2} = 1.3 \times 10^{-13}$

Answer Key

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1. (a) (B) (b) (A)
2. (a) (D) (b) (B) (c) (C)
3. $[S^{2-}] = 2.5 \times 10^{-15}$
4. (i) $[H_3O^+] = 5 \times 10^{-3}$ M (ii) $[H_3O^+] = 5 \times 10^{-3}$ M.
5. $[H^+] = 6.6 \times 10^{-5}$, $[HCO_3^-] = 6.06 \times 10^{-5}$, $[CO_3^{2-}] = 4.8 \times 10^{-11}$.
6. $C_1 = 6$ M.
7. 2×10^{-11}.
8. pH = 10.6.
9. $[HS^-] = 4 \times 10^{-8}$ M ; $[S^{2-}] = 2.08 \times 10^{-20}$ M.

Hints & Solutions

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1. **(b)** $H_2PO_4^- \rightleftharpoons HPO_4^{2-} + H^+$.

$$8 \times 10^{-8} = \left(\frac{HPO_4^{2-}}{H_2PO_4^-}\right) \times 4 \times 10^{-8}. \qquad \Rightarrow \qquad \left(\frac{HPO_4^{2-}}{H_2PO_4^-}\right) = \frac{2}{1}.$$

3. $$K_a = \frac{[H^+]^2[S^{2-}]}{(H_2S)} \Rightarrow 10^{-21} = \frac{4 \times 10^{-8} \times [S^{2-}]}{10^{-1}}$$

so $[S^{2-}] = \frac{1}{4} \times 10^{-14} = 2.5 \times 10^{-15}$ M.

6. $C_1\alpha_1 = C_2\alpha_2$

$$\sqrt{K_{a_1} C_1} = \sqrt{K_{a_2} C_2}$$

$2 \times 10^{-5} \times C_1 = 2.4 \times 10^{-4} \times 0.5 = \qquad C_1 = 6$ M.

When two weak acids are mixed in such concentration that their $[H^+]$ ions are same the % dissociation of both the acids will not change.

9.

$$H_2S \rightleftharpoons H^+ + HS^- \qquad .....(i)$$
$$0.1 - x \qquad 0.25 \qquad x$$

$$HS^- \rightleftharpoons H^+ + S^- \qquad .....(ii)$$
$$x - y \qquad 0.25 \qquad y$$

$$HCl \longrightarrow H^+ + Cl^- \qquad .....(iii)$$
$$0.25$$

(i) $$10^{-7} = \frac{0.25 \times [HS^-]}{0.1 - x} \qquad [HS^-] = 4 \times 10^{-8}.$$

(ii) $$1.3 \times 10^{-13} = \frac{0.25 \times [S^{2-}]}{4 \times 10^{-8} - y} \qquad [S^{2-}] = 2.08 \times 10^{-20}.$$