

IONIC EQUILIRBIUM

Q.1 A Buffer solution can be prepared from a mixture of-

- (i) Sodium acetate and acetic acid in water
- (ii) Sodium acetate and hydrochloric acid in water
- (iii) Ammonia and ammonium chloride in water.
- (iv) Ammonia and sodium hydroxide in water.

(A) i, iii (B) i, ii (C) iii, ii (D) iii, iv

Q.2 The pK_a of acetyl salicylic acid (aspirin) is 3.5. The pH of gastric juice in human stomach is about 2-3 and pH in the small intestine is about 8. Aspirin will be-

- (A) Unionised in the small intestine and in the stomach.
- (B) Completely ionised in the small intestine and in the stomach.
- (C) Ionised in the stomach and almost unionised in the small intestine.
- (D) Ionised in the small intestine and almost unionised in the stomach.

Q.3 At 25°C, the dissociation constants of CH_3COOH and NH_4OH in aqueous solution are almost same (10^{-5}). If pH of some acetic acid solution is 3. The pH of solution of NH_4OH of same conc. at the same temperature would be-

(A) 3.0 (B) 4.0 (C) 10.0 (D) 11.0

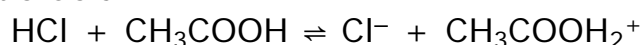
Q.4 When equal volumes of the following solutions are mixed, precipitation of $AgCl$ ($K_{sp} = 1.8 \times 10^{-10}$) will occur only with-

- (A) 10^{-4} M (Ag^+) and 10^{-4} M (Cl^-)
- (B) 10^{-5} M (Ag^+) and 10^{-5} M (Cl^-)
- (C) 10^{-5} M (Ag^+) and 10^{-6} M (Cl^-)
- (D) 10^{-10} M (Ag^+) and 10^{-10} M (Cl^-)

Q.5 Which of the following mixture solution has $\text{pH} \approx 1.0$?

- (A) $100 \text{ mL } \frac{\text{M}}{10} \text{ HCl} + 100 \text{ mL } \frac{\text{M}}{10} \text{ NaOH}$
(B) $55 \text{ mL } \frac{\text{M}}{10} \text{ HCl} + 45 \text{ mL } \frac{\text{M}}{10} \text{ NaOH}$
(C) $10 \text{ mL } \frac{\text{M}}{10} \text{ HCl} + 90 \text{ mL } \frac{\text{M}}{10} \text{ NaOH}$
(D) $75 \text{ mL } \frac{\text{M}}{5} \text{ HCl} + 25 \text{ mL } \frac{\text{M}}{5} \text{ NaOH.}$

Q.6 The following equilibrium is established when hydrogen chloride is dissolved in acetic acid :



The set that characterises the conjugate acid-base pairs is-

- (A) $(\text{HCl}, \text{CH}_3\text{COOH})$ and $(\text{CH}_3\text{COOH}_2^+, \text{Cl}^-)$
(B) $(\text{HCl}, \text{CH}_3\text{COOH}_2^+)$ and $(\text{CH}_3\text{COOH}, \text{Cl}^-)$
(C) $(\text{CH}_3\text{COOH}_2^+, \text{HCl})$ and $(\text{Cl}^-, \text{CH}_3\text{COOH})$
(D) $(\text{HCl}, \text{Cl}^-)$ and $(\text{CH}_3\text{COOH}_2^+, \text{CH}_3\text{COOH})$

Q.7 The pK_a of HCN is 9.30. The pH of a solution prepared by mixing 2.5 moles of KCN and 2.5 moles of HCN in water and making upto total volume to 500 mL is-

- (A) 9.30 (B) 7.30 (C) 10.30 (D) 8.30

Q.8 In pK_b for fluoride ion at 25°C is 10.83, the ionisation constant of hydrofluoric acid at this temperature is-

- (A) 1.74×10^{-5} (B) 3.52×10^{-3} (C) 6.75×10^{-4} (D) 5.38×10^{-2}

Q.9 The solubility of A_2X_3 is $y \text{ mol dm}^{-3}$. Its solubility product is-

- (A) $6y^4$ (B) $64y^4$ (C) $36y^5$ (D) $108 y^5$

Q.10 At pH of 0.1 M solution of following increases in the order-

- (A) $\text{NaCl} < \text{NH}_4\text{Cl} < \text{NaCN} < \text{HCl}$ (B) $\text{HCl} < \text{NH}_4\text{Cl} < \text{NaCl} < \text{NaCN}$
(C) $\text{NaCN} < \text{NH}_4\text{Cl} < \text{NaCl} < \text{HCl}$ (D) $\text{HCl} < \text{NaCl} < \text{NaCN} < \text{NH}_4\text{Cl}$

ANSWER KEY

Q.No.	1	2	3	4	5	6	7	8	9	10
Ans.	A	D	D	A	D	D	A	C	D	B

SOLUTIONS (IONIC EQUILIBRIUM)

Ans.1 The mixtures given in choice 'i' and 'iii' can constitute buffer solutions.

Ans.2 Gastric juice (PH = 2.3) is more acidic. Hence, ionisation of aspirine is suppressed. On the other hand, in small intestine (PH = 8) has basic medium. Hence, aspirine will be more ionised here.

Ans.3 pH of CH_3COOH sol = 3

$$\therefore [\text{H}_3\text{O}^+] = \sqrt{C \times K_a} = 10^{-3}$$

$$\text{or } 10^{-3} = \sqrt{C \times 10^{-5}} \quad \text{or } C = 10^{-1} \text{ M}$$

$$\therefore s = \frac{1.8 \times 10^{-10}}{0.2} = 9 \times 10^{-10} \text{ M.}$$

pH of 10^{-3} M solution of NH_4OH

$$[\text{OH}^-] = \sqrt{10^{-1} \times 10^{-5}} = 10^{-3}$$

$$\text{pOH} = 3 \quad \text{or } \text{pH} = 14 - 3 = 11$$

Ans.4 Ionic product, $[\text{Ag}^+][\text{Cl}^-]$ exceeds K_{sp} when 10^{-4} M (Ag^+) and 10^{-4} M (Cl^-) ions are mixed.

Hence precipitation takes place.

Ans.5 In choice (D), Millimoles of HCl = $75 \times \frac{1}{5} = 15$

$$\text{Millimoles of NaOH} = 25 \times \frac{1}{5} = 5$$

$$\text{Millimoles of HCl left} = 15 - 5 = 10$$

$$\text{Volume of solution} = 100 \text{ ml}$$

$$\text{Mol L}^{-1} \text{ of } [\text{H}_3\text{O}^+] = \frac{10 \times 10^{-3} \times 1000}{100}$$

$$= 10^{-1} \text{ M}$$

$$\therefore \text{pH} = -\log 10^{-1} = 1$$

Ans.6

HCl	+	CH ₃ COOH	⇌	Cl ⁻	+	CH ₃ COOH ₂ ⁺
Acid 1		Base 2		Base 1		Acid 2

Ans.7 As $[\text{Salt}] = [\text{Acid}]$.

$$\therefore \text{pH} = \text{pK}_a = 9.30$$

Ans.8 The dissociation constant of a weak acid and its conjugated base are related by a following expression

$$K_a \times K_b = K_w$$

or $\text{PK}_a \times \text{PK}_b = \text{PK}_w$

So $\text{PK}_a + 10.84 = 14$

$$\text{PK}_a = 3.17$$

$$\text{PK}_a = -\log_{10} K_a$$

or $3.17 = -\log_{10} K_a$

$$K_a = 6.75 \times 10^{-4}$$

Ans.9 $\text{A}_2\text{X}_3 \rightleftharpoons 2\text{A}^{3+} + 3\text{X}^{2-}$

Solubility y mol/dm³ $\quad\quad\quad 2y \quad 3y$

$$K_{\text{sp}} = \text{of } \text{A}_2\text{X}_3 = [\text{A}^{3+}]^2 [\text{X}^{2-}]^3$$

$$\therefore K_{\text{sp}} = (2y)^2 (3y)^3 = 108 y^5$$

Ans.10 NH_4Cl undergoes cationic hydrolysis hence pH is < 7 because the solution due to cationic hydrolysis is acids. NaCN undergoes anionic hydrolysis, hence pH is > 7 . HCl is strong acid and NaCl is neutral solution. Hence the pH of given solutions will increase as

