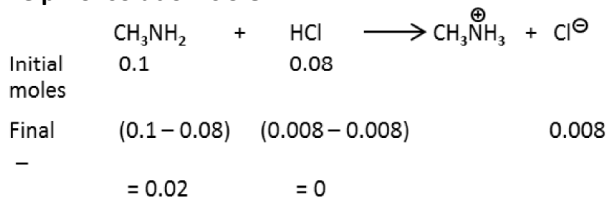


XI - CHEMISTRY - SOLUTIONS

Section I - Multiple Choice Type

1. a) The concentration of H^{\oplus} ion is 8×10^{-11} M.

c) The pH of solution is 9.8



Since W_b is left, so it forms basic buffer solution

$$OH^{\ominus} = K_b \frac{[Base]}{[salt]}$$

$$= 5 \times 10^{-4} \times \frac{0.02}{0.08}$$

$$= 1.25 \times 10^{-4}$$

$$[H^{\oplus}] = \frac{K_w}{[OH^{\ominus}]} = \frac{10^{-14}}{1.25 \times 10^{-4}}$$

$$= 8 \times 10^{-11} \text{ M}$$

$$pH = -\log(8 \times 10^{-11})$$

$$= -\log 2^4 + 11$$

$$= -0.3 \times 4 + 11 = 9.8$$

$$pOH = 14 - 9.8 = 4.2$$

2. a) $CH_3COO^- < HS^- < NH_3 < CO_3^{2-}$

The conjugate acids are CH_3COOH , H_2S , NH_4^+ and HCO_3^- . Their order of acid strength is

$CH_3COOH > H_2S > NH_4^+ > HCO_3^-$. The base strength of their conjugate base follows the reverse order.

3. a) $[H^+] = 10^{-7} \text{ mol L}^{-1}$

b) $[OH^-] = 10^{-7} \text{ mol L}^{-1}$

c) $K_w = 10^{-14} (\text{mol L}^{-1})^2$

Conceptual

4. a) 4

$$K_a^0(HX) = K_w^0 / K_b^0(X^-) = 10^{-14} / 10^{-10}$$

$$pH = pK_a^0 + \log\left(\frac{[salt]}{[acid]}\right) = 4$$

5. c) The basicity of phosphorous acid is three.

d) Ostwald dilution law is valid for strong electrolytes.

Conceptual

6. a) 10 mL 0.1 M HCl + 20 mL 0.1 M NaCN

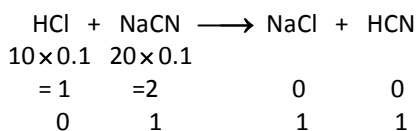
b) 10 mL 0.1 M NaOH + 20 mL 0.1 M NH_4CN

c) 10 mL 0.1 M NH_4OH + 20 mL 0.1 M

CH_3COONH_4

d) 10 mL 0.1 M CH_3COOH + 20 mL 0.1 M

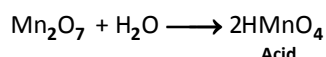
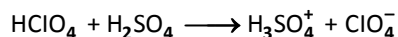
XI - Chemistry - Solution



$$[\text{HCN}] = \frac{1}{30} \text{ and } [\text{NaCN}] = \frac{1}{30}$$

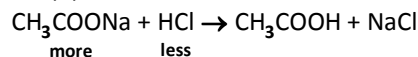
7. a) HCN is weak acid
 b) Reaction of $\text{HCl}_{(g)}$ and $\text{NH}_{3(l)}$ is Arrhenius acid-base reaction
 c) Pure H_2SO_4 and HClO_4 do not conduct current but in presence of each other they are good conductor
 d) Mn_2O_7 is acidic oxide.

Arrhenius concept is in aqueous medium

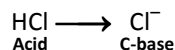


8. a) Sodium acetate and acetic acid in water
 b) Sodium acetate and hydrochloric acid in water
 c) ammonia and ammonium chloride in water

For (b)



9. d) (HCl , Cl^-) and ($\text{CH}_3\text{COOH}_2^+$, CH_3COOH)



10. b) pH of acidic solution increases if more salt is added.
 c) pH of basic buffer decreases if more salt is added.

$$\text{Acidic buffer : } \text{pH} = \text{pK}_a + \log \frac{[\text{Salt}]}{[\text{Acid}]} \text{ If more salt is added, pH increases.}$$

$$\text{Basic buffer : } \text{pOH} = \text{pK}_b + \log \frac{[\text{Salt}]}{[\text{Base}]} \text{ If more salt is added, pOH increases or pH decreases.}$$

Section II – Matrix Match Type

1. A-PQRS ; B-Q ; C-PQRS ; D-Q
 Conceptual

2. A-P,Q,R ; B-R ; C-S ; D-Q,R
 A-P,Q,R – Acidic buffer (mixture of W_A + salt of W_A/S_B)

$$\text{pH} = \text{pK}_a + \log \left(\frac{\text{salt}}{\text{acid}} \right)$$

$$= 4.74 + \log \left(\frac{0.1}{0.1} \right) = 4.74$$

Thus, it is acidic buffer at maximum buffer capacity. Because buffer limits are $\text{pH} \pm 1$. When $\text{pH} = \text{pK}_a$, it is buffer at maximum buffer capacity.

B – R – It is mixture of W_A and S_A . So pH of 0.1 M HCl will predominate and $\text{pH} < 7$.

XI - Chemistry - Solution

C – S – it will form salt of $\frac{W_A}{W_B}$.

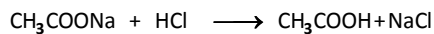
Since $pK_a = pK_b$.

$$\text{Thus } pH = 7 \left(pH = \frac{1}{2} (pK_w + pK_a + pK_b) \right)$$

D – Q,R

mmol of $CH_3COONa = 300 \times 0.1 = 30$

mmol of $HCl = HCl = 100 \times 0.1 = 10$



Initial 30mmol 10mmol 0 0

Final (30-10)=20 (10-10)=0 10 -

It is a mixture of W_A and salt of W_A/S_B . It forms acidic buffer.

$$pH = pK_a + \log \left(\frac{\text{salt}}{\text{acid}} \right)$$

(Total volume = 300 + 100 = 400 mL)

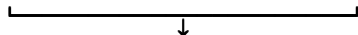
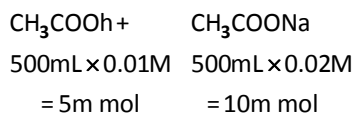
$$= 4.74 + \log \left[\frac{\frac{20}{400}}{\frac{10}{400}} \right]$$

$$= 4.74 + 0.3 = 5.03$$

Section III – Integer Type

1.

9



After mixing total volume is 1000mL

→ for acidic buffers

$$pH = pK_a + \log \frac{[\text{salt}]}{[\text{acidic}]}$$

$$5.3010 = pK_a + \log \left[\frac{\frac{10}{1000}}{\frac{5}{1000}} \right]$$

$$pK_a = 5.3010 - 0.3010$$

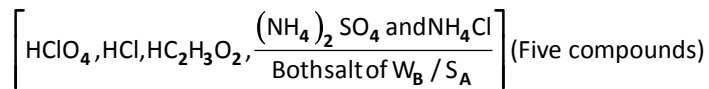
$$= 5$$

$$\Rightarrow pK_b = 14 - pK_a \Rightarrow pK_b = 14 - 5 = 9$$

2.

5

Acidic



3.

3

$$\frac{[H^+]_1}{[n^+]_2} = \sqrt{\frac{C_1 \times K_A}{C_2 \times K_B}} = \sqrt{\frac{3 \times \frac{C}{2} \times K_A}{C_2 \times K_B}}$$

XI - Chemistry - Solution

$$\Rightarrow 3 \times \frac{k_1}{k_2} \Rightarrow$$

$$\Rightarrow \frac{H_B(K_B)}{H_A(K_A)} = 3 \text{ times}$$

4. 6

pka = 10-a Lets consider it as HA

$$[HA] = 0.01 \text{ M}$$

$$[NaA] = 0.01 \text{ M}$$

$$pH = pka + \log \frac{(\text{salt})}{[\text{Acid}]}$$

$$6 = pka + \log \frac{0.01}{0.01}$$

$$Pk_a = 6$$

5. 8

Basic buffers of $NH_4Cl + NH_4OH$

For basic buffers \Rightarrow

$$p^H = pk_b + \log \frac{[\text{salt}]}{[\text{base}]}$$

$$= 5 + \log \frac{0.1}{0.01}$$

$$= 5 + 1$$

$$= 6$$

$$p^H = 14 - 6 = 8$$

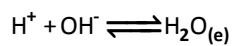
6. 7

$$p^H = 10 \text{ and } p^H = 4$$

Let's take volume as v.

$$\Rightarrow p^H = 10 \Rightarrow [OH^-] = 10^{-4} \text{ M}$$

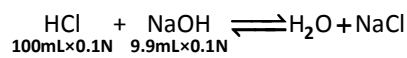
$$\Rightarrow p^H = 4 \Rightarrow [H^+] = 10^{-4} \text{ M}$$



$10^{-4} \quad 10^{-4}$ will give neutral solution.

$$\text{So } p^H = 7$$

7. 3



$$100\text{mL} \times 0.1\text{N} \quad 9.9\text{mL} \times 0.1\text{N}$$

10m mol 9.9 m mol – after mixing only 0.1 m mol H^+ are left.

$$[H^+] = \frac{0.1}{109.9} = \frac{1}{1099}$$

$$p^H = -\log \frac{1}{1099}$$

$$= \log(1.099 \times 10^3)$$

$$= 3 + 0.04 \approx 3$$

8. 6

Conceptual