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

	CH_3NH_2	+ HCl	$\longrightarrow CH_3\overset{\oplus}{N}H_3$	+ $Cl^{\ominus}$
Initial moles	0.1	0.08		
Final –	(0.1 – 0.08) = 0.02	(0.008 – 0.008) = 0	0.008	

Since W_B is left, so it forms basic buffer solution

$$\overset{\odot}{O}H = K_b \frac{[Base]}{[salt]}$$

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

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

$$[H^{\oplus}] = \frac{K_W}{[\overset{\odot}{O}H]} = \frac{10^{-14}}{1.25 \times 10^{-4}}$$

$= 8 \times 10^{-11}$ 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) $[H^+] = 10^{-7}$ mol L^{-1}

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

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

Conceptual

4. a) 4

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

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

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

CH_3COONH_4

$$\underset{10\times0.1}{HCl} + \underset{20\times0.1}{NaCN} \longrightarrow \underset{0}{NaCl} + \underset{0}{HCN}$$
$$\underset{0}{=1} \quad \underset{1}{=2} \qquad \underset{1}{0} \qquad \underset{1}{0}$$

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

7. **a)** **HCN is weak acid**

b) **Reaction of $HCl_{(g)}$ and $NH_{3(l)}$ is Arrehenius 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.**

Arrehenius concept is in aqueous medium

$$HClO_4 + H_2SO_4 \longrightarrow H_3SO_4^+ + ClO_4^-$$

$$Mn_2O_7 + H_2O \longrightarrow \underset{\text{Acid}}{2HMnO_4}$$

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)

$$\underset{\text{more}}{CH_3COONa} + \underset{\text{less}}{HCl} \rightarrow CH_3COOH + NaCl$$

9. **d)** **(HCl, Cl^-) and $(CH_3COOH_2^+, CH_3COOH)$**

$$\underset{\text{Acid}}{HCl} \longrightarrow \underset{\text{C-base}}{Cl^-}$$

10. **b)** **pH of acidic solution increases if more salt is added.**

c) **pH of basic buffer decreases if more salt is added.**

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

Basic buffer : $pOH = pK_b + \log \frac{[Salt]}{[Base]}$ 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)

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

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

Thus, it is acidic buffer at maximum buffer capacity. Because buffer limits are $pH \pm 1$. When $pH = pK_a$, 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 pH < 7.

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

Since $pK_a = pK_b$.

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

D – Q,R

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

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

	CH_3COONa + HCl $\longrightarrow$	CH_3COOH	NaCl
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.

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

(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**

CH_3COOh + CH_3COONa

$500mL \times 0.01M$ $500mL \times 0.02M$

$= 5m\ mol$ $= 10m\ mol$

↓

After mixting total volume is 1000mL

$\rightarrow$ for acidic buffers

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

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

$pK_a = 5.3010 - 0.3010$

$= 5$

$\Rightarrow pk_b = 14 - pk_a \Rightarrow pk_b = 14 - 5 = 9$

2. **5**

Acidic

$$\left[HClO_4, HCl, HC_2H_3O_2, \frac{(NH_4)_2\,SO_4 \text{ and} NH_4Cl}{\text{Both salt of } W_B / S_A}\right] \text{(Five compounds)}$$

3. **3**

$$\frac{\left[H^+\right]_1}{\left[n^+\right]_2} = \sqrt{\frac{C_1}{c_2} \times \frac{K_A}{k_B}} = \sqrt{\frac{3 \times c/2}{c_2} \times \frac{K_A}{k_B}}$$

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

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

4. **6**

pka = 10-a Lets consider it as HA

[HA] = 0.01 M

[NaA] = 0.01 M

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

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

$Pk_a = 6$

5. **8**

Basic buffers of $NH_4Cl + NH_4OH$

For basic buffers $\Rightarrow$

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

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

= 5 + 1

= 6

$p^H = 14 - 6 = 8$

6. **7**

$p^H = 10$ and $p^H = 4$

Let's take volume as v.

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

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

$H^+ + OH^- \rightleftharpoons H_2O_{(e)}$

10^{-4} 10^{-4} will give neutral solution.

So $p^H = 7$

7. **3**

$\underset{100mL \times 0.1N}{HCl} + \underset{9.9mL \times 0.1N}{NaOH} \rightleftharpoons H_2O + NaCl$

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

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

$p^H = -\log \frac{1}{\log 9}$

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

$= 3 + 0.04 \approx 3$

8. **6**

Conceptual