Chapter 16: Ionic Equilibrium in Aqueous solution

Q1:

Sol:- $CH_3COOH \rightleftharpoons CH_3COO^{(-)} + H^{(+)} : Ka = 1.81\times0^{-5}$

Initially 0.4

At eq-^{b} $0.4 - 0.4x$ $\quad 0.4x \quad 0.4x$ (x = degree of dissociation)

$$\therefore Ka = \frac{[CH_3COO^-][H^+]}{[CH_3COOH]} = \frac{(0.4x)(0.4x)}{0.4-0.4x}$$

$$1.8\times10^{5} = \frac{0.4x^2}{1-x}$$

$$x^2 = \frac{1.8}{0.4}\times10^{-5} \quad \therefore (1-x\approx1)$$

$$x = \sqrt{4.5\times10^{-5}} = 6.71\times10^{-3} \quad \textbf{Ans}$$

Q2:

Sol:- $HA \rightleftharpoons H^+ + A^-$, $Ka = 1.8\times10^{-5}$

Initially 0.2 $\quad$ 0 $\quad$ 0

At eq-^{b} $0.2{-}0.2x$ $\quad 0.2x \quad 0.2x$ (x = degree of dissociation)

$$ka = \frac{(0.2x)(0.2x)}{(0.2-0.2x)} = \frac{0.2x^2}{1-x} = 1.8\times10^{-5}$$

$$x^2 = \frac{1.8}{0.2}\times10^{-5} = 9\times10^{-5}$$

$$x = \sqrt{9\times10^{-5}} = 9\times487\times10^{-3}$$

Conc-^{n} Of $[H^+] = 0.2x = 9.487\times0.2\times10^{-3} = 1.897\times10^{-3}M$ **Ans**

Q3:-

Sol:- pH = 6.2

$\log[H^+] = -6.2 = -7 + 0.8$

taking antilog

$[H^+] = 6.31\times10^{-8}$

$$[OH^-] = \frac{10^{-14}}{[H^+]} = \frac{10\times10^{-15}}{6.31\times10^{-7}} = 1.6\times10^{-8}M \quad \textbf{Ans}$$

Q4:-

Sol:- $HCN \rightleftharpoons H^+ + CN^-$, $Ka4.8\times10^{-10}$

$$Ka = \frac{[H^+][CN^-]}{[HCN]} = 4.8\times10^{-10}$$

When NaCN is dissolved,

Major species = Na^+, $\quad CN^-$

(does nothing) $\quad$ 0.16 mole in 450 ml

$$M = \frac{0.16}{450} = 3.56\times10^{-3}$$

$$CN^{-} + H_2O \rightleftharpoons HCN + OH^{(-)}$$

$$keq\text{-}^{b} = \frac{Kw}{Ka} = \frac{10^{-14}}{4.8\times10^{-10}}$$

Initially 3.55×10^{-3} excess 0 0

At eq- $3.55\times10^{-3}-x$ x x

$$Keq\text{-}^{b} = \frac{x^2}{3.55\times10^{-3}-x} = \frac{1}{4.8}\times10^{-4}$$

Solving quadratic equation, we ahve

$$X = 2.72\times10^{-3}M$$

$\therefore [OH^{-}] = [HCN] = 2.72\times10^{-3}$ M **Ans**

$[H^{+}] = \dfrac{Kw}{[OH^{-}]} = \dfrac{10^{-14}}{2.72\times10^{-3}} = 3.676\times10^{-12}M$ **Ans**

Q5:-

Sol:- Let the concentration of HNO_2 is M.

$$HNO_2 \rightleftharpoons H^{+} + NO_2^{-},\ Ka = 4\times10^{-4}$$

Initially M 0 0

At eq-^{b} M −0.2M 0.2 M 0.2 M

$$\therefore Ka = 4\times10^{-4} = \frac{(0.2M)(0.2M)}{M-0.2M} = \frac{0.04M\times10}{0.8M\times100}$$

$$M = 20\times4\times10^{-14} = 8\times10^{-3}M$$

Conc-^{n} of $HNO_2 = +0.008$ M **Ans**

Q6:-

Sol:- $\therefore \alpha = 1.32\times10^{-2}$

$$HNO_2 \rightleftharpoons H^{+} + NO_2^{-},\quad Ka = 4\times10^{-4}$$

Initially x(say) 0 0

At eq-^{b} $x-1.32\times10^{-2}x$ $1.32\times10^{-2}x$ $1.32\times10^{-2}x$

$$Ka = \frac{[H^{+}][NO_2^{-}]}{[HNO_2]} = 4\times10^{-4}$$

$$\Rightarrow \frac{(1.32\times10^{-2}x)^2}{x-1.32\times10^{-2}x} = 4\times10^{-4}$$

$$x-1.32\times10^{-2} = \frac{(1.32)^2\times10^{-4}}{4\times10^{-4}} = 0.4356$$

$$(1-1.32\times10^{-2})\times4\times10^{-4} = (1.32)^2\times10^{-4}x$$

$x = 2.29\times(1-0.0132) = 2.27M$ **Ans**

Q7:-

Sol:- (i) 5×10^{-8} M HCl

Molar species : 5×10^{-8} M H^+, 5×10^{-8}M Cl^-

$$\begin{array}{llll} & H_2O \rightleftharpoons & H^+ \quad + & OH^-, \quad Kw = 1\times10^{-14} \\ \textbf{Initially} & \text{excess} & 5\times10^{-8} & 0 \\ \textbf{At eq-}^{b} & & 5\times10^{-8}+x & x \end{array}$$

$$(5\times10^{-8}+x)x = 1\times10^{-14}$$

$$x^2+5\times10^{-8}x-10^{-14}=0$$

$$x = -5\times10^{-8} \pm \frac{\sqrt{25\times10^{-16}+4\times10^{-14}}}{2} = \frac{\sqrt{4.25}\times10^{-7}-5\times10^{-8}}{2}$$

$$= \frac{(2.06-0.5)\times10^{-7}}{2} = 0.78\times10^{-7}\text{M} \quad \textbf{Ans}$$

pH = 6.89 **Ans**

(ii) 5×10^{-10} M HCl

Molar species H^+, Cl^-, H_2O

5×10^{-10}M

Since H^+ from HCl is very less compare to that of dissociation of pure water (10^{-7} M H^+), So we can think that $[H^+]$ in solution is solely due to dissociation of water only.

$$[H^+] = 10^{-7}\text{M}$$

$$\therefore PH = 7$$

(iii) 10^{-8}M NaOH

Major species : Na^+, OH^- H_2O

10^{-8}M 10^{-8}M

eq-reac-^{n}

$$\begin{array}{llll} & H_2O \rightleftharpoons & H^+ + & OH^-, Kw = 10^{-14} \\ \textbf{Initially} & \text{excess} & 0 & 10^{-8}\text{M} \\ \textbf{At eq-}^{b} & \text{excess} & x & 10^{-8}+x \end{array}$$

$$Kw = 10^{-14} = x(10^{-8}+x)$$

$$x^2+10^{-8}x-10^{-14}=0$$

$$x = \frac{-10^{-8}\pm\sqrt{10^{-16}+4\times10^{-14}}}{2}$$

$$x = \frac{\sqrt{4.01}\times10^{-7}-10^{-8}}{2} = \frac{1.9}{2}\times10^{-7} = 0.95\times10^{-7}$$

$$[H^+] = 9.95\times10^{-7}$$

$$pH = 7.02$$

(iv) 10^{-10} M NaOH

$\therefore$ pH = 7 [because $OH^- = 10^{-10}$ M is less to affect the dissociation & concentration of of H^+ & OH^- from H_2O]

Q8:-

Sol:- Pure water has $(OH^{-}) = 10^{1}M$

A/q, solution is twice as alkaline as that of water

$[OH^{-}]_{solution} = 2 \times [OH^{-}]$ water $= 2 \times 10^{-7}$ M

$$\therefore [H^{+}]sol-^{n} = \frac{10^{-14}}{[OH^{-}]sol-^{n}} = \frac{10^{-7}}{2}$$

$\therefore$ PH = -log $[H^{+}]_{sol\text{-}}{}^{n}$ = {log 10^{-7} – log2} = 7+ log2 = 7.3 **Ans**

Q9:-

Sol:- pH of blood = 7.36

$\therefore [H^{+}] = 10^{-7.36}M$

pH of spinel fluid = 7.53

$\therefore [H^{+}] = 10^{-7.53}$ **M**

pH of spinel fluid = 7.53

$\therefore [H^{+}] = 10^{-7.53}M.$

$$\therefore \frac{[H^{+}]blood}{[H^{+}]spinel\,fluid} = \frac{10^{-7.36}}{10^{-7.55}} = 10^{7.53-7.36} = 10^{0.17} = 1.5$$ **Ans**

Q10:

Sol:- density of NaOH = 0.1 g/lit

Molarity of NaOH $= \frac{0.1}{40}$ mole/lit $= 2.5 \times 10^{-3}M$

If NaOH is dissociated completely, then

$[OH^{-}] = 2.5 \times 10^{-3}M$

pOH = – log$[OH^{-}]$ = -log (2.5×10^{-3}) = 3- log(2.5)

$\therefore$PH = 14 – POH = 11 + log (2.5) = 11.40

Q11:

Sol:- $CH_3COOH \rightleftharpoons CH_3COO^{(-)} + H^{(+)}$

Initially 0.01 M

At eq-^{b} $0.01 - 0.01 \times \frac{4.2}{100}$ $\quad \frac{0.01 \times 4.2}{100} \quad \frac{0.01 \times 4.2}{100}$

$0.01 - 4.2 \times 10^{-4} \quad 4.2 \times 10^{-4} \quad 4.2 \times 10^{-4}$

$\therefore$pH = -log$[H^{+}]$ = - log(4.2×10^{-4})

PH = 4- log (4.2) = 3.38 **Ans**

Q12:

Sol:- HCl $\rightarrow$ 25ml of 0.2M

NaOH $\rightarrow$ 50 ml of 0.25 N

no. of mmoles of HCl = 25 ×0.2 = 5 mmole

no. of m moles of NaOH $= 50 \times \frac{25}{100} = 12.5$m mole

	$NaOH$	+	$HCl \longrightarrow NaCl + H_2O$
Initially	**12.5**		**5**
Finally	**12.5-5**		**0**

$\therefore$ m moles of NaOH remained = 7.5

Volume of final sol-ⁿ = volume of HCl + vol. of NaOH = 25 + 50 = 75ml

$$\therefore \text{Molarity of NaOH} = \frac{75}{750} = 0.1$$

$[OH^-] = 0.1$ M

POH = -log[OH⁻] = 1 $\quad \therefore pH = 13$ **Ans**

Q13:

Sol:- volume of water taken = one millionth art of 1 ml

$= 10^{-6}$ ml $= 10^{-9}$ lit

Molarity of H^+ ions in pure water $= 10^{-7}$ M.

As pure water is neutral, so $[H^+] = (OH^-) = 10$

no. of moles of H^+ ions $= 10^{-7} \times 10^{-9} = 10^{-6}$

$\therefore$ no. of ions = moles $\times 6.023 \times 10^{23}$

$= 10^{-16} \times 6.023 \times 10^{23} = 6.023 \times 10^{7}$

$= 60.23 \times 10^{6} = 60.23$ million **Ans**

Q14:-

Sol:- 0.1 M H_2SO_4

	$H_2SO_4 \longrightarrow$	H^+ +	HSO_4^-
Initially	0.1	0	0
After complete Dissociation	0	0.1	0.1

	$HSO_4^- \rightleftharpoons$	H^+ +	SO_4^{2-}
Initially	**0.1**		
After dissociation	**0.1-x**	**x**	**x**

$$\therefore Ka = \frac{[H^+][SO_4^{2-}]}{[Hso_4^-]}$$

$$1.2 \times 10^{-2} = \frac{x^2}{0.1 - x}$$

$x^2 + 1.2 \times 10^{-2} x - 1.2 \times 10^{-3} = 0$

Solving we have x = 0.01

$\therefore [H_2SO_4] = 0, [HSo_4^-] = 0.1 - 0.01 = 0.09$ M

$[H^+] = 0.1 + 0.01 \doteq 0.1$ M & $[SO_4^{2-}] = 0.01$ M **Ans**

Q15:-

Sol:- $[H_2S] = 0.1$ M.

$Ka_1 = 1 \times 10^{-7}$ M & $Ka_2 = 1.3 \times 10^{-13}$

$$H_2S \rightleftharpoons H^+ + HS^-$$

	H_2S	H^+	HS^-
Initially	0.1M	0	0
At eq-^{b}	0.1-x	x	x

$$Ka_1 = \frac{x^2}{0.1-x} = 10^{-7}$$

$$X^2 \approx 10^{-8} \; (\therefore 0.1 - x \approx 0.1) \; \Rightarrow X = 10^{-4} M$$

Approximation is valid $\therefore \left(\frac{x}{0.1} \times 100 = \frac{10^{-4} \times 100}{0.1}\right) = 10^{-1}$

$\therefore [HS] = 10^{-4}$ M, $[H_2S] = 0.1 - 0^{-4} \approx 0.1$ M

$$HS^- \rightleftharpoons H^+ + S^{2-}$$

	HS^-	H^+	S^{2-}
Initially	10^{-4}	10^{-4}	
At eg-^{b}	$10^{-4} - y$	$10^{-4} + y$	y

$$Ka_2 = \frac{[H^+][S^{2-}]}{[HS^-]} = \frac{(10^{-4} + y)y}{(10^{-4} - y)}$$

$$1.3 \times 10^{-13} = \frac{10^{-4} y}{10^{-4}} \Rightarrow y = 1.3 \times 10^{-13} M.$$

$$\therefore (10^{-4} \pm y \approx 10^{-4})$$

$\therefore [H_2S] = 0.1$ M, $[HS] = 10^{-4}$M, $[H^+] = 10^{-4}$M & $[S^{2-}] = 103 \times 10^{-13}$ **Ans**

Q16:-

Sol:- $[BOH] = 0.02$ M

PH = 10.45

POH = 14 − 10.45 = 3.55, $[OH^-] = 2.82 \times 10^{-4}$ M

$$BOH + HCl \longrightarrow BCl + H_2O$$

	BOH	HCl	BCl	H_2O
	0.2	0.1 M		
	100 ml	10 ml		
Initially	2mmoles	1 mmoles		
Finally	**2−1**	**0**	**1**	**1**

$\therefore$ mmoles of BOH Now = 1

Volume of sol-^{n} = 100 ml + 10 ml = 110 ml

$\therefore$ Molarity of sol-^{n} = $\frac{1}{110}$M

From (1), degree of dissociation = $\frac{2.82 \times 10^{-4}}{0.02} = 1.41 \times 10^{-2}$

$$K_b = \frac{[B^+][OH^-]}{[BOH]} = \frac{0.02x^2}{1-x} \approx \frac{0.02(1.41 \times 10^{-2})^2}{1} = 3.976 \times 10^{-6}$$

After adding HCl, we have a basic buffer sol-^{n}

$$\therefore POH = pK_b + \log\frac{[Salt]}{[Base]}$$

$$POH = 5.4 + \log\frac{1}{2} = 5.401 \quad \therefore PH = 14 - POH = 8.599 \quad \textbf{Ans}$$

Q17:-

Sol:- CH_3COONa & CH_3COOH ($Ka = 1.8 \times 10^{-5}$)

0.05 mole   0.005 M

0.05 M   1 lit

PH(initially) = $-\log [H+]_{initially}$

$CH_3COOH \rightleftharpoons CH_3COO^{(-)} + H^{(+)}$

Initially 0.005   0   0

At eq-^{b} $0.05 - 0.0056x$ $0.005x$ $0.005x$

$$\therefore Ka \frac{0.005x^2}{0.005(1-x)} \approx \frac{0.005x^2}{1}$$

$1.8 \times 10^{-5} = 0.005 \times x^2$

$X^2 = 36 \times 10^{-4} \quad x = 6 \times 10^{-2}$

$\therefore [H^+] = 0.005x = 3 \times 10^{-4}$

$\therefore PH_{initially} = -\log [H^+] = 3.52$

$$PH\ final = PKa + \log\frac{[salt]}{[acid]}$$

$$= 5 - \log(1.8) + \log\frac{0.05}{0.005} = 6 - \log(1.8) = 5.744$$

$\therefore \Delta PH = 5.74 - 3.52 = 2.22$ (increased) **Ans**

Q18:

Sol:- $CH_3COOH \rightleftharpoons CH_3COO^{(-)} + H^{(+)}$

Initially 0.1M   0   0

At eq-^{b} 0.1 -0.1x   0.1x   0.1x

$$Ka = \frac{0.1x^2}{1-x} \approx 0.1x^2 = \quad x^2 = 1.8\times10^{-6} \Rightarrow x = 1.34\times10^{-3}$$

$\therefore [H^+] = 0.1x = 1.34 \times 10^{-5}$ M

$\therefore [PH] = -\log[H^+] = 2.87$

$CH_3COOH + HCl$

0.1 M   0.05 M

HCl dissociates completely, so now the major in the sol-^{n}

$CH_3COOH,$ H^+ Cl^-

0.1M   0.05 M   0.05M

$CH_3COOH \rightleftharpoons CH_3COO^{(-)} + H^{(+)}$

Initially 0.1   0.05   0.05

Finally 0.1-0.1x   0.1x   0.1x + 0.05

$$\therefore Ka = 1.8\times10^{-5} = \frac{0.1(0.5+x)x}{0.1(1-x)}$$

$$X = 36\times10^{-5}$$

$$\therefore [H^+] = 0.05 + 0.1x = 0.05 \quad => \quad pH = 1.3 \textbf{ Ans}$$

Q19:

Sol:- Mass of $CH_3COONa = 2.05$ g

$$\therefore \text{no. of moles} = \frac{2.05\,g}{24+3+23+32} = 0.025\,\text{moles}$$

$$CH_3COO\,Na + HCl \longrightarrow CH_3COOH + NaCl$$

	CH_3COONa	HCl	CH_3COOH	$NaCl$
Initially	25 mmoles	100 ml **0.1 M** **10 mmoles**	$\downarrow$	$\downarrow$
Finally:	**15 mmoles**		**10 mmoles**	**10 mmoles**

$$pH = pKa + \log\frac{[salt]}{[acid]} = 5 - \log 1.8 + \log\frac{15}{10}$$

$$pH = 5 + \log\left(\frac{1.5}{1.8}\right) = 5 - 0.079$$

$$\therefore [H^+] = 1.23\times10^{-5} \quad \textbf{Ans}$$

If 6 ml of 1 M HCl is further added then

$$CH_3COONa + HCl \longrightarrow CH_3\,COOH + NaCl$$

	CH_3COONa	HCl	CH_3COOH	$NaCl$
Initially	**15**	**6 mmoles**	**10**	**10**
Finally	**15-6 = 9**	**0**	**16**	**16**

$$\therefore pH_{Now} = pKa + \log\frac{9}{16} = 5\text{- }\log 1.8 + \log\left(\frac{9}{16}\right)$$

$$= 5 + \log\left(\frac{\overset{5}{9}}{16}\times\frac{10}{\underset{2}{18}}\right) = 5 + \log\left(5/16\right) \quad = 4.4948$$

$$\therefore [H^+] = 3.2\times10^{-5}\,M \quad \textbf{Ans}$$

Q20:-

Sol:- For 30 g Na_2CO_3

$$\text{no. of moles} = \frac{30}{106} = 0.283\,\text{moles}$$

$$\therefore \text{Molarity} = \frac{0.283}{500}\times1000 = 0.566\,M$$

150 ml of 1M HCl sol-^{n}

	Na_2CO_3	+ $HCl \longrightarrow$	$NaHCO_3$	+ $NaCl$
Initially	0.283	0.150	0	0
Finally	0.283 – 0.15	0	0.15	0.15

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

$11\text{-}\log 4.8 + \log\left(\frac{0.133}{0.150}\right)$ For 2nd dissociation $NaHCO_3$ is the acid & Na_2CO_3 is the salt

$= 11\text{-}\log(4.8/0.8866) = 11\text{-}\log(5.4)$

$= 10.27 \approx 10.3$ **Ans**

Q21:

Sol:- For 0.1M CH_3COOH & 0.1 M CH_3COONa

$$pH = pKa + wt\ \frac{0.1}{0.1} = pKa$$

$PKa = 4.74 - (1)$

When 0.05 moles of HCl is added to 1 lit of the sol-^{n}

$$CH_3COONa + HCl \longrightarrow CH_3COOH + NaCl$$

	CH_3COONa	HCl	CH_3COOH	$NaCl$
Initially	**0.1M** **1 lit** **0.1 mole**	**0.05**	**0.1 M** **1 lit**	
Finally	**0.05 mole**	**0**	**0.15 mole**	

$$PH_{Now} = PKa + \log\frac{[salt]}{[acid]} = 4.74 + \log\frac{0.05}{0.15} = 4.74 - \log 3 = 4.27$$ **Ans**

Q22:-

Sol:- In 0.2M HCOOH, $[H^+] = 6.4 \times 10^{-3}M$

$HCOO\,Na = 1M$

Since degree of dissociation is 0.75

So $[HCOO^-] = 0.75$

$$\therefore PH = pKa + \log\frac{[salt]}{[acid]} = 4 - \log(2.4) + \log\left(\frac{0.75}{0.02}\right) = 4 + \log\left(\frac{37.5}{2.4}\right)$$

$= 4 + \log(1.5625) = 4.194$ **Ans**

Q23:

Sol:- $CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O$

	CH_3COOH	$NaOH$	CH_3COONa	H_2O
Initially	0.2	0.2	0	0
Finally	**0**	**0**	0.2	0.2

Major species, CH_3COO^-, Na^+, H_2O

0.2 0.2 $\downarrow$

Does nothing (conjugate acid of strong base NaOH)

$$CH_3COO^- + H_2O \longrightarrow CH_3COOH + OH^{(-)}$$

Initially 0.2 excess 0 0

At eg-^{b} 0.2 – 0.2 h 0.2 h 0.2 h

h = degree of hydrolysis

$$K_b = \frac{Kw}{Ka} = \frac{[CH_3COO][OH^-]}{[CH_3COO^-]}$$

$$\frac{10^{-14}}{1.8\times10^{-5}} = \frac{(0.2h)(0.2h)}{0.2-0.2h} = \frac{0.2h^2}{1-h}$$

$$\frac{10}{1.8}\times10^{-10} \approx 0.2h^2$$

$$5.56\times10^{-10} = 0.2h^2$$

$$h = 5.27\times10^{-5}$$

$$\therefore [OH^-] = 0.2h = 1.0545\times10^{-5}$$

pOH = 4.977 => PH = 14- 4.977 = 9.02 **Ans**

Q24:

Sol:- 0.1 M NH_4Cl has pH = 5.13

$$NH_4Cl + H_2O \rightleftharpoons NH_4OH + HCl$$

Initially **0.1** **excess** **0** **0**

At eg-^{b} **0.1 -0.1h** **0.1h** **0.1h**

Given PH = 5.13

$[HCl] = 7.41\times10^{-6}$

$\therefore 0.1h = 7.41\times10^{-5}$

$$\therefore Kh = \frac{0.1h^2}{1-h} = 0.1(7.41\times10^{-5})^2 = 5.495\times10^{-10}$$

∴dissociation constant of NH_4OH

$$= \frac{Kw}{Kh} = \frac{10^{-14}}{5.495\times10^{-10}} = 1.82\times10^{-5}$$ **Ans**

Q25:-[HCOONa] = 0.2 moles & [HCOOH] = 0.25 moles

$$pH = PKa + \log\frac{[HCOONa]}{[HCOOH]} = 4\text{-}\log(1.8) + \log\left(\frac{0.20}{0.25}\right)$$

$$= 4 + \log\left(\frac{4\times10}{5\times18}\right) = 4 + \log\left(\frac{4}{9}\right)$$

pH = 3.6478

$[H^+]$ antilog (-3.6578) = 2.25×10^{-4}

$$\therefore [OH^-] = \frac{10^{-14}}{[H^+]} = 4.49\times10^{-11}$$ **Ans**

Q26:-

Sol:- 0.05 moles of HCOOH & 0.06 moles of HCOONa

(i) $pH = PKa + \log\dfrac{[HCOONa]}{[HCOOH]} = 4\text{-}\log(1.8) + \log\dfrac{(0.06)}{(0.05)}$

$$4+\log\left(\frac{6\times10}{5\times18}\right)=4+\log\left(2/3\right) \quad = 3.824 \approx 3.80 \qquad \textbf{Ans}$$

(b) Dilution changes the individual conc-^{n} of EtCOOH & HCOOH but the ratio of HCOONa with HCOOH remain effectively same. So PH doesn't changes much.

Q27:

Sol:- Let x g moles of HCl is required

$$NaCN + HCl \longrightarrow HCN + NaCl$$

0.01 gmole

	NaCN	HCl	HCN	NaCl
Initially	10^{-2}	x	0	0
Finally	10^{-2}-x	0	x	x

$$PH = PKa + \log\frac{[NaCN]}{[HCN]}$$

$$8.5 = 10 - \log(4.1) + \log\frac{10^{-2}-x}{x}$$

$$0.8872 = \log\frac{10^{-2}-x}{x} \quad => \quad \frac{10^{-2}-x}{x} = 0.13$$

$$x = \frac{10^{-2}}{1.13} = 0.00885\,\text{mole} \qquad \textbf{Ans}$$

Q28:

Sol:- PKa of Aspirin = 3.5

PH of stomach = 2-3 $[H^{+}] \geq 10^{-3}M$

PH of small intestine = 8

$[H^{+}] = 10^{-8}M$

So in small intestine Aspirin should be ionised because of which $[H^{+}] = 10^{-8}$ M is possible

In stomach $[H^{+}] \geq 10^{-3}$ M is not possible with aspirin having PKa = 3.5 M.

$$KCN + H_2O \rightleftharpoons HCN + KOH$$

$$\left(\frac{1}{10}N = M\right) \quad \text{excess} \qquad 0 \qquad 0$$

$$\frac{1}{10}-\frac{h}{10} \quad \text{excess} \qquad \frac{h}{10} \qquad \frac{h}{10}$$

$$Kh = \frac{Kw}{Ka} = \frac{0.1h^2}{0.1(1-h)} = 0.1h^2$$

$$h^2 = \frac{Kw}{Ka \times 0.1} = \frac{10^{-14}}{7.2 \times 10^{-10} \times 10^{-1}} = \frac{10^{-14}}{7.2 \times 10^{-11}}$$

$$h^2 = 1.389 \times 10^{-4}$$

$$h = 1.178 \times 10^{2}$$

$$\therefore \text{Degree of hydrolysis (\%)} = \frac{1.178 \times 10}{1} \times 100 = 1.18\%$$

Ans

Q30:-

Sol:- $CH_3COOH + H_2O \rightleftharpoons CH_3COOH + KOH$

Initially 0.1 M excess 0 0

At eg-^{b} 0.1-0.1h excess 0.1h 0.1h

$$k_h = \frac{Kw}{Ka} = \frac{[CH_3COOH][KOH]}{[CH_3COOK]}$$

$$\frac{10^{-14}}{1.8 \times 10^{-5}} = \frac{(0.1h)(0.1h)}{0.1(1-h)} \approx 0.1h^2$$

$$5.56 \times 10^{-10} = 0.1h^2$$

$$h = 5.56 \times 10^{-9} = 55.6 \times 10^{-10}$$

degree of hydrolysis = 7.45×10^{-5} **Ans**

$\therefore [OH^-] = 0.1\ h = 7.5 \times 10^{-6}$

$\therefore$ POH = 6-log 7.5 = 5.126

$\therefore$ PH = 8.88 **Ans**

Q31:

Sol:- $NH_4Cl + H_2O \rightleftharpoons NH_4OH + HCl$

Initially 0.01 M excess 0 0

At eq-^{b} 0.01-0.01h excess 0.01h 0.01h

$$\therefore K_h = \frac{Kw}{Kb} = \frac{10^{-14}}{1.8 \times 10^{-5}} = \frac{0.01h^2}{1-h}$$

$$h^2 = \frac{5.56 \times 10^{-10}}{10^{-2}} \Rightarrow 5.56 \times 10^{-8}$$

$$h = 2.358 \times 10^{-4}$$

$\therefore Kh = 0.0h^2 = 5.56 \times 10^{-4}$ **Ans**

$h = 2.36 \times 10^{-4}$ **Ans**

$\therefore [H^+] = 0.01h = 2.36 \times 10^{-6} = 5.627$ **Ans**

Q32:

Sol:- $CH_3COONa + H_2O \rightleftharpoons CH_3COOH + NaOH$

Initially0.02 M excess

At eq-^{b} 0.02-0.2h **excess** **0.02 h** **0.02h**

$[OH^-]$ 0.02h

$$[H^+] = \frac{10^{-14}}{[OH^-]} = \frac{10^{-14}}{0.02h} = 3\times10^{-9}M \quad \therefore \text{Molarity} = \frac{3\times10^{-9}}{1}M$$

$$h = \frac{10^{-14}}{6\times10^{-11}} = 1.67\times10^{-4}$$

$\therefore Kh = 0.02h^2 = 0.02\times2.78\times10^{-8} = 5.67\times10^{-10}$ **Ans**

Q33:-

Sol:- $HCO_2^- + H_2O \rightleftharpoons HCOOH + OH^-$

0.15 M

0.06-0.15h excess 0.15h 0.15h

$$Kh = \frac{Kw}{Ka} = \frac{10^{-14}}{1.8\times10^{-4}} = 5.56\times10^{-11}$$

$\therefore Kh = 0.15h^2 = 5.56\times10^{-11}$

$$h^2 = \frac{5.56}{0.15}\times10^{-11} = 37.066\times10^{-11} = 3.7066\times10^{-10}$$

$h = 1.92\times10^{-5}$

$\therefore [OH^-] = 0.15\,h = 2.88\times10^{-6}$ M **Ans**

$[HCOOH] = 0.15h = 2.88\times10^{-6}M$ **Ans**

$[HCOO^-] = 0.15 - 0.15h \approx 0.15$ M. **Ans**

$$[H^+] = \frac{10^{-14}}{[OH^-]} = \frac{10^{-14}}{2.88\times10^{-6}} = 3.463\times10^{-15}$$ **Ans**

Q34:-

Sol:- 100 ml of 0.1 M CH_3COOH & 100 ml of 0.1 M NaOH

$CH_3COOH \rightarrow NaOH \longrightarrow CH_3COONa + H_2O$

Initially 10 m mole 10 mole 0 0

Finally **0** **0** **10** **10**

$$\therefore \text{Molarity of } CH_3COONa = \frac{10}{200} = 0.05M$$

$CH_3COONa + H_2O \rightleftharpoons CH_3COOH + NaOH$

Initially 0.05 excess 0 0

At eq-^{b} 0.05-0.05h excess 0.05h 0.05h

$$\therefore Kh = 0.05h^2 \Rightarrow h^2 = \frac{10^{-14}}{1.8\times10^{-5}\times0.05}$$

$$h^2 = \frac{5.56}{5}\times10^{-8} \quad \Rightarrow h = 1.055\times10^{-4}$$

$\therefore [OH^-] = 9.05\,h = 0.05\times1.053\times10^{-4} = 5.56\times10^{-6}$

$$\therefore [H^+] = \frac{10^{-14}}{5.56\times10^{-6}} = 1.8\times10^{-9} \Rightarrow PH = 9 - \log(1.8) = 8.73$$ **Ans**

(b) $CH_3OH \rightarrow 100\,ml \,\&\, 0.1M = 10\,m\,moles$

$NaOH \rightarrow 50\,ml\,of\,0.1M = 5\,m\,mole$

$$CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O$$

Initially	10	5	5	0
Finally	5	0	5	5

$PH = PKa + \log \frac{[CH_3COONa]}{[CH_3COOH]}$ $= 5 - \log(1.8) + 0 = 4.78$ **Ans**

(c) 50 ml of 0.1 M CH_3COOH = 5 m mole of $CH_3\,COOH$

100 ml of 0.1 M NaOH = 10 m mole of NaOH

$$CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O$$

Initially	5	10	0	0
Finally	0	5	5	5

$\therefore [OH^-] = \frac{5}{150} M. = \frac{1}{3} \times 10^{-1} = 3.33 \times 10^{-2}$

$POH = 2 - \log 3.33 = 1.4775$

$\therefore PH = 14 - POH = 12.52$ **Ans**

Q 35:

Sol: $AgCl \rightleftharpoons 1Ag^+ + Cl^-$

Let s is the solubility of AgCl in H_2O.

Then $Ksp = S^2 = 1.8 \times 10^{-10}$

$S = \sqrt{1.8 \times 10^{-10}} = 1.34 \times 10^{-5}\,M$ **Ans**

Q36:-

Sol:- Solubility of $Ag_2CrO_4 = \frac{0.0166/332}{500} \times 1000 = 10^{-4}\,M$

$Ag_2CrO_4 \rightleftharpoons 2Ag^+ + CrO_4^{2-}$

Excess-S 2s s

$\therefore Ksp = (2s)^2\,(s) = 4x^3 = 4 \times 10^{-12}$ **Ans**

Q37:-

Sol:- $PbSO_4 \rightleftharpoons Pb^{2+} + SO_4^{2-}$

-s' S' $\frac{1}{50} + S'$

$Ksp = s'\left(\frac{1}{50} + S'\right)$

$1.06 \times 10^{-8} = S'\frac{1}{50}$ Neglecting S' w.r.t. $\frac{1}{50}$

$\therefore S' = 50 \times 1.06 \times 10^{-8} = 5.3 \times 10^{-7}$ **Ans**

Q38:

Sol:- $Bi_2S_3 \rightleftharpoons 2Bi^{3+} + 3S^{2-}$

$-S \qquad 2S \qquad 3S$

$Ksp = (2S)^2(3S)^3 = 4S^2 \times 27S^3 = 108\,(S)^5$

$= 108\,(1.7 \times 10^{-15})^5 = 1.533 \times 10^{-72}$ **Ans**

Q39:-

Sol:- $Mg(OH)_2 \rightleftharpoons Mg^{2+} + 2OH^-$

Excess $\qquad 0.05$

$-S \qquad (S) \qquad (0.05 + 2S)$

$\therefore Ksp = [Mg^{2+}][OH^-]^2$

$8.9 \times 10^{-12} = S(0.05 \times 2S)^2$ => $8.9 \times 10^{-12} = S(25 \times 10^{-4})$

$$S = \frac{8.9\times10^{-12}}{25\times10^{-4}} = 3.56\times10^{-9}M$$ **Ans**

Q40:-

Sol:- Normality becomes half when eved volume mixed toge

$CaCl_2 + Na_2SO_4 \rightleftharpoons CaSO_4 + 2NaCl$

0.01 N $\qquad$ 0.01 N

Conc-^{n} of $Ca^{2+} = 0.01 = 0.01\ M$

Conc-^{n} of $So_4^{2-} = 0.01 = 0.01\ M$

$\therefore Q = [Ca^{2+}]\,[So_4^{2-}] = 2 \times 10^{-2} \times 1 \times 10^{-2} = 10^{-4} < Ksp$

So precipitation of $CaSO_4$ doesn't occur.

$AgNO_3 \rightarrow 450$ ml of $0.001\ N = 0.45 \times 10^{-3}$ m moles

$HCl \rightarrow 50$ ml of $0.001\ N = 0.05 \times 10^{-3}$ m moles

$AgNO_3 + HCl \longrightarrow AgCl + HNO_3$

Initially conc-^{n} $= \dfrac{0.45\times10^{-3}}{500}\times1000 = 0.9\times10^{-3}$

$[Ag^+]$

$[Cl^-] = \dfrac{0.05\times10^{-3}}{500}\times1000 = 0.1\times10^{-3}$

$\therefore Q = [Ag^+]\,[Cl^-] = 9 \times 10^{-8} >$ ksp of AgCl

So precipitation will occur

Q42:

Sol:- $CaF_2 \rightleftharpoons Ca^{2+} + 2F^-$

$-S \qquad S \qquad 2S$

Ksp of $CaF_2 = 4S^3$

$= 4 \times (2.04 \times 10^{-4})^3 = 3.39 \times 10^{-11} = 3.4 \times 10^{-11}$ **Ans**

In 0.01 M NaF sol-^{n}

$[F^-] = 0.01\ M$

$\therefore Ksp = (Ca^{2+})\,[F^-]$

$3.4\times10^{-11} = S\,(0.01+2S)^2$

$S = 3.4\times10^{-7}$ M **Ans**

Q43:-

Sol:- $H_2SO_4 + 2AgNO_3 \longrightarrow Ag_2SO_4 + 2HNO_3$

$\frac{1}{2}$N 0.01 M

$\therefore Q = [SO_4^{2-}]\,[Ag^+]^2 = 0.5\times(0.01)^2 = 5\times10^{-5} > K_{sp}$ of Ag_2SO_4

$\therefore$ So precipitation will occur

Q44:-

Sol:- (i) $CaCl_2 \rightarrow 0.02$ M

$Na_2SO_4 \rightarrow 0.0004$ M

When equal volume of $CaCl_2$ & Na_2SO_4 mixed, then

$[CaCl_2] = 0.01\text{ M} = 1\times10^{-2}$

$[Na_2SO_4] = 0.002\text{ M} = 2\times10^{-4}$

$\therefore Q = [Ca^{2+}]\,[So_4^{2-}] = 2\times10^{-6} < K_{sp}\,(CaSO_4)$

So precipitation won't occur.

(ii) $[CaCl_2] = 0.08$ M & $[Na_2SO_4] = 0.02$ M

When equal volume mixed, then conc-^{n} becomes half

$\therefore [Ca^{2+}] = 0.04$ M

$[So_4^{2-}] = 0.02$ M

$Q = [Ca^{2+}]\,[So_4^{2-}] = 4\times10^{-4} > K_{sp}\ CaSO_4$ So ppt will occur

Q45:-

Sol:- $CaCl_2 \rightarrow 0.01M$ & $SrCl_2 \rightarrow 0.01M$

Added $H_2SO_4 \rightarrow 0.01$ N.

$Q_{caso_4} = [Ca^{2+}]\,[SO_4^{2-}] = 10^{-4} < K_{sp}\ Caso_4$ PPt of $CaSo_4$ can't

$Q\ SrSO_4 = [Sr^{2+}]\,[SO_4^{2-}] = 10^{-4} > K_{sp}\ SrSo_4$.

$\therefore$ So precipitation of $SrSO_4$ occur first

Q46:-

Sol:- $K_{sp} = 1\times10^{-11}$ for $(Ag_2C_2O_4)$

$Ag_2C_2O_4 \rightleftharpoons 2Ag^+ + C_2O_4^{2-}$

2S S

$K_{sp} = 4S^3 = 1\times10^{-11} = 10\times10^{-12}$

$S = \left(10/4\right)^{1/3}\times10^{-4} = 1.357\times10^{-4}$

Moles of $Ag_2C_2O_4$ dissolved in 2.5 lit

$= 1.357\times10^{-4}\times2.5 = 3.4\times10^{-4}$

$\therefore$ Wt of $Ag_2C_2O_4$ in 2.5 lit Sol-^{n} $= 3.4\times10^{-4}\,(216+24+64)$

$= 1031\times10^{-4} = 0.1031$ g **Ans**

Q47:-

Sol:- In 0.05 M $CaCl_2$ sol-^{n}

$$CaF_2 \rightleftharpoons Ca^{2+} + 2F^-$$

$$\begin{array}{llll} & \text{excess} & 0.05 & 0 \\ \text{At eq-}^b & -S & 0.05+S & 0.2S \end{array}$$

$\therefore Ksp = [Ca^{2+}]\,[F^-]^2 = (0.05 + S)\,(2S)^2$

$4 \times 10^{-11} = 0.05 \times 4 \times S^2$

$S^2 = 20 \times 10^{-11} = 2 \times 10^{-10}$

$S = 1.414 \times 10^{-5}$ **Ans**

In water

$Ksp = S(2S)^2 = 4S^3$

$4 \times 10^{-11} = 4 \times S^3$ => $S_{H_2O} = (1)^{1/3} \times 10^{-4} = 2.15 \times 10^{-4}\,M$

$$\therefore \frac{SH_2O}{SCaCl_2} = \frac{2.15\times10^{-4}}{1.414\times10^{-5}} = 15.4 \text{ time greater}$$ **Ans**

Q48:

Sol:- $AgCl \rightleftharpoons Ag^+ + Cl^-$

$Ksp = S^2 \quad S = \sqrt{Ksp} = \sqrt{1.8} \times 10^{-5}$

1.34×10^{-5}

As Cl^- is added to 0.03 M. then

$Ksp = S'\,(0.03 + S') = S' \times 0.3$

$$S' = \frac{0.8}{0.03} \times 10^{-10} = 60 \times 10^{-10} = 6 \times 10^{-9}$$

$$\frac{[Ag^+]_{finally}}{[Ag^+]_{intially}} = \frac{S'}{S} = \frac{6\times10}{1.34\times10^{-5}} = \frac{6}{1.34}\times10^{-4} = \frac{1}{2233}$$

$$\therefore [Ag^+]_{final} = \frac{1}{2233}[Ag^+]\text{initial}$$ **Ans**

Q49:

Sol:- $CaC_2O_4 \rightleftharpoons Ca^{2+} + C_2O_4^{2-}$

Let s is the solubility then

$Ksp = S^2 \quad S = \sqrt{Ksp} = \sqrt{20} \times 10^{-5} = 4.47 \times 10^{-5}$

$$\begin{array}{lll} CaC_2O_4 \rightleftharpoons & Ca^{2+} & + C_2O_4^{2-} \\ S & S & 0.1 + S \end{array}$$

$\therefore Ksp = 2 \times 10^{-9} = S(0.1 + S) = 1.1\,S$

$S = 2 \times 10^{-8}$

$$\frac{[Ca^{2+}]_{final}}{[Ca^{2+}]_{initial}} = \frac{2\times10^{-8}}{4.40\times10^{-5}} = \frac{2}{4400} = \frac{1}{2200} \text{ times}$$

Q50:

Sol:- Ksp (AgCl) = 1.7×10^{-10}

Ksp (AgI) = 1.5×10^{-16}

That ion will precipitate first which has lower Ksp value i.e. AgI will ppt first

For ppt of AgCl to start

$$Q_{AgCl} = Ksp_{AgCl}$$

$$[Ag^+][Cl^-] = 1.7 \times 10^{-10}$$

$$[Cl^-] = \frac{1.7\times10^{-10}}{[Ag^+]}$$

Also $[I^-]$ at this instant

$$= \frac{Ksp\,AgI}{[Ag^+]} = \frac{1.5\times10^{-16}}{[Ag^+]}$$

$$\therefore \frac{[I^-]}{[Cl^-]} = \frac{1.5\times10^{-16}}{[Ag^+]} \times \frac{[Ag^+]}{1.7\times10^{-10}}$$

$$\frac{[I^-]}{[Cl^-]} = \frac{1.5}{1.7}\times10^{-6} \approx 10^{-6}$$ **Ans**

Q51:

Sol:- moles of Mn^{2+} = 2×10^{-4} moles (in 1 lit) = 2×10^{-4} M

moles of Cu^{2+} = 2×10^{-4} moles (in 1 lit) = 2×10^{-4} M

$[H_2S]$. 0.1 M, $[HClO_4]$ = 0.003 M

$$H_2S \rightleftharpoons 2H^+ + S^{2-}, \quad K = K_1.K_2$$

Initially 0.1M 0.003M 0 $= 1 \times 10^{-7} \times 1.1 \times 10^{-14} = 1.1 \times 10^{-21}$

At eg-^{b} 0.1-x (0.003 +2x) x

$$\therefore K = 1.1\times10^{-21} = \frac{(0.003+2x)^2 x}{0.1-x}$$

$$1.1\times10^{21} = \frac{9\times10^{-6}(x)}{10^{-1}}$$

$$X = \frac{1.1\times10^{-22}}{0.9\times10^{-5}} = 1.22\times10^{-17}$$

$\therefore [S^{2-}] = 1.22 \times 10^{-17}$ M

$\therefore$ QMnS = $[Mn^{2+}][S^{2-}] = 2 \times 10^{-4} \times 1.22 \times 10^{-17} = 2.44 \times 10^{-21}$ < KspMns

So Mns will not PPt

QCus = $[Cu^{2+}][S^{2-}] = 2 \times 10^{-4} \times 1.22 \times 10^{-17}$

2.44×10^{-21} > Ksp Cus

So Cus will precipitate

Cu will precipitate till Q ≤ Ksp

$$Cu^{2+} \quad + \quad S^{2-} \longrightarrow \quad CuS$$

Initially 2×10^{-4} $\quad < 0.1(\text{ from } H_2S)$

Finally **0** $\quad 1.22\times10^{-17}$ $\quad \mathbf{2\times10^{-4}}$

Now $CuS \rightleftharpoons Cu^{2+} + S^{2-}$

$0 \qquad 1.22\times10^{-17}$ $\qquad Ksp = S\,(1.22\times10^{-17}+S)$

$8\times10^{-37} = 8\times1.22\times10^{-17}$

$$S = \frac{8\times10^{-37}}{1.22\times10^{-17}} = 6.56\times10^{-20} \quad \therefore (Cu^{2+})S = 6.56\times10^{-20}\,M$$

$$\therefore \%\text{ of } Cu^{2+} \text{ on precipitated} = \frac{6.56\times10^{-20}}{2\times10^{-4}}\times100 = 3.28\times10^{-14}\%$$ **Ans**

If $[H^+] = 10^{-7}\,M$

$$H_2S \rightleftharpoons 2H^+ + S^{2-} \quad K = K_1.K_2 = \mathbf{1.1\times10^{-21}}$$

Initially $\quad \mathbf{0.1\,M} \quad \mathbf{10^{-7}} \quad \mathbf{0}$

At eq-^{b} $\quad 0.1-y \quad 10^{-7}+2y \quad y$

$$\therefore 1.1\times10^{-21} = \frac{(10^{-7})^2y}{0.1} \approx 10^{-13}y$$

$$y = 1.1\times10^{-8} \Rightarrow [5^{2-}] = 1.1\times10^{-8}\,M$$

$$\therefore Q_{mns} = 2\times10^{-4}\%1.1\times10^{-8} = 2.2\times10^{-12} > KspMnS$$

So ppt of MnS occur

Q52:-

Sol:- Let $[H^+] = x$ to present the ppt of ZnS

$$H_2S \rightleftharpoons 2H^+ + S^{2-}$$

Initially 0.1 $\quad$ **x** $\quad$ **0**

0.1-y $\quad$ **x+2y** $\quad$ **y**

$$1.1\times10^{-21} = \frac{(x+2y)^2y}{0.1-y} = \frac{(x+2y)^2y}{0.1}$$

$$(x+2y)^2y = 1.1\times10^{-22} - (1)$$

Also to ppt of Zns not to occur

$$Q_{Zns} < Ksp_{Zns}$$

$$[Zn^{2+}][S^{2-}] < Ksp_{Zns}$$

$$10^{-3}\times[S^{2-}] < 1\times10^{-21}$$

$$[S^{2-}] < \frac{1\times10^{-21}}{10^{-3}} \Rightarrow [S^{2-}] < 1\times10^{-18}$$

$$\therefore y < 1\times10^{-18}$$

$$\therefore (1):-\ (x+2y)^2.y < 1.1\times10^{-22}$$

$$x^2. < \frac{1.1\times10^{-22}}{1\times10^{-18}} = 1.1\times10^{-4}$$

$$x < 1.1\times10^{-2}$$

$$\therefore [H^+] = x < 1.1\times10^{-2}M$$

$\therefore$ PH < 2 **Ans**

Q53:-

Sol:- $PH^- = 3.5$

$$[H^+] = 3.16\times10^{-4}$$

	$\therefore H_2S \rightleftharpoons$	$2H^+ +$	S^{2-}
Initially	0.1	3.16×10^{-4}	0
At eqb	0.1-x	$3.16\times10^{-4}+2x$	x

$$K = 1.1\times10^{-21} = \frac{(3.16\times10^{-4}+2x)(x)}{0.1-x}$$

$$1.1\times10^{-21} = \frac{8.16\times10^{-4}}{0.1}x$$

$$x = \frac{1.1\times10^{-21}}{3.16\times10^{-3}} = 3.48\times10^{-19}$$

$$\therefore QFes = [Fe^{2+}][S^{2-}] = 0.002\times3.48\times10^{-19}$$

$$6.96\times10^{-22} < ksp\,Fes$$

So precipitation doesn't occur

Q54:-

Sol:-

$$PH = PKa + \log\frac{[CH_3COONa]}{[CH_3COH]}$$

$$= 5 - \log(1.74) + \log\left(\frac{0.15\ 3}{0.25\ 5}\right) = 5 + \log\left(\frac{3}{5\times1.74}\right) = 5 - 0.46$$

$$\therefore [H^+] = 2.9\times10^{-5}$$

	$H_2S \rightleftharpoons$	$2H^+ +$	S^{2-}
Initially	0.1	2.9×10^{-5}	0
At eq-	0.1-x	$2.9\times10^{-5}+2x$	x

$$\therefore 1.1\times10^{-21} = \frac{(2.9\times10^{-5})^2 - x}{0.1} = 8.41\times10^{-9}x$$

Initially **0.004** **x** **For mation constant** $= \frac{10^8}{6} = \text{large}$

Finally **0** **x-0.008** **0.004** So complete reaction occur

Now $Ag(NH_3)_2^+ \rightleftharpoons Ag^+ + 2NH_3$

Initially 0.004 0 (x-0.008)

At eq- $0.004 - y$ y x-0.008+2y

A/q, $y = 1.8\times10^{-7}$

So $0.004 - y \approx 0.004$

$x - 0.008 + 2y \approx x - 0.008$

$$\therefore \text{kdiss} = \frac{(Ag(\frac{1}{2})[NH_3]^2}{[Ag(NH_3)_2^+]} = \frac{1.8\times10^{-7}x(x-0.008)^2}{(0.004-y)}$$

$$6\times10^{-8} = \frac{18\times10^{-8}(x-0.008)^2}{0.004}$$

$$\frac{4}{3}\times10^{-3} = (x-0.008)^2$$

$$3.65\times10^{-2} = x - 0.008$$

$X = 0.0365 + 0.008 = 0.045$ mole / lit

$\therefore [NH_3]$ required to present Molarity $= 0.0445$ M **Ans**

Q57:-

Sol:- (1) $CaF_2 \rightleftharpoons Ca^{2+} + 2F^-$ $ksp_1 = 3.9\times10^{-11}$

-x x $2x + 2y$,

(2) $SrSrF_2 \rightleftharpoons Sr^{2+} + 2F^-$ $Ksp_2 = 2.9\times10^{-9}$

-y **y** **2Y + 2x**

For (1) $Ksp_1 = x(2x+2y)^2 = 4x(x+y)^2$

$Ksp_2 y(2x+2y)^2 = 4y(x+y)^2$

$Ksp_1 + Ksp_2 = 4(x+y)(x+y)^2 = 4(x+y)^3$

$$(x+y) = \left(\frac{Kop_1 \times Ksp_2}{4}\right)^{1/3} = \left(\frac{2.939\times10^{-9}}{4}\right)^{1/3}$$

$(x+y) = 0.9\times10^{-3}$

$\therefore$From $Ksp_1 = 4x(x+y)^2 = 4x\times(0.9\times10^{-3})^2$

$$3.9\times10^{-11} = 4x(0.815\times10^{-6})$$

$$x = \frac{3.9\times10^{-11}}{3.26\times10^{-6}} = 1.19\times10^{-5}M$$

Ans

$$\text{From} Ksp_2 = 4y(x+y)^2$$

$$y = \frac{2.9\times10^{-9}}{3.26\times10^{-6}} = 8.89\times10^{-4}\text{M}$$

Ans

Q58:- (aniline) lone pair on Nitrogen is in resonance with ph ring, so is a weak base. The basic strength can be increased by using an acid of greater deficiency of e^-

Q59:-

Sol:- Acidic strength tells about how much of acid to give H^+ ion whereas acid concentration means have much acid is dissolved in water.

Q60:

$$2NH_3 \rightleftharpoons NH_4^+ + NH_2^-$$

Sol:- ↓ ↓

acid base

Q61:-

Sol:- $H_2SO_4 \rightleftharpoons H^+ + HSO_4^-$

Initially 0.15M 0 0

Finally 0 0.15M 0.15 M. (complete dissociation) A

$HSO_4^- \rightleftharpoons H^+ + SO_4^{2-}$

Initially 0.15 M 0.15 0

At eg- 0.15-x 0.15+x x

$$\therefore K_2 = 1.02\times10^{-2} = \frac{[H^+][SO_4^{2-}]}{[HSO_4^-]} = \frac{(0.15+x)x}{0.15-x}$$

Solving we have (quarddraic dq has to solve)

$$x = 8.9\times10^{-3}$$

$$\therefore [SO_4^{2-}] = x = 8.9\times10^{-3}\text{M}$$

Ans

Q62:- $HCOOH + NaOH \longrightarrow HCOONa + H_2O$

50 ml 10 ml

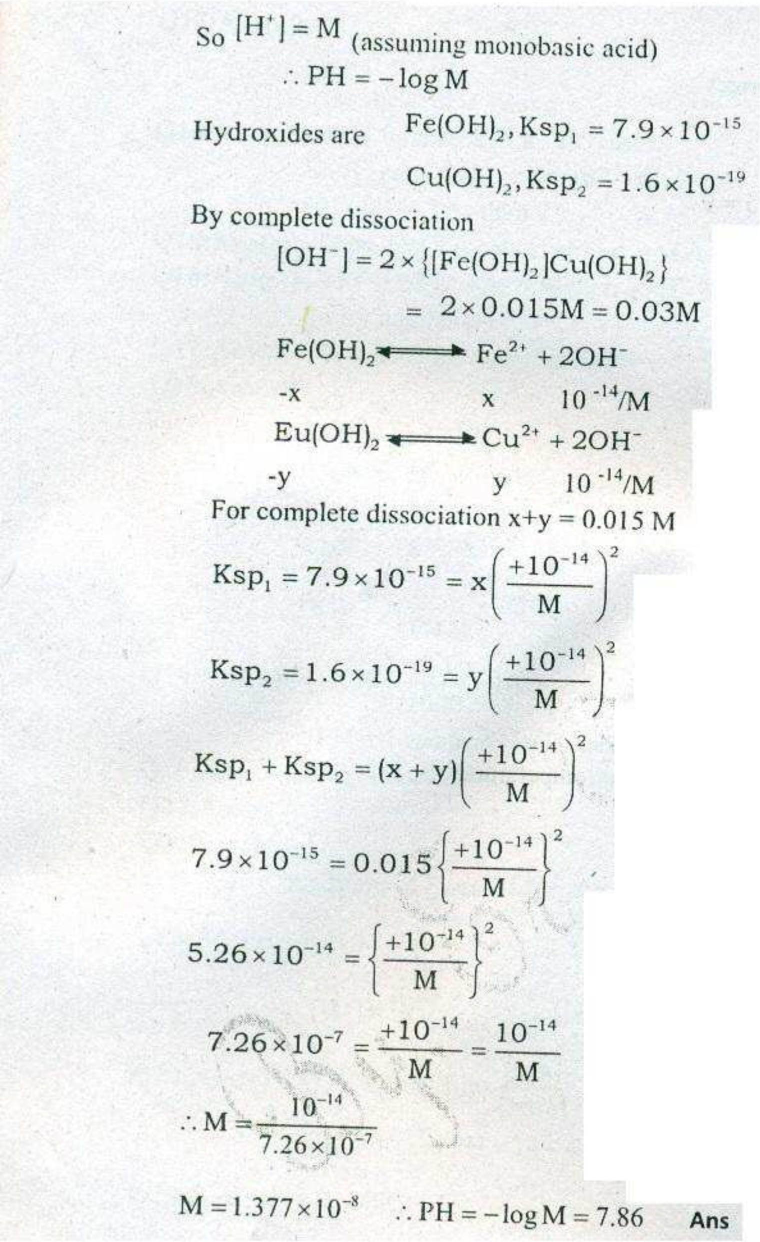
0.01 M 0.1 M

Initially 0.5 mmole 1 mmole

Finally 0 0.5 m mole 0.5 mmole

$$\therefore [NaOH] = \frac{0.5}{60} = \frac{5}{600}\text{M}$$

$$\therefore [OH^-] = \frac{5}{600}\text{M}$$



So $[H^+] = M$ (assuming monobasic acid)

$\therefore PH = -\log M$

Hydroxides are $Fe(OH)_2, Ksp_1 = 7.9\times10^{-15}$

$Cu(OH)_2, Ksp_2 = 1.6\times10^{-19}$

By complete dissociation

$$[OH^-] = 2\times\{[Fe(OH)_2]Cu(OH)_2\}$$

$$= 2\times0.015M = 0.03M$$

$$Fe(OH)_2 \longleftrightarrow Fe^{2+} + 2OH^-$$

$$-x \qquad x \qquad 10^{-14}/M$$

$$Eu(OH)_2 \longleftrightarrow Cu^{2+} + 2OH^-$$

$$-y \qquad y \qquad 10^{-14}/M$$

For complete dissociation x+y = 0.015 M

$$Ksp_1 = 7.9\times10^{-15} = x\left(\frac{+10^{-14}}{M}\right)^2$$

$$Ksp_2 = 1.6\times10^{-19} = y\left(\frac{+10^{-14}}{M}\right)^2$$

$$Ksp_1 + Ksp_2 = (x+y)\left(\frac{+10^{-14}}{M}\right)^2$$

$$7.9\times10^{-15} = 0.015\left\{\frac{+10^{-14}}{M}\right\}^2$$

$$5.26\times10^{-14} = \left\{\frac{+10^{-14}}{M}\right\}^2$$

$$7.26\times10^{-7} = \frac{+10^{-14}}{M} = \frac{10^{-14}}{M}$$

$$\therefore M = \frac{10^{-14}}{7.26\times10^{-7}}$$

$M = 1.377\times10^{-8}$ $\therefore PH = -\log M = 7.86$ **Ans**

Q1:Ans(a):- $Kw = [OH^+][OH^-] = 1\times10^{-14}$ at 25^0C

Q2:Ans(d):- Btw none of the answer written is correct

$$K = \frac{Kw}{Ka} = \frac{10^{-14}}{10^{-6}} = 10^{-8}$$

Q3:Ans(d):- $PK_b = 5 \quad PKa = PKw - Pka = 14 - 5 = 9$

Q4:Ans(a):

$$NH_3 + H_2O \longrightarrow NH_4^+ + OH^-$$

Initially $\quad M \quad$ excess $\quad 0 \quad 0$

At eq-^{b} $\quad M\text{-}x \quad$ excess $\quad x \quad x$

$$\therefore Kb = 1.8\times10^{-5} = \frac{x^2}{M-x} = \frac{x^2}{M-x}$$

A/q, $x = 1.5\times10^{-3}$

$$\therefore M = \frac{2.25\times10^{-6}}{1.8\times10^{-5}} = 0.125M + 1.5\times10^{-3}$$

Q5:Ans(d):- a):- Ka:- 10^{-6}

b) :-PKa:- 0 Ka = 10^{-5}

c):- PKb = 10 :- Kb = 10^{-10} = Ka = 10^{-4}

d):- Kb = 10^{-11} :- Ka = 10^{-3} – Strongest acid

Q6:Ans(a)

The value of Kw will be always same at constant temperature

Q7:Ans(c):- $\therefore [H_3O^+] = 10^{-6}$

For pure water, $[H_3O^+] = [OH^-] = 10^{-6}$

$\therefore Kw = [H_3O^+][OH^-] = 10^{-12}$

Q8:Ans(b):- PH = 4 $\quad [H^+] = 10^{-4}M$

[Acid] = 10^{-2}

∴ so acid is work

Q9:Ans(d):- $[KOH] = \frac{10^{-2}}{10} = 10^{-3}M$

$[OH^-] = 10^{-3}M \quad POH = 3$

$\therefore PH = 14 - POH = 11$

Q10:Ans

H^+ from 0.1 N HCl = 0.1

H^+ from 0.1 CH_3COOH ≈ negligible due to common ion effect

$\therefore [H^+]$ total = 10^{-1}

PH = 1

Q11:Ans(d):- Will be slightly less than 7, because of pure water PH =7; since very negligible amount of acid is added so PH will be slightly less than 7

Q12:Ans(d):- PH = 7 because the acid conc-^{n} is too less to consider

Q13;Ans(a):- PH = 2 $[H^+] = 0.01$

[Acid] = 0.01

$\therefore$ so the acid is strong

Q14:Ans(c):- As T increases, Kw increases,

So H^+ conc-^{n} also increases and hence

PH will be less than 7

Q15:Ans(a):- Since NaCl is salt of strong acid & strong base. so won't effect the Ph of the sol-^{n}

Q16:Ans(c):- At $T > 25^0C$, Kw is higher, so H^+ will be $> 10^{-7}M$.

So for neutral sol-^{n}, PH < 7

Q17:Ans(d):- Will be slightly acidic so PH < 7

Q18:Ans(a):-

$$Ka[HA] = 1\times10^{-5}$$

$$HA \rightleftarrows H^+ + A^-$$

$$\begin{array}{lll} 0.1 & 0 & 0 \\ 0.1\text{-}x & x & x \end{array}$$

$$1\times10^{-5} = \frac{x^2}{0.1} \quad x = 10^{-3} \qquad PH = 3$$

Q19:Ans(b):- $[HCl] = \dfrac{0.1}{1000} = 10^{-4}$

$\therefore$ PH = 4 because NaCl doesn't effect PH

Q20:Ans(a):- PH = PKw – POH = 14-14 = 0

Q21:Ans(c):-

Q22:Ans(b),(c)

Addition of more HCl to the sol^n will decrease the PH of the solution.

Q23:Ans(a) $1.8\times10^{-5} = \dfrac{x^2}{0.1} \Rightarrow x = \sqrt{1.8\times10^{-6}} = 1.34\times10^{-3}$

$\therefore [H^+] = 10^{-14}/1.34\times10^{-3} \Rightarrow PH = 11.13$ **Ans**

Q24:Ans(c):- $POH = PKb + \log\dfrac{[salt]}{[base]}$

$POH = 4 \quad \rightarrow PH = 14 - 4 = 10$

Q25:Ans(a):- $PH = PKa + \log\dfrac{[Salt]}{[Acid]}$

If $\dfrac{Salt}{Acid}$ is increased by 10 times, so PH will increase by 1.

Q26:Ans(a):- Hydrolysis involve breaking of bonds, so is always endothermic.

Q27:Ans(d):- $PH = 7 + \frac{1}{2}(PKa - PKb)$

$\therefore$ So on Ka & Kb PH will be less or greater or equal to 7.

Q28:Ans(b):- Hydrolysis percentage doesn't depend on conc-^{n}

Q29:Ans(b):- For a strong acid & weak base salt

e.g. NH_4Cl

$$NH_4^+ + H_2O \rightleftharpoons NH_4OH + H^+$$

$$M - xM \quad \text{excess} \quad Mx \quad Mx$$

$$\therefore \frac{Kw}{Kb} = \frac{(Mx)(Mx)}{M(1-x)} = \frac{Mx^2}{\approx 1-x} \approx Mx^2$$

$$x = \sqrt{\frac{Kw}{Kb \times M}}$$

Q30:Ans(b):- Ksp doesn't change, solubility changes.

Q31:Ans(a):- If $Q = [Aq^-]\,[Cl] < Ksp$

then less amount of ions are present, so sol-^{n} is unsaturated sol-^{n}.

Q32:Ans(b):- $Al(OH)_3 \rightleftharpoons \underset{S}{Al^{3+}} + \underset{3S}{3OH^-}$

$$KsP = S.\,(3S)^3 = 27S^4$$

Q33:Ans(b):- Wt of $BaSO_4 = 1g$

Let the volume of water needed is v lit

$$M_{BaSO_4} = \frac{\frac{1}{233}}{V} = \frac{1}{233V}$$

$$\therefore Ksp = S^2 \quad S = \sqrt{KSP} = \sqrt{1.1 \times 10^{-5}}$$

$$\frac{1}{233V} = 1.048 \times 10^{-5} \quad => V = \frac{10^5}{244.37} \approx 450\,\text{lit}$$

Q34:Ans(d):- $KsP = \left(\frac{0.00223}{223}\right) = \left(10^{-5}\right)^2 = 10^{-10} - 0.1 \times S$

$$S = 10^{-9}\ \text{mole / lit}$$

Q35:Ans(a):- For ppt to occur, $Q > KSp$

When equal volume are mixed, then conc-^{n} become half.

$$\text{(a) } Q = \frac{10^{-5}}{2} \times \frac{10^{-4}}{2} = \frac{1}{4} \times 10^{-8} = 2.5 \times 10^{-9} > KSp$$

So ppt occur in case of a

Q36:Ans(a):- KSp of Pz_3 will be less because it will produce more no. of ions. Also $M_2 \times 1\,QY_2$ have same solubility.

$KSP\ Pz_3 = 27S^4$

$KSP\ M_2X = KSP_{QYZ} = 4S^3$

Q37:Ans(c):- $PKb = 10.83$

$PKa = 14 - PKb = 14 - 10.83 = 3.17$

$Ka = \text{anti log}(-3.17) = 6.76 \times 10^{-4}$

Q38:Ans(d):- KSP = $(2y)^2\,(3Y)^3 = 108\,y^5$

Q39:Ans(d):- For most effective buffering, they (buffering component) will have greater value

Q40:Ans(a):- when 9.99 ml of 0.1 NaOH is added

$$[H^+] = \frac{1-0.99}{20} = \frac{0.001}{20}\text{moles} = \frac{1}{2}\times10^{-4}$$

PH = 4 – log2.

When 10.01 ml of 0.1 M NaOH is added

$$[OH^-] = \frac{1.001-1}{20} = \frac{0.001}{20} = \frac{1}{2}\times10^{-4}$$

POH = 4 –log2

PH = 14 – POH = 10 + log 2

Q41:Ans(a):- One drop has 10^{-4} M of acid so that PH becomes 4

∴ So, pH = 4

When 2nd drop is added 10^{-4} M is again added

$[H^+] = 2\times10^{-4}$M => PH = 4 – log2 = 3.7

Q42:Ans(c):- $CH_3COO^{(-)} + H_2O \longrightarrow CH_3COOH + OH^{(-)} + NH_4^{+} \longrightarrow NH_4OH$

Both H^+ & OH^- are furnishing, so degree of dissociation is maximum.

Q43:Ans(b):- Will be slightly basic, so PH will be slightly greater than 7

Q44:Ans(b):- act as acid, so will have PH slightly less than 7

Q45:Ans(c):- $PH = 7 + \frac{1}{2}PKa - \frac{1}{2}PKb$

$\therefore Ka = Kb \Rightarrow PKa = PKb \quad \because PH = 7$