II part :- IONIC & EQUILIBRIUM :-

It A Branch of chemistry which study about flow of ions, Ionization & ionic conductivity is called IONIC Eq.

→ Basically conductors are of 2 types :-

i) Metallic conductor - It allows to flow electrons.

ii) Ionic conductor - It allows to flow ions but they need to form aqeous soln.

→ Acid, Base & salt can ionise in the availability of water

→ Electrolytes : are the substance which can allow ionization of acid, base & salt.

Aq. solution → dissociation of ions.

$NaCl \longrightarrow$ salt, solid $+ H_2O \longrightarrow NaCl(aq)$

$H_2SO_4 \longrightarrow$ Acid, liq $+ H_2O \longrightarrow H_2SO_4(aq)$

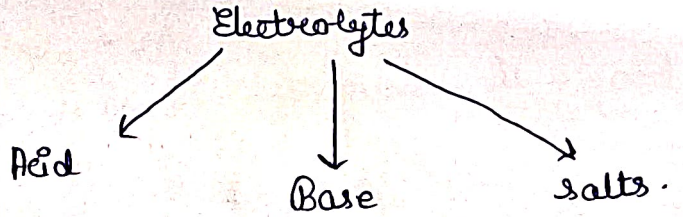
$NaOH \longrightarrow$ Base, solid $+ H_2O \longrightarrow NaOH(aq)$

$HCl \longrightarrow$ Acid, gas $+ H_2O \longrightarrow HCl(aq)$

$NaCl(aq) \longrightarrow Na^+_{aq} + Cl^-_{aq}$ ions.

$H_2SO_4(aq) \longrightarrow H^+ + HSO_4^-$ ions

* Substance $+ H_2O \longrightarrow$ ionization.



* Types of Electrolytes

i) Strong electrolytes which can ionized 100% completely.

ii) Weak Electrolytes which cannot ionize completely.

eg: Strong Acid : H_2SO_4, HCl, HNO_3, $HClO_4$, HBr, HI

Strong Base : KOH, NaOH, $Ba(OH)_2$, CsOH, RbOH

Salt : NaCl, KCl, H_2SO_4.

weak electrolyte :-

weak Acid - CH_3COOH, HCN, HCOOH, H_3PO_3, H_2PO_2 etc.

weak Base - NH_4OH, $Cu(OH)_2$, $Zn(OH)_2$, $Fe(OH)_3$, $Al(OH)_3$.

* What is Acid / Base ?

1) Taste (experiment) Sour → Acid & Bitter → Base.

2) Litmus paper Blue $\xrightarrow{ACID}$ Red

Red $\xrightarrow{BASE}$ Blue.

3) Arrehenius → H^+ given → Acid

↳ OH^- given → Base.

4) Bronsted lowry - H^+ give → Acid after H^+ give → conjugated Base.

H^+ take → Base → after that conjugated Acid.

eg: $HCl + H_2O \rightleftharpoons H_3O^+ + Cl^-$

strong Acid, Base, Conj. Acid., conjugated / weak base

eg: $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$

strong Base, Acid, Conj. acid (weak), Conj. Base

* weak base are best leaving base group.

* $HCl + CH_3COO^- \longrightarrow Cl^- + CH_3COOH$

strong Acid, Base, Conj. weak base., Conj. Base, weak acid, weak Base

Acid, Base, Conj. Base, Conj. Acid

eg: $H_2O + H_2O \rightleftharpoons H_3O^+ + OH^-$ — (1)

eg: $HX + B^- \rightleftharpoons X^- + HB^+$

Acid, Base, Conj. Base, Conj. Acid. — (2)

3) HSO_4^- + NH_3 ⇌ NH_4^+ + SO_4^{-2}
Acid — Base — Conj. Acid — Conj. Base.

4) $[Fe(H_2O)_6]^{+3}$ + H_2O ⇌ H_3O^+ + $[Fe(H_2O)_5OH]^{+2}$
Acid — Base — Conj. Acid — Conj. Base.

5) HCl + NH_3 ⇌ NH_4^+ + Cl^-
Acid — Base — Conj. Acid — Conj. Base

6) H_2SO_4 + H_2O ⇌ H_3O^+ + HSO_4^-
Acid — Base — Conj. Acid — Conj. Base.

7) $H_2SO_4^-$ + $R-NH_2$ ⇌ $R-NH_3^+$ + SO_4^{-2}
Acid — Base — Conj. Acid — Conj. Base

8) CH_3COOH + NH_3 ⇌ NH_4^+ + CH_3COO^-
Acid — Base — Conj. Acid — Conj. Base

9) NH_4^+ + S^{-2} ⇌ SH^- + NH_3
Acid — Base — Conj. Acid. — Conj. Base

Ques:- which can act as Both Acid / Base ?

(a) H_2O
(b) HCl ✗
(c) HSO_4^-
(d) NH_3

H_3O^+ — H_2O — OH^-

HCl — Cl^-

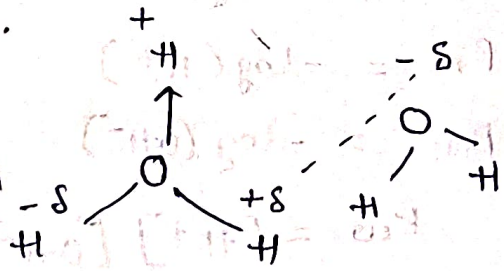
NH_4^+ — NH_3 — NH

H_2SO_4 — $H_2SO_4^-$ — SO_4^{-2}

* WATER

$H_2O + H_2O \longrightarrow H_3O^+ + OH^-$ H^+ = proton H^+ = lewis Acid.

$H_2\ddot{O} + H^+ \longrightarrow \underline{H_3O^+}$ ← Hydronium ion.



$H_3O^+ + H_2O \longrightarrow HSO_2^+$

$HSO_2^+ + H_2O \longrightarrow HFO_3^+$

$HFO_3^+ + H_2O \longrightarrow HgO_4^+$

} compound.

* Hydrogen (protium) always behaves as compound in H_2O. It never exist as H^+ ion.

* Lewis – Ip given → BASE → $\ddot{N}H_3$, $H_2\ddot{O}$, $H\ddot{F}$:

Ip taken → ACID → $AlCl_3$ & H^+, $FeCl_3$, $ZnCl_2$.

$H_2O \longrightarrow H^+ + OH^-$

at every temp $[H^+] = [OH^-]$ only in water.

Conc at 298 K = $[H^+] = [OH^-] = 10^{-7}$

at 60°C - 90°C = $[H^+] = [OH^-] = 10^{-6}$.

K_w = constant conc of water.

$H_2O \longrightarrow H^+ + OH^-$ $\quad K_w = [H^+] * [OH^-]$

↑

it is neither reactant nor a solvent so it is not in the Q.

$K_w = 10^{-7} \times 10^{-7}$

$K_w = 10^{-14}$ at 298

$K_w = 10^{-6} \times 10^{-6}$

$K_w = 10^{-12}$ at 60°

$KCl_{(aq)} = K^+_{(aq)} + Cl^-_{(aq)}$

$$K_{salt} = \frac{[K^+][Cl^-]}{[KCl]}$$

The value of $P = -\log$.

$P_{ka} = -\log k_a$

$P_{kb} = -\log k_b$

$P_{kw} = -\log k_w$

$P_H = -\log (H^+)$

$P_{OH} = -\log (OH^-)$

$\therefore \log (x \cdot y) = \log x + \log y$.

$k_w = [H^+]\,[OH^-]$

taking both side (-log)

$-\log k_w = -\log ([H^+][OH^-])$

$-\log k_w = -[\log (H^+) + \log (OH^-)]$

$-\log k_w = -\log [H^+] + (-\log [OH^-])$

$P_{kw} = P_H + P_{OH}$ at 298k $= 10^{-14}$

$-\log 10^{-14} = P_H + P_{OH}$

$14 = P_H + P_{OH}$

$\Rightarrow P_H = P_{OH}$

$14 = P_H + P_H$

temp ↑ P_H of H_2O ↑

$14 = 2P_H$

$P_H = 7$ at 298 K

at 10°C,

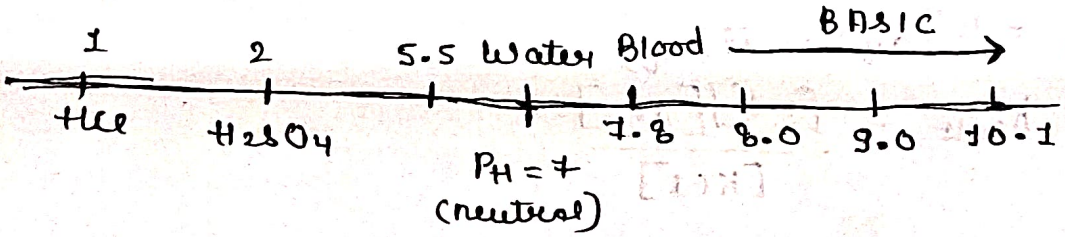
$H^+ = OH^- = 10^{-6}$

$P_{kw} = P_H + P_{OH}$

$-\log 10^{-12} = P_H + P_{OH}$

$\boxed{P_H = 6.}$

* P_H Scale :-



Que> P_H of 0.01M HCl

$\Rightarrow P_H = -\log [H^+]$

$= -\log (10^{-2})$

$P_H = 2.$

Eg que of 194 > soft drink $= 3.8 \times 10^{-3} M$

$P_H = -\log (3.8 \times 10^{-3})$

$= -\log 3.8 + \log 10^{-3}$

$\Rightarrow -2 \times \log 2$

$\Rightarrow -2 \times 0.$

Que> $P_H = 10^{-8}$ HCl

$P_H = 8$ never possible.

at 298 = 25°C

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

$HCl \longrightarrow H^+ + Cl^-$

10^{-8}

$10^{-7} + 10^{-8}$

$1 \times 10^{-7} \times 0.1 \times 10^{-7}$

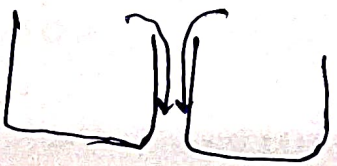
$[H^+] = 1.1 \times 10^{-7}$

$P_H = -\log 1.1 \times 10^{-7}$

$= -\log 1.1 + -\log 10^{-7}$

$\Rightarrow -0.030 + 7$ $\quad P_H \approx 6.99.$

Que>



$P_H = 2$ $\quad P_H = 3$

$-\log [H^+] = 2$ $\quad -\log [H^+] = 3$

$\log [H^+] = +\log 10^2$

$[H^+] = 10^{-2}$

Trick

$P_H = 3 = 10^{-3}$

$P_H = 4 = 10^{-4}$

$P_H + P_{OH} = 14$

$P_H = 9$

$P_{OH} = 5$

$[OH^-] = 10^{-5}.$

Water $P_H = P_{OH} = 10^{-7}$

$P_H + P_{OH} = 14$

$[H^+][OH^-] = 10^{-14}$

$P_H = 9$

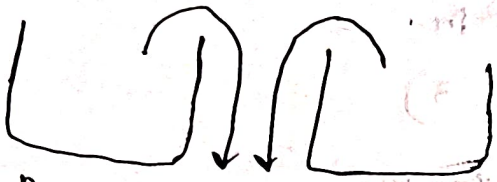
$[H^+] = 10^{-9}$ //

$[H^+][OH^-] = 10^{-14}$

$[OH^-] = \frac{10^{-14}}{10^{-9}}$

$[OH^-] = 10^{-5}$ //

Que :>



$P_H = 2$ $\quad$ $P_H = 3$

$10^{-2} + 10^{-3}$

$\Rightarrow 1 \times 10^{-2} + 0.1 \times 10^{-2}$

$(1 + 0.1) \times 10^{-2}$

$P_H = 1.1 \times 10^{-2}$

$-\log 1.1 \times 10^{-2}$

$-\log 1.1 - \log 10^{-2}$

$-0.030 + 2$

$P_H = 1.98$

$N_1V_1 + N_2V_2 = N_3V_3$

Que :> 0.1M HCl 100ml $\quad$ $n = 1$ given

0.2M H_2SO_4 100ml. $\quad$ $P_H = ?$ $\quad$ $n = 2$ given

$\Rightarrow N_1V_1 = n \times M \times V$

$= 1 \times 0.1 \times 100$

$= 10$

$N_2V_2 = n \times M \times V$

$= 2 \times 0.2 \times 100$

$= 40$

$N_3 = \frac{N_1V_1 + N_2V_2}{V_1 + V_2}$

$N_3 = \frac{10 + 40}{100 + 100} = \frac{50}{200} = \frac{1}{4} = 0.25$

$N_3 = 0.25 = [H^+]$

$P_H = \log 4 = \log (2)^2$.

$P_H = 0.8030$

Acid + Acid ; Acid + Base ; Base + Base :-

eg:- HCl $\frac{M}{100}$ + $\frac{M}{1000}$ H_2SO_4 + 300 ml.

$V_1 = 100$ ml $\quad V_2 = 100$ ml.

$\Rightarrow$ HCl $\rightarrow N_1V_1 = n_1 \times M_1 \times V_1$

$= 1 \times \frac{1}{100} \times 100$

$= 1$.

$H_2SO_4 \rightarrow N_2V_2 \rightarrow n_2 \times M_1 \times V_1$

$\Rightarrow 2 \times \frac{1}{100} \times 100$

$\Rightarrow 2$

$N_3 = \frac{N_1V_1 + N_2V_2}{V_1 + V_2 + \text{water}}$

$= \frac{1 + 2}{100 + 100 + 300}$

$[H^+] = \frac{3}{500} = 6 \times 10^{-3}$

$\Rightarrow -\log[H^+] = pH$

$P_H = -\log 6 \times 10^{-3}$

$= -(\log 6 + \log 10^{-3})$

$= -\log 6 - \log 10^{-3}$

$\Rightarrow -(\log 2 + \log 3) + 3$

$\Rightarrow -(0.3010 + 0.477) + 3$

$\Rightarrow -0.777 + 3 \Rightarrow 2.334$.

Que:- $N_{NaOH} = 0.01\,M$ $\frac{1}{2}$ lit

$Ca(OH)_2 = 0.01\,M$ $\frac{1}{2}$ lit

$\Rightarrow N_{NaOH} = N_1V_1 = n_1 \times V_1 \times M_1$

$\Rightarrow 1 \times \frac{1}{2} \times 0.010$

$\Rightarrow 0.005$.

$Ca(OH)_2 = N_2V_2 = n_2 \times V_2 \times M_2$

$= 2 \times \frac{1}{2} \times 0.01 = 0.010$

V.F

HCl = 1 $\quad H_2SO_4 = 2$

$H_3PO_3 \rightarrow 2 \quad H_3PO_4 \rightarrow 3$

$H_2PO_2 \rightarrow 1 \quad H_3PO_2 \rightarrow 1$

$HNO_3 \rightarrow 1 \quad NaOH = 1$

$Ca(OH)_2 = 2 \quad Al(OH)_3 = 3$

$$N_3 = \frac{N_1V_1 + N_2V_2}{V_1 + V_2}$$

$$\Rightarrow \frac{0.005 + 0.010}{1}$$

$$\Rightarrow 0.015$$

$$[OH^-] = 15 \times 10^{-3}$$

$$-\log [OH^-] = POH$$

$$POH = -\log (15 \times 10^{-3})$$

$$= -\log (5 \times 3 \times 10^{-3})$$

$$= -\log 5 - \log 3 - \log 10^{-3}$$

$$\Rightarrow -0.7 - 0.47 + 3$$

$$\Rightarrow -1.17 + 3.$$

$$POH = 1.83$$

$$PH = 14 - POH$$

$$= 14 - 1.83 \Rightarrow \underline{PH = 12.17}.$$

* Acid + Base

$$N = \frac{|N_1V_1 - N_2V_2|}{V_1 + V_2}$$

eg:- H_2SO_4 100ml $\frac{M}{100}$

$Ca(OH)_2$ 100ml $\frac{M}{200}$

$\Rightarrow H_2SO_4 = N_1V_1 = n_1 \times V_1 \times M_1$

$= 2 \times 100 \times \frac{1}{100}$

$= 2$

$N_2V_2 = n_2 \times V_2 \times M_2,$

$= 2 \times 100 \times \frac{1}{200}$

$= 1.$

$\Rightarrow \frac{|N_1V_1 - N_2V_1|}{V_1 + V_2}$ as Acid & Base are mixed.

$\Rightarrow \frac{2-1}{100+100} = \frac{10 \times 10^{-5}}{200 \times 10} = \frac{10^{-5}}{2000} = 5 \times 10^{-3} = [H^+]$

$\Rightarrow -\log [H^+] = PH = -\log 5 \times 10^{-3}$

$= -\log 5 - \log 10^{-3}$

$PH = -0.7 + 3$

$PH = 2.3.$

APP-04

Que.1) $P_H = 3$ 100ml

$P_H = 3$ 400ml

$N_1 = 10^{-3}$ $V_1 = 100$

$N_2 = 10^{-3}$ $V_2 = 400$

$$[H^+] = N = \frac{N_1V_1 + N_2V_2}{N_1 + V_2}$$

$$N = \frac{10^{-3} \times 100 + 10^{-3} \times 400}{500} \Rightarrow \frac{0.1 + 0.4}{500} = \frac{1}{1000}$$

$[H^+] = 10^{-3}$ $P_H = -\log 10^{-3} = 3.$

Que.2) $P_H = 3 = 10^{-3}$

$P_H = 6 = 10^{-6}$

10^{-3} 10^{-6}

1000 times less.

Reduced to 100 times.

Que.3) $P_H = 3 = 10^{-3}$

$P_H = 5 = 10^{-5}$

$$\Rightarrow \frac{N_1V_1 + N_2V_2}{V_1 + V_2} \Rightarrow \frac{10^{-3} \times x + 10^{-5} \times x}{2x} = \frac{100 \times 10^{-5} x + 10^{-5}}{2}$$

$$\Rightarrow \left(\frac{100 + 1}{2}\right) \times 10^{-5}$$

$$\Rightarrow \frac{101}{2} \times 10^{-5}$$

$$\Rightarrow 50.5 \times 10^{-5}$$

$$\Rightarrow 5.05 \times 10^{-4}$$

$-\log [H^+] = P_H = -\log 5 - \log 10^{-4}$

$= -0.7 + 4$ $P_H = 3.3$

Que.4) $HCl = 10^{-9}$

assume at 298K

$H_2O \rightarrow H^+ = 10^{-7}$

$HCl \rightarrow H^+ = 10^{-9}$

1.01×10^{-7}

$P_H = 7 - 0.01$

$P_H = 6.99$ //

Que 5) KOH $M = 0.001$.

$-\log [OH^-] = -\log 0.001$

$= -\log 10^{-3}$

$P_{OH} = 3$

$P_H = 14 - 3$

$P_H = 11$

Que 6) $N_{NaOH} = N_1 V_1 = n_1 \times V_1 \times M_1$

$= 1 \times 10 \times 0.1 = 1$

$H_2SO_4 = N_2 V_2 = n_2 \times V_2 \times M_2$

$= 2 \times 10 \times 0.05$

$= 1$

$[H^+] = [OH^-]$ are equal = Neutral. at 298K.

$[H^+] = [OH^-] = 10^{-7}$ $P_H = 7$.

Que 7) $P_H = 10^{-10}$ NaOH

$[OH^-] = 10^{-10}$

$P_{OH} = 10$

$P_H = 4$

$P_H = 10^{-10}$ is almost 0. & it is considered as neutral.

$P_H = 7$

Que 9) 8g NaOH one lit

$N_1 = \frac{w}{mw} \times \frac{1000}{v} \times N_f$

$= \frac{8}{40} \times \frac{1lit}{1lit} \times 1$

$= \frac{1}{5}$

$N_1 = 0.2$

$N_2 = \frac{4.9}{98} \times \frac{1lit}{1lit} \times 2$

$H_2SO_4 = \frac{1}{10} = 0.1$

$= 0.2 - 0.1$

$N_{NaOH} = 0.1$

$N_{NaOH} = [OH] = 0.1$

$= -\log 0.1$

$= -\log 10^{-1}$

$P_{OH} = 1$ $P_H = [14 - 1]$

$P_H = 13$

Qu. 10% w = ?

NaOH

Mw = 40

V.F = 1

V = 250 ml

PH = 13

POH = 1

$[OH^-] = M_1 = 10^{-1}$

$M = \frac{w}{Mw} \times \frac{1000}{V} \times n$

$0.1 = \frac{w}{\frac{40}{10}} \times \frac{1000}{250}$

w = 1g.

* PH of weak Acid / Weak Base :-

→ Ostwald dilution law – only for weak acid / Base.

ionization is very very less. $\alpha = 1_{max}$

$\alpha = 0.005$

$1 >>> \alpha$

for weak Acid.

$HA(aq) \rightleftharpoons H^+ + A^-$

at t=0 C (Concentration)

at t=t C(1-α) Cα Cα.

$K_a = \frac{[H^+][A^-]}{[HA]} = \frac{C\alpha \times C\alpha}{C(1-\alpha)} = \frac{C\alpha^2}{(1-\alpha)} = C\alpha^2$

↳ 1

value is approx negligible.

acc^n to Ostwald dilution law.

$K_a = \frac{C\alpha^2}{1}$

$K_a = C\alpha^2$

$\sqrt{\frac{K_a}{C}} = \alpha$

$[H^+] = C\alpha$

$= C\sqrt{\frac{K_a}{C}}$

$1 >> \alpha$

$\Rightarrow \sqrt{\frac{K_a C^2}{C}}$

$\Rightarrow [H^+] = \sqrt{K_a C}$

$$-\log [H^+] = P_H = -\log (K_a C)^{\frac{1}{2}}$$

$$= -\frac{1}{2} \log (K_a C)$$

$$= -\frac{1}{2} (\log K_a + \log C)$$

$$= \frac{1}{2} (-\log K_a - \log C)$$

$$P_H = \frac{1}{2} [P_{Ka} - \log C]$$

$$P_H = \frac{P_{Ka}}{2} - \frac{1}{2} \log C.$$ P_H * for weak acid.

for WEAK BASE,

$$BOH \rightleftharpoons B^+ + OH^-$$

at $t=0$	C	0	0
$t=t$	$C(1-\alpha)$	$C\alpha$	$C\alpha$

$$K_b = \frac{[B^+][OH^-]}{[BOH]}$$

$$= \frac{C\alpha \cdot C\alpha}{C(1-\alpha)}$$

$$K_b = \frac{C\alpha^2}{(1-\alpha)}$$ Ostwald dilution law $1 \gg \alpha$.

$$K_b = C\alpha^2$$

$$\alpha = \sqrt{\frac{K_b}{C}}$$

$$\Rightarrow [OH^-] = C \cdot \alpha$$

$$= C \times \sqrt{\frac{K_b}{C}}$$

$$= \sqrt{\frac{K_b C^2}{C}}$$

$$[OH^-] = \sqrt{K_b C}$$

$$-\log [OH^-] = -\log [K_b C]^{\frac{1}{2}}$$

$$P_{OH} = -\frac{1}{2} [\log K_b - \log C]$$

$$P_H = 14 - P_{OH}$$

$$= 14 + \frac{1}{2} [\log K_b + \log C]$$

$$= 14 + \frac{1}{2} \log K_b + \frac{1}{2} \log C$$

$$= 14 - \left(-\frac{1}{2} \log K_b + \frac{1}{2} \log C\right)$$

$$P_H = 14 - \frac{P_{Kb}}{2} + \frac{1}{2} \log C.$$

Que. 2 DPP-03 pg=40

$\alpha = ?$ $C = 10^{-2}$ $[OH^-] = 10^{-3}$

$NH_4OH \longrightarrow$ w.B

$NH_4OH \rightleftharpoons OH^- + NH_4^+$

$C(1-\alpha)$ $C\alpha$ $C\alpha$

$[OH^-] = C\alpha = \sqrt{K_b \cdot C}$

$[OH^-] = C\alpha$

$\frac{[OH^-]}{C} = \alpha$

$\frac{10^{-3}}{10^{-2}} = \alpha$ $\alpha = 10^{-1} \times 100\%$

$\alpha = 10\%$.

Que. 3) $C = 10^{-3}$

w.Acid $CH_3COOH \rightleftharpoons H^+ + CH_3COO^-$

$K_a = 10^{-5}$

$[H^+] = \sqrt{K_a \cdot C}$

$[H^+] = \sqrt{10^{-5} \times 10^{-3}}$

$= 10^{-4}$

$-\log[H^+] = PH = -\log 10^{-4}$

$PH = 4$ //

$PH = \frac{1}{2}(-\log K_a - \log C)$

$= -\log 10^{-5} - \log 10^{-3}$

$= \frac{1}{2}(5+3)$

$= 4$

Que. 3) $H_3PO_3 \rightleftharpoons 2H^+ + HPO_3^{-2}$

$C(1-\alpha)$ $2C\alpha$ $C\alpha$

$[H^+] = 2C\alpha$

$PH = -\log(H^+) = -\log(2 \times 10^{-3} \times 10^{-1})$

$\Rightarrow -\log[H^+] = -\log(9 \times 10^{-4})$

$= -\log 2 - \log 10^{-4}$

$\Rightarrow -0.3010 + 4$

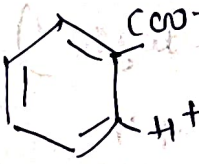
$\Rightarrow 4 - 0.30$

$\Rightarrow 3.7 \approx PH$.

Que. 4) $C = 0.006$

$K_a = 6 \times 10^{-5}$

benzoic acid.



$COO^- + H^+$

$[H^+] = C\alpha = C\sqrt{\frac{K_a}{C}}$

$[H^+] = \sqrt{K_a \cdot C}$.

$= \sqrt{6 \times 10^{-5} \times 0.006}$

$= \sqrt{6 \times 10^{-5} \times 6 \times 10^{-3}}$

$= \sqrt{6 \times 6 \times 10^{-8}}$ $(\sqrt{} = \frac{1}{2})$

$[H^+] = 6 \times 10^{-4}$.

$K_a \times K_b = K_w$

DPP-01 pg-36.

Que.1) $Ba(NO_3)_2 \rightarrow Ba^{+2} + 2NO_3^-$

1 + 2

= 3

Total 3 ions but 0 charge.

Que.2) $[H^+] = \frac{2}{3} \times 10^{-4}$

$P_H = ?$

$P_H = -\log \frac{2}{3} \times 10^{-4}$

$= -(\log 2 - \log 3 + \log 10^{-4})$

$\Rightarrow -0.3010 + 0.477 + 4$

$\Rightarrow +0.17 + 4$

$\Rightarrow P_H = 4.17.$

Que.3) w.A / w.B CH_3COOH

Q.4) $H_2O \rightleftharpoons H^+ + OH^-$

$c(1-\alpha)$ $c\alpha$ $c\alpha$

$\Rightarrow [H^+] = c\alpha$

$\Rightarrow \frac{10^{-7}}{c} = \alpha$

$\frac{10^{-7}}{c55.5} = \alpha$

$\Rightarrow \frac{10^{-7}}{55.5} \times 100\ \%$

$\Rightarrow 1.8 \times 10^{-7}\ \%$ //

$H^+ = 10^{-7}$ in water.

$[H^+] = [OH^-]$

Que.5) $[H^+]$ 1 lit $= 6.02 \times 10^{16}$

1000 ml $= 6.0 \times 10^{16}$

$1 ml = \frac{6.0 \times 10^{16}}{1000}$

$10 ml = \frac{6.0 \times 10^{16}}{1000} \times 10$

$\Rightarrow 6.0 \times 10^{14}$ //

Que.6)

$P_{Kw} = 13.36$ at $50^\circ C$

$P_{Kw} = P_H + P_{OH}$ at $50^\circ C$

$P_H = P_{OH}$

water at any temp. $P_H = P_{OH}$

$P_{Kw} = 2P_H$

$\frac{P_{Kw}}{2} = P_H. = \frac{13.36}{2}$

$\Rightarrow 6.68$ //

Que.7) $P_H = 13$

$P_{OH} = 1$

$[OH^-] = 10^{-1}$

$[H^+] \times [OH] = 10^{-14}$

$[H^+] = \frac{10^{-14}}{10^{-1}} = 10^{-13}$

$[H^+] = 10^{-13}$ //

1 ml

1 lit $= 10^{-13}$

1000 ml $= 10^{-13}$

$1 ml = \frac{10^{-13}}{1000}$ mol

$= 10^{-16}$ mol

$= 10^{-16} \times 6.02 \times 10^{23}$

no. of ions.

no. of ions $= 6.02 \times 10^{7}$ //

Que.8) A = 9.5

B = 8.5

C = 3.5

D = 5.5.

Que·9) $P_{Ka}\downarrow = \uparrow -\log 10$.

* lowest the value of P_{Ka} lowest the value of PH.

$$P_{Ka} \propto P_H$$

* lowest the value of P_{Kb} highest the basicity.

$$P_{Kb} \propto \frac{1}{\text{Basic strength}}$$

Que·10) 3Cl of anion.

$$AB_3 \longrightarrow A^+ + 3B^-$$

Cl 3Cl

Cl (3Cl) //

PPP-02 Pg = 38

Que·1) $HClO_4 + H_2O \rightleftharpoons H_3O^+ + ClO_4^-$

Acid Base Con acid Con base

option = 4) ✓

Que·2) $NH_2^- \longrightarrow NH^{2-}$

Acid Con. base

give H atom. as it is Acid

Que·3) $CH_3COOH + HF \rightleftharpoons CH_3COOH_2^+ + F^-$

Base Acid Con. Acid Con. Base

Que·4) $HPO_3^{-2} \longrightarrow H_2PO_3^-$

base Conj. Acid

Que·5) $O^{-2} + H^+ \longrightarrow OH^-$

Base Con. Acid

Que·6)

$(CH_3)_2 \overset{*}{N}H_2^+ \longrightarrow (CH_3)_2NH$

Acid Conj. Base

Salt (AB) → A^+ + B^-

A^+ Base

B^- Acid.

Acidic
B^-
Acidic Anion.
$HB \rightarrow H^+ + B^-$
anion
acid.

Basic
A^+
Basic cation.
$AOH \rightarrow A^+ + OH^-$
cation
Base

* Acid + Base → salt + H_2O are of four types.

1) SA + SB → salt pH = 7

2) SA + WB → Acidic salt pH < 7

3) WA + SB → basic pH > 7

4) WA + WB → pH = 7 neutral.

1) SA + SB → salt.

eg) HCl + NaOH → NaCl

$NaOH + HNO_3 \rightarrow$ * $NaNO_3$, K_2SO_4, $Ca(PO_4)_2$, Na_2HPO_3

eg.

2) Acidic salt → Acid strong + Base weak

$Zn(OH)_2$, $Mg(OH)_2$, $Fe(OH)_2$, $Bi(OH)_2$

HCl HCl eg.

3) Basic salt

$NaHNO_3$, $NaHSO_4$, NaH_2PO_4, Na_2HPO_4.

4) WA + WB → salt

CH_3COONH_4.

Salts never show ionization it only shows electrolysis.

1) * NaCl + H_2O dehydralysed → Na^+ + Cl^-
cation Base, Anion Acid

$$K_h = Ch^2$$

where h = hydrolysis constant.

2) Ka ↓ weak a° Kb ↓ weak base.

$W_A + S_B \rightarrow CH_3COONa \rightarrow K_a$

$W_B + S_A \rightarrow NH_4Cl \rightarrow K_b$.

$W_A + W_B \rightarrow CH_3COONH_4 \rightarrow K_a \times K_b = K_w$

$K_h = Ch^2$

$h = \sqrt{\frac{K_h}{C}}$

3) $K_h = \frac{K_w}{K_a} = W_A + S_B$

$K_h = \frac{K_w}{K_b} = S_A + W_B$.

4) Salt = $W_B + S_A$ eg: NH_4Cl.

$K_h = Ch^2$

$K_h = \frac{K_w}{K_b}$

$h = \sqrt{\frac{K_w}{K_b \cdot C}}$ $= ch = [H^+]$

$h = [H^+] = ch = ch = hxc = \sqrt{\frac{K_w \cdot C^2}{K_b \cdot C}}$

$= ch = [H^+] = \sqrt{\frac{K_w \cdot C}{K_b}}$

$= -\log [H^+] = pH$

$pH = -\log \left(\frac{K_w \cdot C}{K_b}\right)^{\frac{1}{2}}$

$= \frac{1}{2}(\log K_w + \log K_b - \log C)$

$= pK_w + \log K_b - \log C$

$= 7 + \frac{\log K_b}{2} - \frac{\log C}{2}$

$7 - \frac{1}{2}(-\log K_b) - \frac{1}{2}\log C$.

$pH = 7 - \frac{1}{2} pK_b - \log C \times \frac{1}{2}$

⊖ means pH less than 7.

Summary

1) WA + SB eg:- NH_4Cl

$K_h = Ch^2$ pH = less than 7

$h = \sqrt{\frac{K_w}{K_b \cdot C}} \Rightarrow [H^+] = \sqrt{\frac{K_w \cdot C}{K_b}} \Rightarrow$ **$pH = 7 - \frac{1}{2} pK_b - \frac{1}{2} \log C$**

2) SB + WA. eg:- CH_3COONa pH > 7.

$K_h = Ch^2$

$h = \sqrt{\frac{K_w}{K_a \cdot C}}$

$[OH^-] = \sqrt{\frac{K_w \cdot C}{K_a}}$ **$pH = 7 + \frac{1}{2} pK_a + \frac{1}{2} \log C$**

3) SA + SB

$K_h = Ch^2$

$h = \sqrt{\frac{K_w}{C}}$

$[H^+]/[OH^-] = \sqrt{K_w \cdot C}$ **$pH = 7 \pm \log C$.**

4) WA + WB.

$K_h = Ch^2$

$h = \sqrt{\frac{K_w}{C}}$

$[H^+]/[OH^-] = \sqrt{\frac{K_w}{K_a \times K_b}}$ **$\Rightarrow pH = 7 + \frac{1}{2}(pK_a - pK_b)$**

* The value of $K_w = 10^{-14}$

SPP-05 pg-44.

Que:- 1) Kel

Que:- 3) Anion - hydrolysis
↓
weak acid
1B + WA

Que:- 4) Cation weak
↓
weak base + SA
↓
K_b $7 - \frac{1}{2} pK_b - \frac{1}{2} \log C$.

pg-06

Que:- 1) $NaCN \rightarrow$ S.B + W.A

$[OH] = \sqrt{\frac{K_w \cdot C}{K_a}}$

$= \sqrt{\frac{10^{-14} \times 1}{5 \times 10^{-10}}}$

$\sqrt{2 \times 10^{-4}}$

$\Rightarrow -\log (1 \times 10^{-2})$

* $pOH = 2$

* $pH = 14 - 2$

$= 12$ //

Qu·2) HA + BOH

0·2 0·3

$K_a = 10^{-5}$ $K_b = 10^{-5}$

$$h = \sqrt{\frac{K_w}{K_a \times K_b}} = \sqrt{\frac{10^{-14}}{10^{-5} \times 10^{-5}}}$$

$$h = 10^{-2}$$

Qu·3) $P_{Kb} = wB + sA$.

$wA + sB$

Name

↳ $sB + wA$.

$P_{Ka} + P_{Kb} = P_{Kw}$

$P_{Ka} + 4·7 = 14$

$P_{Ka} = 14 - 4·7 = 9·3$ //

$$P_H = 7 + \frac{1}{2} P_{Ka} + \frac{1}{2} \log c$$

$$= 7 + \frac{1}{2} \times 9·3 + \frac{1}{2} \times \log \frac{0·5}{9·3}$$

$$= 7 + 4·65$$

$P_H = 11·65$..

Qu·5) $h = \sqrt{\frac{K_w}{K_a \cdot c}} = \sqrt{\frac{10^{-14}}{1·4 \times 10^{-9} \times \frac{1}{100}}} = 0·026$ //

* Buffer Solution *

The solution which resist on dilution or with the addition of small amount of adding acid or alkali are called as BUFFER SOLUTION.

→ Properties of Buffer soln

1) The pH of B.S. doesn't change when small amount of S.A or W.A is added.

2) The pH of the soln doesn't depend upon volume. That means the soln can be diluted without changing in pH.

3) The pH of B.S remains constant when we put in long time the concentration of $[H^+]$ & $[OH^-]$

* Types of Buffer Solution.

- Simple B.S. — formed by $W_A + W_B$
- Mixed B.S
  - Acidic B.S
  - Basic B.S.

$$pH = 7 + \frac{pK_a}{2} - \frac{pK_b}{2}$$

eg) CH_3COONH_4

NH_4CN, $AgCN$

→ On the mixing of $[H^+]$ (acid) then H^+ is removed by CH_3COO^- & pH remains constant or can be balanced.

→ CH_3COONH_4 + HCl

CH_3COO^- NH_4^+ ; H^+ Cl^-

CH_3COOH & NH_4Cl

↑ remains constant.

→ When we add some base then the pH of solution ~~when~~ doesn't change due to the removal of OH^- ion by NH_4^+.

$CH_3COONH_4 + NaOH$

↓ ↓

$CH_3COO^- \quad NH_4^+ \quad Na^+ \quad OH^-$

$\not\rightleftharpoons NH_4OH$ //

DPP-08 pg-48

$P_{Ka} + P_{Kb} = P_{Kw}$

$K_a \times K_b = K_w$.

Que.1) 10ml 0.1 acetic acide (Acid)
$P_{Ka} = 5$
10ml 0.1N NH_3 soln

$P_{Kb} = 5$

WA + WB = Simple buffer.

$P_H = 7 + \frac{1}{2}(P_{Ka} - P_{Kb})$

$P_H = 7$.

Que.2) $P_{Ka} = 4.8$

$P_H = 5.8$

$P_H = P_{Ka} + \log \frac{[Salt]}{[Acid]}$

$5.8 = 4.8 + \log \frac{[Salt]}{[Acid]}$.

$\text{anti}\log 1 = \log \frac{[Salt]}{[Acid]}$

$\log 10^1 = \log \frac{(Salt)}{(Acid}$

$Acid/Salt = \frac{1}{10} \Rightarrow 0.1$

Que.3) $P_{OH} = P_{Kb} + \log \frac{[Salt]}{[Base]}$

$\frac{[NH_4Cl]}{[NH_4OH]}$

$8 - 1$

$P_{OH} = 4$

$P_H = 14 - 4$

$P_H = 10$

Que.4) $P_{Ka} = P_H$ $\frac{[Salt]}{[Acid]}$ 1

$\log 1 = 0$

$K_a = 1.8 \times 10^{-5}$

$-\log(1.8 \times 10^{-5})$

$-\log 2 - \log 10^{-5}$

$P_H = 0.3010 + 5 = 4.7$

Que.5) $\frac{x}{5}$ & $\frac{HX}{Acid}$ $\frac{Salt}{Acid} = 1$
Salt

$P_{OH} = P_{Kb}$

$P_{OH} = P_{10^{-10}}$

$P_{OH} = -\log 10^{-10}$

$P_{OH} = 10$

$P_H = 14 - 10 = 4$

Que.6) $P_H = P_{Ka} + \log_{10} \frac{[Salt]}{(Acid)}$
7
5.5

$5.5 = 4.5 + \log 10 \frac{[Salt]}{0.1}$

$10 = \log 10^1 = \log 10 \frac{[Salt]}{0.1}$

$10 = \frac{Salt}{0.1}$

$1M = Salt$.

Que.8) $P_H = 9$

NH_4Cl NH_4OH
↓ ↓
? 1M

$P_{OH} = 5$

$P_{OH} = P_{Kb} + \log \frac{[Salt]}{[Base]}$

$5 = -\log 1.8 \times 10^{-5} + \log \frac{[Salt]}{[Base]}$

$5 = 4.7 + \log \frac{[Salt]}{[Base]}$.

$0.3 = \log \frac{[Salt]}{1}$.

$Salt = 2M$.

*Solubility Product – At constant temp. the maximum no. of moles of solute can be dissolved in a solvent to obtain 1 litre of solution is called SOLUBILITY.

It's unit are mol Lit^{-1}

Solubility product – when a sparingly soluble salt such as AgCl put it to the water a very small amount AgCl is dissolved in H_2O. & most of the salts remains undissolved k/a saturated soln.

At the saturation point, the equilibrium constant for the saturated soln is defined as solubility product its unit are depend the no. of ionizations on the ions.

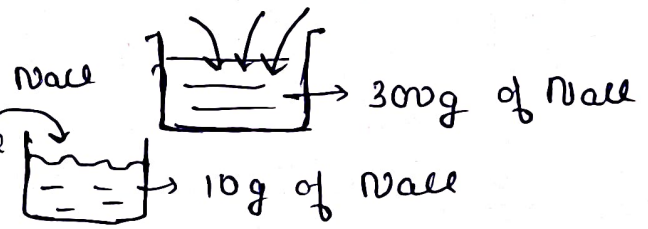
~~Diff-of~~ :-

Solubility Product

Saturated solution.

↓

Solution are of 3 types.

→ Saturated soln ⟶ 

→ Unsaturated soln ⟶

→ Super saturated soln ⟶ percipitation.

eg: $NaCl_{(s)} + H_2O_{(l)} \longrightarrow NaCl_{(aq)}$ saturated.

$$NaCl \rightleftharpoons Na^+ + Cl^-$$

at $t = 0$ $\quad s$

$t = t \quad\quad s \quad\quad s$

solubility product $= K_{sp} = [Na^+][Cl^-]$

$$K_{sp} = s^2$$

∴ in the ⊖ NaCl is not present as it can be back form again eg. H_2O.

eg: $A_2B \rightleftharpoons 2A^+ + B^-$

at $t=0$ $\quad s$

$t=t \quad\quad 2s \quad\quad s$

$$K_{sp} = [2s]^2[s]$$

$$K_{sp} = 4s^3.$$

$AB_2 \rightleftharpoons A^{+2} + 2B^-$ $\quad K_{sp} = s \cdot [2s]^2$

s $\quad$ 2s

$K_{sp} = 4s^2$

AB_3 eg. $AlCl_3$.

$AB_3 \rightleftharpoons A^{+3} + 3B^-$ $\quad K_{sp} = s \cdot (3s)^3$

at $t=0$ s $\quad K_{sp} = 27s^4$

$t=t$ 0 $\quad$ s $\quad$ 3s

$A_2B_3 \rightleftharpoons AlPO_4$

$A_2B_3 \rightleftharpoons 2A^{+3} + 3B^{-2}$ $\quad K_{sp} = (2s)^2 \cdot (3s)^3$

at $t=0$ s $\quad = 4s^2 \times 27s^3$

$t=t$ $\quad$ 2s $\quad$ 3s $\quad K_{sp} = 108 \times s^5$

$= 108 s^5$

$A_xB_y \rightleftharpoons xA^{+y} + yB^{-x}$

at $t=0$ t. $\quad$ xs $\quad$ ys

$K_{sp} = (xs)^x (ys)^y$

$= x^x \cdot s^x \cdot y^y \cdot s^y$

$= x^x y^y (s^{x+y})$

* $NaCl = K_s = 5 \times 10^{-20}$ to find $s = ?$

$NaCl \rightleftharpoons Na^+ + Cl^-$

s $\quad$ s

$K_{sp} = s^2$ $\quad s = \sqrt{K_{sp}}$

$= \sqrt{5 \times 10^{-20}} = \sqrt{5} \times 10^{-10}$

* Concept of Quotient :-

$aA + bB \rightarrow cC + dD$

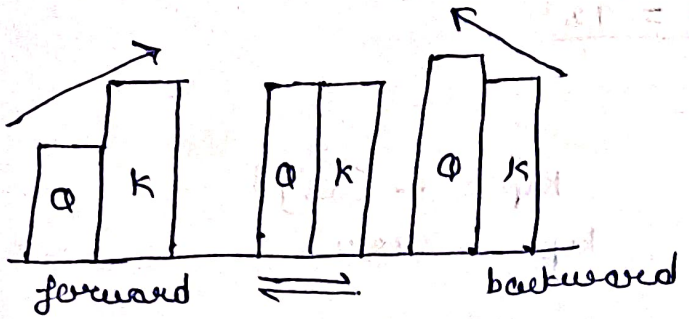
$$Q = \frac{[C]^c [D]^d}{[B]^b [A]^a}$$

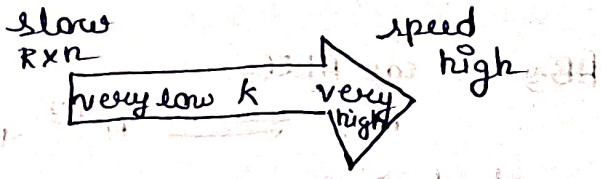
$Q < K$ Rxn forward.

$Q > K$ Rxn backward

$Q = K$ Rxn in Equilibrium.

Application of k





* Common ion Effect - I.P ionic product :-

eg:- NaCl

$NaCl \rightleftharpoons Na^+_{aq} + Cl^-_{aq}$

	s	(s)	
HCl	H^+	Cl^-	← common ion
at t=0	C	0	
t=t	0	(C)	

$K_{sp} = s + (s+C)$

$K_{sp} = s^2 + sC$ *we avoid high power of s as it is very small.

$K_{sp} = sC$

$s = \frac{K_{sp}}{C}$.

$s = 5 \times 10^{-3}$

$s^2 = 25 \times 10^{-6}$

$C = 0.01$

$s^2 + sC$

$\Rightarrow 25 \times 10^{-6} + 5 \times 10^{-3} \times 0.01$

$20.5 \times 10^{-5} + 5 \times 10^{-5}$.

$s = 1 \times 10^{-10}$

$C = 0.01$

$s^2 + Cs$

$10^{-20} + 10^{-12}$

$I_{sp} < K_{sp}$ ppt not possible

$I_{sp} = K_{sp}$ solubility equilibrium

$I_{sp} > K_{sp} \rightarrow$ ppt.

Ques: solubility of CaI_2 is 4×10^{-8} find out the new solubility in the presence of 10^{-2} M $Ca(OH)_2$.

Sol:

$CaI_2 \rightleftharpoons Ca^{+2} + 2I^-$

at $t = t$ (s) 2s

$Ksp = 4s^3$

$Ksp = 4 \times 4 \times 4 \times 4 \times 10^{-24}$

$= 2.56 \times 10^{-22}$.

$Ca(OH)_2 \rightarrow Ca^{+2} + 2(OH)^-$

$t = t$ (C) 2C

(10^{-2}) (2×10^{-2})

new $Ksp = (s + C)(2s)^2$

$= 4s^3 + 4s^2 C$

New

$Ksp = 4s^2 C$

$\frac{Ksp}{4C} = s^2$

$\frac{2.56 \times 10^{-22}}{4 \times 10^{-2}} = s^2$

$\sqrt{0.64 \times 10^{-20}} = s$

$s = 0.8 \times 10^{-10} \Rightarrow 8 \times 10^{-11}$ //

OPP - 10

Que: 1) Any precipitation

$Ksp < Qsp$ (IP)

option - 4 ✓

Que: 2) $\boxed{Ksp = 1.7 \times 10^{-10}}$ is always fixed

* Acc to NCERT Ksp value is always constant Qsp value can vary. *

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

$s \quad 2s$

$[Ca^{+2}] \quad [F^{-2}]^2$

$\Rightarrow 10^{-4} \times (10^{-4})^2$

$Qsp \Rightarrow 10^{-12}$.

$[10^{-2}] [10^{-3}]^2$

$\Rightarrow 10^{-2} \times (10^{-3})^2$

$\Rightarrow Qsp = 10^{-8}$ //