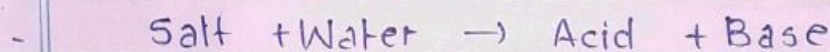


Calculation of pH after mixing weak acid

$$H^+ = \sqrt{(K_{a1} \times C_1) + (K_{a2} \times C_2) + \dots}$$

* SALT HYDROLYSIS

- Hydrolysis is a process where salt reacts with water to form acid and base.



- It is the reverse of Neutralisation Reaction.

* - Only Weak Acid / Weak Base are involved in hydrolysis of salt.

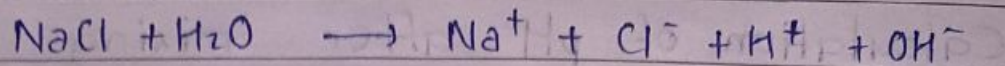
- Nature of aqueous solution of salt depends upon relative strength of acid and base formed.

- On the basis of strength of acid or base there are 4 kinds of salts:

1.) SALT OF STRONG ACID OR BASE

Eg: NaCl, NaNO₃, Na₂SO₄, CuSO₄ etc.

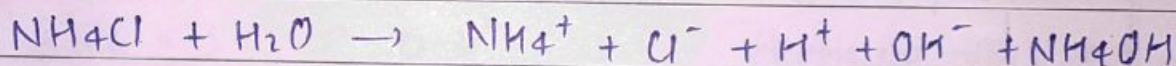
- Does not undergo hydrolysis, they simply result to the 'ion-formation'



- pH of that salt solution = 7 (Neutral)
(SASB) [This is possible when gram equivalent is equal]

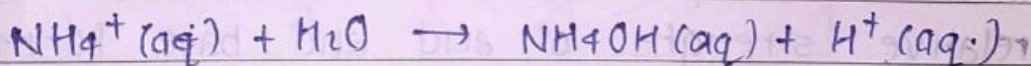
☀️ SALT OF STRONG ACID OR WEAK BASE:

Eg: NH_4Cl , NH_4NO_3 , $(\text{NH}_4)_2\text{SO}_4$ etc.



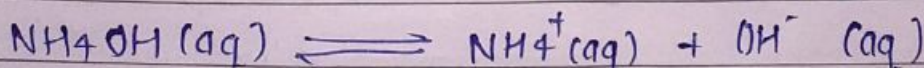
- HYDROLYSIS CONSTANT FOR NH_4^+ (K_h)

In SAWB salt, hydrolysis of NH_4^+ should be carried out. So, this type of hydrolysis also called Cationic Hydrolysis.



$$K_h = \frac{[\text{NH}_4\text{OH}][\text{H}^+]}{[\text{NH}_4^+]} \quad \text{--- (1)}$$

- DISSOCIATION CONSTANT OF WEAK BASE (K_b)



$$K_b = \frac{[\text{NH}_4^+][\text{OH}^-]}{[\text{NH}_4\text{OH}]} \quad \text{--- (2)}$$

* मातापिता - गुरुजनोना आशीर्वाद्यी सर्वत्र सुभी यथाय. *

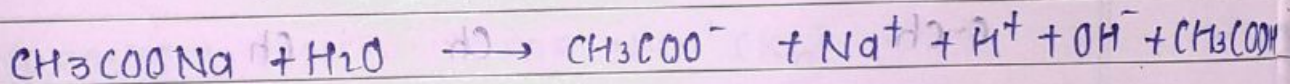
$$pH = \frac{1}{2} pK_w - \frac{1}{2} \log c - \frac{1}{2} pK_b \quad \text{--- (6)}$$

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

Note: Overall pH of S.A.W.B Salt is < 7 (Acidic in Nature)

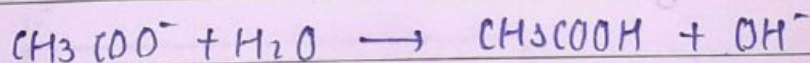
* SALT OF STRONG BASE OR WEAK ACID

Eg: CH_3COONa , $HCOOK$ etc:



HYDROLYSIS CONSTANT (K_h) FOR CH_3COO^-

It is anionic hydrolysis



$$K_h = \frac{[CH_3COOH][OH^-]}{[CH_3COO^-]} \quad \text{--- (1)}$$

DISSOCIATION CONSTANT FOR WEAK ACID



$$K_a = \frac{[CH_3COO^-][H^+]}{[CH_3COOH]} \quad \text{--- (2)}$$

* मातापिता - गुरुजनोना आशीर्वादिथी सर्वत्र सुधी यथाय. *

$$pH = -\log \left(\frac{K_w \times K_a}{c} \right)^{1/2}$$

$$pH = -\frac{1}{2} \log \left(\frac{K_w \times K_a}{c} \right)$$

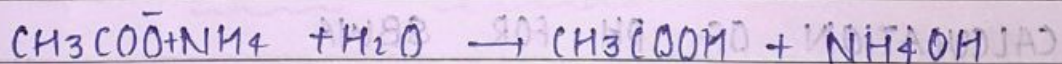
$$pH = -\frac{1}{2} \log K_w - \frac{1}{2} \log K_a + \frac{1}{2} \log c$$

$$pH = \frac{1}{2} pK_w + \frac{1}{2} pK_a + \frac{1}{2} \log c$$

Note: Overall pH of SBWA is more than 7 and it is basic in nature.

☀️ SALT OF WEAK ACID OR WEAK BASE:

Eg: CH_3COONH_4 , $HCOONH_4$ etc.

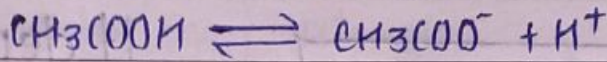


It is also known as Cationic Anionic Hydrolysis or Neutral Hydrolysis.

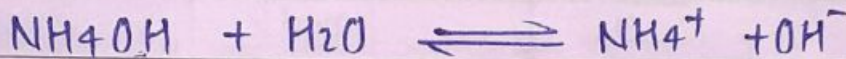
• HYDROLYSIS CONSTANT FOR WAWB:

$$K_h = \frac{[CH_3COOH][NH_4OH]}{[CH_3COO^-][NH_4^+][H_2O]} \quad \text{--- (1)}$$

DISSOCIATION CONSTANT OF WAWB:



$$K_a = \frac{[\text{CH}_3\text{COO}^-][\text{H}^+]}{[\text{CH}_3\text{COOH}]} \quad \text{--- (2)}$$



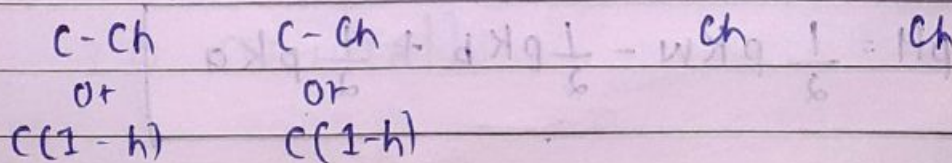
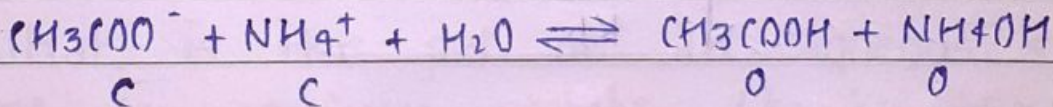
$$K_b = \frac{[\text{NH}_4^+][\text{OH}^-]}{[\text{NH}_4\text{OH}]} \quad \text{--- (3)}$$

• RELATION B/W K_w , K_a , K_b and K_h

After multiplying the equation (1), (2) & (3)

$$K_w = K_a \times K_b \times K_h \quad \text{--- (4)}$$

• CALCULATION OF DEGREE OF HYDROLYSIS



$$K_h = \frac{c^2 h^2}{c^2 (1-h)^2} \quad \text{or} \quad K_h = h^2 \quad \text{or} \quad h = \sqrt{K_h} \quad \text{L(5)}$$

* दुसंगी मित्र - दुश्मन समान छे. *

NOTE Degree of hydrolysis for WAWB salt does not depend on initial concentration of salt.

It depends only on temperature

$$h = \sqrt{\frac{K_w}{K_a \times K_b}} \quad \text{--- (6)}$$

CALCULATION OF pH

From eqn: 02

$$H^+ = \frac{K_a [CH_3COOH]}{[CH_3COO^-]}$$

$$H^+ = K_a \times h$$

$$H^+ = K_a \times h$$

$$h(1-h)$$

Approx = 1

$$H^+ = K_a \sqrt{\frac{K_w}{K_a \times K_b}}$$

$$H^+ = \sqrt{\frac{K_w \times K_a}{K_b}}$$

$$pH = \frac{1}{2} pK_w - \frac{1}{2} pK_b + \frac{1}{2} pK_a$$

SASB: Neutral Salt : (pH = 7)

	K_h	h	H^+	pH
(NH ₄ Cl)	$K_h = ch^2$ $K_h = \frac{K_w}{K_b}$	$h = \sqrt{K_h/c}$ $h = \sqrt{\frac{K_w}{K_b \times c}}$	$H^+ = ch$ $H^+ = \sqrt{\frac{K_w \times c}{K_b}}$	$pH = \frac{1}{2} pK_w - \frac{1}{2} pK_b - \frac{1}{2} \log c$
(CH ₃ COONa)	$K_h = ch^2$ $K_h = \frac{K_w}{K_a}$	$h = \sqrt{\frac{K_w}{K_a \times c}}$	$H^+ = \sqrt{\frac{K_w \times K_a}{c}}$	$pH = \frac{1}{2} pK_w + \frac{1}{2} pK_a + \frac{1}{2} \log c$
(CH ₃ COONH ₄)	$K_h = h^2$	$h = \sqrt{\frac{K_w}{K_a \times K_b}}$	$H^+ = \sqrt{\frac{K_w \times K_a}{K_b}}$	$pH = \frac{1}{2} pK_w - \frac{1}{2} pK_b + \frac{1}{2} pK_a$

Note: In case of WAWB salt,
 if $pK_a > pK_b$: Basic in nature ($K_a < K_b$)
 if $pK_a < pK_b$: Acidic in nature ($K_a > K_b$)
 if $pK_a = pK_b$: Neutral

Que: 9 DPP: 05
 What is the pH of an aqueous solution of Ammonium acetate ($K_a = K_b = 1.8 \times 10^{-5}$)
 7.0 (Neutral)

Que: 12 DPP: 05
 $K_h = 6.25 \times 10^{-8}$
 0.5M ammonium benzoate ($C_6H_5COONH_4$)
 % Hydrolysis of salt = ?
 $K_h = h^2 \Rightarrow h = \sqrt{6.25 \times 10^{-8}} = 0.25 \times 10^{-3}$

Que 13 0.10M NaZ

DPP05

pH = 8.90

Ka of HZ = ?

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

$$pH = 7 + \frac{1}{2} pK_a + \frac{1}{2} \log c$$

$$8.9 = 7 + \frac{pK_a}{2} + \frac{1}{2} (-2)$$

$$8.9 = 7 - 1 + pK_a$$

$$8.9 = \frac{12 + pK_a}{2}$$

$$17.8 = 12 + pK_a$$

$$pK_a = 17.8 - 12.0$$

$$pK_a = 5.8$$

$$pH = 7 + \frac{1}{2} pK_a + \frac{1}{2} \log c$$

$$8.90 = 7 + \frac{1}{2} pK_a + \frac{1}{2} \times \log 10^{-1}$$

$$8.90 = 7 + \frac{1}{2} pK_a - \frac{1}{2}$$

$$8.90 - 7 + 0.5 = \frac{1}{2} pK_a$$

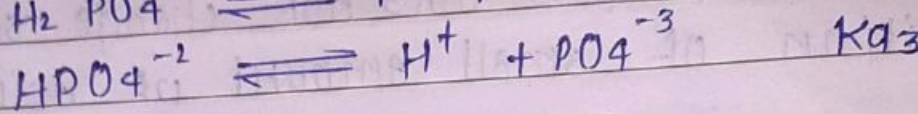
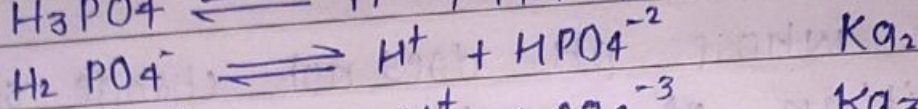
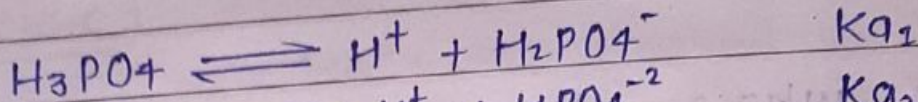
$$2.4 = \frac{1}{2} pK_a$$

$$4.8 = pK_a$$

$$K_a = 1.6 \times 10^{-5}$$

* मातापिता - गुरुजनोना आशीर्वाद्यी सर्वत्र सुभी थवाय. *

Note



$$K_{a1} \gg \gg K_{a2} \gg \gg K_{a3}$$

$$K_a = K_{a1} \times K_{a2} \times K_{a3}$$

Ques 13
DPP04

pH = ?

0.01M H_3PO_4

$[\text{PO}_4^{3-}] = 10^{-5} \text{M}$

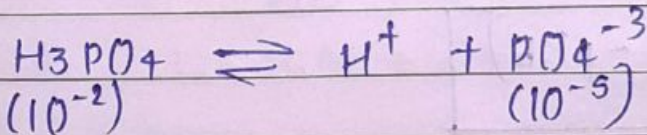
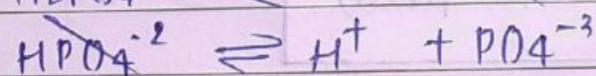
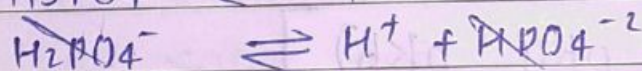
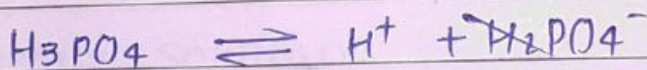
$K_{a1} = 10^{-4}$

$K_{a2} = 10^{-6}$

$K_{a3} = 10^{-8}$

$$K_a = K_{a1} \times K_{a2} \times K_{a3} = 10^{-18}$$

$\text{H}_3\text{PO}_4 =$ Weak acid



$$K_a = \frac{[\text{PO}_4^{3-}][\text{H}^+]}{[\text{H}_3\text{PO}_4]}$$

$$10^{-18} = \frac{(10^{-5})[\text{H}^+]}{(10^{-2})} \Rightarrow \frac{10^{-36}}{10^{-8}} = [\text{H}^+]$$

* કુસંગી મિત્ર - દુશ્મન સમાન છે. *