SALT OF A STRONG ACID AND A STRONG BASE

Such a salt, say NaCl, does not undergo **hydrolysis** as both the ions are not reactive. The solution is thus, neutral in nature.

Hydrolysis of Amphiprotic Anion:

Let us consider hydrolysis of **amphiprotic anion** only, i.e., when counter cation is not hydrolysed, example of some salts of this category are NaHCO₃, NaHS, Na₂HPO₄, NaH₂PO₄.

(i)
$$H_{3}PO_{4} \rightleftharpoons H_{2}PO_{4}^{-+} H^{+}$$
 $K_{\alpha_{1}} = \frac{[H_{2}PO_{4}^{-}][H^{+}]}{[H_{2}PO_{4}]}$
(ii) $H_{2}PO_{4}^{-} \rightleftharpoons HPO_{4}^{2-} + H^{+}$ $K_{\alpha_{2}} = \frac{[HPO_{4}^{2-}][H^{+}]}{[H_{2}PO_{4}^{-}]}$
(iii) $HPO_{4}^{2} \rightleftharpoons PO_{4}^{3-} + H^{+}$ $K_{\alpha_{3}} = \frac{[PO_{4}^{3-}][H^{+}]}{[HPO_{4}^{2-}]}$

Here, $H_2PO_4^{-}$ and HPO_4^{2-} are **amphiprotic anions**. pH after their **hydrolysis** can be calculated as,

pH of $H_2PO_4^-$ in aqueous medium = $(pk_{a1} + pk_{a2})/2$ pH of $H_2PO_4^{2-}$ in aqueous medium = $(pk_{a2} + pk_{a3})/2$

Here, $H_2PO_4^{2-}$ is conjugate base of $H_2PO_4^{-}$ and H_3PO_4 is conjugate acid of $H_2PO_4^{-}$.

Similarly, PO^{3-}_{4i} s conjugate base of HPO^{-2}_{4} and HPO^{-4}_{4i} is conjugate acid of PO^{3-}_{4i} .

(iv) Let us consider **amphiprotic** bicarbonate anion.

$$HCO_{3}^{2-} + H_{2}O \rightleftharpoons CO_{3}^{2-} + H_{3}^{+}O \quad \text{(Ionisation)}$$
Acid Conjugate base
$$HCO_{3}^{-} + H_{2}O \rightleftharpoons H_{2}CO_{3} + OH^{-} \quad \text{(Hydrolysis)}$$
Base Conjugate acid
$$H_{2}CO_{3} \rightleftharpoons H^{+} + HCO_{3}^{-} \quad K_{a_{1}} = \frac{[H^{+}][HCO_{3}^{-}]}{[H_{2}CO_{3}]}$$

$$HCO_{3}^{-} \rightleftharpoons H^{+} + CO_{3}^{2-} \quad K_{a_{2}} = \frac{[H^{+}][CO_{3}^{2-}]}{[HCO_{3}^{-}]}$$

pH HCO⁻₃of ion after **hydrolysis** in aqueous medium

$$= (pk_{a1} + pk_{a2})/2$$

(v) Let us consider the hydrolysis of amphiprotic anion along with cation, e.g., NH_4HCO_3 , NH_4HS .

In above examples both cations and anions are derived from weak base and weak acids respectively hence, both will undergo **hydrolysis** in aqueous medium.

When these salts are dissolved in water, $[H_3O^+]$ concentration can be determined as,

$$[H_3O^+] = \sqrt{k_{a1}[k_w/k_b + k_{a2}]}$$

 $pH = -log = \sqrt{k_{a1}[k_w/k_b + k_{a2}]}$

Hydrolysis at a Glance

Salt	Nature	Degree	Hydrolysis Constant	рН
1. NaCl	Neutral	No Hydrolysis	-	-
(Strong acid + Strong Base)				
2. Ch ₃ COONa (Weak acid + Strong base)	Base	h = √kw/Cka	K _h = kw/ka	pH=1/2[pkw + pka + logC]

3. NH₄CI				
(Strong acid + Weak base)				pH=1/2[pkw- pkb - logC]
	Acidic	$h = \sqrt{kw/Ckb}$	$K_h = kw/Ckb$	
4. CH ₃ COONH ₄ (Weak acid + Weak base)				
	*	h = √kw/(ka + kb)	$K_h = kw/(ka + kb)$	pH=1/2[pkw + pka - pkb]

In the case of salt of weak acid and weak base, nature of medium after **hydrolysis**is decided in the following manner:

- (i) If $K_a = K_b$, the medium will be neutral.
- (ii) If $K_a > K_b$, the medium will be acidic.
- (iii) If $K_a < K_b$, the medium will be basic.

The degree of **hydrolysis** of salts of weak acids and weak bases is unaffected by dilution because there is no concentration term in the expression of degree of**hydrolysis**.

Note : Degree of **hydrolysis** always increases with increase in temperature because at elevated temperature increase in K_w is greater as compared to K_a and K_b .

Source : http://ciseche10.files.wordpress.com/2013/12/ionic-equilibrium.pdf