HYDROLYSIS OF IONS

The anion (-) and/or the cation (+) of some salts react with water to change the 1:1 ratio of H^+ ions and OH^- ions. This reaction is called **HYDROLYSIS**. The net result is a solution which is either acidic or basic.

I) Salts made from strong acids and strong bases

For example the salt NaCl $NaOH_{(aq)} + HCl_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O(l)$

The Na^+ comes from the base NaOH and the Cl^- comes from the acid HCl.

Anions of salts formed by the addition of a strong acid and a strong base will NOT hydrolyze. In the above example the anion is Cl^- and is a **weak conjugate base**, therefore it is too weak a base to pull H^+ ions from H_2O.

Cations of salts formed by the addition of a strong acid and a strong base will NOT hydrolyze. The cation Na^+ is a weak conjugate acid, therefore it is too weak an acid to remove OH^- ions from H_2O. Metallic cations form Group IA or IIA, except Be, do not hydrolyze.

A solution of a salt formed by a strong acid and a strong base will be neutral because:

(Neither the cation or the anion hydrolyzes, .: the solution has a pH of 7)

Because Be^{2+} is such a tiny dense ion it has enough concentration of positive charge to pull OH^- ions from H_2O and leave H^+ ions in a solution. Metallic ions, (e.g. Fe^{+3}, Al^{+3}), from groups other than IA and IIA act in a similar manner, producing acidic solutions.

II) Salts made from the addition of strong acids and weak bases.

For example the salt NH_4Cl $NH_{3(g)} + HCl_{(g)} \longrightarrow NH_4Cl_{(s)}$

The cation NH_4^+ comes from NH_3 which is a weak base and therefore the NH_4^+ must be a relatively strong conjugate acid. The NH_4^+ ion will thus donate a proton to H_2O easily in solution to form H_3O^+ and therefore an acidic solution.

A solution of a salt formed by a strong acid and a weak base will be acidic because of

(Because the cation hydrolyzes to produce H_3O^{+1}, .: pH < 7)

III) Salts made from the addition of weak acids and strong base.

For example the salt: CH_3COONa:

$NaOH_{(aq)} + CH_3COOH_{(aq)} \longrightarrow CH_3COONa_{(aq)} + H_2O_{(l)}$

The anion CH_3COO^- comes from the weak acid CH_3COOH and therefore the anion must be a relatively **strong conjugate base**. The CH_3COO^- ion will pull protons away from water to produce OH^- ions in solution and therefore a basic solution.

A solution of a salt is formed by a weak acid and a strong base will be basic because of hydrolysis of the anion to produce OH-

(The anion hydrolyzes to produce OH^{-1}, .: pH > 7)

IV) Salts of weak acids and weak bases

Both anion and cation hydrolyze, the pH will depend on the extent of the hydrolysis.

Example: NH_4CH_3COO: $K_a = 1.8 \times 10^{-5}$ for CH_3COOH, $K_b = 1.8 \times 10^{-5}$.: pH = 7

Example: NH_4CN: $K_a = 4.0 \times 10^{-10}$ for HCN, $K_b = 1.8 \times 10^{-5}$.: pH = ?

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