KEY

Hydrolysis of Salts

1.) Write the hydrolysis of a salt reaction in water and discern if the solution is acidic, basic, or neutral.

a.) LiBr — $LiBr \rightarrow Li^{+} + Br^{-}$ — neither undergoes hydrolysis as both ions are spectators as they come from strong acids or bases.

b.) K_2CO_3 — $K_2CO_3 \leftrightarrow K^{+} + CO_3^{-2}$ — $CO_3^{-2} + H_2O \leftrightarrow HCO_3 + OH^{-}$

Basic

c.) $Na_2HC_6H_5O_7$ — $Na_2HC_6H_5O_7 \leftrightarrow 2Na^{+} + HC_6H_5O_7^{-2}$ — this is amphiprotic!!!!!

acting as an acid: $HC_6H_5O_7^{-2} + H_2O \rightleftharpoons C_6H_5O_7^{-3} + H_3O^{+}$ — $K_a = 4.1 \times 10^{-7}$

acting as a base: $HC_6H_5O_7^{-2} + H_2O \rightleftharpoons H_2C_6H_5O_7^{-} + OH^{-}$

Which one???

$K_a \times K_b = K_w$ — $7.1 \times 10^{-4} \times K_b = 1.00 \times 10^{-14}$ — $K_b = 1.4 \times 10^{-11}$

$K_a > K_b = K_a$ it acts as an acid!!!

d.) NH_4F — $NH_4F \leftrightarrow NH_4^{+} + F^{-}$ — $F^{-} + H_2O \leftrightarrow HF + OH^{-}$ and $NH_4^{+} + H_2O \leftrightarrow NH_3 + H_3O^{+}$

$K_a = 5.6 \times 10^{-10}$ — $K_a \times K_b = K_w$ — $3.5 \times 10^{-4} \times K_b = 1.00 \times 10^{-14}$ — $K_b = 2.9 \times 10^{-11}$

$K_a(NH_4^{+}) > K_b(F^{-}) = more\ OH^{-}\ made\ than\ H_3O^{+}$ — it acts as an acid!!!

2.) Why are the following two solutions both only **slightly** basic: $0.1\ M\ NaNO_2$ and saturated $Fe(OH)_3$?

$NaNO_2 \leftrightarrow Na^{+} + NO_2^{-}$ — $NO_2^{-} + H_2O \leftrightarrow HCO_2 + OH^{-}$ — weak base = low {OH^{-}]

$Fe(OH)_{3\,(s)} \leftrightarrow Fe^{+3} + 3OH^{-}$ — strong base so complete dissociation BUT $Fe(OH)_3$ is **low solubility**!!!

3.) Arrange the following from highest pH to lowest pH: NH_4Cl, HCl, $NaCH_3COO$, NH_4CH_3COO, NaOH.

$NH_4Cl \leftrightarrow NH_4^{+} + Cl^{-}$ — $NH_4^{+} + H_2O \leftrightarrow NH_3 + H_2O$ — $K_a = 5.6 \times 10^{-10}$ — weak acid

HCl — strong acid

$NaCH_3COO \leftrightarrow Na^{+} + CH_3COO^{-}$ — $CH_3COO^{-} + H_2O \leftrightarrow CH_3COOH + H_3O^{+}$ — weak base

$NH_4CH_3COO \leftrightarrow NH_4^{+} + CH_3COO^{-}$ — $CH_3COO^{-} + H_2O \leftrightarrow CH_3COOH + H_3O^{+}$

and $NH_4^{+} + H_2O \leftrightarrow NH_3 + H_3O^{+}$ — $K_a = 5.6 \times 10^{-10}$

$K_a \times K_b = K_w$ — $1.8 \times 10^{-5} \times K_b = 1.00 \times 10^{-14}$ — $K_b = 5.6 \times 10^{-10}$

$K_a(NH_4^{+}) = K_b(CH_3COO^{-}) = same\ OH^{-}\ made\ as\ H_3O^{+}$ — it acts neutral!!!

NaOH — strong base — Final answer = NaOH, $NaCH_3COO$, NH_4CH_3COO, NH_4Cl, HCl