8.3 Acid-Base Properties of Salt Solutions

- Salts can form solutions with a wide range of pH.
- Even thought the salts do not contain H^+ or OH^- they affect pH by interacting with H_2O. The concentrations are very low but it does affect the pH.
- Hydrolysis: a reaction of and ion with water to produce an acidic or basic solution (hydronium or hydroxide ions).
- E.g. $NaCl \rightarrow Na^+ + Cl^-$ *Neutral pH*

In the presence of H_2O Na^+ would like to form NaOH. However NaOH is a strong base and completely disassociates.

In the presence of H_2O Cl^- would like to form HCl. However HCl is a strong acid and completely disassociates.

- E.g. $Na_2CO_3 \rightarrow 2Na^+ + CO_3^{2-}$ *High pH*

In the presence of H_2O Na^+ would like to form NaOH. However NaOH is a strong base and completely disassociates.

In the presence of H_2O CO_3^{2-} would like to form H_2CO_3. CO_3^{2-} is a conjugate base of an acid and removes H^+ from the solution and raises the pH. $CO_3^{2-} + H_2O \rightarrow OH^- + HCO_3^-$

- E.g. $NH_4Cl \rightarrow NH_4^+ + Cl^-$ *Low pH*

In the presence of H_2O NH_4^+ would like to form NH_3. NH_4^+ is a conjugate acid of a base and releases H^+ into the solution and lowers the pH. $NH_4^+ + H_2O \rightarrow NH_3 + H_3O^+$

In the presence of H_2O Cl^- would like to form HCl. However HCl is a strong acid and completely disassociates.

Salts that form Neutral Solutions

- Cations of strong bases and anions of strong acids do not act appreciably with H_2O and therefore are neutral.

Salts that form Acidic Solutions

- Cations of weak bases act as acids (e.g. NH_4^+)
- Certain metals also act as acids. They are usually small atoms that are highly charged. See Table 3 on p. 582 (e.g. Al^{3+})

Salts that form Basic Solutions

- Anions of weak acids act as bases (e.g. $C_2H_3O_2^-$ *acetate*).

Salts that form Acidic and Basis Solutions

- Need to determine K_a and K_b (remember you can calculate K_b by manipulating the equation $K_aK_b=K_w$).
- E.g. $NH_4CN \rightarrow NH_4^+ + CN^-$

$NH_4^+ + H_2O \rightarrow NH_3 + H_3O^+$
$K_a = 5.8 \times 10^{-10}$

$CN^- + H_2O \rightarrow HCN + OH^-$
$K_b = 1.6 \times 10^{-5}$

$K_b > K_a$ therefore Basic

Hydrolysis of Amphoteric Ions

- Both act as and acid and base.
- E.g. $NaHCO_3 \rightarrow Na^+ + HCO_3^-$

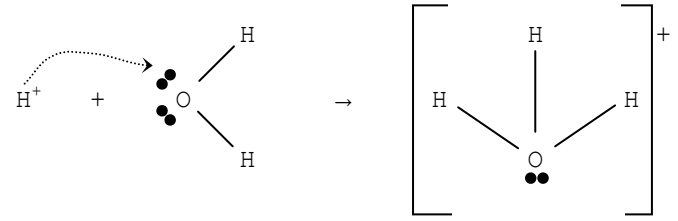
HCO_3^- acts as both an acid and base.
$HCO_3^- + H_2O \rightarrow CO_3^{2-} + H_3O^+$ *acid*
$HCO_3^- + H_2O \rightarrow H_2CO_3 + OH^-$ *base*
Find K_a and K_b
$K_a = 4.7 \times 10^{-11}$ & $K_b = 2.7 \times 10^{-8}$
$K_b > K_a$ therefore basic

In the presence of H_2O Na^+ would like to form NaOH. However NaOH is a strong base and completely disassociates.

Hydrolysis of Metal and Non-Metal Oxides

- metal $oxide_{(s)} + H_2O_{(l)} \rightarrow$ basic $solution_{(aq)}$
- E.g. $CuO_{(s)} + H_2O_{(l)} \rightarrow Cu^{+2}_{(aq)} + 2OH^-_{(aq)}$
- nonmetal $oxide_{(s)} + H_2O_{(l)} \rightarrow$ acidic $solution_{(aq)}$
- E.g. $SO_{2(s)} + 2H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + HSO_3^-{}_{(aq)}$

Lewis Acids and Bases

- Lewis Acid: a compound that is an electron pair acceptor (e.g. H^+)
- Lewis Base: a compound that is an electron pair donor (e.g. OH^-)
- E.g. 

Homework

- Practice 1,2,3,4,5,8,9,10,12
- Questions 1,2,3,4,5