## Types of Equilibrium Reactions and Constants

solubility reaction and solubility product  $(K_{sp})$ 

$$AgCl(s) \rightleftharpoons Ag^{+}(aq) + Cl^{-}(aq)$$
$$K_{sp} = [Ag^{+}][Cl^{-}] = 1.8 \times 10^{-10}$$

acid dissociation reaction and acid dissociation constant  $(K_a)$ 

$$CH_3COOH(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + CH_3COO^-(aq)$$

$$K_a = \frac{[H_3O^+][CH_3COO^-]}{[CH_3COOH]} = 1.8 \times 10^{-5}$$

base dissociation reaction and base dissociation constant  $(K_b)$ 

$$NH_3(aq) + H_2O(l) \rightleftharpoons OH^-(aq) + NH_4^+(aq)$$

$$K_b = \frac{[OH^-][NH_4^+]}{NH_3} = 1.8 \times 10^{-5}$$

water dissocation reaction and water's dissociation constant  $(K_w)$ 

$$2H_2O(l) \rightleftharpoons H_3O^+(aq) + OH^-(aq)$$
  
 $K_w = [H_3O^+][OH^-] = 1.00 \times 10^{-14}$ 

complex formation reaction and step-wise formation constant  $(K_i)$ 

$$Ag^{+}(aq) + NH_{3}(aq) \rightleftharpoons Ag(NH_{3})^{+}(aq)$$

$$K_{1} = \frac{[Ag(NH_{3})^{+}]}{[Ag^{+}][NH_{3}]} = 2040$$

$$Ag(NH_3)^+(aq) + NH_3(aq) \rightleftharpoons Ag(NH_3)_2^+(aq)$$
 
$$K_2 = \frac{[Ag(NH_3)_2^+]}{[Ag(NH_3)^+][NH_3]} = 8130$$

complex formation reaction and overall formation constant  $(\beta_i)$ 

$$Ag^{+}(aq) + 2NH_{3}(aq) \rightleftharpoons Ag(NH_{3})_{2}^{+}(aq)$$
$$\beta_{2} = \frac{[Ag(NH_{3})_{2}^{+}]}{[Ag^{+}][NH_{3}]^{2}} = K_{1} \times K_{2} = 1.66 \times 10^{7}$$