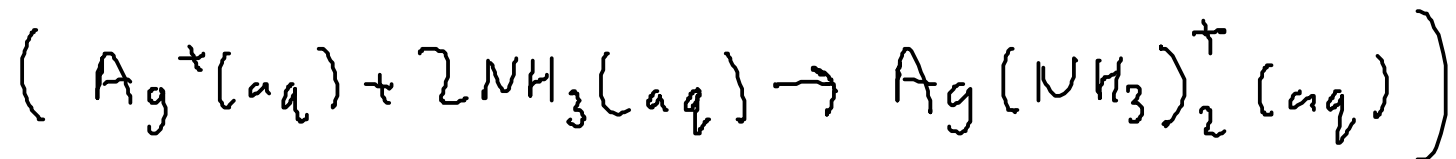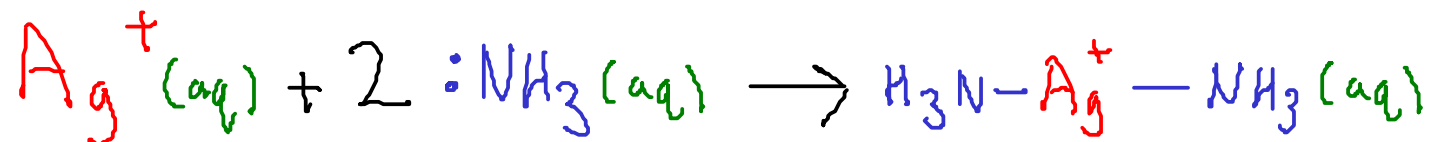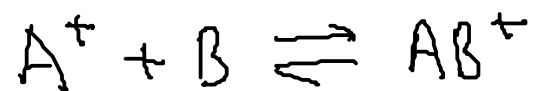# COMPLEX IONS

- are ions that result from the reaction of a Lewis base (like water, ammonia, hydroxide ion, etc.) with a metal ion

- The Lewis base attaches to the metal ion by forming a COORDINATE COVALENT BOND with the metal ion.
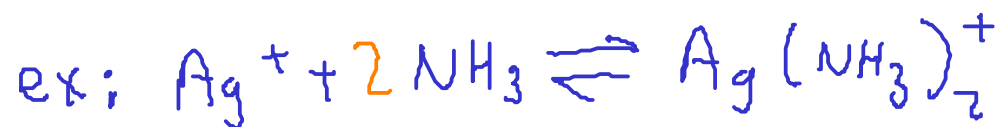
$$Ag^+ (aq) + 2 :NH_3 (aq) \longrightarrow H_3N-Ag^+ - NH_3 (aq)$$

$$\left(Ag^+ (aq) + 2NH_3 (aq) \rightarrow Ag(NH_3)_2^+ (aq) \right)$$

- The product of the reaction is called a "COMPLEX", and the attached Lewis bases are called "LIGANDS"

COMPLEX ION EQUILIBRIUM

- Described by the FORMATION CONSTANT, Kf

$$A^+ + B \rightleftharpoons AB^+$$

$$K_f = \frac{[AB^+]}{[A^+][B]}$$

ex; $Ag^+ + 2NH_3 \rightleftharpoons Ag(NH_3)_2^+$
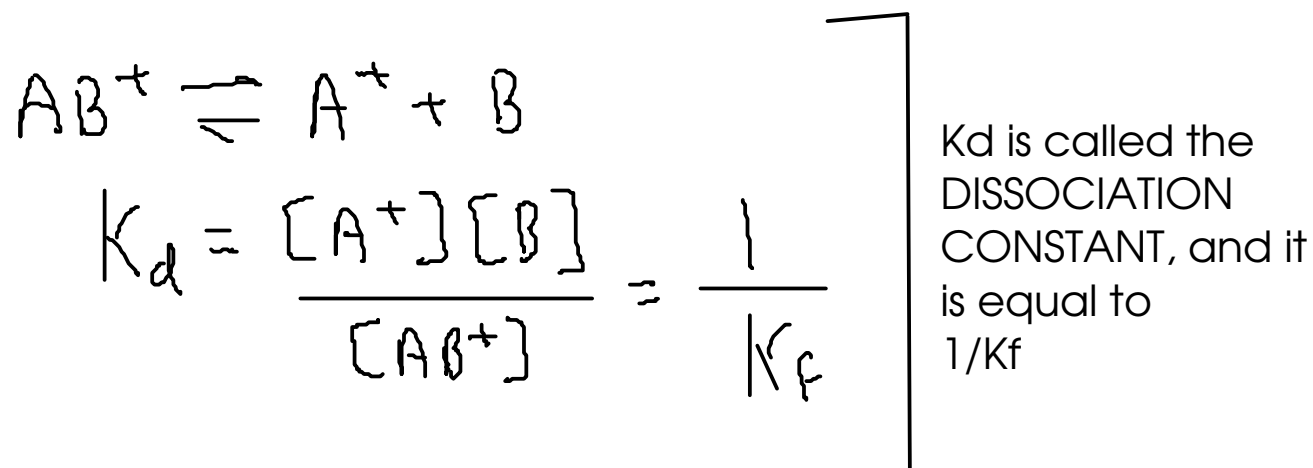
$$K_f = \frac{[Ag(NH_3)_2^+]}{[Ag^+][NH_3]^2} = 1.7 \times 10^7$$

What does this value for the equilibrium constant say about the favorability of the formation of the complex ion?
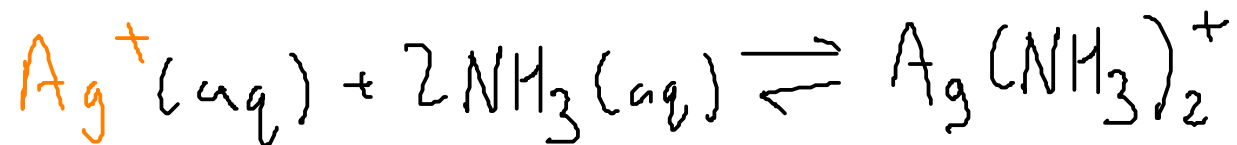
Since the formation of these complex ions is so favorable, we often assume that these reactions go to completion, and instead look at the small amount of complex ion that DISSOCIATES!

$$AB^+ \rightleftharpoons A^+ + B$$

$$K_d = \frac{[A^+][B]}{[AB^+]} = \frac{1}{K_f}$$

Kd is called the DISSOCIATION CONSTANT, and it is equal to 1/Kf

ex: $Ag(NH_3)_2^+ \rightleftharpoons Ag^+ + 2NH_3$

$$K_d = \frac{[Ag^+][NH_3]^2}{[Ag(NH_3)_2^+]} = \frac{1}{1.7 \times 10^7} = 5.9 \times 10^{-8}$$

COMPLEX IONS AND SOLUBILITY

- What is the effect of complex formation on solubility?

$$AgCl \; (s) \rightleftharpoons Ag^+ \; (aq) + Cl^- \; (aq)$$

$$Ag^+ \; (aq) + 2NH_3 \; (aq) \rightleftharpoons Ag(NH_3)_2^+$$

What will the presence of ammonia do to the solubility of silver chloride?

(1) Since the formation of the silver-ammonia complex is favorable, we expect that any dissolved silver ion would react with ammonia to make the complex.

(2) This will REDUCE the concentration of free silver ion.

(3) The reduction of free silver ion will cause more silver chloride to dissolve (Le Chateleir's principle - the equilibrium will try to produce more free silver ion to replace what the ammonia has removed)

So, the presence of a ligand which can form a complex with an ion from a salt will greatly INCREASE the solubility of that salt!