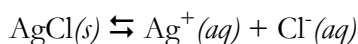


Types of chemical reactions and their equilibrium constants

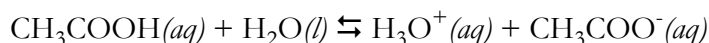
Solubility/precipitation – always described by solubility reaction



with the equilibrium constant called the solubility product

$$K_{\text{sp}} = [\text{Ag}^+][\text{Cl}^-] = 1.8 \times 10^{-10}$$

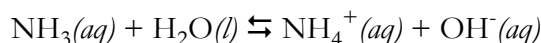
Acid/base – described by either the reaction of the acid with water



with the equilibrium constant called the acid dissociation constant

$$K_a = \frac{[\text{H}_3\text{O}^+][\text{CH}_3\text{COO}^-]}{[\text{CH}_3\text{COOH}]} = 1.8 \times 10^{-5}$$

or by the reaction of the base with water



which gives the base dissociation constant

$$K_b = \frac{[\text{NH}_4^+][\text{OH}^-]}{[\text{NH}_3]} = 1.8 \times 10^{-5}$$

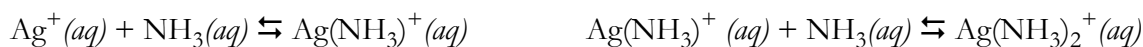
A special case is that of water reacting with itself in a proton-transfer reaction



which is characterized by water's dissociation constant

$$K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 1.00 \times 10^{-14}$$

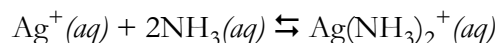
Complex formation/dissociation – usually described by the formation reaction in either a step-wise fashion in which ligands bind to the metal one-by-one



with corresponding step-wise formation constants

$$K_1 = \frac{[\text{Ag}(\text{NH}_3)^+]}{[\text{Ag}^+][\text{NH}_3]} = 2040 \quad K_2 = \frac{[\text{Ag}(\text{NH}_3)_2^+]}{[\text{Ag}(\text{NH}_3)^+][\text{NH}_3]} = 8130$$

or as an overall formation constant in which the ligands bind simultaneously



with a corresponding overall formation constant

$$\beta_2 = \frac{[\text{Ag}(\text{NH}_3)_2^+]}{[\text{Ag}^+][\text{NH}_3]^2} = K_1 \times K_2 = 1.66 \times 10^7$$