Chapter 17 Equilibrium: The Extent of Chemical Reactions

Chemical equilibrium is introduced in this chapter. Much of this is straightforward application of equations and principles and the dynamic status at equilibrium. Equilibrium is a major concept in the AP curriculum and is tested yearly in both the multiple-choice and free-response sections of the AP Exam. Question one in the free-response section is currently dedicated to equilibrium concepts.

The chapter first emphasizes writing equilibrium constant expressions: *Kc* and *Kp*, and conversions between them. However, writing an expression does not mean the reaction is "at equilibrium." Only when numerical values are inserted and the ratio is identical to the equilibrium constant do we know the system is at equilibrium. Otherwise, the expression gives the equilibrium quotient *Q*. The equilibrium expression is a mass-action ratio where the products raised to the power of their stoichiometric coefficients is divided by the reactants raised to their coefficients. The reverse reaction expression would be the inverse. If the value of *K* is greater than one, the products value must be larger than the reactants value in the denominator so at equilibrium much reaction has occurred. If *K* is less than one, the products must be less than the reactants and at equilibrium not much forward reaction has occurred. When a reaction happens in several steps, each step has a *K* value. Multiplying the *K* values together will give the overall *K*.

Le Châtelier's principle will help qualitatively to determine what will happen when stress is put on a system. Changes in any concentration will disturb the equilibrium and cause a shift but changing concentrations does not change the equilibrium constant. The ONLY change that can affect a value of *K* is temperature. *K* values are temperature dependent, since forward and reverse reactions have different ΔH values and are affected differently by a change in temperature. Using Le Châtelier's idea, an increase will cause a shift away from the stress; an increase of temperature in an endothermic reaction will cause a shift to the right, increasing the product concentrations and the value of *K*. Increasing the temperature in an exothermic reaction will cause a shift to the left, increasing the reactant concentrations and decreasing the value of *K*. Catalysts do not affect equilibriums but they do affect how fast a chemical reaction reaches equilibrium.