# Kinetics and Equilibrium

**Unit:** Kinetics

### Knowledge/Understanding:

* relate the rate of reaction to the equilibrium constant and the activation energy of the reaction

chemical equilibrium: when a chemical reaction in the forward direction is happening at the same rate as the chemical reaction in the reverse direction; when the overall concentrations or partial pressures of chemicals in a reaction are not changing.

equilibrium constant (K): a number that relates the forward and reverse rates of reaction. If K = 1, the forward and reverse rates are equal. If K > 1, then the forward reaction is faster than the reverse reaction. If K < 1, then the reverse reaction is faster.

## Kinetics and the Equilibrium Constant

Consider the following reaction:

N2 (g) + 3 H2 (g)  2 NH3 (g)

The rate laws for the forward and reverse reactions are:

forward: Rf = *k*f [N2] [H2]3

reverse: Rr = *k*r [NH3]2

At equilibrium, Rf = Rr, which means:

*k*f [N2] [H2]3 = *k*r [NH3]2.

Using algebra, we can get the rate constants on one side of the equation and the concentration terms on the other:



Notice that this is exactly identical with the equilibrium expression:



Therefore, 

In general, for a reaction:

aA + bB → cC +dD

=

 [C]c + [D]d

 [A]a + [B]b