Chemical Equilibrium

1. What is the implication of the following reaction arrows?

   a. →
   The reaction runs to completion.

   b. ⇌
   The reaction reaches equilibrium.

2. In general, reactions go to equilibrium.

3. What is equilibrium?

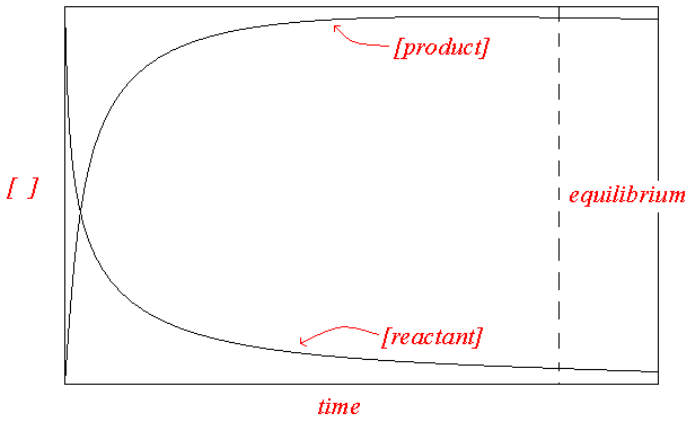
   Equilibrium is the point in a reaction where the rate of the forward reaction equals the rate of the reverse reaction.

   i.e.

   A+B → C+D = C +D → A +B

   The rate at which A and B form C and D equals the rate at which C and D form A and B.

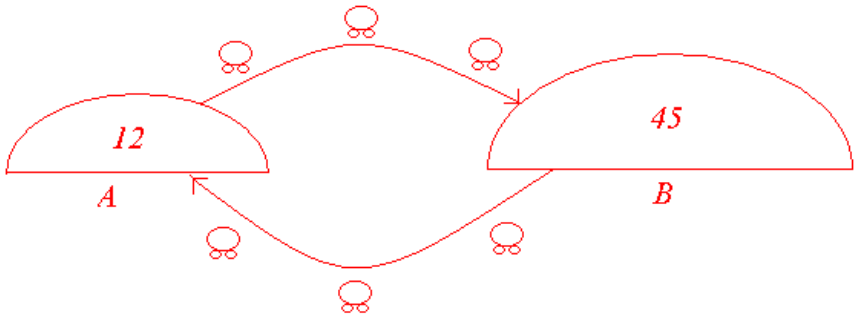
4. Why does equilibrium occur?



Initially there is only reactant in the reaction vessel – therefore

the reaction can only proceed in the forward direction. After some time the concentration of the products increases to an amount that ups the probability that product will be able to find each other and reactant in the reverse direction. A point is achieved at which the formation of reactant equals the formation of product – this is equilibrium.

Another way to understand this is to consider two islands connected by two bridges. One bridge is for the entering cars and the other is for the exiting cars…



12 and 45 represent the population totals. If you notice there are 3 cars going from A → B and three cars going from B→ A. These islands have come to a point where, although there is still movement between them, the population counts remain unchanged.

5. It is important to remember that equilibrium is

   a. Macroscopically static.
      From a large view it looks like the reaction is done and nothing is changing. (i.e. the populations above never shifted from 12 and 45)

   b. Microscopically dynamic.
      There is, in reality, constant change happening. (i.e. the cars are still moving between islands – they haven't stopped though the population counts remain the same)

6. How is the equilibrium point described?

Every reaction has an equilibrium point that it achieves. Some heavily favor products, other heavily favor reacts and still others remain somewhere in the middle.

The equilibrium point always occurs at the same ratio of product to reactant at a given temperature. This constant is called the equilibrium constant, K. The numerical value of K describes the equilibrium point.