March 30 2005  Kinetics

Today we are going to begin the last section of the course. Up until now we have been primarily concerned with issues of energy – how much is required or released during a reaction to reach the point of lowest energy (equilibrium)? What does the distribution of products and reactants look like at equilibrium? How are those free energy changes and equilibrium distributions affected by the starting concentrations?

Now we are going to switch our focus to thinking not just about the end point but rather about how long it will take for the reaction to reach the end point. This is the subject of kinetics, of motion through time.

There are two important reasons why scientists study kinetics.

First because we care about how long it takes for a reaction to finish. Do you have time to go for a swim before it is done or will it take several centuries? Are products going to pile up so fast that you’ll have to shovel them away or will you have still have a mixture of reactants and products after a day that will need to be separated?

Second, because we can extract information from the study of kinetics that gives us insight into how, at a molecular level, molecules react to form products.

Chemical reactions can span a wide range of speeds. Some reactions take place essentially instantly. Molecules diffuse in solution at the rate of approximately 1 angstrom per nanosecond on average at room temperature so we can think about reactions that are limited only by the rate at which they can bump into each other as taking place a billion ($1^9$) times per second. On the other extreme there are reactions that take millions of years to reach equilibrium.

Today we are going to go over the key definitions we need to know to do work with kinetics as well as the mathematical equations that we will need to be able to determine given relevant experimental data. These mathematical equations, once determined experimentally, will enable us to predict how many reactants and products will be present in a solution at a given time $t$ after the reaction has started.

On Monday we’ll work through some problems that use these equations and definitions.

On Wednesday, we’ll understand how data on rates of reactions allows us to say important things about how – at a molecular level – reactants become products.

On Wednesday and Friday we’ll work through problems that use this knowledge.

On Tuesday at 8 am we’ll have a review in this room from 8-9:30.
Definitions:

Rate of reaction:

Rate law:

Rate constant:

Examples:

A. non-chemical example
B. chemical example