1. Consider the following reaction:

$$A \rightleftarrows^{k+}_{k-} B$$

What is the probability that:

   (a) A molecule of A becomes B over a short time step Δt?

   (b) A molecule of A remains A over the time step?

   (c) A molecule of B becomes A over the time step?

   (d) A molecule of B remains B over the time step?

2. Construct an excel spreadsheet that lets you calculate a single "move" for the equations above. However you set it up, make sure that you can easily change: $A(t)$, $B(t)$, k_+, k_- and Δt.

3. Start with $[A] = 100$ and $[B] = 0$, $k_+ = 100\ s^{-1}$ and $k_- = 100\ s^{-1}$. Try values of Δt from 0 to very large.

   (a) What happens to $A(t + \Delta t)$ and $B(t + \Delta t)$ as a function of Δt?

   (b) Can you understand what is going on for large Δt?

   (c) What is a "resonable" value of Δt for your analysis? Can you come up with a rule-of-thumb for a useful Δt?

4. Choose a "reasonable" value for Δt from your analysis above.

   (a) What happens to the concentration of A and B?

   (b) Does this make sense, chemically?

   (c) What is the value of $A(t) + B(t)$ and $A(t + \Delta t) + B(t + \Delta t)$?

   (d) What physical property of the reaction does this capture?

5. Use $A(t + \Delta t)$ and $B(t + \Delta t)$ as *inputs* to the equations.

   (a) What happens to the concentrations of A and B?

   (b) What is the sum of the concentrations of A and B?

6. Run the equations 15 times, taking the output each time as the input for the next step. Save your values for $[A]$ and $[B]$ at each step. Make a graph of these against step. What do you observe?

7. What happens if you set $k_- = 10\ s^{-1}$? Does this match what you would expect chemically?

8. Bonus 1: Write these equations in *matrix* form.

9. Bonus 2: Write a matrix describing

$$A \rightleftarrows B \rightarrow C$$