PART II: DUE FRIDAY, MARCH 2nd, turn in in groups of 3-5.
In Chapter 9 we will discuss Newton's law of cooling which says that the rate of change of a temperature of an object is proportional to the difference between the temperature of the object and the surrounding temperature. If $T(t)$ is the temperature of the object at time t and T_s is the room temperature, then Newton's law says that

$$\frac{dT}{dt} = k(T - T_s),$$

for some constant k (a cooling constant dependent on the container).
In this project, I'm going to have you do some experiments with Newton's law and to compare the effectiveness of various coffee mugs. For this part, I want you to work in groups of 3, 4 or 5 (I'd actually prefer groups of 5). Each of you will do the first 3 parts separately, then you will work together in the last part.

Staple the individual work for each experiment together and put the group summary on the first page. I expect the packet will be about 6 pages; 1 summary and 5 individual experiments.

UNITS NOTE: Use degrees Fahrenheit for temperature, and for time do two calculations, one using hours and the other using minutes.

1. Find a coffee mug or other container that can hold hot liquid and get/borrow/check-out an accurate thermometer. Then do the following experiment:

   (a) Fill the container with hot liquid. Measure the initial temperature of the liquid and measure the room temperature.

   (b) Wait 15 minutes and measure the temperature of the liquid again.

   (c) Wait another 15 minutes (30 minutes since you started) and measure the temperature again.

   Give me a short paragraph, or picture, that describes your container, particulars of your experiment (lid on or lid off), and summarize your measurments in a table.

2. Using your measurements as initial values, solve the differential equation $\frac{dT}{dt} = k(T - T_s)$ finding all constants. You really only needed two measurement for this, but I want you do use the first two and find the constants, then use the first and third and find the constants, then average your results. (Remember to do it in minutes and in hours)

3. Solve for how long it will take for the temperature to get cooled half way to room temperature. That is, when will $T(t) = \frac{1}{2}(T_0 - T_s)$? (This is the 'half-life' in some sense).

4. Now come together as a group. Summarize the results of your experiments in a table that gives all the values of k and the 'half-life' for each of your cups. Compute the average value for the k across all your experiments. Who had the best and worst cups?