1. The temperature of our classroom is set to always be exactly 70°. The water inside my water bottle is currently 40°. I accidentally leave my water bottle in this room for a long time. We want to think about how the temperature of the water changes over time. *(problem 2 on the back page may be helpful)*

(a) Sketch a plot with time on the horizontal axis and water temperature on the vertical axis (label as appropriate).

(b) What if instead of cold water, I had filled my bottle with hot chocolate at a temperature of 120°. Sketch the plot for the temperature of the hot chocolate.

(c) Imagine that instead of using this water bottle, I had a cheap thin plastic water bottle. Like in Problem 1, I filled the bottle with 40° water. Sketch the plot for the water temperature in this bottle.
2. Let $x(t)$ be the temperature of the liquid at time $t$.

(a) Find $x(0)$ in each of the three previous examples. (this is called the initial condition)

(b) Find $\lim_{t\to\infty} x(t)$ in each of the three previous examples

3. Let’s try and write down a differential equation for the change in temperature. $\frac{dx}{dt} =$?

(a) Does the rate at which the water changes temperature depend on the current temperature of the water?

(b) Does the rate at which the water changes temperature depend on how much time has elapsed? (say after a few hours the water warmed to 50°, at that moment I brought in an IDENTICAL water bottle with water at 50°. Would the water in these two change at the same or different rates?)

(c) What has to be true for the water in the bottle not to be changing temperature? (i.e. $\frac{dx}{dt} = 0$)

(d) Using (a) and (b), should we see an $x$ on the right side of the differential equation? a $t$? What other quantities are important? How are the differential equation for my bottle and the cheap plastic bottle similar, yet different?