Cooling Water with Logger Lite [1]

Introduction:

Did you ever drink something that was too hot? Perhaps you waited some time for it to cool. How long did it take? In this experiment we will examine how hot water cools over time. You will use mathematics to describe how the water cools over time and you will be able to use this model to make more accurate predictions about how long it will take for your drink to cool.

Data Collection:

(1) Plug the Temperature probe into the USB port of the computer using Logger Lite.
(2) Place some hot water in a cup and place the temperature probe in the water. Ideally, the probe should not rest on the bottom of the cup.
(3) Wait about 15 seconds for the sensor to read the temperature of the water. Then press Collect.
(4) Collect the temperature of the hot water for about 20 minutes.
(5) Choose Export As from the File menu. Export the data as a csv file.
(6) Open the file in Fathom.
(7) Create a Case Table and Graph of Temperature versus Time.

Questions:

Q1. Describe the relationship of temperature versus time.

Q2. What was the temperature of the water when you started collecting data.

Q3. Describe how the temperature of the water was changing between each set of successive data points. Is the temperature changing at a constant rate? Explain.

Q4. In the case table compute ratios of the differences by entering Next (Temp)/Temp as a formula.

Q5. Newton's Law of Cooling can be described using the following equation:

$T = T_0 e^{-kt} + T_{room}$

Where T is the current temperature, T_0 is the initial temperature of the water, k is a constant, t is time, and T_{room} is the temperature of the room.

[1] http://www.vernier.com/files/sample_labs/PWV-30-COMP-newtons_law_cooling.pdf

Q6. Bring down sliders for T_0, k, and T_{room}.

Q7. Plot the equation given in Q5 in the graph and use the sliders to adjust the values of T_0, k, and T_{room}. Record the mathematical model.

Q7. Use the mathematical model to predict the temperature of the water when time is 600 seconds. Compare the predicted value to the actual value. Are they the same or different? Why?

Q8. Use your model to predict how much time it will take for the water to reach 1° C above room temperature.

Q9. If the original temperature of the hot water is reduced by half, will it take half as long to reach 1° C above room temperature?

Q10. What could you do to with the experiment to change the value of k?