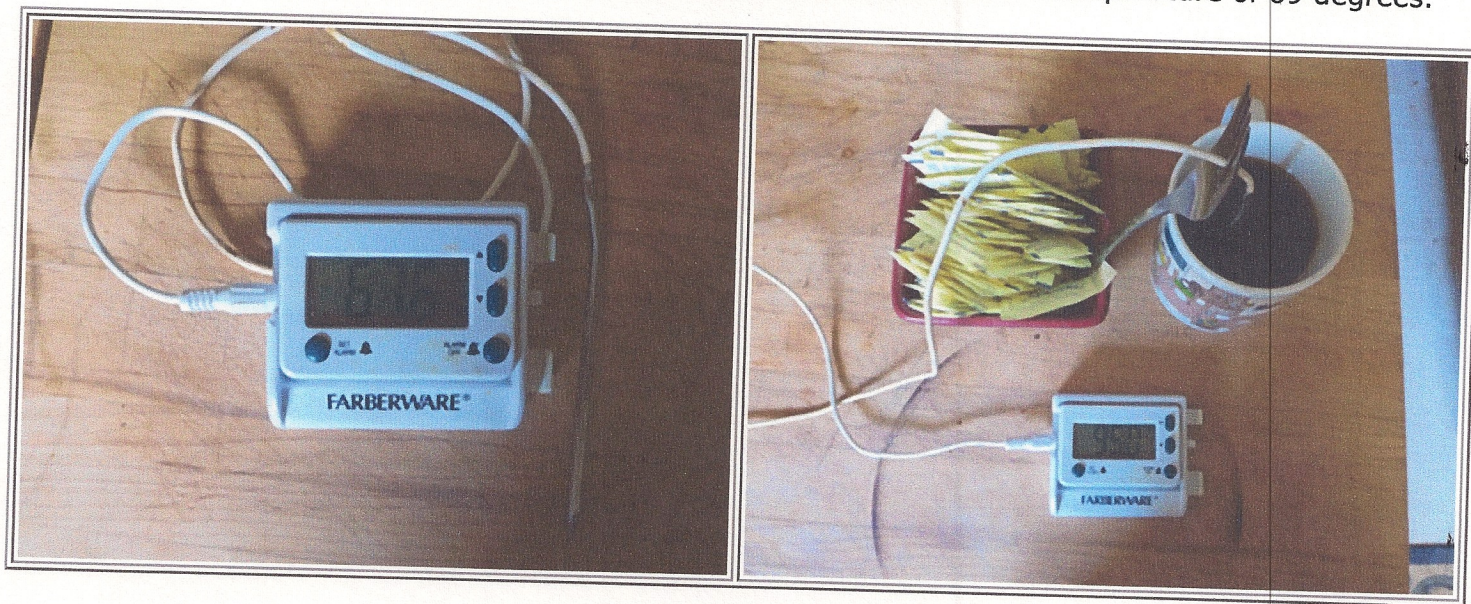


Nonlinear Model Project - Parameters					
Student Number	Last Name	First Name	Quadratic Model		Exponential Model
			Input Time of Day (hour)	Target Outdoor Temperature	Input Elapsed Time (minutes)
1					
8			10.0	3.5	48
					87

Exponential Regression (ER)

Data: A cup of hot coffee was placed in a room maintained at a constant temperature of 69 degrees.



The temperature of the coffee was recorded periodically, and the following table was compiled.

Table 1:

Time Elapsed (minutes)	Coffee Temperature (degrees F.)
x	T
0	166.0
10	140.5
20	125.2
30	110.3
40	104.5
50	98.4
60	93.9

REMARKS: Common sense tells us that the coffee will be cooling off and its temperature will decrease and approach the ambient temperature of the room, 69 degrees.

So, the temperature difference between the coffee temperature and the room temperature will decrease to 0.

We will be fitting the data to an exponential curve of the form $y = A e^{-bx}$. Notice that as x gets large, y will get closer and closer to 0, which is what the temperature difference will do.

So, we want to analyze the data where x = time elapsed and $y = T - 69$, the temperature *difference* between the coffee temperature and the room temperature.

Table 2

Time Elapsed (minutes)	Temperature Difference (degrees F.)
x	y
0	97.0
10	71.5
20	56.2
30	41.3
40	35.5
50	29.4
60	24.9

Tasks for Exponential Regression Model (ER)

(ER-1) Plot the points (x, y) in the second table (Table 2) to obtain a **scatterplot**. Note that the trend is definitely non-linear. Use an appropriate scale on the horizontal and vertical axes and be sure to label carefully.

(ER-2) Find the **exponential function of best fit** and **graph** it on the scatterplot. State the **formula** for the exponential function. It should have the form $y = A e^{-bx}$ where software has provided you with the numerical values for A and b .

(ER-3) Find and state the value of r^2 , the coefficient of determination. Discuss your findings. (r^2 is calculated using a different formula than for linear regression. However, just as in the linear case, the closer r^2 is to 1, the better the fit.) Is an exponential curve a good curve to fit to this data?

(ER-4) Use the exponential function to make a **coffee temperature estimate**. Each class member will compute a temperature estimate for a different elapsed time x assigned by your instructor. Substitute your x value into your exponential function to get y , the corresponding temperature difference between the coffee temperature and the room temperature. Since $y = T - 69$, we have coffee temperature $T = y + 69$. Take your y estimate and add 69 degrees to get the coffee temperature estimate. State your results clearly -- the elapsed time and the corresponding estimate of the coffee temperature.

(ER-5) Use the exponential function together with algebra to **estimate the elapsed time when the coffee arrived at a particular target temperature**. Report the elapsed time to the nearest tenth of a minute. Each class member will work with a different target coffee temperature T assigned by your instructor.

Given your target temperature T , then $y = T - 69$ is your target temperature *difference* between the coffee and room temperatures. Use your exponential model $y = A e^{-bx}$. Substitute your target temperature difference for y and solve the equation $y = A e^{-bx}$ for elapsed time x . **Show algebraic work** in solving your equation. State your results clearly -- your target temperature and the estimated elapsed time, to the

nearest tenth of a minute.

For instance, if the target coffee temperature $T = 150$ degrees, then $y = 150 - 69 = 81$ degrees is the temperature *difference* between the coffee and the room, what we are calling y . So, for this particular target coffee temperature of 150 degrees, the goal is finding how long it took for the temperature difference y to arrive at 81 degrees; that is, solving the equation $81 = A e^{-bx}$ for x .

Please see the **Technology Tips** topic for additional information about generating the scatterplot and exponential function.