Name _____

Date _____

Investigation: Exponential Models and Logarithmic Scales

In this investigation you will explore two models for the growth of a population of bacteria. One model will be based on the collected data; the other will be a linear model from the same data, modified slightly.

Outcomes:

- Create an exponential model for growth data
- Modify data using logarithms
- Create a linear model for modified data
- Apply a logarithmic scale to exponential data

PROCEDURE:

Part 1: Enter the Data

1. Enter the list editor (STAT, Edit).
2. With the cursor on L_1, press INSERT (2nd DEL)
3. Name the list TIME.
4. Repeat step 2. Name the new list POP.
5. Enter the data below into the new lists.

TIME	0	1	2	3	4	5	6	7	8	9
POP	3	7.54	18.93	47.5	119.43	300	753.57	1892	4754.7	11943

Part 2: The Exponential Model

1. Set up the scatter plot (2nd Y=), using your new lists as Xlist and Ylist (see picture at right).
2. In the space below, record reasonable maximum and minimum values for the x and y axes. Remember that these should be outside of your actual maximums and minimums.

Xmin: approx. -1   Ymin: approx. 0

Xmax: approx. 10   Ymax: approx. 12,000

3. Press WINDOW and enter your values from step 2 in the appropriate places.

4. Press GRAPH to graph the scatter plot.

5. Find the exponential model that fits the data. The input should look like ExpReg TIME, POP, Y1. Record your exponential model: $y = 3.00(2.51)^x$
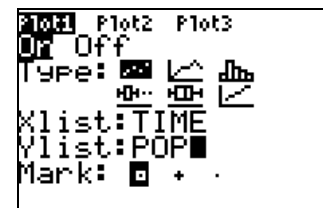
Part 3: A Linear Model for Exponential Growth?

Believe it or not, we can make our exponential data appear to be linear by using logarithms. This allows us to look at the data in a different way, and maybe draw some different conclusions.

1. Open the list editor.
2. Place the cursor on L₁ and press CLEAR.
3. Press LOG, 2nd STAT, scroll to POP, and then press ENTER twice. This enters the logarithm of the population data into List 1.
   a. How does this data compare to the original values for population? Answers vary. Sample response: The logarithmic data is significantly smaller than the original population data.
   b. Why do you think the difference is so great? Answers vary. Sample: The logarithmic data is powers of 10 that are equal to the original data.

4. Change your settings for scatter plot 1. The Ylist is now List 1.
5. Adjust the window so you can see your modified population data. Press GRAPH.
6. Find the linear model for the modified population data. The input should look like LinReg TIME, L1, Y2. Record the linear model: y = 0.400x + 0.477

Part 4: Interpreting the Results

1. What is the relationship between the linear and exponential models? In other words, for a given value of X (time), what does each model tell us? The exponential model tells the actual population, while the linear model is the logarithm of the pop.

2. If Y represents the population at time X, write the linear model in terms of Y. (HINT: The equation has a base 10 logarithm in it…) log (y) = 0.400x + 0.477

3. Rewrite the equation in step 2 in exponential form: y = 10 ^ (0.400x + 0.477)

4. Turn off the scatter plot and graph both the exponential model from Part 2 and the equation above in the standard viewing window. What do the graphs tell you about these two equations? They are equivalent.

5. When might this technique be useful? Answers vary. Check student responses.