Introduction

On the field trip to La Push you collected data in a number of experiments. In this lab you will plot your data, add a line of best fit where appropriate (Excel refers to this as a trendline) and compare your data to a theoretical model. This type of analysis is called graphical analysis. You will do this analysis for the Perspective on the Beach experiment and the Tide Marking experiment. You will also do an additional experiment where you measure the growth of a Chambered Nautilus.

Perspective on the Beach

In this experiment you measured the distance of 4 vertical logs, with similar height, from a fixed viewing location. The logs were placed so that the second log appeared to be half the size of the first, the third log appeared to be a quarter the size and the fourth log appeared to be an eighth the size.

1. Create a well labeled data table in Excel with log number in the first column and distance in the second column. Include your units in your headings. Plot distance vs log number using Excel. Label your axes and include units.
2. Does the graph appear to be linear or exponential? Add the appropriate trendline.
3. If the first log is a distance a from the viewing location, theory suggests that the second log will be a distance $2a$, the third will be at a distance $4a$ and the fourth will be at a distance $8a$. Make a data table with this theoretical model and plot it on the graph in part 1.
4. In a text box, compare the two graphs and explain any differences.

Tide Marking

In this experiment you positioned 13 markers up the beach from the low tide level up to the high tide level, in roughly even increments. The data you collected should consists of a table with one column showing the distance of each marker from the high tide marker and another column showing the time at which the tide reached each marker.

1. Enter your rough data into Excel columns (include column headings with units). From your rough data create a well labeled table with the first column being distance the tide has risen from the low tide marker and the second column being the amount of time it took the tide to reach that marker. (Note: You will need to calculate these results from your rough data.)
2. Plot time vs distance on a well labeled graph. Does the data appear to be linear or exponential or neither? Add a trendline if you think it is appropriate.
3. A rule of thumb for the rising tide is that the tide takes about 6 hours to rise. It rises one 12th of the total distance during first hour, 2 12ths during second hour 3 12ths during the third hour, 3 12ths during the fourth hour, 2 12ths during the fifth hour and 1 12 during the final hour. That is, it does not rise at a uniform rate, but instead rises fastest half way between high and low tide. Create a table for this theoretical model, and plot the data on the same graph as in part 1.
4. In a text box, compare the two graphs and give an explanation for the differences you observe.

Chambered Nautilus

The Chambered Nautilus, with its beautifully symmetric spiral shell is often cited as an example of mathematics in nature. For this lab assignment you will quantify the order that is apparent in this spiral, by measuring the radius of the shell for different angles, using the diagram below with the superimposed polar coordinate system. The aim is to determine whether the nautilus fits a known mathematical rule.

1. Create a table with angle θ in degrees in the first column and radius r measured in cm in the second column.

2. On the spiral outlined on the shell in the diagram below, choose a point that is about 0.5 cm from the center along the positive side of the horizontal axis. We will take the angle for this point to be $\theta = 0$. Measure the radius as accurately as possible (measure to the center of the highlighted line) and enter the data in the first row of your table.

3. Move along the spiral until $\theta = 90^o$ and measure r again.

4. Continue moving along the spiral by 90^o increments and recording the radius until you have reached the end of the spiral.

5. Enter your data in Excel and plot a graph of r versus θ. Does the growth in radius as a function of angle appear to be linear or exponential?

6. Add a trendline, using either a linear or exponential fit depending on what you decided above.

7. If the growth is linear find the approximate growth rate (in cm per revolution). If the growth is exponential find the approximate growth factor per 90^o rotation.

8. Check your answer to the above question by plotting growth curves for your mathematical model.

This is the end of the lab, drop your completed worksheet in the drop box using the naming convention

`Plotting_Data_LastName_FirstName.xls`