

**GS331 In-Class Exercise**  
**Introduction to Scientific Inquiry and Data Analysis**

c:wou:ocean:quantex.wpd

**Introduction**

Earth Science employs the scientific method via qualitative and quantitative observation, the collection of data, hypothesis formulation / testing, and hypothesis modification. This lab exercise provides a basic introduction to quantitative observation and analysis.

**Part 1 - Unit Conversion**

Using the attached metric and English measurement unit conversion tables, complete the following conversions. **SHOW ALL OF YOUR MATH WORK IN THE SPACE PROVIDED.**

2.05 m = \_\_\_\_\_ cm

$2 \times 10^5$  in = \_\_\_\_\_ mi

1.50 m = \_\_\_\_\_ mm

$2 \times 10^9$  ft = \_\_\_\_\_ mi

5.4 g = \_\_\_\_\_ mg

126,765,000 ft = \_\_\_\_\_ km

6.8 m = \_\_\_\_\_ km

72° C = \_\_\_\_\_ ° F

4214.6 cm = \_\_\_\_\_ m

8° F = \_\_\_\_\_ ° C

321.5 g = \_\_\_\_\_ kg

0° C = \_\_\_\_\_ ° F

1 in = \_\_\_\_\_ cm

212°F = \_\_\_\_\_ ° C

1 m = \_\_\_\_\_ ft

$5.7 \times 10^{45}$  sec = \_\_\_\_\_ years

1 mi = \_\_\_\_\_ km

$9.8 \times 10^{20}$  days = \_\_\_\_\_ years

123.4 mi = \_\_\_\_\_ km

$2.0 \times 10^{31}$  in = \_\_\_\_\_ km

1234 km = \_\_\_\_\_ mi

If 1 inch equals 2000 ft on a map; points A and B are 7.8 inches apart on the map. How far apart are points A and B on the ground in feet? Now how about in miles?

1054 lb = \_\_\_\_\_ kg

## Part 2. Solving Equations

A. The density of a substance is defined by it's mass divided by it's volume. The equation has the following form:

$$D = M / V$$

where D is density in gm/cm<sup>3</sup>, M = mass in grams, and V is volume in cm<sup>3</sup>

1. You measure the mass of a substance as 2356 gm. It's volume is 534 cm<sup>3</sup>, calculate it's density in gm/cm<sup>3</sup>. **SHOW THE FORMULA AND ALL OF YOUR MATH WORK!**
2. The density of a substance is 9.8 gm/cm<sup>3</sup>. If you had a volume of 3.8 cm<sup>3</sup> of the substance, what would be the corresponding mass in grams? Hint: Rearrange the density equation to solve for mass. **SHOW THE FORMULA AND ALL OF YOUR MATH WORK!**
3. The density of a substance is 2.5 gm/cm<sup>3</sup> and you possess 15.3 grams of that material. What will be it's corresponding volume in cm<sup>3</sup>. Hint: Rearrange the density equation to solve for mass. **SHOW THE FORMULA AND ALL OF YOUR MATH WORK!**

B. The velocity of moving objects (for example your car while driving) is measure as a rate of motion, according to the following equation:

$$V = d / t$$

where V is velocity (m/sec), d is distance (m), and t is time (sec).

4. You drive your car between two cities that are 123 miles apart. It takes you 4 hours to get there. Calculate your average velocity in mi/hr. **SHOW THE FORMULA AND ALL OF YOUR MATH WORK!**
5. Using the velocity you caculated in 4 above, what was your velocity in m/sec? Hint: you will have to use a distance and time conversion factor. **SHOW THE FORMULA AND ALL OF YOUR MATH WORK!**
6. You are driving a car at a velocity of 10 m/sec for a distance of 12 km. How long did it take you to get there? Answer in hours. **SHOW THE FORMULA AND ALL OF YOUR MATH WORK!**

### Part 3. Introduction to Hypothesis Testing, Data Collection, and Analysis

The scientific method involves observation, hypothesis formulation, data collection/analysis, and hypothesis testing. Let's use your lab class to introduce the basic concepts.

**A. Observation** - Make a qualitative (non-numeric) observation by examining all the individuals in your lab class and pay attention to their relative height and shoe size. Based on your observations, write a hypothesis that relates a person's height to their shoe size (i.e. how do you think they relate to one another, if at all?).

**B. Data Collection** - Now let's collect some data to test your hypothesis from "A" above. Using the meter sticks and other tools available in the lab, measure the height of 15 class mates (to the nearest hundredth of a meter) and their shoe length (to the nearest whole millimeter). Randomly select your subjects from the group. Fill in the data table below.

Person ID	Height (nearest hundredth of meter)	Shoe Length (nearest millimeter)
1	_____ m	_____ mm
2	_____ m	_____ mm
3	_____ m	_____ mm
4	_____ m	_____ mm
5	_____ m	_____ mm
6	_____ m	_____ mm
7	_____ m	_____ mm
8	_____ m	_____ mm
9	_____ m	_____ mm
10	_____ m	_____ mm
11	_____ m	_____ mm
12	_____ m	_____ mm
13	_____ m	_____ mm
14	_____ m	_____ mm
15	_____ m	_____ mm

**C. Graphical Analysis** - Plot a "scatter graph" of the data collected with Shoe Length (mm) on the X-axis, and Height (m) on the Y-axis. A blank piece of graph paper is provided on the following page. Once you plot the points, do the following, and answer the questions at the end.

(i) Describe the overall shape or trend of the data points on the graph (for e.g. straight line pattern, curved line pattern, "shot gun" scatter pattern, etc.).

(ii) If there is a linear trend to the data, draw a "best-fit" line on the graph that appears to average the pattern of the data points.

insert blank graph here

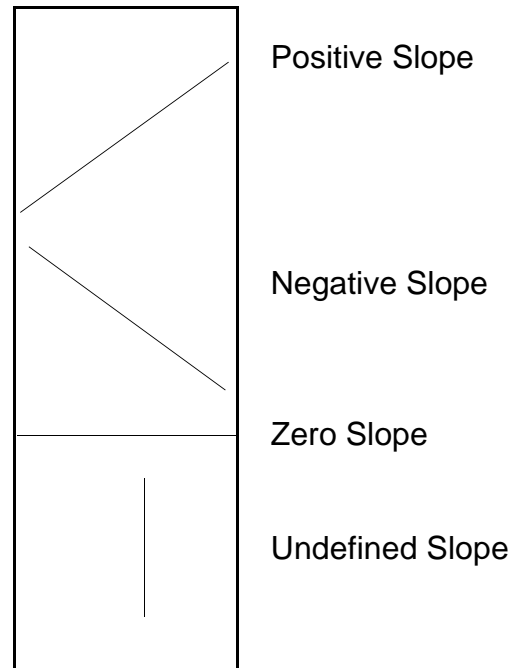
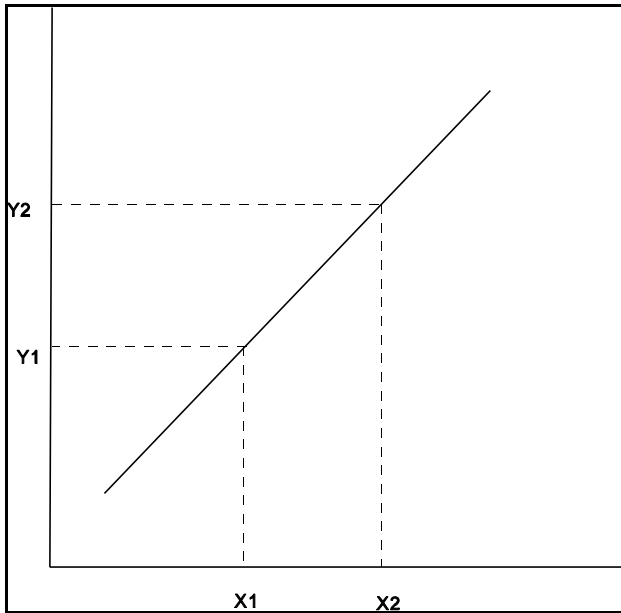
## Analytical Questions / Summary

The general equation of a line has the form:  $Y = mX + B$

Where  $Y$  is the predicted value on the  $Y$  axis,  $X$  is the observed value on the  $X$  axis,  $B$  is the  $Y$ -intercept or the  $Y$  value at the point where the line intersects the  $Y$  axis. and  $m$  is the slope of the line.

### Determining Slopes of Lines

slope of any line on a graph = rise / run =  $(Y_2 - Y_1) / (X_2 - X_1)$



1. Using your data plotted on the height-shoe size graph, determine the equation of the line that best fits the data. In the case of your equation, the  $Y$  value is Height, and the  $X$  value is Shoe Length.

Your line equation will have the form:  $Ht = m(SL) + B$

where  $Ht$  = predicted height of individual,  $SL$  = measured shoe length,  $m$  = slope of line,  $B$  =  $y$  intercept.

- Steps:
- 1 - determine the Height value where your best fit line intersects the  $Y$  axis (this is  $B$ )
  - 2 - calculate the slope of the line using the rise/run formula above (this is  $m$ )
  - 3- Plug your  $B$  and  $m$  values into the blanks of the equation below:

$$Ht = \underline{\quad} (SL) + \underline{\quad}$$

there! you have determined the equation of the linear relationship between height and shoe size for your class mates!

2. Ask several class mates who you did not include in your graph what their height and shoe size is. Plug their data into your equation above and see if the values are equal. How well does your equation predict the shoe size of your unknown participants?
  
3. Using your graph's ability to predict height and shoe size, comment on the viability of your original hypothesis. Does the data support it or reject it? Explain your answer.
  
4. What would you do to further test the validity of your hypothesis? What would happened if you collected height and shoe data from Brazilian class mates? Would they likely fall in the same data set or not? Discuss the strengths and limitations of your analytical ability to predict height and shoe size.