SMS-204: Integrative marine sciences.

Assignment #1

Knowledge base: Linking mass, volume and density. Skills: uncertainties, propagation of uncertainties, graphing data, regression, adding error bars to graphs. Computing basic statistical estimators with a spreadsheet.

The assignment can be done by a group. However, each student hands-in *individual* homework that is NOT IDENTICAL to other group members. In the case of IDENTICAL homework the grade will be split among the students. Make sure you pay attention to report only ***significant digits*** (see appendix to lab handout).
Submit the homework electronically to the designated folder on blackboard by **next Sunday (2/2/20) at 20:00pm**. Late homework will suffer an automatic 10pt penalty for the first week and will get a grade of zero beyond a week.

1. (50pts total) A. Compute the volume and densities and their uncertainties for all the rods your group measured. Divide the rods into ***two groups*** with similar densities (5pts).

Rod #	1	2	3	4	5	6	7	8
length								
diameter								
mass								
Δmass								
volume								
Δvolume								
density								
Δdensity								

Don't forget to add the appropriate units to the above table (Δ represents the uncertainty, which is an estimate of how well we know each of the values – see lab sheet for how to compute the uncertainties for mass, volume and density). **Note:** uncertainties for each rod are computed from uncertainties in each measurement, some of which are the same for all rods (e.g. for length) and some of which differ (e.g. density).

B. Plot the **mass** as a function of **volume** for these ***two groups***. Use your experience from previous classes to make a good plot (one that has: labels for each axis which includes units, tick marks on axis and a symbol to denote each datum with *no* line connecting the data and no grid lines) (10pts).

Note: it may be easier for you to separate the two groups of similar density rods into separate graphs. That is OK.

C. For the two groups of rods, obtain the linear regression line between Mass and volume (one line per group for a total of two line. This can be done by right clicking the data points in Excel, see links below). (5 pts)

D. Display each of the line equations on the graph. You should get an equation of the type: Mass=A × Volume + B. (5pts)

E. Does there seem to be a linear relationship between Volume and Mass? (5pts)

F. What does the slope of the regression line represents (A in the equation in question 1D) (5pts)? What are its units (5pts)?

G. What are the units of the intercept (B in the equation in question 1D) (5pts)?

I. Add uncertainties (in the form of error bars, see links below) to your plot (5pts).

J. Explain how the uncertainties were computed (5pts).

2. (30pts total) A. Using an Excel spreadsheet (or another program of your choice) and the **data your whole class collected** on sinking speeds of different beads, compute for each bead the mean, median, maximum, minimum, 16^{th} percentile, 84^{th} percentile, and the standard deviation of the sinking speed for that bead (5pts, those program have built-in function to compute these, to learn how to use them, for example google 'how to compute percentile with excel' + some tutorial on YouTube will walk you through it).

B. How do the median and mean compare? How does the standard deviation compare to (84^{th} percentile-16^{th} percentile)/2? We expect them to be similar for a normal distribution (5pts).

C. Plot the **median** sinking speed of the beads (y or vertical-axis) as function of their cross-sectional area (=$\pi \times \text{radius}^2$) ($x$ or horizontal axis). (10pts)

D. Does there seem to be a relationship between cross-sectional area and median sinking speed (determine a relationship by plotting the regression line and displaying its equation on the plot)? Note: When the bead reaches terminal velocity, a balance exists between the downward pool of gravity and the drag force. We will get back to these data later in the semester when we will analyze the forces acting on bodies immersed in water. (5pts)

E. Add the uncertainties of the data points to the graph (these are called 'error bars', see links below). Use the statistics from the whole class dataset for uncertainties. What do such uncertainties represent? How do they compare to uncertainties in individual measurements of sinking speed? (5pts)

3. (10pts total): Watch the movie "Introduction of the Study of Fluid Motion" https://www.youtube.com/watch?v=EIuU9Q8CGDk, and answer the following questions (note: there is no need to use more than 4 sentences to answer each part correctly):

a. (4pts) Find in the movie 4 natural phenomena that are relevant to Oceanography or marine Biology.

b. (4pts) What are the fundamental dimensions in physics? Give example of their units.

c. (2pts) In order to build a model that is similar in behavior in fluid to the real life object in water, what needs to be done?

4. (10pts, 2pts each): Answer the following unit conversion problems:

1.5 m^3 seawater into liters: 1.5 m^3 = _____l

14 liters of seawater into m^3: 14 l seawater = _____m^3

1.5 mg NaCl L^{-1} = _____ µg cm^{-3}

3 mg chlorophyll L^{-1} = _____ g m^{-3}

20 µL =_____ mL

Resources that may be useful for this homework:

A few links on how to plot a graph with Microsoft Excel (found using Google with 'making graphs with excel 2007' in the subject line). I have no doubt you can find better ones.

http://spreadsheets.about.com/od/excelcharts/ss/line_graph.htm

http://www.youtube.com/watch?v=8B8kFVNzlQ8

How to plot error bars on a graph in excel

http://www.youtube.com/watch?v=90zGaV0KLuk

http://www.youtube.com/watch?v=gmdeYI1DqLs

How to plot a good graph:

http://www.biostathandbook.com/graph.html

More on how to propagate uncertainties (see lab appendix first):

http://courses.washington.edu/phys431/propagation_errors_UCh.pdf

https://en.wikipedia.org/wiki/Propagation_of_uncertainty

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