

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. A rubric addressing level of expertise in treatment of data is provided on the class's web site.

Submit the homework electronically to: sms204.umaine@gmail.com by next Monday at 12:10pm. Late homework will suffer an automatic 10pt penalty for the first week and afterwards will get a grade of zero. Name your homework: lastname_initial_HW#.doc or .pdf (e.g. Smith_N_HW1.doc for the first homework).

1. 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
mass								
length								
diameter								
mass								
Δ mass								
volume								
Δ volume								
density								
Δ density								

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 one rod are computed from uncertainties in measurements.

B. Plot the **mass** as a function of **volume** for these **two groups**. Use your experience from previous IMS 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 them 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 both groups of rods, obtain the linear regression line between Mass and volume, a (this can be done by right clicking the data points in Excel, see links below). (5 pts)
- D. Display the equation and the line on the graph. You should get an equation of the type: $\text{Mass} = A \times \text{Volume} + B$. (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. 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, 16th percentile, 84th percentile, and the standard deviation of the sinking speed for that bead (10pts, 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 $(84^{\text{th}} \text{ percentile} - 16^{\text{th}} \text{ percentile})/2$? 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 pull 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. (15pts): Watch the movie “Introduction of the Study of Fluid Motion” <https://www.youtube.com/watch?v=EluU9Q8CGDk>, and answer the following questions (note: there is no need to use more than 4 sentences to answer each part correctly):

- Find in the movie 4 natural phenomena that are relevant to Oceanography or marine Biology.
- What are the fundamental dimensions in physics? Give example of their units.
- 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?

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)

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

<http://www.youtube.com/watch?v=8B8kFVNzIQ8>

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.biostat handbook.com/graph.html>

http://chemsite.lsrhs.net/tutorials/good_graphs.pdf

More on how to propagate uncertainties:

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

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

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