The Milli-Can Oil Drop Experiment

(Note: This idea stolen from http://phys.csuchico.edu/ayars/300B/handouts/millican.pdf.)

Your goal is to find the mass of a single ball bearing. You should end up with a value for this mass, and also some estimate of the "uncertainty" in your measurement. Report your final result as $xx.x \pm zz.z$ where $xx.x$ is your best value for the mass, and $zz.z$ is your estimate of the uncertainty. A convenient unit for reporting the mass is *grams*.

It is best to work in pairs, so pick a lab partner. Around the room, you will find four stations. At each station you will find a sensitive, easy-to-use scale, and three film canisters. The film canisters are labeled A, B,... L. Each pair of you should make your own measurements of the weights of all twelve canisters. Record these twelve values in your lab books.

Each of the twelve canisters contains some number of more-or-less identical ball bearings. (There is also some packing material inside, so you can't rattle the canisters to "hear" the number of ball bearings.) You have no information on the number of ball bearings in any one canister, other than the weight of the whole thing.

However, this is enough information for you to determine the mass of a single ball bearing. Figure this out in whatever way you'd like. A graph of your data is always a good idea. Can you think of a useful way to graph it?

And how are you going to estimate the uncertainty of your measurement? Using whatever method you choose, think about how much give or take you have in estimating the necessary values from your data. (We'll talk about this. I'm sure this sounds like double talk to many of you.)

One popular approach used by scientists in general, and physicists in particular, is to come up with a "model" to describe your data, and then "fit" the model to the data in order to extract the quantity you're after. For a model, try writing a formula that expresses the weight of the canister (your measured data) in terms of the mass of a single ball bearing (the quantity you're after). Then, using graph paper or some computer program, try to adjust the mass of a ball bearing (and any other quantities you don't know) so that the curve described by the model passes through the data points. The values that work best are your "best values", and the extent to which you'd be comfortable varying those values gives you the "uncertainty" in them.

Your laptops will be useful for a lot of this. Microsoft EXCEL is a popular program for doing this sort of data analysis. Another good choice (maybe a better one) is MATLAB. Both of these are available to you through the campus site license.