Finding the Mass of a Pin in a Very Inconvenient Fashion:

An Introduction to Data Collection and Experimentation.

The single most important aspect of science is experimentation. An experiment is a way of testing ideas to see if they make sense. In order for any idea to be accepted as science that idea must be testable. Different people in different places must be able to repeat the experiment and get the same results. If not, the results cannot be trusted.

 In this course we will try to learn some methods for designing and conducting simple experiments. You should be aware that most of the experiments you have done so far, or are going to do this year, are not real science. You were not discovering anything new. A real science experiment often takes many years to design and perform!

The purpose of the experiments (or labs) that we do in high school is to help you learn techniques of observation, *measurement* and analysis that you can use in the future. Some of the labs also help you to confirm first hand the ideas you learn in class.

**The Parts of a Basic Experiment:**

1. **Question/Purpose**
2. **Hypothesis**
3. **Prediction**
4. **Procedure**
5. **Data/Observations**
6. **Analysis**
7. **Discussion/Error**
8. **Conclusion/Result**

Not all of these parts will be necessary in every experiment. For example in our simple experiment we will not need a hypothesis or a prediction. There are also many versions of this list that may have more or less parts but the basic idea will be the same.

**Question/Purpose:**

 What do you hope to find out from this experiment? This step can be written as a question:

“What is the mass of a pin?”

 This step may be written as a statement of purpose:

“To determine the mass of a pin.”

 However, it is important to make sure that you understand the actual goal of the lab you are doing. Both the question and purpose stated above would actually be incorrect for this lab. It would be silly to do a lab to find the mass of a pin; you can simply put the pin on a scale.

 So what is the real purpose of this lab? That’s for you to figure out.

**Hypothesis:**

 A hypothesis is a statement of what **you** *think is true*.

Your hypothesis is an assumption that you will test. If the experiment is very simple, like this one, there really is no point to making a hypothesis. There is nothing to be gained by guessing the mass of a pin.

 An example of a hypothesis from a classic chemistry experiment is that *water is a compound.* This is an idea that a few chemists had a long time ago. Before them it was believed that water was an element.

**Prediction:**

 Once you have a hypothesis there should be a prediction that you can test based on the hypothesis. Again for our simple lab this step is not necessary.

 Continuing the example from above, the prediction that follows directly from the hypothesis is: *Water can be broken down into simpler parts*. It is this prediction that the scientist will now test.

**Procedure:**

This is the longest part of the experiment. Often in science class the procedure is given as a set of steps to follow. However in real science you don’t know all of the steps before you start! So when you design your own experiment you will need to break this up into stages:

1. Come up with a rough plan. Your plan should include a list of the equipment and materials you think you will need, as well as a point form list of steps to follow.
2. Keep notes and make observations and measurements as you go. In particular note changes to your rough plan. If an experiment takes many days you should keep track of the date and time when particular observations are made. It is much better to have too much information at this stage than to realize afterward that you missed something.
3. If you are going to need to produce graphs from your data it is a good idea to make a rough graph as you go. In this way you can more easily spot if something strange is going on.
4. Your actual procedure that you present with your lab report is a numbered step by step record of what you did. That means it should be written in *past tense*.
5. Your procedure should be detailed, but brief. This is a balancing act. Your procedure should be detailed enough that someone else could repeat you experiment by reading it. However you do not need to include everything you did: “At 1:05pm I scratched my nose with my left hand”. The most common step that is given, but not needed is: “Gather the materials”.
6. Included at the beginning of your procedure should be: **Materials, Independent Variable and Dependent Variable.**

**Data/Observations:**

 This section is a neatly organized summary of all of the important data and observations that you made throughout the lab. The data should be reported in the appropriate form such as a diagram or a data table. Some observations may simply be presented as a point form list.

 Not every observation that you made during the lab needs to be reported. You need to look back over the entire procedure and decide which observations you this are important.

 If your data is in the form of measurements, be sure to include the proper units.

**Analysis:**

 This is where you put all of the information and try to make sense of it all. Most commonly that will take the form of some sort of graph or chart.

 Depending on the type of data collected this could take many forms including: Line graph, Scatter Plot, Histogram, Bar Graph, Pie Chart and more. For science a line graph is the most common.

 In the analysis you should include examples of any non-trivial calculations you performed.

**Discussion/Error:**

 After the lab is completed you may wish to make a summary of things you might do differently or ways to improve the overall design of the experiment. You may also wish to suggest possible extensions to the experiment. You might also wish to highlight any steps that proved to be particularly difficult. These are all parts of the discussion.

 This section should also include a list of the sources of error within the experiment. Sources of error include limitations in the measuring devices or flaws in the design of the experiment. You should not include “human error” as a source of error.

**Conclusion/Result**

 This should be a summary that addresses the purpose or the question. If the result is numeric, you should include a percent error.