

SPU 27: Problem Set Comments

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- **Read the directions carefully.** If asked for "two short sentences", please only write that much. As stated on the first page of the problem sets, submit your answers on separate paper, not on the problem set (questions) itself. Also, "Be sure to calculate all results fully (don't leave numbers in fraction form)."
- **Show work for all steps.** If any computation was involved, I'd like to see it.
- **Cite your sources.** If you found a density from Wolfram Alpha or a specific heat from Google, please say so. If a justification is based on the reading, say which one.

Experimental Design

The scientific method relies on making hypotheses and then testing them, using experiments. A hypothesis is an explanation for an observation or problem that has been reworded so that it can be tested.

Most properly designed experiments have the following characteristics:

- an **independent variable**: variable being changed or manipulated by the experimenter
- a **dependent variable**: variable being observed that may change in response to the independent variable
- **controls**: tests in which the independent variable is kept constant in order to measure changes in the dependent variable, or a reference decided on by the experimenter as a standard for comparison. There are several different types of controls for experiments, two are described below:
 - **Positive Controls** - see if an expected positive result will be observed. This is a good way to make sure all your solutions (or independent variables) are what they should be.
 - **Negative Controls** - see if an expected negative result will be observed.
- Everything that's not intended to be a variable is kept **constant**, so as to avoid confusing different effects.
- Possible **sources of error** are considered.
- They **test the hypothesis** and **address the problem**.

adapted from http://bioweb.wku.edu/courses/Biol1115/Wyatt/Sci_method/Sci_method2.asp

Example:

Problem: My car won't start.

Hypothesis: My car won't start because the battery is dead.

Experiment: Measure the voltage of a brand new car battery, with known voltage (positive control). Measure the voltage of a dead car battery (negative control). Measure the voltage of my car battery. Compare the voltages to find out whether or not the car battery is dead. This comparison, however, is **not sufficient** to tell you why the car won't start. To do so, you need to try all three batteries in the car and see if the car will start. If it starts with the new battery and you've measured that your battery has a low voltage, then we can say that the hypothesis is correct. If, however, you find that the battery has low charge, but the car won't start with the new battery, then we know there's some other issue. (Further interpretation of results can be discussed).