**Experimental Error**

In conducting an experiment a person encounters one or more of three general types of errors: **human error**, **systematic error**, and **random error**.

**Human error** (a mistake) occurs when you, the experimenter, make a mistake. Examples would be when you set up your experiment incorrectly, when you misread an instrument, or when you make a mistake in a calculation. Human errors are not a source of experimental error; rather, they are “experimenter's” error. Do not quote human error as a source of experimental error.

**Systematic error** is an error inherent in the experimental set up which causes the results to be skewed in the same direction every time, i.e., always too large or always too small. One example of systematic error would be trying to measure the fall time of a ping pong ball to determine the acceleration due to gravity. Air resistance would systematically reduce the measured acceleration, producing a systematic error. Some systematic errors can be easily corrected. For example, if a balance reads 0.25 g when there is no mass on it, this would introduce a systematic error to each mass measurement—they would all be too large by 0.25 g. This can be corrected by zeroing the balance. Other systematic errors can only be eliminated by using a different experimental setup. Most of the simple experiments you do will have some systematic error.

All experiments have **random error**, which occurs because no measurement can be made with infinite precision. Random errors will cause a series of measurements to be sometimes too large and sometimes too small. An example of random error could be when making timings with a stopwatch. Sometimes you may stop the watch too soon, sometimes too late. Either case introduces random error in your measurements. (Note that when a human is involved in the actual measurement process, he/she can introduce valid experimental error that is not within the definition of human error. Your finite reaction time is not a mistake; it is a limitation of one part of the experimental process, the human making the measurement.) Random error can be reduced by averaging several measurements.

**ERROR ANALYSIS**

One way to analyze experimental error is with a % error calculation. The % error is useful when you have a single experimental result that you wish to compare with a standard value, or when you have two experimental values obtained by different means that you wish to compare. (In the latter case it is often called % difference since there is no standard to compare to.)

The % error is calculated according to the following formula. In the formula,