

Name: _____

Partner(s): _____

LAB #1

THE SCIENTIFIC METHOD

Due 6/25

Objective

The lab is designed to remind you how to work with scientific data (including dealing with uncertainty) and to review experimental design.

Uncertainty and Error

Suppose you read a study in a magazine stating that in the general population 20-30% of people have ear piercings and 1-3% of people have body piercings.

Scientists would write this as

25 +/- 5% of people have ear piercings.

2 +/- 1% of people have body piercings.

The first number is the **result**, and the second number is the **random error** in the result (sometimes also called the random uncertainty). Random error indicates how the results might change if you did the survey many times. Usually, if you repeat the survey, your results will agree with the number quoted within the error.

Generally, errors are quoted as percentages such that:

$$\text{percent error} = 100 \times (\text{error} / \text{total}).$$

Through most of this course we will ask you to find your uncertainty. Often this is simple enough. If you make a measurement your random uncertainty is the *smallest value that you can measure*. If you are using a ruler you may be only able to tell things down to the nearest mm. In that case you would record your uncertainty as: +/- 1mm.

Other times, you will be recording a number of data points. In this case, your random uncertainty is the *“scatter” of your data*. For that your random uncertainty is how high above and below an “average” value your data falls. For example you time how many seconds it takes a rock to fall to the ground five times and measure: 5.0, 5.1, 4.9, 5.2, 4.8. You could report this as 5.0 +/- 0.2 seconds.

In some cases, as in this assignment, your errors come from sampling a number of things, essentially an *error in counting*. The concept is that you are drawing your data points from

a larger sample and somebody else doing the same experiment would draw a different data points and get a different answer – thus leading to uncertainty between the answers. The equation for sampling error has been determined statistically to be:

$$\text{error} = \sqrt{\text{number}}$$

To summarize random error:

- Measurement: smallest measurement one can determine
- Data scatter: amount off of an “average”
- Counting: square root of the number sampled

There is another type of error, *systematic error*. This would be the case if all of your values were too big, or too small, instead of fluctuating up and down. Systematic error often comes from a *bias* in your methods, or equipment, say using a meter stick that isn't really a meter to measure things.

In a few questions you will be asked to compare numbers. To compare two numbers scientifically, you must see if they agree within their respective uncertainties. It's not enough to say that two numbers are close together unless they are within their uncertainties of each other. So the answer to this type of question involves a little math.

To compare two numbers: If $|A - B| < |(\text{uncertainty in A} + \text{uncertainty in B})|$ then the two numbers are in agreement.

Notice nowhere do the words *human error* show up. Please don't *ever* use them. Instead of listing your source of error as “human”, explain what specifically was the source.

Questions

The following questions are based the hypothetical magazine survey on the percent of the general population with ear and body piercings. You will be asked questions on designing an experiment to reproduce the results and interpreting the error. Use the following table to record your results.

Type of Piercing	% From the class survey	% Error from the class survey	% From the UW survey	% Error from the UW survey	% From Magazine	% Error From Magazine
Ear Piercing					25%	5%
Body Piercing					2%	1%

- (1 pt)** Suppose you want to know the percentage of people in this class (teaching, auditing and enrolled) with ear/body piercings and to compare these results to the results of the survey. State a reasonable hypothesis.
- (1 pt)** How will you collect the necessary data?
- (5 pts)** Using your desired method, find out how many people in the class have ear and body piercings.

	Number	Percent	Error	Percent Error
Total Number of People				
Ear Piercing				
Body Piercing				

Transform the number of ear and body piercings into percents and fill in the appropriate results column of the table directly above and table at the top of the page. Use the correct number of significant figures!