Error Analysis

Name_____

Introduction

It is important to understand the meaning of error in science. Error in a scientific measurement usually does not mean a mistake or blunder. Instead, the terms "error" and "uncertainty" both refer to unavoidable uncertainty in measurements. Of course, not all measurements have uncertainty. If asked how many people there are in a room, one can usually give an exact number as an answer. However if you wanted to know exactly how many bees are in a beehive, giving an exact answer is nearly impossible. In our laboratory work, most of our measurements will be have some inherent uncertainty.

An important part of science is being able to think about what you do in the lab and analyze what might have contributed to poor results. This process is called error analysis. Not all comments are valid and useful for instance, you should avoid discussion about the absolutely obvious human blunders, such as "we measured wrong." It is not valid to blame sources of error on "lousy" measuring devices, or faulty calibration. It is never valid to say that a mistake in calculations is a source or error.

Examples of Error Analysis

- **really bad**
  - **"**I read the measuring tube wrong."
- **still bad**
  - **"**Another source of error is approximation of the substance's mass or volume on the lab participant's part thereby giving incorrect values for determining density."
- **really bad**
  - **"**The balance is wrong."
- **still bad**
  - **"**The balance may not have been calibrated correctly giving larger or smaller results for mass."
- **really bad**
  - **"**The density is wrong because I did the calculations wrong."
- **still bad**
  - **"**The density may have been incorrectly calculated by using the volume in the numerator and the mass in the denominator thereby resulting in the calculation of the inverse of the density, while mistakenly believing it was density."

Sources of error should go beyond readings, calibrations, and calculations. Instead, error analysis should cite problems with the procedure that are either difficult to avoid, or important to "watch out" for.

When doing an error analysis, it is important to take a "three-pronged" approach.

A. State the source of the error,

B. state which data and how that data would be affected (higher or lower),

C. then state how any intermediate and final calculated value(s) would be affected (higher or lower).

- **bad**
  - **"**Air bubbles in the liquid would mess things up."
- **still bad**
  - **"**Air bubbles in the liquid would give an inaccurate reading of the volume."
- **better**
  - **"**Air bubbles in the liquid would give a bigger reading of the volume."
- **best**
  - **"**Air bubbles in the liquid would give a larger value for volume without changing the mass, which would result in a lower density."

- **best**
  - Volume measurements could have been inaccurate because of some of the liquid, especially the mineral oil and glycerin, sticking to the sides of the graduated cylinder. This would cause a low volume reading for the amount of mass measured, making the density appear greater.
- **best**
  - The balance pans must be clean before massing anything. Any material on the pan would increase the mass measurement but not be adding into the volume measurement and therefore make the density appear larger than it should be.
- **best**
  - Changing from one liquid to the next, graduated cylinders must be cleaned and dry. This would prevent a difference in mass when put on the balance. For example, a contaminant that was less dense than the liquid being tested would make the tested liquid appear less dense than it actually is.