Recall that precision refers to how closely a series of measurements of the same quantity are to one another. Accuracy is defined with respect to how close a given value agrees with a known ‘true’ value. In most experimental work the ‘true’ value is unknown and the laboratory work is designed to find this ‘true’ value. If the ‘true’ value were known time and expense would not be spent in pursuit of it! (Of course introductory chemistry labs are not in search of ‘true’ values, rather, they seek to increase the skills of the novitiate in order that in the future they may then seek new unknowns.) To this end we will undertake an ‘experiment’ to determine the mass of five nickels and their relationship to the true value. In fact we will assume the true value to be the ‘ideal’ value as established by the U.S. Mint of 5.000 g/nickel.

The exercise will be completed using the analytical balances in the lab. The balances have a maximum capacity of ~100 g - so be careful not to exceed this amount. The balance will not read any weight if you do exceed its limit and if exceeded sufficiently it could be damaged. Recall the following guidelines for proper use:

1) never put chemicals directly on the balance pan,
2) always place objects on the pan gently,
3) never weigh hot objects (must be cool enough to hold in your bare hands),
4) Do not move or physically adjust the position of the balance,
5) be sure all doors are closed prior to zeroing and while weighing,
6) keep the balance pan area clean.

When several samples are needed for analysis (as in five nickels), weighing by difference is often more convenient. A clean, dry, weighing bottle containing the substance (5 nickels) is tared. Then some of the substance is transferred to the container to be used in the analysis (one nickel is removed). The weighing container is re-weighed, (the balance will now read in the negative) this number, without the negative sign, is the mass of the removed material. The container is tared again and the process repeated as many times as samples are needed.

**EXPERIMENTAL PROCEDURE**

I. Obtain five nickels and place them in a clean dry weighing container (small beaker will do). When handling the weighing container from here on out use a piece of paper towel to protect against finger oils.

II. Determine by difference the mass of each of the five nickels to ±0.0001 g and record. Calculate the mean (X bar) for the set of five mass measurements as described on the following page.

III. Determine the precision of the results by calculating the standard deviation (S_x) and the relative standard deviation (rsd) in parts per thousand, ppt, using the method shown on the next page.
The Nickel Exercise

\[
S_x = \sqrt{\frac{\sum(x_i - x-bar)^2}{n-1}} \quad \text{RSD} = \frac{S_x}{x-bar} \times 1000
\]

Use your calculator, if it has statistical functions, to verify your hand calculations.

IV. The accuracy of the mean (\(x-bar\)) is indicated by the relative error, in ppt. This where the mean is compared to the known value.

\[
\text{Relative error} = \frac{x-bar - \text{true value}}{\text{true value}} \times 1000
\]

Your lab report

All data and results for this lab should be recorded just as you would for any other lab. Be certain to show proper units and significant figures on all measured quantities. The significant figures for \(s_x\) and \(\text{rsd}\) must also be reported. Note: it is rare that either of these exceeds two S.F.

The lab is sufficiently simple that it should be completed and graded prior to leaving lab.