Laboratory 6: Measurement Uncertainty

An *essential* part of making a measurement in Physics is to attach an uncertainty to it. The reported uncertainty is an attempt to quantify the confidence we have in the number reported. For instance, if I say: $x = 5.2 \pm 0.3$ cm, we mean that if someone were to repeat the measurement, we would expect their answer to be in the range: $4.9 < x < 5.5$ cm. These uncertainties are based on knowing how the measurement or prediction was made and what would likely happen on similar trials.

A. Mystery Bags & Estimation Tools

Your task is to estimate the number of M&M candies in a large bag by weighing a *sample* of M&Ms, knowing that not all M&Ms are identical.

- The bags you are trying to estimate are at the back of the room.
- You have a scale and samples of M&Ms to weigh (10 each Plain and Peanut).
- You have to make a prediction about the number of M&Ms in the large bags.
- Do this each for both Plain and Peanut M&Ms.

For each case, you will give a prediction and an uncertainty range, like 1022 ± 15.
For each case, the winning group gets a bag of M&Ms to take home.

- To qualify to win, the number of M&Ms in the bag has to be in your range.
- The winners will be the qualifying group with the smallest estimated uncertainty (note: this may not be the group whose prediction is closest to the number).

B. Tell Us Your Process

Normally, we might give you specific instructions on how to do your estimations. But today, we are interested in reading about the logic behind the process that your group comes up with. As you are doing this activity, keep notes in your lab book about what you did and why you did it that way for each case (Plain and Peanut). Use that to make your prediction and to prepare us a 1-page write-up of what you did and why.

C. Deciding on a Winning Group

We'll tabulate your initial predictions on the board. Once you have seen everyone's predictions we will make a second table of revised (or unchanged) predictions. Winners will be decided once we have determined the number of M&Ms in each bag.

D. M&M Decay Curve

We will give each group a roughly equal number of each type of M&Ms to work with. Weigh your group's samples. Then we will simulate a decay process.

- Dump your sample onto a clean paper plate. Any M&Ms that land M side up are considered to have decayed. Count them back into your cup and record the number that decayed.
- Repeat these steps until all your M&Ms have decayed or you are left with a stable population that will not decay (some M&Ms have no M's on them).
- Find the total number of M&Ms in your sample by adding up all the decayed M&Ms and the final stable population number.

Lab Write-up

All we want is for you to give is your group's estimates of numbers and uncertainties, and to explain your process for arriving at those numbers.