

## Lab 0: Measurement Uncertainty

Today it is good practice to use nitrile gloves whenever handling the M&M's and the bags they are in. Please don't hesitate to throw away any M&M's that could be contaminated.

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, I mean that if someone were to repeat the measurement, I 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.

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

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

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

- To qualify to win, the number in the bag has to be in your predicted range.
- To win, you must have the smallest estimated uncertainty. (Note: this will not necessarily be the group whose prediction is closest to the actual number).

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). I am looking for you to explain your logic.

- 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.

**Decaying M&M's:** To count the M&M's in the mystery bags we will do a second set of decay experiments. I will break the contents of the mystery bags up into roughly equal sized samples for each group.

- Weigh your sample.
- Dump your sample onto a clean paper plate. Any M&M's 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&M's have decayed or you are left with a stable population that will not decay (some M&M's have no M's on them).
- Find the total number of M&M's in your sample by adding up all the decayed M&M's and the final stable population number.

We'll compare different groups' decay curves at the black board. We'll also use the total of all the groups' sample numbers to evaluate the winners of the Mystery bags.