

Mass of a Chocolate Chip

How much does one chocolate chip weight? It seems like a simple question, and in many ways it *is* a simple question, but the procedure we use to answer that question will dramatically influence how reliable the answer is when we move on to the next chocolate chip in the bag. Measuring a physical quantity involves not just getting “the” answer, but also including some indication of how much that answer can be trusted or repeated.

Procedure: {Work in pairs.}

1. Get a cup of chocolate chips. You will be weighing varying numbers of chocolate chips to determine the mass of a single chocolate chip. Be sure to note the chocolate chip type.
2. When it is your turn at the scale, weigh some number of chocolate chips. {See “Using the Scales” below.} Then weigh a different number of chocolate chips. Repeat until you have measured the mass of at least 5 different numbers of chocolate chips. A few guidelines:
 - a. Weight at least 10 chips each time.
 - b. Don’t just keep adding chocolate chips. After each weighing, dump out the chips that were just weighed and re-count a new number of chips.
 - c. Weigh a broad range of numbers of chips. For example, DO NOT weigh 10/11/12/13/14 chips as your 5 weights, spread the numbers out more.
 - d. Don’t worry about “even” numbers of chips. Your chip counts don’t have to be evenly spaced. They *can* be evenly spaced, but there is no advantage or disadvantage to using exactly equal spacing.
3. Enter your data in the correct area of the class spreadsheet.
4. “Dispose” of your chocolate chips in the manner you feel is most appropriate.

Using the Scales:

1. Make sure the scale is sitting flat on the table.
2. Place an empty cup on the scale and tap the “tare” button. This will set the scale at zero.
3. Count chocolate chips into the empty cup, but try not to look at the weight display while you are counting. Why not? You might introduce “observer error” or “observer bias” into your data.

Data Analysis:

Mathematical Analysis #1:

For each of your five masses, calculate “grams per chocolate chip”. List these from largest to smallest and take the average of these 5 values. How close to the average is the middle value in your list?

Determine the “range” of your data by subtracting the smallest of your values from the largest of your values. For ideally distributed data, half of the range should be above the average and half should be below the average. Divide your range by 2. This is the uncertainty or “error” in your data. For relatively small data sets, using “range over 2” for error is usually reasonable. Report your average and error:

Mathematical Analysis #2:

Using the raw data you collected, calculate the average mass of a chocolate chip by dividing the *total* mass of chocolate chips for all five samples by the *total* number of chocolate chips used in all 5 samples. How does this number compare to the average you calculated in the previous section? Is this value within the error you reported in the previous section?

Graphical Analysis:

Prepare a graph of mass of chocolate chips vs. number of chocolate chips for the five samples you measured. Your five points should be approximately linear; use a straightedge to draw a line that fits your five points. The slope of a line is equal to the change in the “y” variable divided by the change in the “x” variable. In this case, “y” is grams of chocolate chips and “x” is number of chocolate chips, so the slope of the line defined by your five points should be “grams per chocolate chip”. This means that the slope of the line should be the average mass of a chocolate chip. Determine the slope of your fit line. How does the slope of your fit line compare to the average mass of a chocolate chip you determined in the previous sections? Is the average mass {determined using the slope of the fit line} within the error you reported in the previous section?

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BCBT 100 – Spring 2014

Name: _____

Partner: _____

Procedure/Data Collection:

Chocolate Chip Type: _____

<i>Number of Chocolate Chips:</i>	<i>Mass of Chocolate Chips (grams):</i>	<i>Notes:</i>

Mathematical Analysis #1:

<i>Highest value</i>		<i>Middle value</i>		<i>Lowest value</i>

Average = _____

Average = _____ \pm _____ {error}

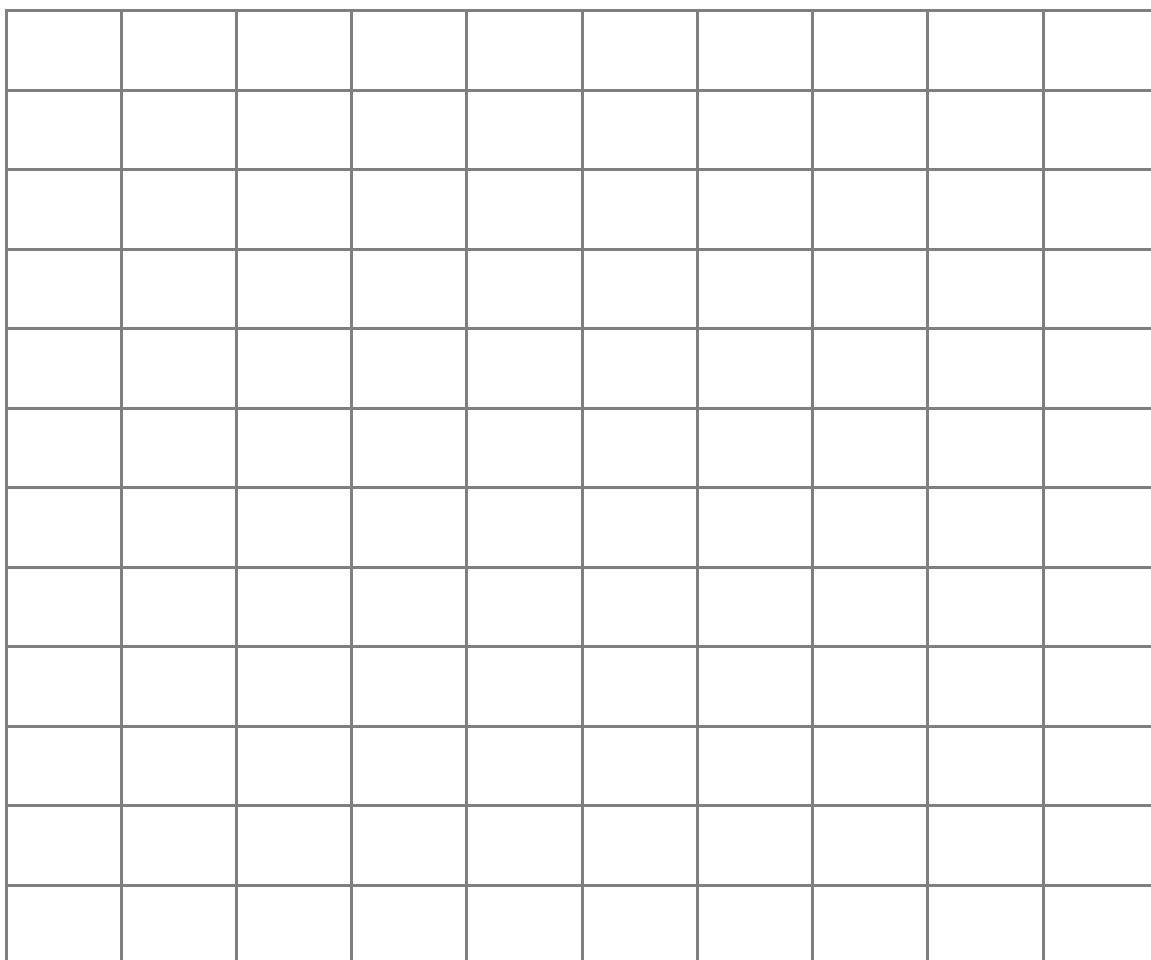
Given the variability {"error"} you reported, how confident are you in the average value you calculated?

Mathematical Analysis #2:

Average = _____

How does this number compare to the average you calculated in the previous section? Is this value within the error you reported in the previous section?

Graphical Analysis:



{ Be sure to label axes on the graph. }

How does the slope of your fit line compare to the average mass of a chocolate chip you determined in the previous sections? Is the average mass {determined using the slope of the fit line} within the error you reported in the previous section?

Comparing Results:

Compare your results to another group that used the *same* type of chocolate chips. Are the averages the same? Are the averages within the error reported for each?

Compare your results to another group that used a *different* type of chocolate chips. Are the averages the same? Are the averages within the error reported for each?