Candy Container Lab

Directions and Suggestions for Teacher

Purpose:

This lab is designed to introduce students to how they can collect data, use the data to create a graph, use the graph to create a mathematical model and then use the model to make predictions. This lab should probably be the first one done during the school year and will help serve as a template to how labs will be conducted and used throughout the year.

Virtual Part:

(https://www.thephysicsaviary.com/Physics/Programs/Labs/CandyContainerLab/)

The virtual part of this lab could be done before students do a live version of the lab or if you have limited lab space you can have half the students working on the virtual part of the lab while the other half work on the live part of the lab.

Measuring # of Candies:

I am a firm believer in making students estimate and make judgment calls as frequently as possible. Because of that, they will need to read an analog gauge that shows how many candies are in the jar.

Measuring Mass of Candies:

When students are using the triple beam balance, they will benefit by clicking on the zoom option to see a larger version of the third beam of the balance. Students should estimate the mass to the nearest 0.01 gram. Encouraging good measuring techniques from the very beginning of the year will pay big dividends later in the year.

If students are having trouble with their triple-beam balance skills you can have them use the program found here (https://www.thephysicsaviary.com/Physics/Programs/Games/ReadtheTripleBeamHard/)

Although there are ten different levels on the virtual program, students need not do all ten levels. I would not suggest less than 5 levels as it is a good practice to collect more data to have greater confidence in your results. The program will randomize the mass of the candy and the mass of the jar holding the candy, so all students will get different results. Students should not refresh the website while working or it will generate new values for candy and container mass and thus make all the old data irrelevant.

Below is a sample of what potential data might look like.

Data:

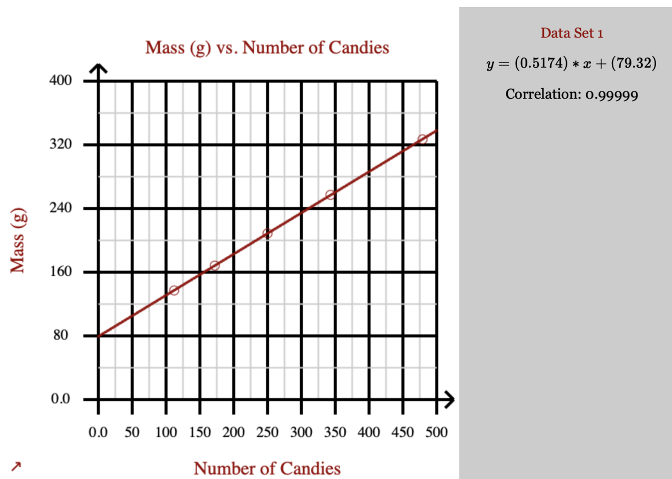
Level #	Number of Candies	Mass (g)
1	112	137.08
3	172	168.27
5	250	208.81
7	343	257.19
10	479	326.88

Graphing Data:

(https://www.thephysicsaviary.com/Physics/Programs/Tools/Graphing/)

Once students have finished collecting data, they should graph it and find a relationship between the variables. The number of candies is the independent variable and should be placed on the x-axis and the mass should be on the y-axis.

I prefer always having the students transfer their graph onto their lab sheet by hand. In this first lab I will often have them create the entire graph by hand and find the slope and y-intercept without using a computer. This is not something I will do often, but it doesn't hurt to have them practice that skill every once in a while for simple linear graphs.



Equation:

This might be the first time students have ever had to create a meaningful mathematical equation from a graph, so take lots of time to make sure they understand this process. They are hopefully all familiar at this time with the general form of a linear graph being:

$$y = mx + b$$

One of the main goals of this first lab is to introduce them to the idea that each of these letters has real physical significance.

Looking at the axes, they should see that the y is the mass of the system in grams and the x is the number of candies in the jar. So the equation becomes:

mass = slope*(number of candies) + y-intercept

We then want students to think about the meaning of the y-intercept. It will be the mass of the system when the number of candies is zero. Hence, the y-intercept is the mass of the empty jar and the equation becomes:

mass = slope*(number of candies) + mass of jar

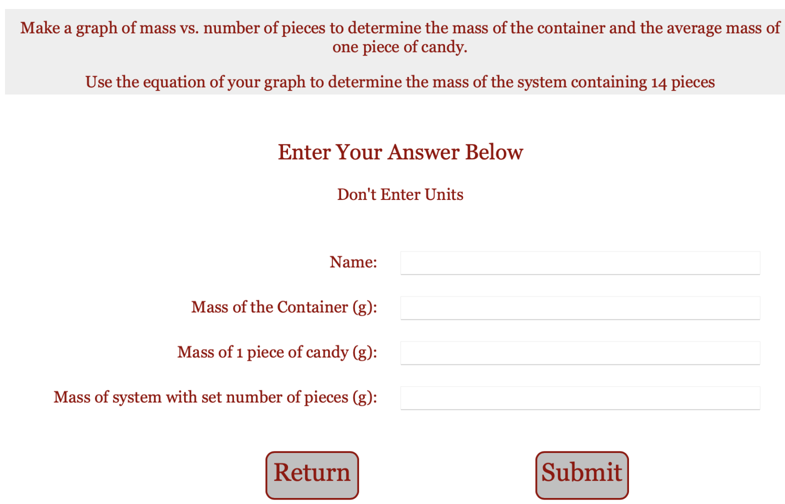
We then want students to think about the meaning of the slope. Have them recall that slope is Δy divided by Δx, which in this case would be the change in mass divided by the change in number of candies. So the slope would be grams per piece of candy. This gives us a final equation of

mass = (mass of one piece of candy)*(number of candies) + mass of jar

Checking their work:

Once the students have reached the point where they have graphed and created an equation, they will then be able to check their work. They should simply hit “Finished” on the program to be brought to a form they can fill out to see if they did everything correctly. Remind students that they all will be getting different answers and that they shouldn’t worry if their answers differ from those of their classmates.

They will be entering in the mass of their container (that is the y-intercept from their graph). Then they will enter the mass of one piece of candy (this is the slope of their graph). Finally, it will ask them to make a prediction on the mass of the system with a set number of candies in the jar. In the picture below it is asking for the mass with 14 pieces of candy. Again the number of pieces will be random and each student will have a different number to use. They will get this system mass by plugging their designated number of candies into the equation they created from their graph.


Make a graph of mass vs. number of pieces to determine the mass of the container and the average mass of one piece of candy.

Use the equation of your graph to determine the mass of the system containing 14 pieces

Enter Your Answer Below

Don't Enter Units

Name:

Mass of the Container (g):

Mass of 1 piece of candy (g):

Mass of system with set number of pieces (g):

Return

Submit

I would normally offer a small amount of extra credit added to the lab grade if they get all their answers correct. I would have them show me their completion certificate so I could record that they earned the extra credit. If a student doesn’t get everything correct, you can have them redo the lab by refreshing their page if time permits.

This lab was created by Frank McCulley for thephysicsaviary.com.

Live Part:

I always suggest a live lab counterpart to any virtual lab that you do with your students. Here are some suggestions for things you can do with the live part of your lab.

1. **Jar:**
    a. You want the jar to have a decent amount of mass so that you get a noticeable y-intercept for your graph.
    b. I personally use the glass jars from OUI yogurt from Yoplait. I just saved a dozen or so of these jars after eating the yogurt.
    c. Buying 4 oz (120 mL) canning (Mason) jars is also a great choice. The jars should be pretty uniform and you can seal up the candies in the jar to use in future years.
2. **Candies**
    a. I personally use a bag of M&M and they have worked very well.
    b. Be mindful of allergies and don't buy candies that could cause issues for some of your students.
    c. If time is a factor, precount the candies and have them in baggies that students can grab, use and then return for another group to use. Each group uses just one bag at a time.
    d. If you can afford it, buy small fun size bags that you can give to students who get good data. Don't let students eat the candies that are being used in the lab.
    e. In place of candies use marbles, pennies, or metal washers. Just make sure the objects you use are pretty uniform in mass.
    f. Setting up 8 Mason jars, each with a different number of candies and sealing them tightly at the end of the lab and storing them in a safe place will allow you to reuse the same candy for multiple years.
3. **Scale**
    a. Feel free to use whatever scales are available to you. If you don't have a triple beam balance, any type of scale that can measure grams will be fine.
    b. Worst case, get an electronic kitchen scale, but an analog scale is always better at teaching measurement and critical thinking skills.

Conclusion:

I personally like to have students write out a conclusion by hand after they are done the entire lab (live part and virtual part). Some things you can have students include in the conclusion.

1. **Restatement of the purpose.**
    a. This is a great way to open the conclusion
    b. It helps to reinforce the reason we were doing the lab.
2. **Brief Summary of the steps**
    a. I don't want too much here but I do want students to transition from the purpose to the results with a sentence or two summary of the steps.
    b. This part of the conclusion should paint with a very broad brush what type of data we were collecting and what remained constant when collecting data.
3. **Results**
    a. I want students to clearly state what type of relationship existed between the two variables we were examining.
    b. I want them to clearly explain what this means in simple to understand terms.
    c. Basically, they will be making sense of the equation they have discovered in the lab.
4. **Error**
    a. They should talk about their percentage of error from the lab (you can have them do this for the live part or the virtual part or both).
    b. They should brainstorm at least one possible source of that error and how it can be minimized if they redid the lab.
5. **Limitations to the model**
    a. Whenever possible I want them to think about when the mathematical model for the lab would break down and no longer apply.
    b. For instance, with this lab, at some point we are going to reach the volume limits for our jar and then the mathematical equation would no longer apply.

Going Further

If you have the time, you could challenge the students with the following types of things.

1. How would your graph change if you used the same jar, but you used a candy that had more mass? You can ask them to sketch a new line on the graph in a different color that would show how things would have changed if each piece of candy was more massive.

2. How would your graph have changed if you had used a lighter jar to hold your candy? You can ask them to sketch a new line on the graph in a different color that would show how things would have changed if a lighter jar was used.

3. Ask them how things would have changed if we didn't use a jar at all but instead just put the candies on the scale and got their mass.