

# Packing Density

A lab about optimal packing

## About the Lab:

The purpose of this lab is to give students a hands on demonstration of density and optimal packing for a constrained space. During the course of this lab students will attempt to create the most dense substance possible using a combination of different sized candies.

<b>Lab Materials:</b> Pixie Sticks Candy Nerds Candy Whoppers Candy 500 ml beaker Triple Beam Balance Calculators Paper Towels (Optional)	<b>Lab Times:</b> Initial Teacher Setup: 10 Minutes Explanation: 25 Minutes Exploration: 25 Minutes Discussion: 10 Minutes Total Lab time: 60 Minutes
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**Student group size:** 2 to 4

## Special Notes:

Do not allow students to apply pressure to the candy within the beaker. Not only is this cheating, but there is an increased risk of damage to materials or injury.

## Lab Procedure:

### *Initial Teacher Setup:*

Placed on students workspace prior to beginning will be the packaged candy, beaker, and calculator. A paper towel may be necessary to be placed under all material for a more hygienic workspace.

### *Explanation:*

1. Students will first be given a short reminder about density and how to calculate it. Solving a warmup problem to prepare them for all calculations pertinent to this lab. A sample problem could be the following:

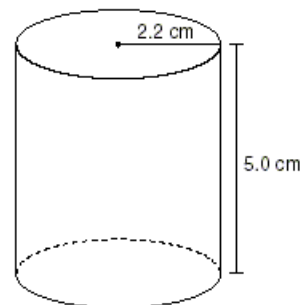
Calculate the density of the given cylinder. Your answer should be given in kg/ml. Students may use calculators to make this division easier.

### *Teachers Answer:*

$$\text{Volume} = \pi * r^2 * \text{height}$$

$$\text{Volume} = 76 \text{ cm}^3 = 76 \text{ ml}$$

$$\text{Density} = .23 / .76 = 0.3 \text{ kg/ml}$$



*Mass: 230 Grams*

2. Students will now be given instruction as to the lab. Letting them know that the goal of the days lab

is to not only create the most dense substance, but also to correctly calculate its density. To do this, students are to remove the weight of the beaker from the substance's density calculation. Before allowing students to open their candy and begin, they must first weigh the cylinder without any candy inside.

*Exploration:*

3. Students may now open their candy and begin the lab. A precaution may be necessary to be careful with their candy as if the cylinder is not packed sufficiently well on the first attempt, all contents may need to be emptied. In previous instances of this lab, students typically understood the problem and devised a near optimal solution after two to three attempts at creating a substance.

4. Once a substance is made and the students are happy with it, have them attempt to calculate its density. The volume should be easily calculated by reading the beaker and the mass can be calculated by using the triple beam balances again.

5. Students who are done and have successfully calculated the density of their substance may begin to eat the candy as a reward.

*Discussion:*

6. After everyone has finished construction of their substance. The winner can be announced. Allow the winner to describe the method they used to create their winning solution. Fill gaps in understanding as necessary.

7. If time permits, analogies to other packing problems may be appropriate. A short discussion of how this can be used to pack a suitcase or backpack may be pertinent. Focus on relating commonly packed items to its equivalent candy.