



Use Ratios and Proportions with PocketLab

Exploration

Barometric pressure is the pressure from the force or weight of air exerted on a surface.

The PocketLab's barometric pressure sensor measures the force of the air molecules that push against the sensor.

Objective

In this investigation students will:

1. Design a system that uses PocketLab's barometer and an understanding of ratios and proportions to build a scale.
2. Use the given supplies to find the weight of unknown objects.

Part 1: What is air pressure?

1. Connect the PocketLab sensor to your device.
2. Place the PocketLab inside the Ziploc bag.
3. Zip up the bag so it is nearly sealed, then blow air into the bag and seal it.
4. Select the Pressure graph in the PocketLab app.
5. Play around with the Ziploc bag and PocketLab.
Squeeze the bag to decrease its volume and observe the change in pressure. Let air out or add more in and observe the change in pressure.



Use your exploration of air pressure to answer the following questions with your group:

What is air pressure actually measuring? When the PocketLab has a greater air pressure reading inside the bag, what is happening to the air molecules inside the bag?

Part 2: How are volume and pressure related?

1. Refill your Ziploc bag with air if necessary.
2. Select the PocketLab's video function if available.
3. Record a short video where you decrease the volume of the Ziploc bag by squeezing it.
4. Review the video to answer the questions below:

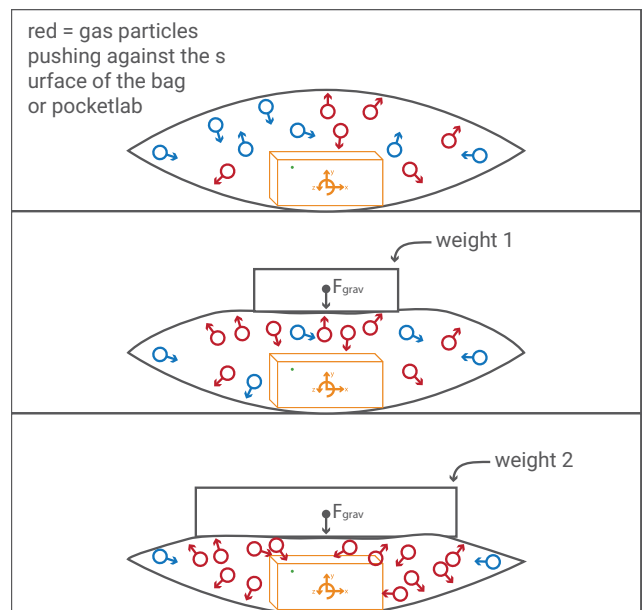
As volume decreases, air pressure _____ (increases or decreases)

Volume and air pressure are _____ (proportional or inversely proportional)

Part 3: Finding Weight with Air Pressure and Ratios

1. Refill your Ziploc bag with air and rest it flat on your table.
2. Place your 1lb weight on the Ziploc bag and record the pressure reading in the table. Place your 3 lb weight on the Ziploc and record the pressure reading in the table.
3. Pick five other objects of unknown weight. Place them on the Ziploc bag and record their pressure readings in the table.
4. Find the ratio between weight and pressure for the amount of air in your Ziploc bag. Use that ratio to find the weight of the other objects and complete the table.

Object	Weight (lbs).	Barometric Pressure (atm)
1lb object	1.00	
3lb object	3.00	



- What is the ratio between the weight of the object and the barometric pressure inside the bag?
- Weight on the bag and barometric pressure are _____ (proportional or inversely proportional).
- Weight on the bag and volume are _____ (proportional or inversely proportional).
- Write an equation that relates the weight on the bag to the barometric pressure inside the bag.

Part 4: Graph the relationship

1. Graph the data from the table above.



2. Find the slope of the line in your graph. How does it relate to the ratio between the weight of the object and the barometric pressure inside the bag?
3. How does the slope of the line relate to the relationship (directly proportional or inversely proportional) between weight and the barometric pressure inside the bag?
4. How could you change the ratio between the weight on the bag and the pressure inside the bag? How could this cause error in finding the weights of the unknown objects?

Engineering Extension: Design a Smart Garbage Can

Problem

Standard 8-10 gallon office or kitchen garbage bags can typically hold about 10 lbs of dry weight. When too much weight is added to the bags they can tear or break easily when handled.

Design

Create a solution using the PocketLab barometric pressure sensor that will tell you at all times how much weight is in a garbage bag. The solution must allow for the weight to be known while the garbage bag is in a can. Your solution will help people know when to take out the trash so the bag doesn't break.

Build

After agreeing on the design with your group, build your Smart Garbage Can.

Optimize and Redesign

After building your solution, test the accuracy of your data. You can use a scale to compare the actual weight of the garbage bag with the data the PocketLab is collecting. After your test, find ways to improve and optimize your design. Rebuild your solution to incorporate your improvements.

Share

When you are satisfied with your design, create a comprehensive list of materials used and a set of instructions for others to build your Smart Garbage Can. Collect and test the data from your solution using different amounts of weight and multiple trials. Write a summary of your solution that includes the decisions and challenges that went into your designs and builds. Be sure to include a description of the accuracy of your solution.





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TEACHER GUIDE

Example design for Engineering Extension: Design a Smart Garbage Can

Step 1

Connect a syringe to a sealed beaker using a plastic tube. Place the PocketLab inside the beaker so it can measure the air pressure in the apparatus.

Step 2

Attach the syringe to the inside wall of a garbage can so the plunger is facing up. When weight is added to the top of the syringe it will be pushed down, increasing the air pressure inside the apparatus.

Step 3

Using cardboard, make a plate for the garbage bag to rest on. Attach the plate/cardboard to the top of the syringe.

Step 4

Add known weights (1 lb, 3 lb, etc.) to calibrate how much pressure in the apparatus equals different amounts of weight. Determine how much pressure equals 10 lbs of weight. Empty the garbage can when the PocketLab reads that amount of pressure.