Pressure Pumper Kit

P1-2060

INSTRUCTIONAL GUIDE

Contents

- 15 Pressure Pumpers
- 15 Liquid Crystal Strip Thermometers
  - 14 – 31°C (58 – 88°F)
- Instructional Guide with 3 activities

Other items required:

- 2 L and 20 oz plastic bottles (ask students to bring them from home)
- Balance accurate to 0.1 g
- Safety Glasses (C5-1030)

Background

The attached activity sheets are designed for middle school students; however, the activities can be easily adjusted for most any level of instruction. Teachers purchasing the Arbor Scientific Pressure Pumper Kit may copy these pages as needed. Not for distribution.

CAUTION: Unscrew the Pressure Pumper VERY SLOWLY while bottles are under pressure. Do not remove completely until the pressure returns to normal. Please use protective eyewear at all times.

Related Products

Vacuum Pumper Classroom Set (P1-2160) This affordable set of hand vacuum pumps and specially designed chambers that have a wide mouth let students test the effects of reduced pressure on many different objects, such as marshmallows. Classroom set includes 6 Vacuum Chambers and Pumpers, 6 Temperature Strips and teachers data sheet and student activity sheet.

Advanced Gas Laws Demo (P1-2065) Quantitatively confirm the Combined Gas Law with one complete apparatus! Students can verify this relationship using air and this unique apparatus.

Fire Syringe (P1-2020) A smokin' example of an adiabatic process. Using the Fire Syringe to compress air into a smaller volume is a classic example of how rapidly doing work on a gas results in an increase in temperature.

Acknowledgement

Thanks to Stu Schultz of Physics Pharm Consulting Services, Detroit, Michigan for contributing these labs.

Weighing Air

1. Attach a Pressure Pumper to a two-liter pop bottle.
2. Measure the mass of the bottle to at least the nearest 0.1 gram. Record the mass in the table below.
3. Pump the Pressure Pumper 25 times.
4. Repeat step 2.
5. Pump the Pressure Pumper another 25 times.
6. Repeat step 2.
7. Repeat this process until you have 225 total pumps, recording the mass of the bottle each time.
8. Release the pressure by slowly removing the Pressure Pumper and find the mass a final time.
9. Calculate the mass gained (or lost) during each step.

Pumps	Mass (g)	Mass gained
0		
25		
50		
75		
100		
125		
150		
175		
200		
225		
Release		

Theory:
Air is composed of atoms and molecules. The atoms and molecules have mass and occupy space. Therefore, air is matter. Why can't we see it if it has mass and takes up space? The atoms and molecules are very small, and have a lot of space between them. (The molecules in your desk, on the other hand, are much closer together.) Why can't we feel the mass when we hold air in our hands? The mass of the atoms and molecules in air is very small. You have to collect a lot of atoms and molecules in one place to detect their mass. This activity used the Pressure Pumper to force a lot of air into a small container. The change in the mass of the container represents the mass of air that you pumped in.

Questions:

1. Why can't you see air?

2. Why can’t you feel the mass of air in your hand?

3. How many grams of air did you add to the bottle?

4. If it took 225 pumps to add that many grams of air, what is the mass of air in 1 pump?

5. Name an object, if you can, that has a mass approximately that size.

Pressure and Temperature

1. Put a temperature strip (58-88 °F) in a clean dry 20 oz. pop bottle.
2. Record the temperature in the bottle: _____
3. Put the Pressure Pumper on top of the bottle.
4. Pump the Pressure Pumper 100 times. What is happening to the pressure in the bottle?

5. Record the temperature in the bottle: _____
6. What happened to the temperature in the bottle?

7. While watching the temperature strip, unscrew the Pressure Pumper. What happens to the temperature as the pressure is released?

8. State the relationship between the pressure of a gas and its temperature.

9. A student got a large balloon at the store. She walked home with the balloon on a very cold day. What do you think happened to the balloon as she walked? Explain your reasoning.

Extension Activity:

1. Repeat steps 1-4 from the previous activity. Record the unpressurized and pressurized temperatures.

   Unpressurized temperature _____ Pressurized temperature _____

2. Let the pressurized bottle sit until it returns to the unpressurized temperature. What is happening to the heat energy that was in the bottle?

3. When the bottle has returned to the previous temperature, release the pressure. Record the new temperature. _____

Theory:

This is the principle behind refrigeration. A gas is compressed, it heats up, and that heat energy is released into the environment (out of the air conditioning unit, or out of the back of the refrigerator). The cooled, compressed gas is allowed to decompress, and it cools to an even lower temperature. The expanding gas absorbs heat from the area being refrigerated. As demonstrated here, air works for this process, but it cannot carry much heat at a time. Special refrigerant gases are used in air conditioners because they are more efficient in moving heat through this process. If you ever let air out of your car tires, feel the air that is escaping. It feels cold!

4. If you left the door open on the refrigerator, would the whole room get cooler? Explain.

Cloud Machine

1. Add a little water to a 20-oz. pop bottle.
2. Light a match and blow it out. Hold it inside the mouth of the bottle and let some of the smoke go in the bottle.
3. Put the Pressure Pumper on top of the bottle.
4. Pump the Pressure Pumper 100 times. What is happening to the pressure inside the bottle?

5. Release the pressure by slowly unscrewing the Pressure Pumper. Carefully watch the air inside the bottle. What happens?

Theory:
As you increased the pressure in the bottle, you also increased the temperature. When the pressure was released, the temperature decreased. The water vapor in the air in the bottle, when cooled suddenly, condensed into water droplets. These water droplets could be seen as a cloud.

The smoke in the bottle acts as a condensation point, something for the water molecules to stick to. Small particles such as those in smoke are called aerosols. An aerosol is about 1000 times larger than a water molecule. A water droplet (like in a cloud or fog) is 20 times larger than an aerosol and a raindrop is composed of about 100 droplets.

Questions:

1. What happens to water vapor as it cools?

2. What is the purpose of the smoke?

3. Why does fog form more often in the early morning than any other time?