Vacuum Pumper Classroom Set

P1-2160

INSTRUCTIONAL GUIDE

Contents

- 6 Vacuum Pumpers
- 6 Vacuum Chambers
- 6 Liquid Crystal Temperature Strips (58-88˚F)
- 3 Activities

Other Required Items:
- Balloons
- Ruler
- Permanent marker

Other Optional Items:
- Marshmallows
- Hypodermic Syringe
- Datalogger

Activities

The attached activity sheets are designed for middle school students; however, the activities can be easily adjusted for most any level of instruction. Some lesson ideas were contributed by Mark Graham of the University of Alabama.

Teachers purchasing the Arbor Scientific Vacuum Pumper Kit may copy these pages as needed for their students. Not for distribution.

Related Products

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.

Hand-Held Vacuum Pump (P1-5201) The Hand-Held Vacuum Pump an essential equipment for your physics or physical science classroom.

Piezo Buzzer in Vacuum Chamber (97-6600) A modern replacement for the traditional Bell Jar and Ringer. An acrylic chamber houses a battery-operated, high output piezo sounder. When the end plates are attached and the unit connected to a vacuum pump no sound can be heard but the sound returns when the air is allowed back in.

Name: __________________

Pressure and Volume

1. Blow up a balloon so that it fills less than half of the chamber.
2. Using a ruler, draw a line 1 cm long on the balloon.
3. Put the balloon in the chamber. Use the vacuum pump to remove as much air from the chamber as you can.
4. Observe the balloon. What do you observe about its size?
5. Use the ruler to measure the length of the line you drew (without removing the balloon from the chamber). How long is it now? ______cm
6. Press on the sides of the stopper to let the air back in. Describe what you observe.

Theory:

A balloon grows bigger because of the air you blow into it. The air pushes out on the balloon walls. There is also air on the outside of the balloon, pushing in. When you remove some of the outside air, it is easier for the inside air to push the balloon walls out, and the balloon expands.

Questions:

Please answer on the back or on a separate sheet.

1. You drive into the mountains for a picnic. While unpacking for the picnic, you discover that the bag of potato chips you brought has blown up like a balloon. What happened?
2. You go on a trip to Hawaii. In your bag, you pack a half-full bottle of shampoo. Your bag gets tossed into the cargo hold of the jet so that the bottle is upside down. During the flight, the pressure in the cargo hold is much lower than it was on the ground. What will happen to your shampoo?
3. What would happen if the bottle of shampoo was completely full?

Extension Activities:

Please answer on a separate sheet.

1. Try other objects in the chamber, such as marshmallows and marshmallow-filled cookies.
2. If you have a small hand-held datalogger, try the following quantitative activity:
    a. Draw some air into a hypodermic syringe and seal the end by melting the plastic. Make sure the syringe has room to expand in the vacuum chamber.

b. Record the initial volume of air in the syringe.

c. Set the datalogger to measure barometric pressure for one minute.

d. Start logging data, and place the sealed syringe and the datalogger in the chamber.

e. Use the pump to reduce the pressure in the chamber. Observe the syringe. Record the final volume of air in the syringe.

f. Remove the datalogger. Examine the pressure data and record the initial and final temperatures. (If the pressure went below the lower limit of the logger, repeat the experiment with less pumping.)

g. Depending on the students' skills, they can simply make a graph of pressure vs. volume and examine the relationship, find the slope of the line and write an equation for the relationship, or introduce the ideal gas law (PV=nRT) and compare the law to experimental data.

h. Devise ways to obtain more than two data points in this experiment. Is the relationship between pressure and volume linear?

Name: __________________

Pressure and Temperature

1. Put a temperature strip (58-88 °F) in the vacuum chamber.
2. Record the temperature in the chamber: ____________________
3. Put the Vacuum Pumper on top of the chamber.
4. Pump the Vacuum Pumper 30 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, press on the sides of the stopper to release the vacuum.
8. What happened to the pressure in the chamber?

9. What happens to the temperature in the chamber?

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

11. 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 temperatures before and after using the vacuum pump.

   Temperature before vacuum: ____________________

   Temperature after vacuum: ____________________

2. Let the vacuumed chamber sit until it returns to its previous temperature. Is heat entering or leaving the chamber?

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

4. How does this temperature compare to the temperature in the room?

5. Explain how you could use what you observed to decrease the temperature in a room.

Name: ___________________

Boiling Water with Pressure

1. Put a 250 mL beaker of water in a microwave until it boils.
2. Remove the beaker. What happens to the boiling?
3. Pour the water in the vacuum chamber. Use the vacuum pump to remove some of the air from the chamber. What happens to the water?
4. Wait a few seconds, for the boiling to stop. Use the vacuum pump to remove more air from the chamber. What happens?

Theory:

Water boils when some of the molecules get enough energy to escape from the surface. Adding heat to the molecules normally gives them the energy they need to escape. When you decreased the air pressure on top of the water, you made it easier for water molecules to escape, and the water could boil at a lower temperature. Water, once allowed to boil, will not increase in temperature. Any part of the water that exceeds the boiling temperature (for the pressure at that location) will vaporize and leave the container.

Questions:

Please answer on the back.

1. What would you do if you wanted to cook something in water at a temperature higher than its normal boiling point?
2. Why are cooking directions sometimes different for people who live at high altitudes?
3. If you were cooking spaghetti on Pike's Peak, would it take more or less time than in Death Valley? Explain.

Extension Activity:

1. Repeat the experiment, and add a thermometer to the water in the chamber.
2. What is the lowest temperature at which you can get the water to boil?