# Are You Under Pressure?

## A Simple Pressure Demonstration

### Introduction

Have you ever wondered why the Earth's atmosphere is sometimes referred to as an "ocean of air"? Should the word ocean be used to describe a gas? Could this ocean of air also be the specific cause of structures and functions of various species? Test your students' powers of observation and deduction by doing this inexpensive exercise.

### Concepts

- Pressure
- Gases
- Atmospheric pressure

### Background

By definition, a fluid is a substance that flows, conforms to the shape of its container, yields to pressure, and exerts pressure on its surroundings. Fluids consist of molecules that are in continuous motion and this motion leads to collisions with other molecules in the environment. As a result, pressure (force) is applied to any object immersed in the fluid. Based on this information, both liquids and gases are considered fluids. In the fluid ocean, pressure increases as depth increases because the amount of fluid above an object increases. In the fluid atmosphere, pressure decreases as altitude increases because the amount of fluid above an object decreases.

Although our atmosphere (which includes the air we breathe) is largely invisible, we are very aware of its effects. For example, all wind, from gentle breezes to tornados and hurricanes, is a result of differences in air pressure. Understanding these differences is essential for accurate weather forecasting.

On a much smaller and more personal level, our ability to drink through a straw or draw a piece of cooked spaghetti into our mouths is a result of the difference between the air pressure on the outside versus the inside of the mouth. When the pressure inside the mouth is reduced, relative to the outside, the greater pressure pushes the liquid in the straw or the spaghetti into the mouth. There are many well-known objects from everyday life that require a pressure higher than the atmosphere to function properly. Bike and automobile tires, inflatable toys, many types of sporting equipment, and the pressurized cabins of modern aircraft are all good examples of greater than atmospheric pressure.

Demonstrating the effects of air pressure in a classroom can help students understand how pressure influences their daily lives. One of the effects of high pressure, for example, may be shown simply by blowing up a balloon until it pops. The instructions outlined in this *BioFax* will help illustrate the effects of low pressure by blowing up a balloon inside a flask. Is that possible? Perform the following procedures and find out!

### Materials

Balloons, 11″ diameter, 3–4
Filtering flasks, 1000-mL, 2
Flexible-neck straw
Small stopper, cork, size 0
Tubing, rubber or clear plastic tubing, 1½″ long (5⁄16″ i.d.)

## *Safety Precautions*

*Although the materials in this activity are considered nonhazardous, follow all normal laboratory safety procedures.*



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## Preparation

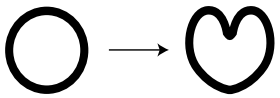

**Figure 1.**

1. Cut one inch off the end of the straw closest to the flexible neck.
2. Holding the short end of the straw in your hand, push down on one side of the straw until a "V-shape" is formed. (See Figure 1.)
3. Lower the straw into the flask and insert the short, folded end of the straw into the sidearm of the filtering flask.
4. Cut a 1½″ piece of tubing (5⁄16″ i.d.) and push the tubing over the first flange of the flask's sidearm.
5. Blow up a balloon to stretch it out then put the balloon inside the flask and stretch the open end over the top.
6. Make a tight seal with your mouth and blow into the balloon until fully inflated. Maintain the seal while the stopper is placed into the tubing on the side arm. (See photo.)
7. Hide this flask until steps 1–4 below have been completed.

## Procedure

### Part 1

1. Ask a student, preferably one large in stature, to assist in the demonstration.
2. Show the students a regular (unaltered) filtering flask.
3. Stretch a balloon across the opening.
4. Ask the volunteer to blow into the balloon and inflate it inside the flask. When the volunteer cannot do it, ask for one or two more volunteers who believe they can blow up the balloon. *Use a fresh balloon for each volunteer!*
5. Reveal the other flask with the inflated balloon inside. *Note:* Hold the flask in such a way that students do not *readily* see the straw, tubing, and stopper.
6. Allow students time to answer Discussion Questions *a–c* on a separate sheet of paper, and then discuss their answers.

### Discussion Questions

*a.* Why could the balloon not be inflated inside the first flask? (Be specific!)

*b.* What do you think allowed the balloon to inflate in the second flask?

*c.* Why does the inflated balloon appear to have a visible "head" and "neck"?

### Part 2

7. Insert a pencil into the opening in the balloon to show that it is completely open to the air, yet it stays inflated.
8. Allow students time to answer Question *d* on their answer sheet, then discuss.

*d.* How might the inflated balloon be deflated? (Be specific.)

### Part 3

9. Deflate the balloon by removing the small stopper.
10. Reinflate the balloon and replace the stopper in the tube.
11. Allow students time to answer Question *e* on their answer sheet, then discuss.

*e.* Explain now how the balloon was able to be inflated.

**Part 4**

11. Fill the balloon at least half full with tap water.
12. Allow students time to answer Question *f* and *g* on their answer sheet.

*f.* Suggest a hypothesis for removing the water without turning the flask over.

*g.* Why do you think your hypothesis will work? (Be specific.)

**Part 5**

13. Ask students to observe carefully as the stopper is removed from the tube.
14. Have students answer questions *h* and *i* on their answer sheet, then discuss.

*h.* Explain your observation of the balloon and the water.

*i.* Was your hypothesis (letter *f*) supported? Why or why not?

## Tips

- As a beginning demonstration, insert a plastic bread bag cut in half or a large zipper-lock bag into a wide-mouth jar. Fold the top of the bag over the rim and secure it with a thick rubber band to make an airtight seal. Have students try pulling the bottom of the bag out of the jar.
- The final demonstration with the water inside the balloon is best done outside. Otherwise, you may be mopping up water because a "geyser" is created when the stopper is removed.
- Practice Part 5 of this demonstration with different amounts of water to determine how much will create the biggest geyser.
- A faucet aspirator or vacuum pump attached to the flask can also be used to inflate the balloon. As air inside the flask is removed, ask students to describe what they observe.
- Another great visual demonstration is the "Atmosphere Bar." Measuring 1″ × 1″ × 52″ and weighing 14.7 lbs., it is identical to atmospheric pressure.

## Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

***Unifying Concepts and Processes: Grades K–12***
Evidence, models, and explanation

***Content Standards: Grades 5–8***
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, understanding of motions and forces
Content Standard C: Life Science, structure and function in living systems
Content Standard D: Earth Science, structure of the Earth system

***Content Standards: Grades 9–12***
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, motions and forces

## Materials for *Are You Under Pressure?* are available from Flinn Scientific, Inc.

| Catalog No. | Description |
|---|---|
| GP4074 | Flask, Filtering Pyrex®, 1-L |
| AP8285 | Rubber Tubing, Black, 109 length, 5/160 i.d. |
| AP1900 | Balloons, Latex, 110 diameter |
| AP8300 | Cork Stopper, Size 0 |
| AP5882 | Atmosphere Bar |

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.