APPENDIX C
AIR PRESSURE AND BAROMETERS

OBJECTIVES

The students

- Explore the meaning of high and low pressure using a balloon-and-bottle system.
- Make barometers.

BACKGROUND

This activity should be done along with Activity 4.4 WEATHER PREDICTION. The barometer provides information for the study of general weather patterns and the details of weather fronts.

Mercury Barometers

Barometers are used to measure changes in air pressure. Air pressure is reported in several units. Classically it is reported in centimeters or inches of mercury. Average sea-level air pressure is 76 cm or 30 inches of mercury. This means that on an average day the air above us pushes mercury 76 cm up into the evacuated glass tube of the barometer. Any reading below 76 cm we consider a *low* reading. Anything above 76 centimeters we call a *high* reading. See Figure 1.

Demonstration

To demonstrate what a barometer measures and how it works, have the students fill a balloon with just enough air to give it shape. Have them tie the end of the balloon so that the air cannot escape and then place the balloon in a clear glass 12-oz juice bottle. Challenge them to shrink the balloon using air alone. They can use their mouth to act as a pressure or vacuum pump. If they put their mouth over the open end of the bottle and force air into it, the balloon will shrink. They will have created a *high-pressure* region around the balloon.

Next challenge the students to expand the balloon, again using only air. They can do this by pulling air from the bottle with their mouth. They will have created a *low-pressure* region around the balloon.

A wonderful anomaly develops when a light plastic soda bottle is substituted for the glass container. The system will work to shrink the balloon under pressure, but the bottle will collapse instead of the balloon as air is withdrawn. This helps to demonstrate that atmospheric air is pushing on the bottle.

Tin-Can Barometer

The tin-can barometer the students make will work the same way the balloon in the bottle did. The barometer should have a flexible diaphragm. This can be made of light, non-porous (non-breathing) plastic wrap or a piece from a large rubber balloon or glove. The diaphragm should not be stretched too tightly. In the middle of the diaphragm a long skewer is attached to the plastic by tape. The diaphragm seals air in the tin can.

When the air pressure outside is higher than the pressure inside the can, the diaphragm will be pushed in and the skewer will move up. When the pressure on the outside of the can is lower than the pressure on the inside, the diaphragm will push up and the skewer will move down. See Figure 2. You may want to have a prototype barometer made ahead of time.
After the barometer has been tested, the rim of the can lid can be sealed. This will further help prevent the loss or entry of air. Having the students use cans of different sizes provides an interesting exploration of the movement of the skewer.

Standardizing Barometers
To standardize the barometer, contact the local office of the local Weather Service and ask whether the barometric pressure is high, low, or normal or check a commercial barometer if available. Build barometers on a day when the pressure is normal. Air in the can on this day can be considered captured normal air. Any reading greater than this is a high; anything lower, a low. This simple three-point differentiation is enough for grade four work and will not exceed the limits of the instrument. Encourage interested students to further refine the scale.

Barometer Maintenance
The barometer diaphragm should be replaced periodically. Before the old barometer wears out, build a new one and standardize it with the older version. It may be helpful to find students who like instrument construction and have them handle the problem of regular replacement.

STUDENT ROLES
Meteorologist
Equipment engineer

MATERIALS
wide-mouthed 12-oz glass juice bottles
12-oz or larger plastic soda bottles
small balloons
tin cans with plastic lids
plastic wrap (non-breathing) or rubber sheeting from a large balloon or surgical glove
skewers
plastic tape

PRODUCTS
Tin can barometers

PROCEDURES

1. **After the students have noted that weather maps show high- and low-pressure areas, try to determine their understanding of the terms.**
   Ask such questions as
   - Has anyone seen the terms *high* and *low* on weather maps or heard weather reporters refer to them? What is meant by a high?
     ✔Work for such ideas as it is a high-pressure area or the air above us is pushing down on us more than average. Don't go beyond the students' existing knowledge.
   - What is meant by an atmospheric low?
     ✔Probe for such ideas as it is a low-pressure area, and the air above us is pushing down on us less than average. Again, don't go beyond the students existing knowledge.

2. **Have the students explore making a balloon-in-a-bottle system. Place a slightly filled balloon in a bottle and give them the following challenges.**
   - **Challenge 1.** With air alone can you cause the balloon in a glass bottle to shrink? Have the students explore and demonstrate their results.
   - **Challenge 2.** With air alone can you cause the balloon in a glass bottle to expand? Have the students explore and demonstrate their results.
   - **Challenge 3.** With air alone can you cause the balloon in a plastic bottle to shrink? Have the students explore and demonstrate their results.
   - **Challenge 4.** With air alone can you cause the balloon in a plastic bottle to expand? Have the students explore and demonstrate their results.
   - Have the students explore their own problems.

3. **Discuss the explorations.**
   Ask such questions as
   - What did you have to do to get the balloon to shrink?
   - What did you have to do to get the balloon to expand?
   - What was the difference between using a glass container and a plastic container?
     ✔Work for agreement that the glass container did not collapse when the air was withdrawn, but the plastic container did.
   - How might you explain the difference between the reaction of the balloon in the plastic and glass bottles when you withdrew air?
     ✔Work for the idea that because the plastic bottle collapsed, it appears that something was pushing on it. This something seems to be air pressure.
   - Which of the challenges produces a high-pressure area?
     ✔Work for the ones where air is pushed into the bottle.
   - Which of the challenges produces a low-pressure area?
     ✔Work for the one where air is pulled out of the bottle.)
   - What else did you observe?

4. **Show a prototype for a barometer and have the students work in groups to make their own.**

5. **Have the students use local Weather Service information on highs and lows to check high and low pressure on their barometers for a week.**
   - Check to be sure that instruments are not leaking and are registering changes.
   - At the end of the week select a class standard barometer and seal it.
   - Periodically replace the existing barometer with a new one standardized using information from the local Weather Service.

6. **(Optional.) Have the students add barometer readings to their daily weather data collection.**
   Help them to observe that
   - High pressure areas often follow low pressure area.
   - High pressure is usually associated with fair weather.
   - Low pressure areas are often stormy.

ILLUSTRATIONS

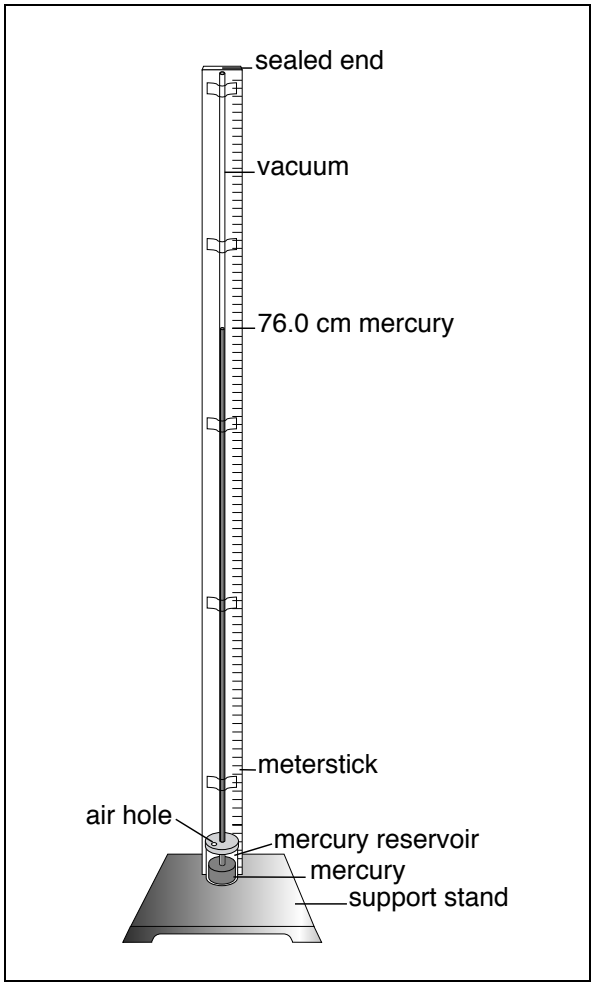

Figure 1. A mercury barometer

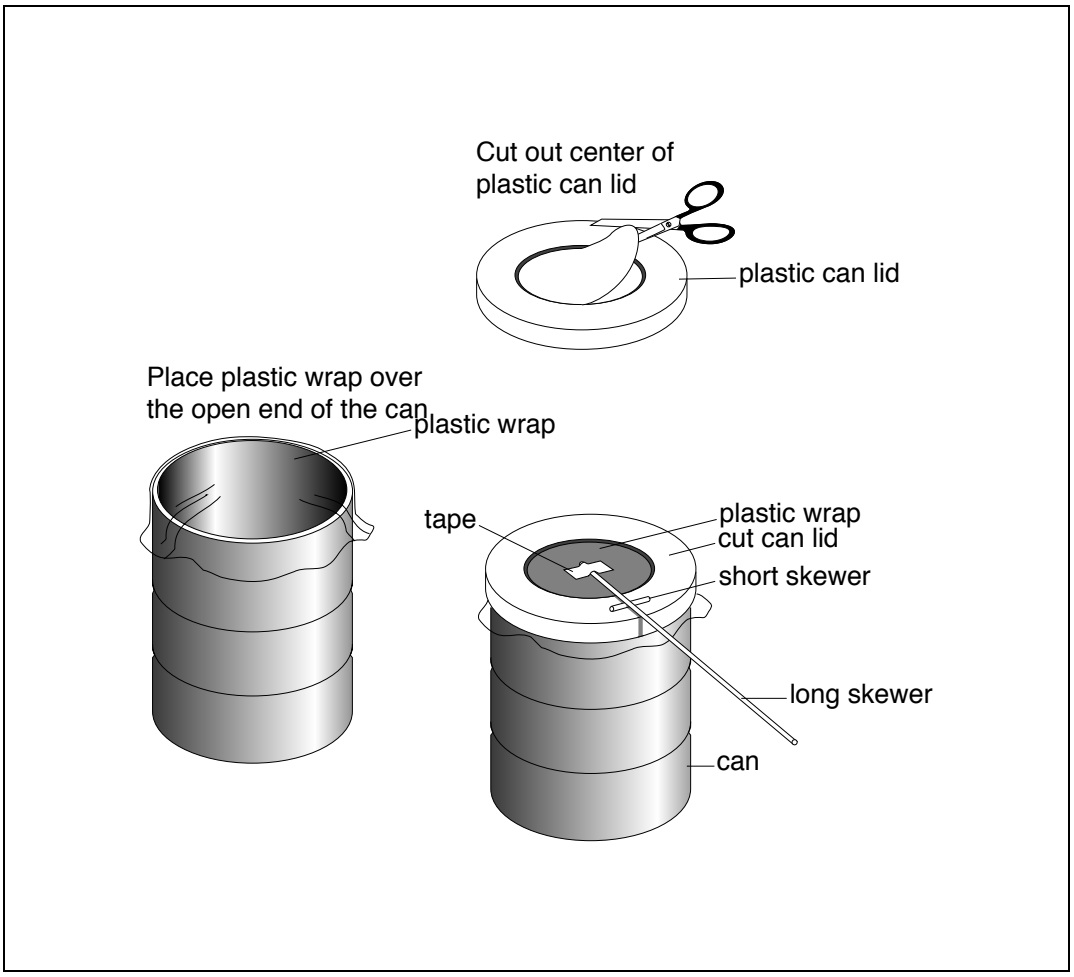

Figure 2. A tin-can barometer