Chapter 6. Constructing a Barometer: A Structured Inquiry Activity

Think About This!

In the previous activity, you constructed the fundamental parts of a barometer. What additional steps are necessary to create a fully functioning barometer? What other parts are necessary? What important part is missing?

How could you validate the accuracy of your barometer?

Probing Further

Examining the difference in the pressure of cold air and warm air. The following are instructions for a student activity, but they can be modified to use as a demonstration.

Objectives for the Learner (Essentials of Inquiry)

Conceptual Theme: To develop a basic understanding of the relationship between temperature and pressure and that a barometer can be constructed to detect this relationship.

Content: Developing basic information relating to how temperature change affects a mechanical response in a barometer, to record such changes and the importance of this instrument to the basics of meteorology.

Skills: The focus is on handling laboratory equipment, making careful observations, recording pressure differences, drawing conclusions, and describing and communicating results.

Scientific Habits of Mind: The importance of careful observations, respect for data, verifying results and performing experiments safely.

Materials

Use one of the two jars prepared previously to construct a barometer by adding the following materials. (Students must complete the previous activity first.)

Metal ring for the pint canning jar

Small stick (wooden or plastic coffee stirrer)

Quick-drying glue

Wood block
2.5 cm thick × 7.5 cm wide × 20 cm long
(1 in. thick × 3 in. wide × 8 in. long)

Ruler (plastic or wooden)
NOTE: The units of measure on the ruler are not important.

Small nail with large head

Hammer

Small drill, screwdriver, or sharp object to make hole in metal ring

For the Teacher: Procedure for Completing the Construction of the Barometer

Because of safety concerns, it is recommended that the teacher complete this procedure (as shown in Figure 6-1) for the student prior to the activity.

Select one of the jars and cut a small slot (just wide enough to accommodate the passage of the wooden stick) near the very top of the metal jar ring by using a small drill or some sharp object to make the hole and then enlarging it with a small screwdriver or similar object.

Place a drop of quick-drying glue in the center of the balloon stretched over the canning jar.

Thread the wooden stick through the hole at the top of the metal jar ring.

Loosely screw the metal lid onto the glass jar (do not tighten).

Place one end of the wooden stick into the drop of glue at the center of the balloon and let it dry.

Make a barometer stand to measure the movement of the indicator (wooden stick) by nailing the ruler to one end of the wooden block as shown in Figure 6-1.

NOTE: At this point, the units of measure on the ruler are not important. It is the general movement of the balloon and stick in response to the warm and cool environments that are key.

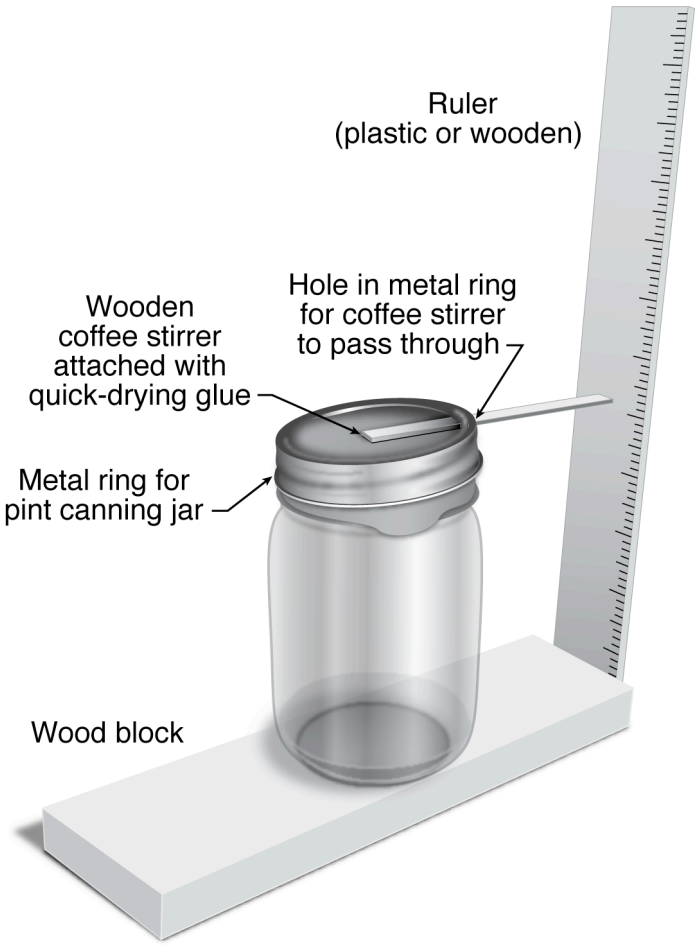

Figure 6-1. Assembled barometer.

Procedure

The purpose of this activity is to verify that warm air exerts less pressure (weight) on the balloon than cool air, as indicated by differences in the barometer readings when the indicator rises and falls.

Assemble the barometer as shown in Figure 6-1.

Place the barometer on the barometer platform with the unattached end of the wooden stick near the ruler. Leave a small space between the end of the indicator and the ruler.

Record the position of the unattached end of the wooden stick. (Note position on ruler.)

Place the barometer in a warm environment, such as near a heat lamp, and make careful observations. Record the results.

Next, place the barometer in a cool environment, such as in a refrigerator or in a container of water and ice, and make careful observations. Record the results.

Examining Results

The important outcome of this activity is to observe that when warmer air inside the jar expands, the indicator moves downward on the scale (inferring less pressure, less weight). On the other hand, when cooler air inside the jar contracts, the indicator moves upward on the scale (inferring more pressure, more weight).

The learner should arrive at the conclusion that warmer air exerts less pressure and cooler air exerts more pressure on the balloon. This foundation is necessary to better understand more complex phenomena later.

Describe your observations related to this activity.

The learner should describe the motion of the stick (indicator) in relationship to the movement of the balloon.

In what way did the movement of the indicator differ in the two environments? How do you account for this difference?

The indicator moved in opposite directions as the diaphragm contracted or expanded responding to the change in pressure due to warming and cooling.

Do you think that the weight of air has anything to do with this difference? Why? Why not?

The learner might logically infer that the warm air weighed less than the cooler air, but more information is needed to verify this fact.

Conclusion

The learner should base the conclusion on the results of the data, but it would be logical to infer that warmer air is lighter per volume but expands and pushes with less force on the balloon.

Going Further

The learner could confirm the results by repeating this activity several times. He/she could vary the temperature of the environment to see what differing results could be obtained.

Challenge

Have the learner suggest ways that the barometer's accuracy could be validated and thus further confirm the obtained results. One way to do this is to repeat the procedure using the constructed barometer and a manufactured barometer.