UNLOCKING SCIENCE HANDS ON!

BAROMETER IN A BOTTLE

Evangelista Torricelli, a pupil of Galileo, invented the first barometer in 1643. Barometers are tools used to measure the air pressure, also called barometric pressure. We use them to predict weather based on whether the pressure is rising or falling. Rising pressure generally indicates warm, calm conditions are ahead. Weather conditions during periods of high pressure may include clear skies, little or no wind, and fair weather. Falling pressure generally indicates cooler, stormy conditions are in the future. Weather conditions during periods of low pressure may include increased cloud cover, rain, or snow.

Provided below are the directions to construct a wet barometer and/or a dry barometer. It is recommended you construct both types so you can compare the results.

Homemade barometers will give you a relative pressure to begin evaluation the day you make them, so you will be able to see whether the pressure is higher or lower compared to the initial reading. You could calibrate it by adding marks and recording the air pressure from a scaled barometer or the value from a weather station.

Construction of these barometers involves cutting various materials, so adult supervision is recommended.

Extra Family Fun: provide an empty bottle by using a full bottle of root beer to make some ice cream floats for everyone to enjoy before the activity.

Wet Barometer

Supplies

- 1-liter or 20-oz plastic bottle
- 12-inch piece of clear tubing
- 4 x 12-inch piece of cardboard or cardstock
- Clear packing tape/transparent tape
- Scissors/utility knife
- Ruler
- 1 piece of chewing gum or small ball of clay
- Permanent marker–fine tip
- Food coloring
- Water

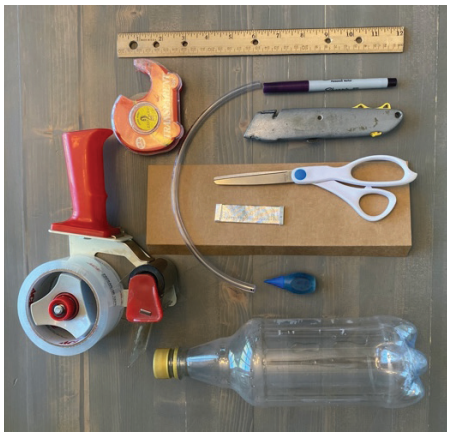

Figure 1: Supplies

Construction

1 Fold the cardstock/carboard about 1 inch down the long side to make a flap to tape to the bottle

2 Create a barometer scale using the ruler and the permanent marker by drawing hash marks, ½ cm or ¼ inch apart, on the left side of the cardboard along the fold starting from the top down about 20 cm or 8 inches. See Figure 2. Set aside for later.

Figure 2

3 Using the ruler, measure 15 cm or 6 inches from the base of the plastic bottle and cut a small x-slit in the bottle using the utility knife or scissors. If the bottle has a taper, make the hole above the taper.

4 Pour water into the plastic bottle approximately 3 cm or 1 inch below the slit.

5 Dye the water with a 6–8 drops of dark food coloring and gently swirl.

6 Screw the top on the bottle, but leave it loose.

7 Insert one end of the plastic tubing into the slit on the plastic bottle. The plastic tubing should not be touching the bottom of the plastic bottle. See the Figure 2.

8 Similar to a straw, draw some water into the tube about ⅔ full. Use your tongue to trap the water in the tube. You can also do this by sticking the tubing into the bottle so you have just enough of the tip sticking out to attach the clay plug.

9 Cap the tube with a piece of chewing gum or roll a small ball of clay.

10 Stick the end of the tubing with the chewing gum (or clay ball) near the top of the cardstock (barometer scale), lining up the water level with one of the lines in the middle of the scale.

11 Mark the height of the water in the tube on the scale with an X so you will know your starting measurement. Record the barometric pressure at the time you made your barometer.

12 Record the height of the water in the tube on your weather log.

13 Place your barometer in a spot that will not receive direct sunlight or have temperature extremes. A garage shelf works well.

Reading the Barometer Scale

To read the barometer scale, observe the liquid in the tubing. As the air pressure changes, you will see the level of the liquid changing inside the tube. As the air pressure outside the bottle decreases, the trapped air inside the bottle will not push the water up the straw as far. As the air pressure outside the bottle increases, it will push the water farther up the straw. As the air pressure outside the bottle increases, it will push the water farther down the straw.

Dry Barometer

Supplies

- 1 wide-mouth pint mason jar or wide mouth glass/ plastic container with rigid sides
- 4 x 6-inch cardstock
- Clear packing tape/trans-parent tape
- Scissors
- Ruler
- 1 large balloon
- Permanent marker–fine tip
- Glue
- 1 wood skewer/toothpick/ craft stick
- 1 rubber band

Figure 3: Supplies

Construction

1 Cut off most of the neck end of the balloon and stretch the balloon tightly over the mouth of the glass jar. Make sure that the surface of the balloon is as flat as possible.

2 Secure the balloon to the jar with the rubber band. It should resemble a drum. See Figure 4. Since neither the glass jar or balloon are permeable (a material that allows air or water to pass through), the air pressure inside the jar will remain constant.

3 Cut the wood skewer to match the diameter of the mouth of the jar, leaving the pointy end intact. Use the marker to color the tip of the skewer for more contrast when reading the measurements.

4 Using a tiny drop of glue at the cut end of the skewer, fasten the wood skewer to the top of the balloon-covered jar as close to the center as possible. The pointed end of the skewer should stick off the edge of the jar. You now have a pointer to measure air pressure. See figure 4.

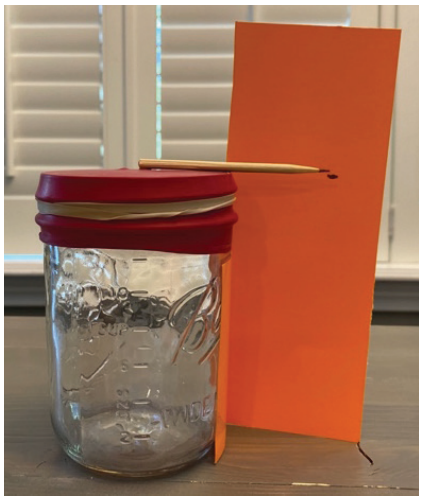

Figure 4

5 Fold the cardstock along the long edge to create a flap to attach to the jar. Using the clear tape, fasten the folded piece of cardstock by taping the flap to the jar, allowing the cardstock to stand vertical next to the jar close to, but not touching, the pointer. See figure 4.

6 Record the height of the pointer by placing a small mark on the cardstock directly next to the skewer. Get down at eye-level to make sure your mark is

even with the pointer. This is your starting pressure. Record the barometric pressure at the time you made your barometer.

7 Place your barometer in a spot that will not receive direct sunlight or have temperature extremes. A garage shelf works well.

Reading the Barometer Scale

As the air pressure changes outside of the barometer, you will observe changes in the height of the pointer relative to the starting pressure inside the jar. For example, when the air pressure is high, the air outside the barometer will be exerting more pressure than the air inside the barometer. You may observe the balloon to be curved down into the glass jar (concave) which will push the pointer above your starting point. The opposite effect will occur when there is low pressure. You may observe the balloon stretching upward (convex), causing the pointer to be below your starting point on chart.

Activity: Monitoring Air Pressure

Use the Weather Log below to record your daily observations. Record the values in the morning and evening. To find the temperature and pressure, you can use a weather app or refer to the National Weather Service (weather.gov) for the temperature and pressure values.

Weather Log

Day	Date	Time AM/PM	Temp.	Air Pressure	Water Level in Tubing	Needle Position (Rising or Falling)	Weather Conditions
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							

Analysis Questions and Discussion

Comparing the data in the table:

1 Compare the daily atmospheric pressure from the NWS or needle readings from your homemade barometer. Did your homemade barometer accurately measure whether the atmospheric pressure was high or low? *Since the instruments are a bit crude, they may not give as accurate of results as higher quality instruments, but they will likely correspond with the actual data.*

2 If you constructed both barometers, describe the air pressure results you observed between the two? If the results were not consistent, what are possible errors in the construction of your barometers? *You should observe your needle rising or falling with the atmospheric pressure in the dry barometer and the liquid rising or falling in the wet barometer. Small leaks in the balloon or tube could produce inconsistent readings.*

3 If you constructed both barometers, what happens if you set them in the sun for 10 minutes? *Warm temperatures will increase air pressure in a closed container. In the dry barometer, as the sun heats the air molecules inside the jar and the molecules begin to move more quickly. The increased collisions of air molecules will cause the air pressure to increase inside the jar and the needle will go down.. The same explanation can be used with the wet barometer but in this case the sun is heating up the molecules in the water, but the lid is not tight, so the pressure does not increase in the bottle but it may in the small air space in the top of the tube.*

4 Watch the weather report/forecast on local news. What terminology and concepts about weather did you recognize? How accurate were the predictions for the following day? For the following week? *Discuss the answers.*

5 Is weather prediction a historical or observational science? *There are two types of science historical and observational. Historical science relies on interpretation of evidence from past events and a philosophical point of view. Historical science is not observable, testable, repeatable, or falsifiable. Observational science uses direct observation, the five senses, and the scientific method to explain a set of facts. Observational science is testable, repeatable, and falsifiable. Consider the topic of evolution versus creation. Neither is observable, testable, or repeatable. Each is based on assumptions about the origin of the earth and the universe. Evolution assumes there is no God and creation assumes there is. Both base their interpretations on the same evidence but come to very different conclusions based on their starting assumption or worldview.*

6 What about predicting weather? Have you ever noticed the weather predictions are not always accurate? Can we really know what the weather was like thousands of years ago? *We can use observational science to measure temperature, atmospheric pressure, and weather conditions on any certain day. Your weather log is an example of using observational science. You were able to test, repeat, and record the data in your lab experiment. When meteorologists predict the weather for the following day or week, they are using historical science. They cannot be there to directly observe what the conditions will be like, so they base their predictions on past weather statistics, models, and data. The same goes for weather in the distant past. We can't be certain unless we have records. We know there was a lot of rain and stormy weather about 4,300 years ago during the flood described in Genesis 6–9.*

**"While the earth remains, seedtime and harvest,
cold and heat, summer and winter, day and night,
shall not cease." Genesis 8:22 (ESV)**

This activity was featured in our *Unlocking Science* program in the Weathering a Storm and Barometer in a Bottle episodes available on Answers.tv.