Weather Stations: The Physical Science Behind Weather

In this lesson, you and a partner will explore various demonstrations, gizmos, or gadgets that demonstrate some physical science principle involved with weather. These principles relate to the behavior of gases and other fluids, source of energy in the atmosphere, energy transfer within the atmosphere or between the atmosphere and ocean, and phase transitions of water.

Follow the numbered questions at each station to make predictions, do an experiment, observe, discuss, and explain each station to sort out the science. Take notes as you discuss the questions with a partner and keep this focusing question in mind:

? Explain how energy is being transferred at each station to explain what you observe **?**

Station 1: Smoke Box
Materials: commercial smoke box* and small tea light candle; incense stick; black construction paper.

*You can order a Smoke Box or "Convection of a Gas Apparatus" for your classroom, it is available from Carolina Biological Supply as item # 753449.

1. Examine the smoke box. Predict how the smoke will behave:
   a. as the incense stick is held in the air.
   b. as the incense stick is held over the "cold" chimney.
   c. as the incense stick is held over the "warm" chimney.

2. Describe what you observe and explain your observations in terms of air density. A piece of black construction paper held behind the smoke box may be useful while making observations.

3. Describe a situation where you've observed this phenomenon in nature.

Station 2: Cloud Chamber
Materials: balloon, large, large plastic or glass jar, warm water, rubber glove, matches (or incense)

1. You are going to blow up a balloon and then release the air. Predict what will happen to the air temperature as you release the air.

2. Blow up a balloon and temporarily pinch it closed. Release the air from the balloon letting the air blow on your skin. Describe how it feels as the pressurized air expands into the room. What does this tell you about how the temperature of air changes when it expands?

3. Put about 1-2 cm of warm water in the jar and with your hand in the glove, stick it down into the jar making a seal with the end of the glove over the jar lip.
   a. Predict what will happen when the glove is pulled up from the inside of the jar.
   b. Shake the jar a little.
   c. Put your hand in the glove and pull up quickly as you make a fist but don't break the seal between the glove and the jar.
   d. Describe what happens.
   e. Predict what will happen as you drop a smoldering match into the jar.

4. Remove part of the glove and light a match. Blow the match out and hold the smoking match in the jar for a second before dropping it into the water.
   a. Replace the sealed glove and pull up as before.
   b. Describe what happens.

5. Think about this demonstration. Describe what conditions must be present for a cloud to form.

6. Based on this demonstration, describe how clouds form in the atmosphere.

Station 3: Bubble Bottle

Materials: clear plastic empty water bottle, liquid dish detergent and water in a cup; two plastic cups (one with hot tap water and the other with cold tap water)

1. Mix a few drops of dish detergent with a few millimeters of water. Lower the mouth of the bottle into the bubble solution. Carefully tilt and lift the bottle out so that a film of bubble solution covers the opening of the bottle. Stand the bottle on the counter and observe the bubble film on the bottle opening.

2. Predict what you think will happen when you place the bottle right-side up into a cup of hot water. Why do you predict this? Try it and describe what happens.

3. Now, predict what you think will happen when you place the bottle into a cup of cold water. Try it and make observations.

4. What happens to a gas when it is heated? Explain in molecular terms.

5. What happens to a gas when it is cooled?

6. Think of several examples where gases are heated/cooled in weather.

Analysis Questions

1. Convection, the movement of energy by circulation in a fluid, is due to density differences. What different ways did you generate density differences in these experiments?

2. Suggest ways that convection helps explain:
   a. why the floor of your house is chilly in winter
   b. why heat vents are placed on the floor of rooms
   c. the formation of thunderhead clouds on a hot summer afternoon

3. Organize your observations about the behavior of gases by formulating a list of "rules" or principles related to heating and cooling, and expansion and compression of gases. You might want to pay attention to whether the gas is contained and when it is not.

4. Organize your observations about phase transitions of water by drawing a diagram that relates liquid water, water vapor, and heat energy with appropriate arrows. Label the process of condensation and evaporation on your diagram.

CONCLUSION

Use what you learned in this lesson to write a conclusion to the focusing question.