WHAT'S UP WITH UPDRAFTS?

Related Subject: Climate and Weather
Group Size: 10-15
Length of Activity: 30 minutes

Objective

Demonstrate the ability of the wind to suspend rain and hail in clouds.

Overview

Suspending a ping pong ball in the stream of air supplied by a hair dryer will demonstrate how rain and hail are supported in storms.

Materials and Supplies

For each pair of participants give the following (or demonstrate to the class):

- Hand-held hair dryer
- Two or more ping pong balls

Preparation

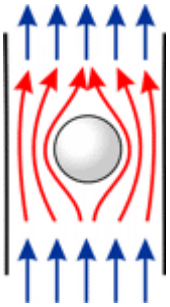
Give each pair of participants a hair dryer and at least two ping pong balls. Have several ping pong balls on hand as occasionally they will fall out of the air stream.

Procedure

- Point the nozzle of the hair dryer up and turn the power on low, then high as the participants become more comfortable with the procedure.
- Place a ping pong ball in the stream of air.
- The ping pong ball will be suspended by the air.
- Slowly tilt the hair dryer until the ball falls.
- Repeat the demonstration but add a second ping pong ball.
- Depending upon power of the hair dryer, both ping pong balls will be suspended.
- Occasionally, the balls will swap their order as they bounce around in the air stream.

Discussion and Processing

- What happened to the ping pong balls?
- How did the ball(s) remain suspended in air? (The ping pong ball remains in the stream of air due to lower pressure created around the surface of the ball. See Bernoulli's Principle explanation.)
- This pressure effect also can be seen around the ping pong ball in a different way. Instead of a narrowing in the center as in the venturi tube (see explanation on venturi tube below), the narrowing takes place around the perimeter of the ping pong ball (see figure above). There is an area of low pressure immediately on either side of the ball.
- Explain that the low pressure is greater in the air outside of the air stream created by the hair dryer. As a result when the pin pong ball reaches the edge of the air stream it bounces from side-to-side and is pushed back into the region of low pressure. Show diagrams below.
- Air exerts pressure in every direction at all times. Bernoulli's Principle says that the slower the air moves, the greater the air pressure. Therefore, we can say that still air exerts more pressure around the ping pong ball than moving air. This pressure difference is what keeps the ball floating even when the hair dryer is tilted. Simply stated, slow-moving air exerts more pressure than fast-moving air.



- **Bernoulli Principle**: Named after Daniel Bernoulli, an eighteenth-century Swiss scientist, who discovered that as the velocity of a fluid increases, its pressure decreases. Bernoulli's principle can be seen easiest through the use of a venturi tube (see left figure). A venturi tube is simply a tube which is narrower in the middle than it is on the ends. When the fluid passing through the tube reaches the narrow part, it speeds up. According to Bernoulli's principle, it then should exert less pressure.

- Repeat the experiment and this time have the students notice the back-and-fourth oscillation of the ball as it tries to fall out of the stream but is pushed inward.

- Ask: What happens to vapor in a cloud when the pressure changes?

- Why do raindrops finally fall to the ground?

- While there is no giant hair dryer to force updrafts in the sky, there are weather conditions that cause air to rise. Can you describe any time you have seen clouds moving due to an updraft? (Almost any visible cloud means that some sort of updraft is present.

- Many of our clouds are thin and flat meaning that only gentle updrafts are present. However, during the spring and summer we can sometimes watch cumulus clouds form and then rapidly explode upwards to form cumulonimbus clouds. These clouds have the greatest updrafts and are the type of cloud that forms hail and large rain drops. If you cannot see the side of clouds, then an indication may be the darkness of the cloud underneath. The darker it is below a cloud then the thicker that cloud may be – a good indication of updrafts overhead.

- What type of cloud here do you think has the strongest updrafts? (Cumulonimbus cloud)

Background

Rain and hail will be suspended by the updraft inside a thunderstorm until the weight of the hail and water can no longer be supported. *Usually, the stronger the updraft in a thunderstorm, the more intense the storm gets, and the larger the size of rain or hail that can be produced*.

While it is very difficult to predict a thunderstorm on any particular day, we can know the area where thunderstorms are possible. If atmospheric conditions are such that the thunderstorms may become severe, the National Weather Service will issue a Severe Thunderstorm Warning or Tornado Watch.

A **warning** is issued when a hazardous weather or hydrologic event is occurring, is imminent, or has a very high probability of occurring. A warning is used for conditions posing a threat to life or property. A **watch** is used when the risk of a hazardous weather or hydrologic event has increased significantly, but its occurrence, location, and/or timing is still uncertain. It is intended to provide enough lead time so that those who need to set their plans in motion can do so.

The National Weather Service defines a "severe thunderstorm" as one having wind speed of 58 miles per hour or greater, and/or hail size of 3/4" or larger.

Sources: http://www.srh.noaa.gov/srh/jetstream/mesoscale/ll_updrafts.htm and http://scifiles.larc.nasa.gov/text/kids/Problem_Board/problems/flight/lift2.html

National Science Education Standards:

NSES K-4:

- Science as Inquiry (4ASI)
  - Abilities necessary to do scientific inquiry (4ASI 1)
  - Understandings about scientific inquiry (4ASI 2)
- Physical Science (4BPS)
  - Properties of objects and materials (4BPSI 1)
  - Position and motion of objects (4BPSI 2)
- Earth and Space Science (4DESS)
  - Objects in the sky (4DESS 2)
  - Changes in earth and sky (4DESS 3)

NSES 5-8:

- Science as Inquiry (8ASI)
  - Abilities necessary to do scientific inquiry (8ASI 1)
  - Understandings about scientific inquiry (8ASI 2)
- Physical Science (8BPS)
  - Motions and Forces (8BPS 2)
- Earth and Space Science (8DESS)
  - Structure of the earth system (8DESS 1)

NSES 9-12:

- Science as Inquiry (12ASI)
  - Abilities necessary to do scientific inquiry (12ASI 1)
  - Understandings about scientific inquiry (12ASI 2)
- Physical Science (12BPS)
  - Structure and properties of matter (12BPS 2)
- Earth and Space Science (12DESS)
  - Energy in the earth system (12DESS 1)