Smog

Target Grade Levels
Third - Fifth

Time
20 minutes

Materials
- clean, dry, wide-mouth glass jar (such as a mayonnaise jar)
- heavy aluminum foil
- two or three ice cubes
- ruler
- scissors
- stop watch or watch with a second hand
- matches
- guest Presenters

Knowledge and Skills (TEKS)
- Science:
  - Recognize that invisible air pollutants and weather conditions are involved in creating smog;
  - Understand that not all air pollution is visible; and
  - Appreciate that human activities can cause air pollution.

Overview
This activity lets students create artificial "smog" in a jar. Teachers can use this module as an introduction to a planned visit from an air quality scientist, or as the basis for extended discussions on the health problems associated with smog.

Background Information
The expression "smog" was first used in turn of the century London to describe a combination of "smoke" and "fog." London has had several episodes of severe industrial smog. The most famous London smog event occurred during five days of December 1952, when calm, foggy weather lead to a smog buildup in the atmosphere that claimed thousands of human lives.

Today, what we call smog is made primarily of ground-level ozone that is produced by a photochemical reaction between nitrogen oxides and volatile organic compounds in the presence of sunlight. Ground-level ozone is an invisible, odorless gas. Ground-level ozone is produced by a combination of pollutants from many sources such as automobile exhausts, smokestacks, and fumes from chemical solvents like paint thinner or pesticides. When these smog-forming pollutants (called "precursors") are released into the air, they undergo chemical transformations and produce smog. Weather conditions, such as the lack of wind or a "thermal inversion," also cause smog to be trapped over a particular area. Smog causes health problems such as difficulty in breathing, asthma, reduced resistance to lung infections, colds, and eye irritation. The ozone ingredient in smog also damages plants and trees, while the haze reduces visibility. This is particularly noticeable from mountains and other beautiful vistas such as National Parks.

Suggested Reading

- Bailey, Donna. What Can We Do About Noise and Fumes. New York: Franklin Watts (1991).
- Baines, John. E*xploring: Humans and the Environment*. Austin, TX: Steck-Vaughn Company (1993).
- Easterbrook, Gregg. "Winning the War on Smog." *Newsweek*, 122 (23 August 1993) p. 29.
- Krupnick, Alan J., and Paul R. Portney. "Controlling Urban Air Pollution: A Benefit-Cost Assessment." *Science*, 252 (26 April 1991) p. 522.
- Pasternak, Judy. "Long-Term Lung Damage Linked to Air Pollution; Respiratory Deterioration Is Found in Areas Where Air Is Dirtiest." *Los Angeles Times*, (29 March 1991) p. A1.
- Pasternak, Judy. "Smog Blamed for Increase in Asthma Cases." *Los Angeles Times* (2 December 1991) p. A1.
- Penny, Malcolm. O*ur World: Pollution and Conservation*. Englewood Cliffs, NJ: Silver Burdette Press (1988).
- Rock, Maxine. T*he Automobile and the Environment*. New York: Chelsea House Publishers (1992).
- Scott, Geoff. "Two Faces of Ozone." *Current Health*, 19 (2 September 1992) p. 24.
- Study Finds Source of Canyon Haze." *National Parks*, 63 (July 1989) p. 10.
- Wald, Matthew L. "Northeast Moving Toward Auto-Emission Goals." *New York Times*, 142 (25 March 1993) p. A12.

Procedure

1) Vocabulary

   a) smog
   b) photochemical
   c) pollutant
   d) nitrogen oxides
   e) hydrocarbons
   f) volatile organic compounds
   g) ground-level ozone
   h) fumes
   i) precursor
   j) thermal inversion

2) Activities

   a) Explain that the class will perform an experiment in which they will create artificial "smog" in a jar. Make sure that students understand that the jar is only a model, and models by nature are limited. For example, the purpose of this model is to illustrate the appearance and behavior of smog, not the composition or effects. It is important to understand that smog is not just a "smoky fog," but a specific phenomenon.

   b) Select students to be part of a large demonstration team. Have them cut a strip of paper about 6 inches by 2 inches. Fold the strip in half and twist it into a rope.

c) Have them make a snug lid for the jar out of a piece of aluminum foil. Shape a small depression in the foil lid to keep the ice cubes from sliding off. Carefully remove the foil and set it aside.

d) Have the students put some water in the jar and swish it around to wet all the inside of the jar. Pour out the extra water.

e) Have them light the paper "rope" with a match and drop it and the match into the damp jar. Put the foil lid back on the jar and seal it tightly. Put ice cubes on the lid to make it cold. (The ice cubes will make the water vapor in the jar condense.) You must do this step very quickly, perhaps with some assistance.

3) Review

a) Ask students to describe what they see in the jar. How is this like real smog? What conditions in the jar produced "smog"? (Moisture plus soot particles from the burning matches plus carbon dioxide and other solvent vapors.)

b) Ask the students if they have ever seen smog (not fog). Have they ever breathed air outside that smelled funny?

c) Discuss with students the actual formation of smog in the local area, the sources of precursors (vehicles, power production, industry), and the conditions needed to transform those precursors into ground-level ozone. (Be sure to distinguish between ground-level ozone, which is invisible, and smog, which is primarily ground-level ozone, but accompanied by other pollutants which make it visible.)

4) Evaluation

a) Students can be quizzed on vocabulary.

b) Students can perform the following extension activities as graded exercises.

5) Extension

a) Have students put a glass thermometer (not plastic) into the jar before they do the experiment. Have them record the temperature before proceeding to step 4. Have them record the temperature during step five. Ask them to describe what the temperature did and why. Let them try it again without adding water.

b) For grades 7-12, assign students to small groups to answer the following questions and report back to class in two weeks. One group will consider the physical and chemical sciences and the other group will consider the health and ecological sciences. Each group should consider referring to several sources of information to answer the questions. Students could possibly interview the weather reporter or meteorologist at the local television or radio station or airport, or interviewing a health scientist from the city or county health department or air quality agency.

i) What conditions are necessary to produce smog in the air? Under what circumstances will these conditions exist in the city? How often are they likely? Can they be predicted in advance?

ii) What are the health effects of smog on people? On plants and trees? Why doesn't everyone in the city get sick or have similar symptoms from smog? What types of people are most sensitive to smog?

Adapted from: "Activity 14—Smog" *United States Environmental Protection Agency–Project A.I.R.E.* 2003. Page 141.