Temperature Inversion

Target Grade Levels
Sixth - Eighth

Time
45 minutes

Materials
- 4 identical small, clear glass jars (baby food jars work well)
- very hot tap water
- ice water (about 50^0F)
- index cards
- red food coloring
- shallow pans or baking dishes

Knowledge and Skills (TEKS)
- Science:
  - Extrapolate from information to make predictions; Identify and demonstrate everyday examples of chemical phenomena;
  - Make inferences and draw conclusions about effects of human activity on Earth's renewable, nonrenewable, and inexhaustible resources; and
  - Analyze effects of regional disposition and weathering.
- Language Arts:
  - Communicate valid conclusions; and
  - Uses active listening skills to critique a speaker's message.

Overview
To demonstrate what happens when a temperature inversion occurs, which can trap air pollutants near the surface of the earth.

Background Information
Air temperature can play an important role in the buildup or dispersion of surface air pollution. In general, air temperature decreases as you move upward in the atmosphere. Under most circumstances, the air close to the earth warms as it absorbs surface heat and begins to rise. Wind is caused when air rushes in to take the place of the rising warm air. Wind movements cause "mixing" in the atmosphere and thereby carry away and dilute pollution.

During a temperature inversion, a layer of warm air aloft acts as a lid above a layer of cold air. The colder, denser air close to the ground does not readily circulate (mix). Pollutants such as carbon monoxide and particle pollution and ozone-producing hydrocarbons are "trapped" in the cold air by the lid. The quantity of pollution tends to increase until the lid is destroyed by heating or by wind.

Procedure
1) Vocabulary
   a) temperature inversion
   b) carbon monoxide
   c) ground-level ozone
   d) particle pollution
   e) hydrocarbons
   f) dispersion

2) Activities
   a) Normal Conditions
      i) Place two jars in a shallow pan.

ii) Fill one jar with hot water and the other jar with ice water (Note: fill jars to brim). If you use ice cubes to cool the water, do not leave any ice in jar.

iii) Put several drops of red food coloring (pollution) in jar with hot water. Place the plastic square over the top of the jar with the cold (clear) water and quickly flip the jar on top of the jar with the hot (red) water. Align the jar openings. Carefully pull the plastic square or index card out. Let the jars stand.

b) Temperature Inversion

i) Note: fill jars to the brim. Place the remaining two jars in a shallow pan.

ii) Fill one jar with hot water and the other jar with ice water.

iii) Add several drops of red food coloring to the ice water. Place the plastic square or index card over the jar with the hot (clear) water and quickly flip the jar on top of the cold (red) water jar. Align the jar openings. Carefully pull the plastic square or index card out. Observe.

3) Review

Discuss results with students. Make sure to note that it doesn't take much temperature difference to create an inversion. Inversions usually happen at night when the ground cools and cools the air touching it faster than air aloft cools off. Inversions happen even during the summer months, when it seems that no air aloft could be hotter than air at ground level, they may not be very strong, but they do happen!

4) Evaluation

a) Questions

i) What happens?

ii) Why do the hot and cold water mix in the first instance (normal conditions)?

iii) Why do the hot and cold water not mix together during the second instance (temperature inversion)?

iv) Ask students to identify sources of pollution that might get trapped down near ground-level during a temperature inversion.

b) Answers

i) In the first instance, the hot (clear) and cold (red) water mix immediately and water in both jars turn red. In the second instance, the cold (red) water is trapped and can not escape upward. The jar on top (hot) stays clear.

ii) The cold water (air) is on top of the hot water (air). In this case the water colors mix, illustrating that the air can move upward and disperse pollution during normal temperature conditions.

iii) The hot water (air) prevents the cooler water beneath (air close to the ground) from rising and dispersing into the atmosphere. This action traps the pollution down where we breathe.

iv) Answers will vary.

5) Extension
Have a local television meteorologist visit with the class to discuss weather phenomena and local weather patterns. Contact information for local media (ask for the weather department):

- WOAI (210) 226-4444
- KSAT (210) 351-1200
- KENS (210) 366-5000
- KABB (210) 366-1129

Adapted from: "Ozone Action! Let's Clear the Air Educational Activities 6th Grade - 8th Grade" *West Michigan Clean Air Coalition.* www.wmcac.org/grades6-8.pdf.

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