

Instant Smog

Environmental Chemistry



Introduction

Ozone in the stratosphere helps to absorb ultraviolet rays from the sun but in the lower atmosphere, ozone and hydrocarbons react to form photochemical smog.

Concepts

- Organic acids
- Environment
- Ozone

Materials (for each demonstration)

Aluminum, foil	Lecture bottle regulator
Copper, wire, bare, 16 gauge	Lecture bottle support
Lemon, fresh	Ring support
Oxygen, lecture bottle	Stopper, rubber, one-hole, size 10
Water, distilled or deionized	Stopper, rubber, solid, size 10
Alligator cord	Support stand
Erlenmeyer flask, borosilicate, 2-L	Tape, electrical
Knife, paring	Tesla coil

Safety Precautions

Ozone is irritating to mucous membranes and the respiratory system. Avoid inhaling ozone. Perform this demonstration in a chemical safety hood or other well ventilated area. Wear chemical splash goggles. Wash hands thoroughly with soap and water before leaving the laboratory. Follow all laboratory safety guidelines. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Preparation

1. Coil the 16-gauge copper wire into a long coil. The coil should not touch the bottom or sides of the Erlenmeyer flask.
2. Insert one end of the copper coil through the hole in the one-hole stopper. Approximately one-inch of copper should extend beyond the hole.
3. Secure the coil to the stopper with electrical tape.

Procedure

1. Flush the Erlenmeyer flask with oxygen and insert the copper coil stopper into the flask.
2. Wrap the Erlenmeyer flask with aluminum foil.
3. Ground the aluminum foil to a ring support on a support stand with an alligator cord.
4. Point the tip of the Tesla coil toward the end of the copper coil and generate a current for 20–30 seconds.
5. Remove the alligator cord ground from the support ring and the aluminum foil.
6. Remove the aluminum foil from the Erlenmeyer flask
7. Cut a couple of strips of fresh lemon peel from the lemon.
8. Flex each piece of lemon peel to release the limonene from the peel.
9. Quickly insert the pieces of lemon peel into the Erlenmeyer flask and replace the copper coil stopper with a solid

stopper.

10. Record any observations.
11. Lift the solid stopper and add several milliliters of water to the Erlenmeyer flask. Reseal the flask immediately.
12. Record any further observations.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. Dispose of the acid cloud and remaining ozone in a chemical safety hood. Fill the Erlenmeyer flask with water to drive the gases from the flask. Dispose of the water down the drain.

Discussion

One way that ozone is formed in the atmosphere is when energy in sunlight acts on a molecule of oxygen, breaking the bond and creating two oxygen atoms. These reactive atoms of oxygen react with two additional molecules of oxygen to produce two ozone molecules and energy. The energy reacts with other atmospheric compounds and the molecules of ozone react with hydrocarbons within the atmosphere to produce nitrogen dioxide and other irritating pollutants. Over the course of a hot day in a large city, such as Los Angeles, ozone and the other components of photochemical smog can reach toxic levels leading to respiratory distress or failure for susceptible individuals.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12

Evidence, models, and explanation

Content Standards: Grades 5–8

Content Standard B: Physical Science, properties and changes of properties in matter

Content Standard F: Science in Personal and Social Perspectives, natural hazards

Content Standards: Grades 9–12

Content Standard B: Physical Science, structure and properties of matter, chemical reactions

Content Standard F: Science in Personal and Social Perspectives, environmental quality, natural and human-induced hazards

References

- Newton, D. E. *Environmental Chemistry*; J. Weston Walch: Portland, ME; 1991; pp. 65–67.
- Miller, G. T. *Living in the Environment, Tenth Edition*; Wadsworth Publishing Company; Belmont, CA; 1998; pp. 463–469.
- Cunningham, W. P.; Cunningham, M. A.; Saigo, B. W. *Environmental Science: A Global Concern, Ninth Edition*; McGraw Hill; New York; 2007; p. 352.

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Instant Smog* activity, presented by DeWayne Leineman is available in *Environmental Chemistry*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Instant Smog* are available from Flinn Scientific, Inc.

Catalog No.	Description
AP5443	Tesla Coil, with On/Off Safety Switch
LB1050	Lecture Bottle Regulator
LB1025	Oxygen Lecture Bottle
LB1045	Lecture Bottle Holder
GP9155	Erlenmeyer Flask, 2-L

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.