Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# Ozone Detection

**Purpose**

The purpose of this lab is to determine if ground-level ozone levels can be easily monitored.[[1]](#endnote-2)

**Background Information**

Ground level ozone, O3 , is a secondary photochemical pollutant formed by numerous reactions involving VOCs and oxides of nitrogen. It is also produced by lightning, electrical motors, arc welders and by copiers and laser printers. It is a highly reactive oxidizing agent that strips electrons from molecules that it encounters. Obviously when living tissue comes into contact with higher than normal ozone levels serious damage can occur. Lung tissue is especially susceptible to injury. This is why asthmatics are caution to restrict outdoor activity during Ozone Action Days. Crops and trees are also damaged by higher than normal ozone concentrations. Ozone damages cell walls and chlorophyll molecules reducing the capacity of leaves to carry on photosynthesis. The productivity and health of affected crops and trees can be seriously reduced due to foliar damage. Crops most sensitive to ozone damage include soybeans, clover, alfalfa, soybeans, sweet corn, green beans, tomatoes and lettuce. A serious decline in oak and hickory tree health in eastern US has been associated with increased O3 levels.

While it s difficult for a high school lab to generate and to measure O3 to study its affects on living tissue; it is relatively easy for students to do a study of ozone levels in and around their homes and school. The data collected can be an excellent introduction to the study of ground-level ozone generation and the problems that it creates. Because ozone levels are highest during the summer months, plan to do this lab then. Or, do it during the summer or early fall and again during the winter to compare results

Students will produce and use Schoenbein (or Schönbein) paper to observe ozone levels. Schoenbein paper is simply a strip of paper coated with a mixture of plant starch and potassium iodide. When the strips are exposed to O3 and water, a triiodide ion, I3-, is formed which complexes with the starch molecules to produce the reddish-blue color associated with the often used starch-iodine test. The depth of color produced on the strips is matched to a color scale which is corrected for humidity. A reasonably accurate measurement of ozone concentration in parts per million is obtained.

**Procedure**

**Materials**

1. potassium iodide 5. corn starch
2. distilled water 6. 250 ml Erlenmeyer flask or beaker
3. white, unlined paper or filter paper sheets
4. large test tubes, 16mm X 150mm (larger or smaller ones will work too)

**Sequence of Steps**

**Procedure for making Schoenbein paper**

1. Cut the unlined paper into strips just narrow enough to fit into the test tubes. For example, if 16 mm X 150 mm tubes are used, cut the strips 15 mm wide. The strips should be about 20cm long.

2. Make a suspension composed of 200 ml distilled water, 2 teaspoons corn starch, and ½ teaspoon potassium iodide, KI, in a flask or beaker. The starch will not dissolve but the KI will.

3. Pour the suspension into test tubes so that they are half filled.

4. Dip the paper strips into the suspension within the test tubes. Allow them to soak for 5 seconds.

5. Remove the strips and allow them to dry away from sunlight. They can be dried on toweling or hung by clothespins on a line. Students should write their names on the end of the strip that is not coated. Each student should prepare at least two strips.

6. Once the strips are dry, store them in sealed plastic bags in a dark cabinet or drawer.

**Ozone testing procedure**

1. Spray the strip with distilled water and hang it, or tape it, or tape it at a place **out of direct sunlight** for about eight hours. Discuss with the class places that might be tested. Sites to consider would be: a corn field, a welding shop; a room where copiers or computers are being used; a parking garage; a school’s mechanical room; near a heavily traveled street or highway; in a forested area, classroom, home, or yard.

2. Collect the strips after eight hours and seal them in a plastic bag until the results are read.

3. To read the strips, match their color to either one of the two scales shown below. Choose the one that best matches student results. Record the Schönbein numbers.

1. The values must be corrected for humidity because increased humidity makes the paper more sensitive to ozone and a higher Schoenbein Number would be recorded. The humidity for most localities can be found at any of the many online weather sites such as http://www.weather.com/. Once the humidity is known, use the Relative Humidity Schoenbein Number Chart below to determine the concentration of ozone in parts per million (ppm). From the Schoenbein number on the X axis draw a vertical line to the curve for the humidity of the day of testing. From that intersection, draw a line parallel to the X axis to the Y axis. The value of Y at that point is the approximate ozone concentration.



**C:\Users\Angela\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.IE5\DRP2N1IJ\MCj04242300000[1].wmf Observations**

1. Consult weather or news sources for your locality and find the reported ozone level. How do they compare to your numbers?
2. Compare your results with those of your classmates. Do their results differ? Discuss the differences
3. Which sites tested by your classmates yielded the highest values and lowest values? Offer an explanation for those results.
4. Why might the color change be more intense at higher relative humidity?
5. If an outdoor location shows high ozone readings, examine the leaves of plants nearby. Do they show any yellowing, spotting or damage?
6. Discuss this lab. Does it provide useful information? How might it be improved?
7. Plot the numbers collected by your class on a map. Are there any trends evident?
8. Why are ozone concentrations lower in the winter?
9. Were any of the ozone concentrations collected by your class cause for concern because they are high?
10. Ground level ozone pollution is caused by human activities. Make a list of such activities.

**Extension**

1. Repeat the lab with commercially available ozone test strips or badges. Compare the ozone concentration values.

2. Modify the lab using different kinds of paper and varying types of starch. Compare the results to the original lab.

3. Repeat the lab but don’t spray the papers with distilled water. Does it make any difference?

4. Investigate and report on Christian Friedrich Schoenbein who discovered ozone in 1839.

5. Investigate the redox reactions involved in the color change of the strips.

6. Investigate the claim that some indoor plants can remove ozone from the air.

7. Do a survey of ozone damage to milkweed plants.

**Links and sources**

Schönbein color charts: http://www.chemistryland.com/CHM107Lab/Lab4/DetectOzone/Lab4Ozone.htm

Relative Humidity Schoenbein Number Chart

http://njnie.dl.stevens-tech.edu/curriculum/norwich/schoenbeinpaper.shtml

Ozone as a pollutant http://www.dnr.state.wi.us/org/caer/ce/eek/earth/air/badozone.htm

http://www.dnr.state.wi.us/org/caer/ce/eek/earth/air/ozone.htm

http://www.eco-systems.org/roleof.htm

Ozone chemistry: http://www.fraqmd.org/OzoneChemistry.htm

<http://www.chm.bris.ac.uk/motm/ozone/Low.htm>

1. Ozone Detection. Retrieved December 15, 2008, from Marketplace for the Mind Web site: http://www.marketplaceforthemind.state.pa.us/m4m/lib/m4m/documents/labs/Ozone\_Lesson.pdf [↑](#endnote-ref-2)