Tropospheric Ozone

In this lab you will prepare and use chemically reactive paper to measure the concentration of ground-level (tropospheric) ozone. The ozone test paper used in the lab is called Schoenbein paper, as it was developed by Christian Friedrich Shoenbein. This paper will be hung, in air, out of direct sunlight overnight which will allow a chemical reaction to take place. If there is ozone in the air, Shoenbein paper takes advantage of its high reactivity. Ozone in the air will oxidize the potassium iodide on the Shoenbein paper to produce iodine. The iodine reacts to the starch in the paper to produce a purple color. The shade of purple on the paper correlates with the concentration of ozone present in the air at the test site. The two chemical reactions follow:

$2KI + O_3 + H_2O \rightarrow 2KOH + O_2 + I_2$ $I_2 + \text{starch} \rightarrow \text{blue or purple color}$

Materials:

Safety goggles
Lab apron
250 mL beaker
Popsicle stick
Hot plate
String/Yarn
Distilled water
Potassium iodide (KI)
Cornstarch
Filter paper (cut in 1"x2" strips)
Small paint brush
Stirring rod
Ziploc bag
Single-hole punch

Preparation of Shoenbein Testing Solution:

1. Place 100 mL (½ cup for virtual) of water in a 250 mL (1 cup for virtual) beaker. Stir in approximately 5 g (1 tsp) of cornstarch.
2. Place the beaker on a hot plate. Heat the mixture over low heat while stirring. Heat and stir until the solution is thick and translucent.
3. Remove the beaker from the hot plate. Stir in approximately 1 g (¼ tsp for virtual) of KI into the mixture. Cool the solution.
4. Take a piece of filter paper (1"x2") and punch a hole in one end. Tie a piece of string to the paper, long enough to be able to tie the string to a fixed object outside.
5. Lay your piece of filter paper on a piece of parchment paper (or plastic wrap) and use a small paint brush to paint the paste evenly on <u>both sides</u>. Apply the paste as uniformly as possible.
    a. If using the paper immediately, it is now ready for use.
    b. If storing the paper for later use, dry in a 200^{o} oven until dry. *Never expose Schoenbein paper to direct sunlight.* Store strips in a Ziploc bag out of direct sunlight until ready for use.

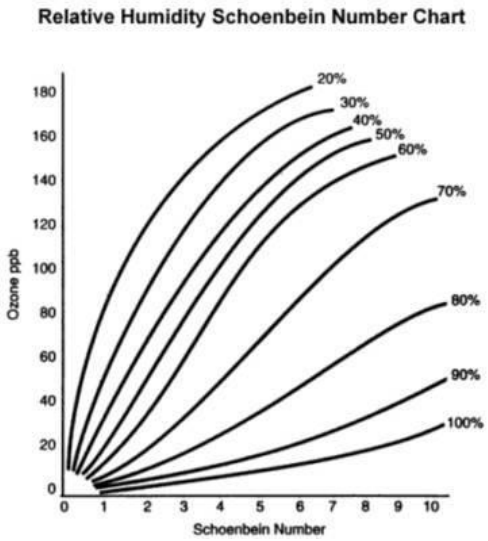
Be sure to use soap to wash hands and scrub under fingernails after working with potassium iodide!

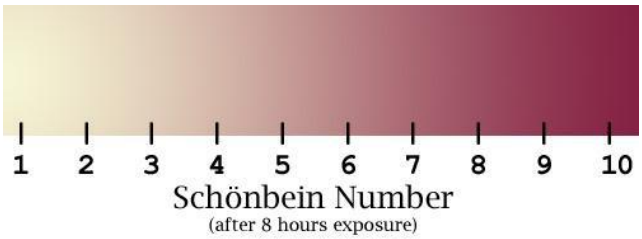
Ozone Testing Procedure:

1. Hang the Shoenbein paper in an area where it can hang freely. Be sure to hang it *out of direct sunlight*.
2. Expose the strip for a minimum of 1-1 ½ hours.
3. Remove the strip and place it in an airtight bag out of direct sunlight until the results are recorded.
4. Determine the ozone concentration at the test site as follows:

a. Moisten the strip with distilled water, then compare the color of the strip with the Schoenbein Color Scale (provided by teacher) and determine the Shoenbein number. If the color of the paper is not uniform, use the color in the area with the most conspicuous change to determine the Shoenbein number.
b. Use internet weather sites or sling psychrometer to determine the relative humidity at the test site and round it to the nearest 0.1. If you use the internet, use a site that will allow you to get data by zip code.
c. **Use the Relative Humidity/Shoenbein Number Chart as follows:**
    i. Along the bottom of the chart, find the point that corresponds to the Shoenbein number.
    ii. Draw a line upward from the Shoenbein number until it intersects the curve that represents the correct relative humidity.
    iii. Draw a line from the intersection made above (in "ii") to the left side of the chart. Note your ozone concentration.

Shoenbein Number	
0-3	Little or no change
4-6	Lavender hue
7-10	Purple or blue





Name ___________________________________ Date __________________ Period _____

Tropospheric Ozone

My testing location for ozone was ____.

My Shoenbein Number was _______.

The relative humidity for my testing location was ______.

The Ozone ppb for my testing location was _______. This would be a code _______ day.

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Post lab Questions: In complete sentences (when possible), respond to the following.

1. Determine the ozone concentration for a testing location with a Shoenbein number of 2 at a relative humidity of:
   a. 23% - ____________ code ____________
   b. 48% - ____________ code ____________
   c. 81% - ____________ code ____________

Which of these three scenarios would be *most* dangerous for a person with asthma or respiratory illnesses?

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2. Determine the ozone concentration for a testing location with a Shoenbein number of 5 at a relative humidity of:
   a. 18% - ____________ code ____________
   b. 53% - ____________ code ____________
   c. 77% - ____________ code ____________

Which of these three scenarios would be *least* dangerous for a person with asthma or respiratory illnesses?

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3. Determine the Shoenbein number of a testing location with 100ppb and a relative humidity of:
   a. 28% - ____________
   b. 40% - ____________
   c. 72% - ____________

4. Compare your Shoenbein paper to other groups in your class. Note, and account for, and discuss the differences you observe.
5. Determine any wind direction or ventilation drafts during your study and discuss how either of these may have affected your results (think about other ozone sources nearby).
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6. Compare your data with current ozone levels from the Texas Commission on Environmental Quality (TCEQ) (https://www.tceq.texas.gov/cgi-bin/compliance/monops/select_curlev.pl Based on this comparison discuss the reliability of using Schoenbein paper to measure tropospheric ozone.

7. List the pollutant levels and units for the following pollutants Nitrous oxide (NO2), Sulfur dioxide (SO2), and carbon monoxide (CO). https://www.tceq.texas.gov/cgi-bin/compliance/monops/aqi_rpt.pl

8. Approximate the UV Index at the test site during the lab. Explain how the UV Index is related to the concentration of ozone present in the air. (Read the information on this link before answering http://www.epa.gov/sunwise/uvindex.html