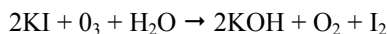


# Tropospheric Ozone Lab

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 this lab was first developed by Christian Friedrich Schoenbein (1799-1868), as a result it is called Schoenbein paper. To prepare the Schoenbein paper, filter paper will be coated with a mixture of potassium iodide, starch and water. To use the Schoenbein paper, you will hang it, in air, out of direct sunlight, for 1-2 hours which will allow a chemical reaction to take place. If there is ozone in the air, Schoenbein paper takes advantage of its high reactivity. Ozone in the air will oxidize the potassium iodide on the Schoenbein paper to produce iodine. The iodine reacts with the starch to produce a purple color. The shade of purple on exposed Schoenbein paper correlates with the concentration of ozone present in the air at the test site. The two chemical reactions follow:



## Materials

- |   |   |   |   |
|---|---|---|---|
| <input type="checkbox"/> safety goggles     | <input type="checkbox"/> hot plate        | <input type="checkbox"/> cornstarch     | <input type="checkbox"/> small paint brush or popsicle sticks |
| <input type="checkbox"/> paper clip hangers | <input type="checkbox"/> distilled water  | <input type="checkbox"/> painting paper | <input type="checkbox"/> stirring rod                         |
| <input type="checkbox"/> 250-mL beaker      | <input type="checkbox"/> potassium iodide | <input type="checkbox"/> filter paper   | <input type="checkbox"/> ziplock bags                         |

## Preparation Procedure for Testing solution


1. Place 100 mL of distilled water in a 250-mL beaker. Stir in approximately 5 g of cornstarch.
2. Place the beaker on a hot plate. Heat the mixture, over low heat, while stirring, until it is thick and translucent.
3. Remove the beaker from the hot plate. Stir approximately 1 g of potassium iodide into the mixture.
4. Cool the solution.
5. Lay a piece of filter paper on a piece of printer paper and use a small paint brush or Popsicle stick to apply the paste evenly onto both sides of the filter paper. Apply the paste as uniformly as possible. **(Note: For immediate testing, the paper is ready for use at this point.)**

 **Use soap to wash hands and scrub under fingernails after working with potassium iodide!!**

## If storing the Schoenbein paper for later use follow steps 6 and 7 below.

6. Dry the Schoenbein paper in a drying oven, at a low temperature. Never expose Schoenbein paper to direct sunlight.
7. Place the strips (should be about 2cm wide) in an airtight ziplock bag and keep them out of direct sunlight.

## Testing Procedure

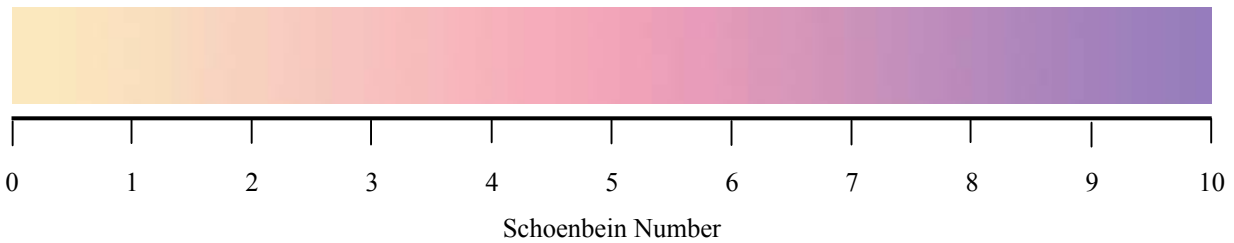
1. If Schoenbein strips have been freshly made, they are ready for immediate testing. If strips have been stored, moisten a strip of test paper with distilled water and hang it, out of direct sunlight, at the test site. The strip must hang freely.  
 **Use soap to wash hands and scrub under fingernails after working with potassium iodide!!**
2. **Expose the strip for approximately 1-1 1/2 hours**. Remove the strip and place it in an airtight ziplock bag out of direct sunlight until the results are recorded. If working with a partner one of you should choose an **INDOOR** location while the other should choose an **OUTDOOR** location out of direct sunlight.
3. Determine the ozone concentration of the air 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 (**see provided color scale**) and determine the Schoenbein Number. If the color of the paper is not uniform, use the color in the area with the most conspicuous change to determine the Schoenbein Number.
  - b. Use internet weather sites or sling psychrometer to determine the relative humidity at the test site and round it to the **nearest 10%**. If you use the internet use a site that will allow you to get data by zip code (try [www.weather.com](http://www.weather.com) or [www.wunderground.com](http://www.wunderground.com) ).
  - c. Use to the Relative Humidity/Schoenbein Number Chart as follows:
    - i. Along the bottom of the chart, find the point that corresponds to the Schoenbein Number.
    - ii. Draw a line upward from the Schoenbein Number until it intersects the curve that represents the correct relative humidity.

iii. Draw a line from the intersection in “ii” to the left side of the chart. Note your ozone concentration.

**Postlab Questions**—Write out and respond to the following.

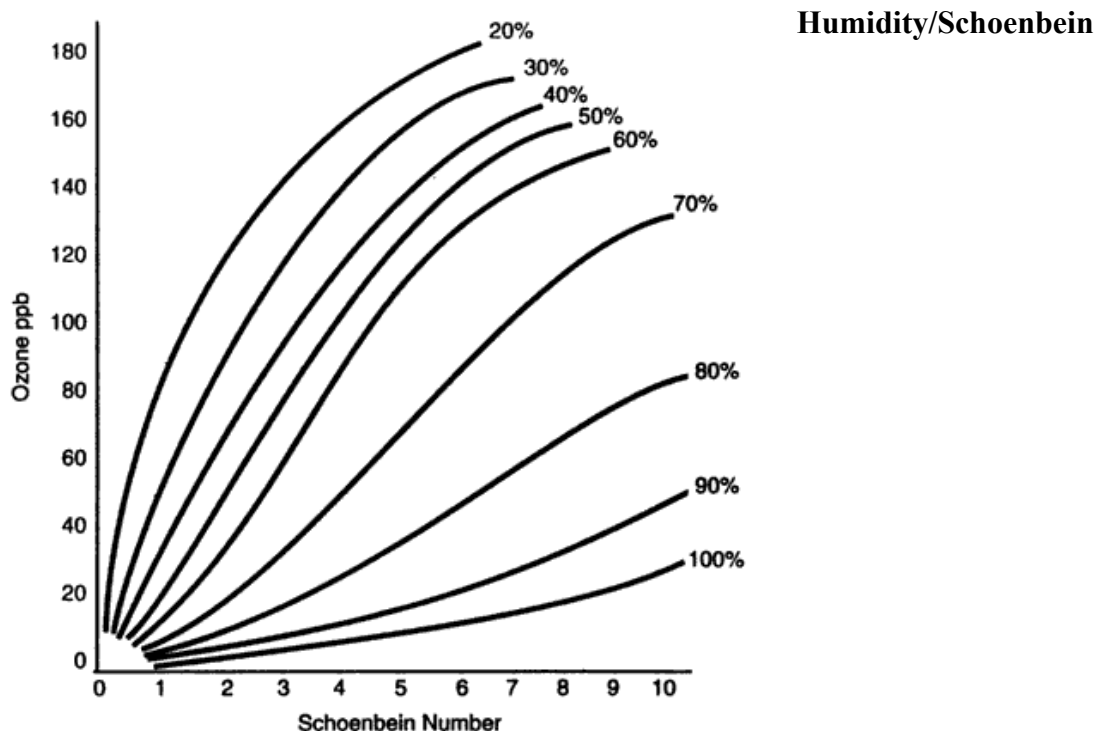
1. Determine the ozone concentration for Schoenbein paper with a Schoenbein Number of 2 at a relative humidity of 23%, 48%, and 81%.
2. Determine the ozone concentration for Schoenbein paper with a Schoenbein Number of 5 at a relative humidity of 18%, 53%, and 77%.
3. If the ozone concentration in two areas was 100 ppb, determine the Schoenbein Number if the relative humidity was 28%, 40%, and 72%.
4. Describe the changes you observed in the Schoenbein paper you used. List your ozone concentration from your graph.
5. Compare your Schoenbein paper to your partner’s or other students. Note, account for, and discuss the differences you observe.
6. Determine any wind direction or ventilation drafts during your study and discuss either of these may have affected your results (think about ozone sources nearby). **YOU MAY WANT TO DO A QUICK SEARCH ON THE WEB FOR COMMON OZONE SOURCES.**
7. Compare your data with data obtained from the San Diego Air Quality Management District ([http://www.sdapcd.org/air/data/web\\_report.txt](http://www.sdapcd.org/air/data/web_report.txt)). Based on this comparison, discuss the reliability of using Schoenbein paper to measure tropospheric ozone. How does your value compare to the current value for Del Mar (convert ppm to ppb).
8. List the pollutant levels and units for the following pollutants→ Nitrous oxide (NO<sub>2</sub>), Sulfur dioxide (SO<sub>2</sub>), and carbon monoxide (CO).
9. Estimate 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 air (Read the information on this link before answering→ [http://www.epa.gov/ozone/science/ozone\\_uv.html](http://www.epa.gov/ozone/science/ozone_uv.html))

**Schoenbein Color Scale**

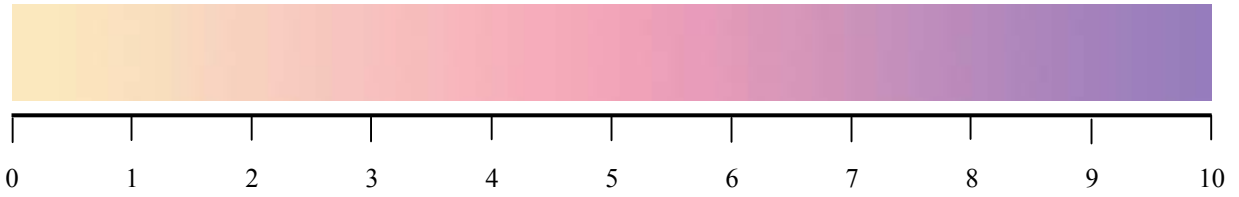


0-3	Little or no change
4-6	Lavender Hue
7-10	Blue or Purple

**Relative Number Chart**



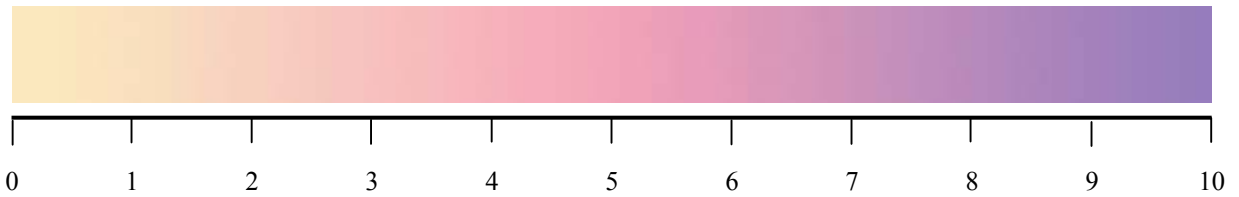
### Schoenbein Color Scale



Schoenbein Number

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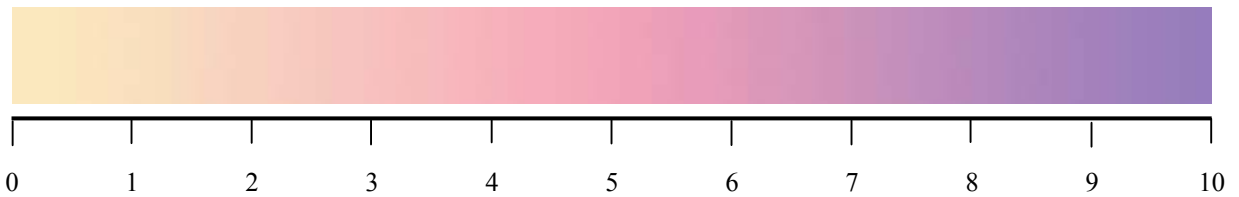
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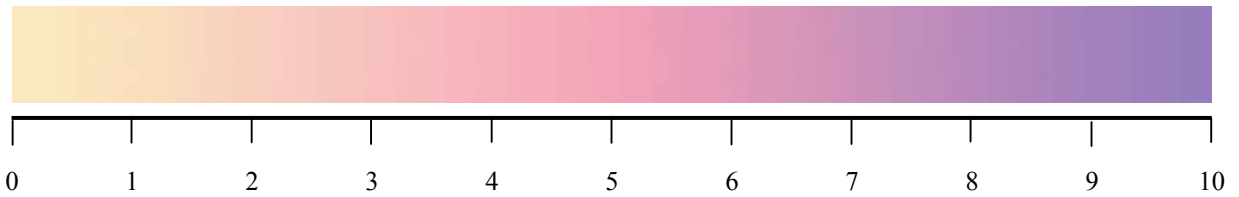
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