



The Color of the Sky & Sunsets

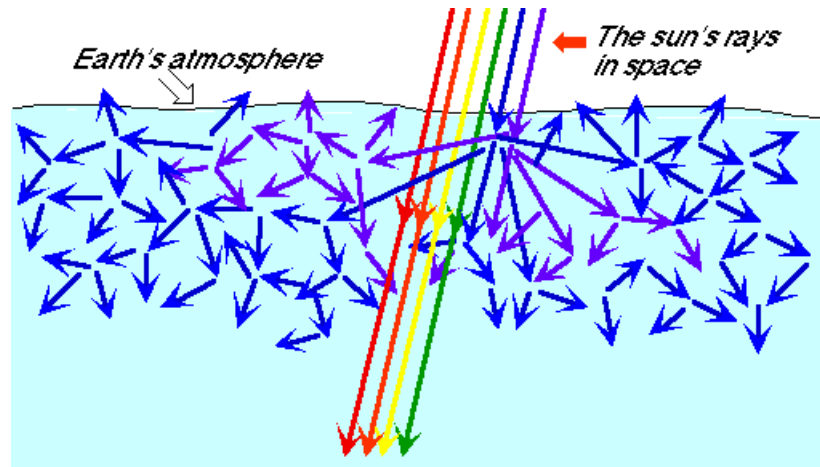
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Background

Rayleigh scattering, named after the British physicist Lord Rayleigh, is the scattering of light because of collisions with small particles in the medium. Small particles in Earth's atmosphere (0.5–1 micron) scatter visible light as it passes through. Because particles of this size are about five times as likely to scatter blue and violet light as light with longer wavelengths, the majority of the scattered light in our atmosphere is blue.



This is also why the sun appears yellow during the day—much of the blue light is scattered out, and the remaining combination of red, orange, yellow and green light appears yellow to us.

Water vapor molecules are much larger—ranging in size from 2–5 microns. For these larger particles, the probability of scattering is approximately the same for all wavelengths, which is why clouds appear white.

At sunset, because the angle of the sun is much lower, the light must pass through much more of the atmosphere before we see it. By the time the light gets to our eyes, nearly all of the colors are removed by scattering, except for the extreme red end of the spectrum. This is why the sun appears red when it sets.

Discussion Questions

Why is the sky blue? Why does the sun look yellow? Why are sunsets orange and red? Is this the same reason the moon looks orange when it's near the horizon? Is it true that pollution causes more spectacular sunsets?

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http://www.mrbigler.com/moodle/pluginfile.php/8541/mod_resource/content/2/sunset.pdf

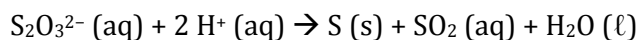
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The Demonstration

How it Works:

The reaction between sodium thiosulfate and acid produces colloidal sulfur:



This is a slow reaction that is often used for kinetics experiments in advanced chemistry classes. The sulfur particles start small, but grow larger as the reaction progresses.

When the particles reach 0.5–1.0 μm in size, they preferentially scatter blue light, and the light passing through the solution appears blue like the sky. When the particles reach 2–5 μm in size, they scatter all wavelengths with equal probability, and the light passing through the solution appears white like water vapor (clouds).

Materials:

- ~1 g of sodium thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3$) dissolved in ~100 mL of water.
- ~1 mL of 1 M hydrochloric acid (HCl).
- A plastic transfer (Beral) pipet, for adding the HCl to the sodium thiosulfate solution.
- 100 mL beaker or other clear glass container.
- Source of bright light. (I use an old filmstrip projector.)
- A white surface to project onto.

Instructions

1. Pour the sodium thiosulfate solution into the beaker or graduated cylinder.
2. Set up the light source so that it shines through the container onto the wall.
3. Use the Beral pipet to squirt a few mL of HCL into the container and stir.
4. Wait and watch.

Typical Results:

Time	In Beaker	Projected on Wall
0:00	clear	white
0:45	light blue	white
1:15	bluish white	yellow
2:00	white	orange
2:30	white	red
3:00	white	getting dark

Sources

The demonstration comes from Prof. Walter Lewin at MIT.

The graphic is from <http://home.comcast.net/~vinelandrobotics/> (by Rich Watkins and Joe Vallandingham at Rowan University)

Information about the reaction is from an AP Chemistry lab procedure by Marsilio Langella.