# Blue Sky

sead : stem

**Subjects**

Earth Science

**Topics**

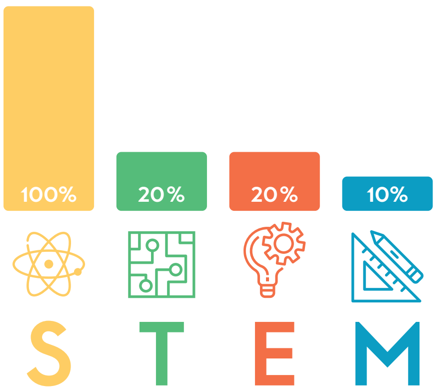
Astronomy · Space · Atmosphere · Perception · Light · Color & Seeing · Physics · Light Waves

**Key Words**

Light scattering · Wave length

**Connection to SDG**


**STEM Chart**




**Time for Activity**

**45 minutes**

## Introduction

The sun produces white light, which is made up of light of all colors: red, orange, yellow, green, blue, and violet. Light is a wave, and each of these colors corresponds to a different frequency and therefore a different wavelength of light. The colors in the rainbow spectrum are arranged according to their frequencies: Violet and blue light have higher frequencies than yellow, orange, and red light.

When the white light from the sun shines through the earth's atmosphere, it collides with gas molecules. These molecules scatter the light. The shorter the wavelength of the light, the more it is scattered by the atmosphere. Because its wavelength is so much shorter, blue light is scattered approximately ten times more than red light.

In addition, the frequency of blue light, compared to red light, is closer to the resonant frequency of the atoms and molecules that make up the air. That is, if the electrons bound to molecules in the air are pushed, they will oscillate with a natural frequency that is even higher than the frequency of blue light. Blue light pushes on the electrons with a frequency that is close to their natural resonant frequency, which causes the blue light to be re-radiated out in all directions in a process called scattering. The red light that is not scattered continues on in its original direction. When you look up in the sky, the scattered blue light is the light that you see.

## Key Objectives

1. When sunlight travels through the atmosphere, blue light scatters more than the other colors, leaving a dominant yellow-orange hue to the transmitted light. The scattered light makes the sky blue; the transmitted light ultimately makes the sunset reddish orange.

## Guiding Questions

1. Why is the sky blue?
2. Why is the sunset is red?

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## Materials/Preparation

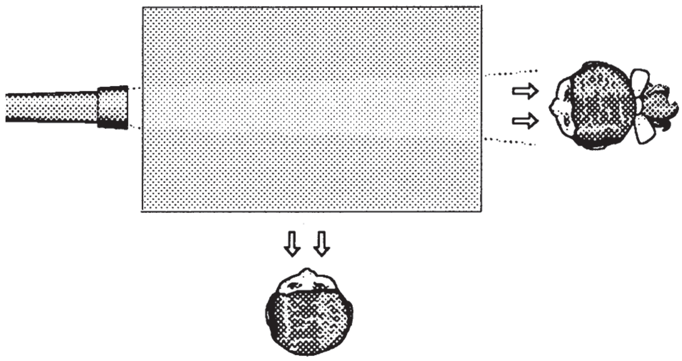
1. Transparent plastic box, or a large beaker, jar, or aquarium
2. Tap water
3. Flashlight
4. A few drops of milk (or some powdered milk) to add to the aquarium water to make the beam visible
5. Polarizing filter, such as a lens from an old pair of polarized sunglasses
6. Optional: Blank white card

Fig 1


## Tasks/Procedure

1. Fill the container with water.
2. Place the light source so the beam shines through the container. (See diagram below)
3. Add milk a few drops at a time (or add powdered milk a pinch at a time). Stir until you can clearly see the beam shining through the liquid.

Fig 2



Look at the beam from the side of the tank and then from the end of the tank (see diagram above). You can also let the light project onto a white card held at the end of the tank. From the side, the beam looks bluish-white; from the end, it looks yellow-orange.

If you've added enough milk to the water, you'll be able to see the color of the beam change from blue-white to yellow-orange along the length of the beam.

## Fostering Discussions

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Why does the setting sun look reddish orange? When the sun is on the horizon, its light takes a longer path through the atmosphere to your eyes than when the sun is directly overhead. By the time the light of the setting sun reaches your eyes, most of the colors of light have been scattered out. The light you finally see is reddish orange.

Violet light has an even shorter wavelength than blue light: It scatters even more than blue light does. So why isn't the sky violet? Because there's just not enough of it. The sun puts out much more blue light than violet light, so most of the scattered light in the sky is blue.

## Possible Extensions

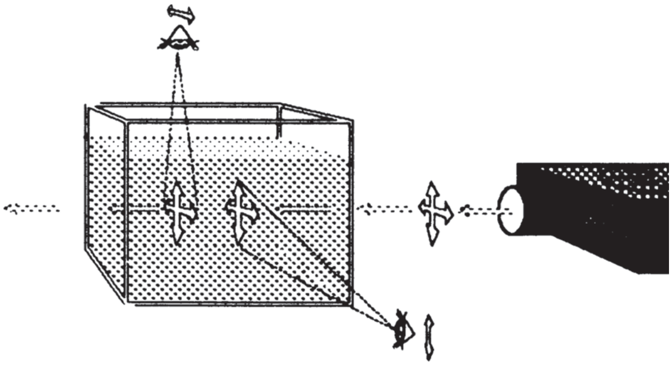
Scattering can polarize light. Place a polarizing filter between the flashlight and the tank. Turn the filter while one person views the transmitted beam from the top and another views it from the side. Notice that when the person looking down from the top sees a bright beam, the person looking in from the side will see a dim beam, and vice versa.

You can also hold the polarizing filter between your eyes and the tank and rotate the filter to make the beam look bright or dim. The filter and the scattering polarize the light. When the two polarizations are aligned, the beam will be bright; when they are at right angles, the beam will be dim.

Scattering polarizes light because light is a transverse wave. The direction of the transverse oscillation of the electric field is called the direction of polarization of light.

The beam of light contains photons of light that are polarized in all directions—horizontally, vertically, and all angles in between. Consider only the vertically polarized light passing through the tank. This light can scatter to the side and remain vertically polarized, but it cannot scatter upward! To retain the characteristic of a transverse wave after scattering, only the vertically polarized light can be scattered sideways, and only the horizontally polarized light can be scattered upward. This is shown in the diagram below.

Fig 3



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