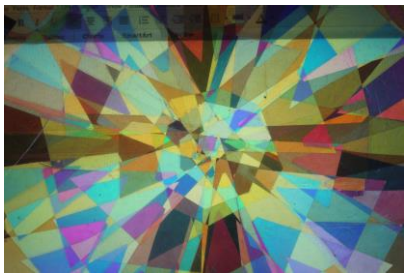
POLARIZED LIGHT ART

Ages 10-14, grades 5-8



Description

In this activity, students will learn what polarized light does, how polarized sunglasses work, and how to make colorful art from clear cellophane tape.

Materials

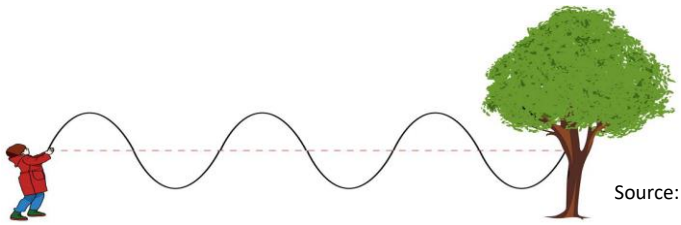
- A pair of polarized sunglasses (or polarized glasses used for 3D movie viewing)
- A laptop or other LCD (liquid crystal display) monitor
- Cellophane tape
- A piece of clear plastic, like a transparency master (to protect the monitor)

Not all sunglasses that say they are polarized really are. You can check by looking at an LCD monitor or television while wearing the sunglasses. Tip your head from side to side. Polarized glasses will cause the monitor to dim and brighten.

Use clear (not frosted) tape, like clear shipping tape. Apply the tape pieces to a separate piece of plastic to protect the monitor; transparency masters for printing work well. Taping directly to a monitor screen is not a good idea!

Background and Misconceptions

Light is a wave. Think of shaking a rope tied to a tree–you can move your hand up and down, side to side, or at some angle in between and make waves that vibrate in the direction your hand is moving. "Ordinary" light, for example sunlight or light from a flashlight, is made up of waves that vibrate in all directions- horizontally, vertically, and angles in between. Polarized light waves only vibrate in one direction, for example up and down, as they move forward. Light can be polarized in a number of ways, including reflecting from a shiny surface like water or by using a polarizing filter (polarizer) like the lenses of some sunglasses. The blue sky is polarized, and some insects have specially adapted eyes that can sense polarization and help them navigate. For more information on polarized light and additional activities see www.lasertechonline.org/Polarized_Light_Art.html



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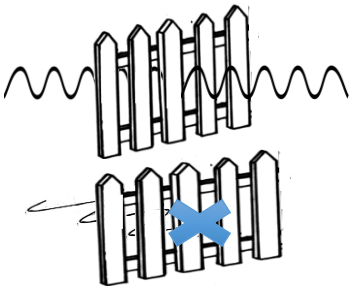


A polarizer like the lens of polarizing sunglasses can be thought of as acting like the pickets of a fence. (Like all analogies, this one is not an exact description of how light behaves but it helps to understand the concept.) Vertically vibrating waves can pass between the vertical pickets but horizontally vibrating waves are blocked.
The glare from sunlight that is reflected from a lake is polarized horizontally (the waves are parallel to the water surface). The polarizers in the sunglasses must be in the vertical direction to block the horizontal waves and thus block the light glare.

Teacher Guided Questions to Inquiry

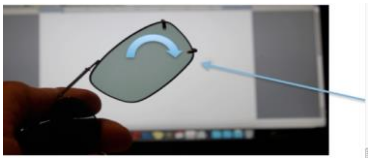
Use these questions to get students started on their own inquiry.

1. **What is a wave?** (Waves move energy from place to place without themselves moving. For example, if you shake the end of a rope tied to a tree you will see the wave disturbance move along the rope even though the end of the rope stays in your hand. Sound and light are both waves.)
2. **What is visible light? (**What humans call visible light is made up of the complete rainbow of colors, red, orange, yellow, green, blue, violet. Each of these is a different wavelength, where wavelength is the distance between the peaks of a wave. Red has the longest wavelength and violet the shortest. All visible light has very, very small wavelengths averaging about 0.00000055 meters between peaks!
   Some animals can see light that humans cannot. Bees, butterflies, some kinds of fish and maybe even cats and dogs can see ultraviolet which has shorter wavelength than violet. Some snakes can sense infrared (heat) energy with wavelengths much longer than visible red light.)

Guided Inquiry

Activity 1: Bright and dark

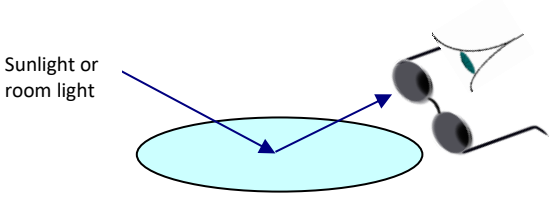
1. For this activity, use a laptop display, phone or LCD television and polarized sunglasses (or polarizing filter)
2. Hold a lens of the sunglasses in front of one eye and look at the screen. Now slowly rotate the lens. What do you see? How many times does the light dim in one 360^o rotation?



The monitor dims and brightens twice as the sunglasses are rotated.

Activity 2: What else creates polarized light?

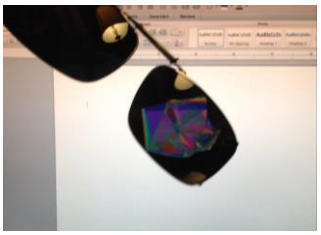
1. Hold the sunglass lens in front of one eye. Look through the lens at the surface of a bowl of water or at the reflection of room lights from a shiny floor. (Look at an angle, not straight down.)
2. Rotate the lens. What happens to the reflected glare? What does this mean about the light that is reflected from the water surface?
3. Are there other surfaces in the room that polarize light when they reflect it?



The reflected light dims and brightens as the sunglasses are rotated.

Activity 3: Colors from polarized light

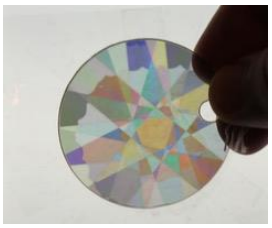
1. Use the same LCD monitor or screen that you used for Activity 1. It's best if the background is white, so open an app that lets you make a white rectangle on the screen.
2. Make a "sandwich" with the screen in the back, then a small crumpled piece of tape in the middle and the polarizer (sunglasses) in front of your eye. Look through the polarizer through the tape at the monitor. Rotate the polarizer as you look through it. Describe what you see.



Bright colors appear in the tape because the direction of light wave vibration changes a different amount depending on wavelength (color). Different colors appear as the lens is rotated to different angles.

Activity 4: Polarized light art

1. Stick pieces of tape to transparency film or other clear plastic. (You don't want to damage a monitor or screen by taping directly to it.) Use different layers of tape and apply the tape in different directions.
2. View your artwork by making a sandwich as in Activity 3: Polarized back light from a LCD screen or monitor, the transparency film with tape stuck on it, then the polarizer that you look through.



Analysis Questions

1. What is polarized light?
2. Suppose you want to buy polarized sunglasses. How could you test the glasses to make sure they have polarized lenses?