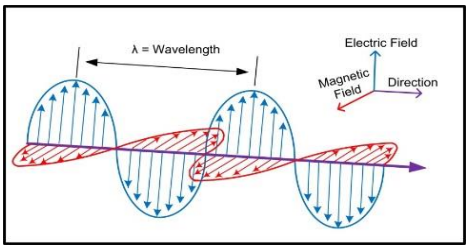
Cuttlefish have the most acute polarization vision yet found in any animal, researchers at the University of Bristol have discovered by showing them movies on a modified LCD computer screen to test their eyesight.

Science Daily, February 2012



This demonstration can be used as a STEM outreach hands-on activity as well as a science project at any K-12 level. It provides strong visual correlation between theory and practice, thereby enhancing student understanding of the phenomenon.

Never look directly at the Sun or a laser beam!

LIGHT POLARIZATION

Lesson Plan. *Developed by LASER-TEC.*

DESCRIPTION:

In this demonstration students will learn about light polarization. They will explore how the polarization of light by transparent and optically active materials can be used to create colorful art. This demonstration is an effective visual tool when introducing students to light polarization.

OBJECTIVES:

Upon completion of this demonstration, you will be able to:

1. Explain the electromagnetic (EM) nature of light
2. Define polarization
3. Define optically active materials
4. Use optically active materials and polarization filters to create art

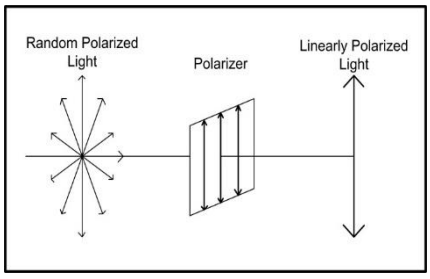
MATERIALS:

1. Cellophane tape
2. Scissors or a tape gun to cut the tape
3. Clear plastic substrate
4. Polarizing filters

BACKGROUND INFORMATION:

Light can be described as an electromagnetic wave in which both electric and magnetic fields oscillate in directions perpendicular to each other and at the same time perpendicular to the direction that the wave moves.
A light wave oscillating in more than one direction is called *unpolarized*. Light emitted by the sun, a light bulb, or a candle is unpolarized. In *polarized light* the waves oscillate in a single plane.

Human eyes do not differentiate between polarized and unpolarized light; we can only "see" polarized light with the help of instruments. Many animals, however—including



This project is supported by National Science Foundation grant DUE-1304628.
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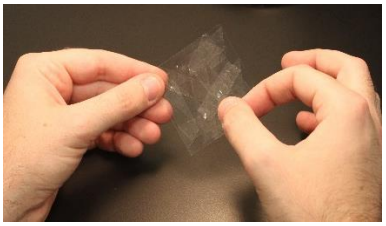
fish, amphibians, and octopi—sense and use polarized light for their vision and navigation.
Polarizers or polarizing filters are materials that absorb certain orientations of light. They often contain long chains of hydrocarbon molecules positioned parallel to each other. These molecules transmit only the plane of light that is parallel to their alignment. As the result, light waves passing through a polarizer are aligned to the same direction as the polarizer. It is said that light becomes then linearly polarized.
Polarized light can travel through the second polarizer without any absorption only if the axis of polarization is parallel to that of the first polarizer. If the axis is rotated at a 90 degree angle to the first polarizer, then the light will be completely absorbed.

PROCEDURE:

A fascinating way to discover polarization of light is to use transparent and optically active materials sandwiched between two polarized filters to create art. Optically active materials such as cellophane tape, clear plasticware, mica, and others rotate the polarization plane of linearly polarized light. By rotating the polarization plane and changing the thickness of the transparent material, colorful patterns can be created.

STEP 1:

Cut and place pieces of cellophane tape in a crisscross and overlapping manner on the transparent plastic substrate.



STEP 2:

Place the transparent substrate between two polarization filters, and hold it against a window or any other source of unpolarized light.

STEP 3:

Rotate one of the filters, and observe continuous change of colors as you rotate the filter.

EXPLANATION:

White light is a combination of all colors. As it travels through the first polarizing filter, the light becomes linearly polarized. When this linearly polarized light travels through an optically active material, the direction of polarization for each color is changed by a different amount. The degree of this rotation depends on the depth of the material and the light wavelength (or color). The shorter the wavelength, the bigger the degree of rotation. Consequently, after polarized white light emerges from an optically active medium, each color has its own direction of polarization. Human eyes cannot detect these changes unless the second polarizer is used. The second polarizer placed over the tape will transmit different colors, depending on the direction of polarization. Therefore you observe changing colors as the polarizer is rotated.

APPLICATIONS:

Polarized filters are used in sunglasses to reduce the sun glare reflected off of surfaces; for the same purpose, polarized filters are also used in photo cameras. Other applications include: quality control and stress evaluation in glass and plastic materials, view blocks from control room windows, 3D displays, LCDs in TVs, computer monitors, and instrumentation panels.

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