FILTERING LIGHT

On September 9th the Bay Area woke up to a strange phenomenon… The skies were filled with smoke, filtering sunlight to a low-orange glow. Not only did this create a sense of unease, as if we were living on a Martian planet, but it also sparked curiosity over the unique phenomena we were collectively experiencing.

Photo: Philip Pacheco/Getty Images/Getty

While acknowledging the terrible devastation that wildfires are causing across the Pacific Northwest, there is also interesting science that can be used to discuss what is going on at home. Use this simple demonstration to show how light filters through our skies and use it to connect to this historic event.

Background information can be found at the end of this activity guide.

PROCEDURE

1. Begin by asking some thinking questions:
    a. What do you think light is?
    b. Do you think light is moving or staying still?
    c. What are some sources of light/what are some things that produce light?
2. Shine a flashlight on a piece of white paper.
3. Grab a piece of colored cellophane and predict:
    a. What do you think will happen if we shine the light through this [red, blue, or green] filter?
4. Place the cellophane over the light and shine it on the paper. Discuss:
    a. What happened to the light?
    b. Did it change at all? How so?
5. Repeat this with the other colors.
6. After testing them all, discuss:
    a. Why do you think the color of the light changes to the color of the filter placed over it?

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MATERIALS

- Flashlight
- Colored cellophane: red, blue, and green. Other colors optional.
- White paper

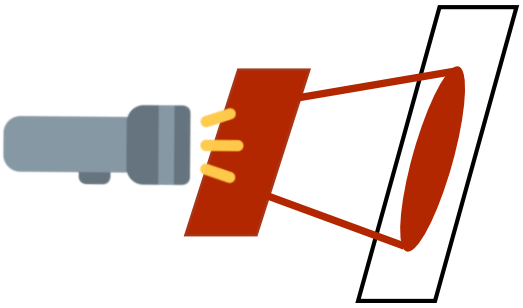
CONCEPTS

- Cause and effect
- Energy and matter

PRACTICES

- Asking questions
- Planning and carrying out investigations
- Constructing explanations

7. Now, try combining two cellophane colors at a time. Predict what will happen before testing each combination. Then, discuss:
    a. Why do you think the light change to [insert color] when we use these two filters together?
8. Now, try combining all of the colors at once. Predict what will happen, then test them together. Make some observations:
    a. What did you notice?
    b. How was it different from the previous tests?
    c. Was this similar or different to your prediction?
9. Discuss some of the following questions with your learners:
    a. What new ideas do you have about light now?
    b. Do you think light travels or stays still now that we've experimented a bit more with it?
    c. Do you think sunlight travels through filters in nature? What would be a natural filter of sunlight?
    d. Is the light from the sun always the same in brightness, color, or direction? What are some of the different ways you've seen sunlight?



10. Use the background information listed below to guide your conversation. Start simple and expand upon concepts as your learner asks more. Light-science can be very complex and difficult to comprehend, even for adults, so meet your learner at their level and focus on their curiosities, explorations, and observations of light instead of trying to gain a full understanding in just one conversation.

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EXTENSION ACTIVITIES

GRAB A LASER

Instead of a flashlight, use a colored laser light. How does that change the results of your experiment? Why do you think the results are different than with the flashlight?

TRY OTHER FILTERS

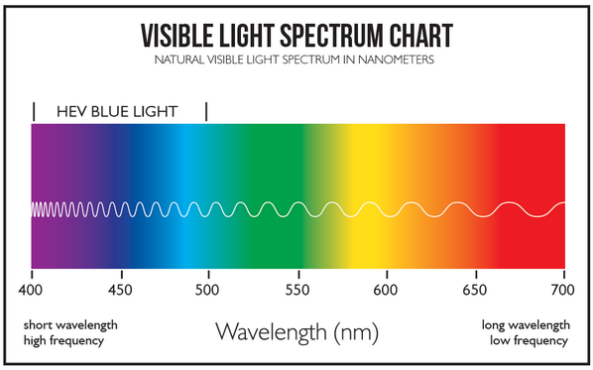
Shine your flashlight though other filters of varying transparency. How does light travel through a clear filter versus a cloudy one? Does the material of the filter influence the way the light shines?

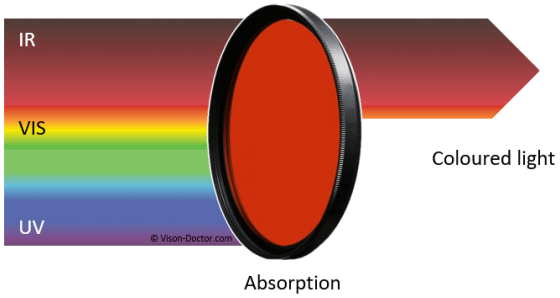
WHAT EXACTLY IS LIGHT?

Light is made up of tiny, invisible waves of energy that travel outward from their source until they bounce off or pass through an object. We cannot see them, but they are traveling all around us!

WHY DOES THE LIGHT CHANGE COLORS?

The size of the tiny waves that light travels in determines what color of light we see. If the waves are long and wide (long wavelength), they make yellow, orange, or red light. If the waves are short and thin (short wavelength), they make green, blue, and purple light. If the wavelength ever changes, so does the light that we see! In this case, when the light from a flashlight passes through a colored filter, the waves change from making white light to making colored light… the same color as the filter. This happens because the filter acts like a screen, only allowing the waves of light that match its color to pass through. All of the other wavelengths (and colors) of light are absorbed by the filter and therefore, not allowed to pass. This leaves only the *one* color of light traveling beyond the filter.





Absorption

WHY DOES LIGHT DISSAPPEAR WHEN ALL COLORS ARE USED?

White light is made up of all colors of light, meaning it contains all wavelengths. When more than one color filter is used, such as red, blue, and green, the wavelengths of light that *would* pass through for each color are being absorbed by the other filters at the same time, leaving no wavelengths left.

WHAT DOES THIS HAVE TO DO WITH THE ORANGE-SKY?

This activity, though simple, is a good representation of what happened on September 9th. You can think of the flashlight as representing the sun and its light, traveling all the way to Earth. As it reaches our planet, it must pass through our atmosphere and any other mediums in its path, such as clouds. These natural filters are similar to the cellophane filters we used in the activity. They slow down and change the light as it passes through, changing its wavelength and therefore, the way we see it.

When there are thick clouds in the sky it can act like a filter and change the light passing through to appear dark and gray, like what we see on a gloomy day… something we are very familiar with here in the Bay Area. On September 9th, we not only had the thick layer of clouds in the sky, but also a thick layer of wildfire smoke sitting on top of the marine layer. This smoke-on-cloud coverage was so thick that it disrupted the light passing through, like a colored filter. The large particulates of smoke and ash slowed down the wavelengths of light, creating a filter that only allowed low-energy, low-frequency light to travel beneath the clouds. This creates orange light and is why the Bay Area experienced an entire day of varying orange, red, and yellow skies.


Photo: Jessica Christian/San Francisco Chronicle/Getty Images

NEXT GENERATION SCIENCE STANDARDS (NGSS)

Completing these activities and experiments will satisfy the following NGSS standards:

- 1-PS4-3: Investigate the effects of placing objects made with different materials in the path of a beam of light.
- MS-PS4-2: Develop and use a model to show that waves are reflected, absorbed, or transmitted through various materials.

NGSS: PRACTICES FOR K-12 CLASSROOMS

Throughout these activities, learners of all ages will practice skills such as:

- Asking Questions
- Planning and Carrying out Investigations
- Constructing Explanations

NGSS: CROSS CUTTING CONCEPTS

Completing these experiments and activities will help children understand the following about cross cutting concepts:

- Cause and Effect: cause and effect relationships are identified and used to explain change and that events have causes that generate observable patterns.
- Energy and Matter: energy transfer between objects is observed and used to explain the motion and/or cycling of matter.