

ANCHORAGE MUSEUM

STARS: INTERDISCIPLINARY EXPLORATION UNIT 2. SCIENCE OF LIGHT

BACKGROUND INFORMATION

Humans can only see with the naked eye a small amount of the light that is in our universe. Light, also known as electromagnetic radiation, comes from many different sources, including stars, like our sun, which emit light and heat to provide the Earth with life-sustaining energy. In this unit, you will discover the different types of light surrounding us and how special technology allows humans to see things in the universe that would otherwise be invisible.

STUDENTS WILL:

- Experiment with colored light to learn about color mixing, shadows, and filters
- Learn about different wavelengths of light
- Understand why astronomers use filters to observe objects in space

MATERIALS

- Computer or tablet with internet connection
- Science of Light Challenge Activity Sheet

RECOMMENDED GRADE LEVEL

- Sixth through eighth grade

KEY TERMS

Light/Electromagnetic Radiation: energy emitted in the form of waves or particles

Emission: the production of something, especially gas or radiation

KEY TERMS CONTINUED

Light Reflection: light that changes direction after bouncing off an object

Light Absorption: light that gives up its energy to an atom or molecule

Wave: a disturbance that travels in space and transfers energy; electromagnetic radiation waves are different than other waves (i.e. sound, ocean) because they can travel through anything, including a vacuum (empty space)

Wavelength: the distance between two consecutive crests or troughs in a series of waves

Frequency: the number of wave cycles that pass in a give amount of time; typically measured in Hertz (cycles per second)

Electromagnetic Spectrum: the full range of wavelengths and frequencies of light

ACTIVITIES

This lesson provides four activity sets and explains each of them in detail on the following pages. Activities should be completed in order. Challenge questions are listed under each activity. You can also print the Challenge Activity sheet, which follows the activity descriptions.

1. **Activity 1:** Mixing Colors
2. **Activity 2:** Shadows
3. **Activity 3:** Filters
4. **Activity 4:** Electromagnetic (EM) Spectrum



ACTIVITY 1

Mixing Colors

[10-15 minutes]

First, we will focus on light that humans can see: visible light. This type of light ranges in color from red to violet. Use the website below for an online interactive, where we will mix red, blue and green spotlights to create other colors of light. You can also adjust the intensity of each color by adjusting the sliders at the bottom of the interactive.

Mixing colors interactive website:

<https://www.physicsclassroom.com/Physics-Interactives/Light-and-Color/RGB-Color-Addition/RGB-Color-Addition-Interactive>

Challenge Questions:

- Write down what colors you combined to make the following colors:
 - Cyan
 - Yellow
 - Magenta
 - White
- List any other combinations you used to make new colors.
- Can you make black? Hypothesize why or why not.

ACTIVITY 2

Shadows

[10-15 minutes]

Using your knowledge from mixing colors, now it is time to experiment with shadows. Always note where the shadow appears compared to the position of the colored spotlight.

Shadows interactive website:

<https://www.physicsclassroom.com/Physics-Interactives/Light-and-Color/Colored-Shadows/Colored-Shadows-Interactive>

Challenge Questions:

- What happens to the color of the background wall and the shadow when you turn on just one colored spotlight?

ACTIVITY 2 CONTINUED

- What happens to the color of the background wall and the shadow when two colored spotlights are used? Why is this happening?
- What happens to the color of the background wall and the shadows when all three colored spotlights are used? Why is this happening?

ACTIVITY 3

Filters

[10-15 minutes]

Now we will look at how filters relate to light. A colored filter is different from the colored spotlights used in the previous activities. Unlike spotlights, filters do not emit any light. Instead, filters absorb or reflect light to only allow a specific wavelength of light to pass through (i.e. when white light shines through a red filter, the red filter absorbs blue and green light while only letting red light pass through).

Filters interactive website:

<https://www.physicsclassroom.com/Physics-Interactives/Light-and-Color/Color-Filters/Color-Filters-Interactive>

Challenge Questions:

- Using just the dark red, dark blue, and dark green filters:
 - In the laser tab, what happens when you put one filter in front of the lasers? When you put two filters in front of the lasers?
 - In the light bulb tab, what happens when you put one filter in front of the light bulb? When you put two filters in front of the light bulb? How is this similar or different to putting filters in front of the lasers?
- Using just the dark cyan, dark yellow, and dark magenta filters:
 - In the laser tab, what happens when you put one filter in front of the lasers? What happens when you put in two filters? Three filters?
 - Why are these filters blocking certain colors of lasers?
- What combination of three 'dark filters' will allow one of the laser colors to pass through?



ACTIVITY 4

Electromagnetic (EM) Spectrum

[20-30 minutes]

Visible (colored) light or radiation is only a small part of the amount of light surrounding us. Use the following links to investigate the EM spectrum further.

EM introductory video:

<https://universeunplugged.ipac.caltech.edu/video/notglados-electromagnetic-spectrum-the-musical>

Challenge Questions:

1. What are the different types of light in the EM spectrum?
2. Which type of light has the longest wavelength?
3. Which type of light has the highest frequency?
4. Why are microwaves used for heating up food?
5. According to the video, what is the worst use of the EM spectrum?

EM spectrum website:

<https://imagine.gsfc.nasa.gov/science/toolbox/emspectrum1.html>

Challenge Questions:

6. Which types of light pass through the Earth's atmosphere?
7. Why would looking at different types of light be helpful in studying objects like stars?

EM interactive website:

https://viewspace.org/interactives/unveiling_invisible_universe/electromagnetic_spectrum/forms_of_light

Challenge Questions:

8. Which types of light will a roaring fire emit?
9. Which types of light does our sun emit?
10. How many types of light are present in the person's living room?

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SCIENCE OF LIGHT CHALLENGE ACTIVITY SHEET

ACTIVITY 1. Mixing Colors

1. Write down what colors you combined to make the following colors:
 - a. Cyan
 - b. Yellow
 - c. Magenta
 - d. White
2. List any other combinations you used to make new colors.
3. Can you make black? Hypothesize why or why not.

ACTIVITY 2. Shadows

1. What happens to the color of the background wall and the shadow when you turn on just one colored spotlight?
2. What happens to the color of the background wall and the shadows when two colored spotlights are used? Why is this happening?
3. What happens to the color of the background wall and the shadows when all three colored spotlights are used? Why is this happening?



SCIENCE OF LIGHT CHALLENGE ACTIVITY SHEET

ACTIVITY 3. Filters

This online interactive has three tabs to click on: Lasers, Light Bulb, and Sunglasses. These challenges will be utilizing just the Lasers and Light Bulb tabs and are best completed using only the 'dark filters'.

1. Using just the dark red, dark blue, and dark green filters:
 - a. In the laser tab, what happens when you put one filter in front of the lasers? When you put two filters in front of the lasers?

 - b. In the light bulb tab, what happens when you put one filter in front of the light bulb? When you put two filters in front of the light bulb? How is this similar or different to putting filters in front of the lasers?

2. Using just the dark cyan, dark yellow, and dark magenta filters:
 - a. In the laser tab, what happens when you put one filter in front of the lasers? What happens when you put in two filters? Three filters?

 - b. Why are these filters blocking certain colors of lasers?

3. What combination of three 'dark filters' will allow one of the laser colors to pass through?

ACTIVITY 4. Electromagnetic (EM) Spectrum

1. What are the different types of light in the EM spectrum?

2. Which type of light has the longest wavelength?

3. Which type of light has the highest frequency?



SCIENCE OF LIGHT ANSWERS SHEET

ACTIVITY 1. Mixing colors

1. Write down what colors you combined to make the following colors:
 - a. Cyan = Equal amounts of blue and green
 - b. Yellow = Equal amounts of red and green
 - c. Magenta = Equal amounts of red and blue
 - d. White = Equal amounts of red, blue and green
2. Can also make purple with more blue than red, and orange with more red than green
3. No; I think that is because you cannot make black using emitted light.

ACTIVITY 2. Shadows

1. One colored spotlight causes the background wall to turn that color and the shadow is black.
2. Two colored spotlights change the background wall color to the same mixed color from before (i.e. green and blue spotlights make a cyan wall, red and green spotlights make a yellow wall, and red and blue spotlights make a magenta wall). Two colored spotlights change the shadows from black to green, and/or blue, and/or red.

This occurs because the person's head is partially blocking the light from each colored spotlight, causing the shadow directly behind that spotlight to no longer receive that color.

3. Three colored spotlights change the background color to white (just like when we mixed red, green and blue lights before). It changes the shadows to yellow, magenta, cyan, red and blue. The shadows change depending on which colored spotlights are getting blocked, and therefore only getting part of the colored light.

ACTIVITY 3. Filters

1. Using just the dark red, dark blue, and dark green filters:
 - a. When you put a dark red, blue, or green filter in front of the lasers, only the colored laser that matches the dark filter color will pass through. The filter blocks the other types of light from passing through. When two filters line up, they absorb and block all light from passing through.
 - b. The light bulb tab presents the same observation. Only the color of light corresponding with the filter passes through. When you put two filters in front of the bulb, they absorb and block all light from passing through.



SCIENCE OF LIGHT ANSWERS SHEET

ACTIVITY 3 CONTINUED

2. Using just the dark cyan, dark yellow, and dark magenta filters:
 - a. One filter allows two laser colors to pass through. Two filters allow one laser color to pass through. Three filters do not allow any laser colors to pass through.
 - b. The cyan, yellow, and magenta filters are each a combination of red, blue, and/or green. For example, cyan allows blue and green light through because blue and green light mixed equally make the color cyan.
3. To allow light through while using three 'dark filters', you need to use two dark filters that are cyan, yellow, or magenta color. The third dark filter needs to match the color of the laser light that gets through the first two filters. For example, dark cyan, dark magenta, and dark blue will allow blue light to pass through.

ACTIVITY 4. Electromagnetic (EM) Spectrum

1. Gamma, Infrared, Microwaves, Radio, Ultraviolet, Visible, and X-Ray.
2. Radio waves have the longest wavelength.
3. Gamma rays have the highest frequency and therefore energy.
4. Microwaves are used because they cause water molecules to vibrate and breakup, removing 'cold' material from food.
5. An elephant dancing app.
6. Part of Ultraviolet, Infrared, Microwaves, and Radio waves pass through Earth's atmosphere. All Visible light makes it through.
7. Studying all types of light being emitted/reflected by objects like stars, can help scientists get a better understanding of the object and the universe.
8. Fires emit Infrared and Visible light.
9. Our sun emits all wavelengths of light (Radio/Microwave, Infrared, Visible, Ultraviolet, X-ray, Gamma-ray).
10. Radio/Microwave, Infrared, Visible, and Ultraviolet. No X-ray or Gamma ray.

