Subject areas: physical science (Astronomy)

Unit title: Holt Astronomy activities

Activity title: Reflection and refraction (Holt Chapter 2, Section 1)

Grade level: 6

Time required: 60 minutes

Keywords: light, spectrum

Educational standards: 3.4.7D
Concept/Vocabulary

In this activity, students investigate how white light is composed of a combined spectrum of various colors. They will use a prism to separate the visible colors from white light, and will understand that these visible colors are added together to generate white light. They will measure the amount of bending each color undergoes. They will also use color filters to subtract different colors from incident light, and will discuss the relevance to interstellar light traveling through clouds of gas. They will also use the Holt text and other resources to review the following terms:

- spectrum
- light-year
- apparent magnitude
- absolute magnitude
- parallax
- absorption/transmittance

Objectives

- Students will learn and understand how light can be refracted and separated into a spectrum of various colors.
- Students will investigate and describe the behavior of light passing through various materials (i.e. prisms, filters).
- Students will discover that light can be both added and subtracted.
- Students will learn how stars containing different elements radiate different colors.

INSTRUCTIONAL STRATEGIES

Group size: This activity can be performed in groups of 4-6 students.

Duration: It can be performed in one class period.

BEFORE

- Students will perform the Quick Lab on page 37 of the Holt text to explore the idea of parallax.
- Students groups will be asked “What colors can light be?”. They should answer with a variety of colors from the spectrum. If they don’t come up with “white” as one of their answers, they should be asked to think about what color of light comes from a frosted light bulb.

TO BE READ ALOUD TO THE CLASS:

Look around you. How many different colors can you see? Can you name them all? Now imagine a world without color. What would it look like? A rose wouldn’t be red. An orange wouldn’t be orange. The grass wouldn’t be green, and the sky wouldn’t be blue.

Color has always existed. But people who lived long ago didn’t know where color came from. Then a scientist in England, named Isaac Newton, discovered something special about sunlight. He found that he could make it turn into a rainbow of colors.

That was nearly 300 years ago. Since then, we’ve learned a lot more about color and how we see it. Our eyes can see something only when it gives off light (like a flame) or reflects light. Reflect means to bounce back. Objects reflect light like a sidewalk reflects a ball. If they didn’t, they’d be invisible.

The light from the sun and electric bulbs contains the colors of the rainbow. However, most things cannot reflect all those colors. If they did, they would look
white (or silver). Instead, inside many objects there are chemicals, called pigments, which absorb some of the colors in light and reflect others. The colors these pigments reflect determine the colors we see. The pigments in a red apple reflect red light, so the apple looks red. Those in a banana reflect yellow light, so the banana looks yellow.

Later in the year, Mr. Cathell will talk about some special objects and creatures that have color that doesn’t come from pigments.

- adapted from Gobble Up Science by Carol A. Johmann and Elizabeth J. Rieth

DURING

- Cover a table with sheets of white paper. Set up a lamp with an exposed light bulb on or near the table (sunlight can also be used, if the table is near a window).

- Have the students place their triangular prisms on the table so that a spectrum is displaced on the white paper.

- Students should trace the triangular footprint of the prism on the sheet of paper. They should also draw a line to represent the direction of light entering the prism. Finally, student should draw a line from the prism to each color of the spectrum they can identify (use of colored pencils may aid in identifying the lines later on).

- Each student group will use a protractor to measure the angles between the incident light (the line from the light bulb into the prism) and each of the different color lines. Students should be able to answer the question, “Which of the colors bent the most (violet and blue), and which bent the least (orange and red)?”

- Students should be prompted to think of the prism as a tool that allows us to see quantities which have been added together. As an analogy, a mathematical similarity may be drawn. Just like the number 6 is made up of the sum $1+1+1+1+1+1$, white light is made up of red+orange+yellow+green+blue+violet (and, as some people might tell you, indigo as well!). The prism simply allows us to see those individual parts that make up a whole.

- Next, students will learn how various colors of light can be subtracted from white light. Colored filters will be used to remove colors from white light. Place a color filter or theater lighting gel (or any other sort of transparent, colored plastic) in front of the light source, and have the students examine what happens to the spectrum. Explain that the filter subtracts colors from the spectrum. Certain colors are absorbed by the filter, while other colors are transmitted through the filter and emerge from the other side.

- Have the students observe the results of passing the light through several filters stacked together. They should speculate why very little light gets through. They should understand that nearly all the light has been subtracted away.
• Draw a parallel between the filters and large **stellar clouds** of gas and dust that filter light from far away stars and galaxies. Ask the students to imagine what colors would get through a stellar cloud if its particles **absorbed** all the **blue** light passing through. Students should realize that other colors (red, orange, yellow, green, violet) will be **transmitted**.

• Ask the students to speculate what color they would see if a cloud **absorbs** orange, yellow green, and violet light. They should understand that yellow and blue light will be transmitted. When that light reaches our eyes, we will see it as a shade of violet (or purple).

**IF AVAILABLE**  This portion of the experiment may be carried out if gas discharge lamps may be borrowed. These lamps are filled with various chemical elements in the gas state – neon, zeron, nitrogen, etc. These tubes are fragile and should not be handled by the students.

• Have the instructor/graduate fellow demonstrate how various gaseous elements, when excited by electricity, give off different colored light.

• Explain to the students that different elements **absorb** different colors of light, allowing the rest to be **transmitted**. Explain to students that this is what happens in “neon” signs. These lights may actually contain many other gases besides just neon. The different gases allow different colors to be produced.

• Draw a correlation between what is occurring in the lamp to what happens in stars. If a star contains enough of a certain element, that element can absorb specific colors of light. Since these colors are absorbed, we cannot see them. Scientists use special instruments called **spectroscopes** to measure the wavelengths of light are absorbed by a star (these appear as dark lines in the spectrum, called **absorption lines**).

• The **temperature** of a star is a very important cause of absorption. Different elements will be absorbed only at specific temperatures. Temperature is the major cause for us seeing stars of all different colors. Remind the students that blue stars are actually the hottest.

**AFTER**

**Reading/Writing**

Students will write a concise summary of the experiment in their science notebooks, focusing on a simple hypothesis, method of testing, and results. They should be encouraged to briefly explore any of their ideas that may have changed during and after the experiment.

As a special journal exercise:  **Research the elements and compounds that scientists studying star-light have found, and use colored pencils to reproduce some of the spectra in your science journal.**

**Inquiry**

Refer to page 33 of the Holt *Astronomy* text. Students may research the “Connection to Physics” question about forensic science.

Students may research different types of gases found in “neon” signs. They should determine which gases are used to various colors of light.
Students may also research the color indigo, and should answer the question of why Isaac Newton included it in his spectrum of colors. Students should write their opinions about whether indigo should be included in the official spectrum list.

**Assessment**

Have students make an illustration of the phenomenon of parallax in their *Science Journals*, and then explain their drawing to other group members.

**Keywords**

light, prisms, astronomy, spectrum

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**Review Question**

Which of these differently colored stars has the highest temperature?

A. yellow  
B. red  
C. blue*  
D. orange

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