The Effect of Light from the Sun

Tanya M. Belitskus

Introduction: What is light?

There are numerous definitions of light. Light can be defined as anything humans can see or something that makes vision possible. It could be defined as a source of light, such as an electric lamp or candle, it can describe a shade of color or a spiritual illumination. [1]Light can also mean not heavy, trivial or easily disturbed. If you ask anyone, "What is light?," they will give you varying answers spanning any of the aforementioned definitions. For this unit, we will be focusing on light as a form of energy that is made up of electromagnetic waves which are a part of the electromagnetic spectrum. It will also focus on a qualitative understanding of how energy from the sun causes heating.

Demographics

Cedar Lane Early Childhood Center is located in Middletown, Delaware in the Appoquinimink School District. Appoquinimink School District currently has 16 schools that serve students from grades k -12. We have 229 kindergarten students in our building, which is one of three kindergarten only buildings in our district. Our school serves students from suburban communities. I have 22 students in my classroom which is a heterogeneous grouping of students. I am not dual certified in special education; therefore, there are not any identified special education students enrolled in my class.

Objectives

Before teaching lessons on the sun's effect on Earth's surface, teachers need to have a deeper understanding that we get light from the sun. Teachers need to convey to their students that we do not get heat from the sun, but rather a transfer of energy. Whereas

[1] "What Is Light?" TheSchoolRun.

sunlight warms the Earth's surface and thus, the heat that reaches the earth warms the molecules in the atmosphere and they warm other molecules. Students will use the Three Dimensional Learning practice of Science and Engineering Practice of Constructing Explanations and Designing Solutions where they will use tools and materials to design a structure that reduces the warming effect of sunlight on an area.

Rationale and Content Objectives

We have adopted the Next Generation Science Standards and Common Core Standards in Appoquinimink School District. We have also adopted STEMscopes for our science curriculum for all elementary schools. STEMscopes uses the term bundles and we have four content bundles in kindergarten. We begin our year with the Dealing With Weather bundle. In this bundle we address four scopes, Weather Conditions, Weather Patterns, Weather Hazards and Energy from the Sun.

The first performance NGSS standard (**K-PS3-1**) is to **make observations to determine the effect of sunlight on Earth's surface**. The assessment of temperature for students in kindergarten is limited to measures such as warmer and cooler. A second NGSS standard **(K-PS3-2**) is **to use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.** The students could design a structure such as umbrellas, canopies and tents that minimize the warming effect of the sun. The third NGSS standard (**K-2-ETS1-1**) has the students **ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool**. The lessons are based on a Three-Dimensional Focus; Science and Engineering Practices, Disciplinary Core Ideas and Crosscutting Concepts. As stated in the STEMscopes curriculum, after completion of the whole bundle, students will apply their knowledge of weather conditions and the effects of the sun in order to build a playground cover that protects against different types of weather. Students are to refer to the anchoring phenomena of, How can we respond to different weather conditions and the effects of the sun?, throughout the bundle. The Disciplinary Core Idea is PS3.B(1) Conservation of Energy and Energy Transfer - Sunlight warms Earth's surface.

Background

In *Light: The Visible Spectrum and Beyond by Kimberly Arcand and Megan Watzke* we learn that all forms of light are energy. The term used by scientists is "electromagnetic radiation." Electromagnetic radiation refers to electromagnetic waves that travel through the empty space of a vacuum or a substance like air or water. Light always moves at the same speed in a vacuum. Once light is emitted, it usually travels in a straight path unless it meets an obstacle or moves from one substance to another.[2]

> **"Visible light** is defined as the narrow sections of the electromagnetic spectrum that humans can see. This is called the **visible light spectrum**."

Of all the different types of light that exist, visible light is actually only a small portion of the total electromagnetic spectrum. Visible light are most often listed as red, orange, yellow, green, blue and violet. Visible light is used in numerous applications ranging from.[3] We can see a rainbow when sunlight hits water droplets in the atmosphere after it rains. As the light hits the droplets, some of the light is reflected. The rest of the refracted. This refracted light is spread into the spectrum of colors.[4] In the 1660s Sir Isaac Newton is credited as being the first to understand how a rainbow works by demonstrating that white light is composed of all the colors of the spectrum.[5] Using a prism, he separated the individual colors (red, orange, yellow, green, blue and violet). He used a second prism to coalesce the individual colors back into white light. He proved that the light was not colored by the prisms but was being refracted.[6]

When light goes from one medium to another this is called **refraction**. This can be seen by conducting a simple experiment of putting a straw in a glass half full of water. When looking at the straw from the side it appears that it is broken. It appears to be broken because the water bent the reflected light from the straw. Your eye bends light because of the lenses in each eye. Lenses are transparent and curved and are able to bend light.[7]

Humans use reflection to see. We learned in seminar that **reflection** is a change in the direction of a wave. Whether the waves are light, heat, sound or water; they bounce off the surface and are not absorbed. For example, when light reflects off an object and

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[2]Arcand and Watzke. *Light the Visible Spectrum and Beyond*. 2015.
[3]Arcand and Watzke. *Light The Visible Spectrum and Beyond.* 2015.
[4] Halpern, Monica. *All about Light*. 2006.
[5] See Appendix 1
[6] Arcand and Watzke. *Light the Visible Spectrum and Beyond*. 2015.
[7] Berger. M. *All About Light.* 1995.

enters the eye you can see the object. The moon reflects the light from the sun; causing us to see it.

Light travels in waves. During the seminar we learned that waves have both an **amplitude** and a **wavelength**. Amplitude is the length of the top of a wave to the next and measures the intensity and brightness of the light. Wavelengths are the distance from the top of one wave to the next. Each light on the spectrum has a different wavelength, causing eyes to see them as different colors.[8] The wavelengths of different colors vary from the shortest, violet, to red as the longest.[9]

Waves of light are called **transverse waves**, as they "move energy away from a source to its surroundings."[10] As most objects are not **luminous** (something that gives off light) they can only be seen from light reflecting upon the surface. A great example of this is the moon. It is only visible when the light from the sun bounces off the surface of the moon, allowing it to be seen.[11]

The Sun is the energy source for the entire Solar System. The sun provides energy of all living things on Earth. The sun is a necessary component of photosynthesis which is the basis of our food chain and provides all of the oxygen that we breathe. However, in the deep sea where the sunlight doesn't reach there is still life. So, without the sun there could be some life, but it would be different from what we currently experience. Sun energy gives Earth natural heat and controls the temperature of Earth. Our atmosphere blocks many of the harmful kinds of light. According to Arcand and Watzke, "The sun gives off all the known types of light, which we can see. Much of the energy from the Sun that reaches Earth does not come in the form that we can see with our eyes (visible light), but as infrared, ultraviolet, radio waves, microwaves, x-rays and gamma rays. The sun emits radiant energy, ultraviolet light and infrared light. The energy from the Sun travels through space to Earth in the process of radiation in the form of electromagnetic waves and travels in a straight line. When those waves come into contact with Earth, they light and heat the Earth."

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[8] See Appendix 2

[9] Rogers, K et al. *Light, Sound and Electricity.* 2002.

[10] Rogers, K et al. *Light, Sound and Electricity.* 2002.

[11] Rogers, K et al. *Light, Sound and Electricity.* 2002.

We learned in seminar that **heat** is the flow of energy between materials due to a temperature difference. Increasing the temperature of a material causes its energy to rise, thus increasing the movement of its atoms. Heat energy can flow from one place to another and cannot be created or destroyed. However, heat energy can be changed into other forms of energy, such as electrical currents, or to perform work, like lifting an object. Heat energy flows from warmer to cooler. All materials have a **specific heat** which is defined as the amount of energy it takes to heat one gram of a material by one degree. Different materials have different specific heat. Solids absorb and lose heat the quickest, while liquids and gases gain and lose heat slower than solids. Light absorbed by a material can increase its energy through radiative heating. **Radiation** is the transfer of heat by electromagnetic waves and occurs without direct contact. **Albedo** is how reflective and bright an object is. Darker colored objects absorb more light and get hotter while lighter colored objects reflect more light and stay cooler. For example, if you are at a pool in the summer months during the day the concrete around the pool feels hot and the water feels warm to the touch. After the sun goes down, the concrete now feels cooler and the water still feels generally the same as it did earlier in the day. This is because water heats up and cools down slower than concrete because it has a larger "specific heat". Water has one of the highest specific heat (the property of a substance). The water is still cool because it takes much more energy to heat up as compared with the concrete around it.

For this unit, it is important for teachers to develop a high level of understanding of the **sun**. The sun is the center of the solar system. The visible part of the sun is about 10,000 °F. It is a fiery ball of gases made up mostly of hydrogen followed closely behind by helium. Almost all matter is made up of seven other elements, oxygen, carbon, neon, nitrogen, magnesium, iron and silicon. The sun has enough nuclear fuel to continue as it is for at least another 5 million years. It will then become a red giant. After it sheds its outer layers, the remaining core will be a white dwarf.[12]

Sun energy impacts the weather conditions on Earth. For example, the heat from sunlight forms clouds and the clouds produce rain, in a process referred to as the water cycle. Without light from the sun, the water cycle wouldn't be possible. In the book, Explore Light and Optics, Anita Yasuda breaks down the **water cycle** in kid friendly terms. She discusses the terms of evaporation, condensation and precipitation.[13] Water absorbs energy from the sun. This causes some of the water to evaporate. **Evaporation** is

[12] Choi, C. *Space.* 2019.
[13] Yasuda, A. *Explore Light and Optics!* 2016.

the process by which a liquid turns into a gas. In the case of water, liquid water turns into water vapor. A water droplet is made up of millions of molecules. Water can evaporate at any temperature, but as the temperature rises so does the speed at which it evaporates. Heat energy makes molecules move faster, thus some of those molecules are changed from a liquid to a gas. The water vapor is spread throughout the atmosphere by the wind. In several days it cools down in a process called **condensation** or changing back into a liquid. The tiny droplets fall to Earth as **precipitation**. Depending on the temperature, the precipitation could be rain, sleet or snow.

Plants use the sun's energy to create food by a process called **photosynthesis**. This is the process where plants use light energy, carbon dioxide and water to make glucose and oxygen. According to Yasuda, plants absorb water and minerals through their roots and it travels to their leaves. During the day, the leaves collect energy.

> "Photons from the sun are absorbed by tiny cells on the green part of a plant, such as its leaves or stem. These cells are like miniature factories where light, carbon dioxide, and water are combined to make glucose and oxygen. Through photosynthesis plants grow, animals eat the plants, and we eat both plants and animals. That means, without the sun, life as we know it would not be here."[14]

The energy from the sun takes millions of years to reach the Earth's surface, however; it is transferred to the Earth in minutes.[15] The amount of sun energy we receive on Earth differs across areas, and parts of the world, depending on the amount of daylight, the seasons, the weather conditions and climate. The sun will transfer more energy to the Earth's surface on a clear day than a foggy or cloudy day. Because the sun is always producing the same amount of energy; however, different amounts of it reaches the Earth's surface depending on the various conditions. From the STEMscopes teacher background:

> "Anything that blocks, reflects, or scatters the Sun's rays from an object causes the surface of that object to remain cooler than it would if the object absorbed the energy from the Sun. Clouds and trees provide such shade. White or shiny surfaces, such as clouds, scatter sunlight and cause the energy from the Sun to go elsewhere. Non-reflective items that provide shade, such as trees absorb the Sun's energy and keep

[14] Yasuda, A. *Explore Light and Optics!* 2016.
[15] "Fun Facts OnSun Energy." Fun Facts on Sun Energy for kids.

objects underneath from receiving that energy. Canopies and umbrellas may be set up to block the Sun's rays and keep areas underneath shaded and therefore cooler."[16]

From the STEMscopes website we learn that different locations on the Earth's surface will vary in temperature due to the angle that they receive the sun's rays. Because Earth's axis is tilted (23.5°) and it changes location as it orbits the sun, certain areas receive varying amounts of direct sunlight; thus varying energy transference. Areas around the Earth's equator receive more direct sunlight year-round; therefore resulting in warm temperatures all year.[17] Polar regions vary according to Earth's tilt. They receive direct sunlight in their summers, but remain cold due to a complex interplay of ocean currents and weather patterns. Areas between the poles and the equator experience four distinct seasons as direct sunlight changes throughout the year.[18]

What are shadows?

The unit will allow the students to gain an understanding that when the light from the sun is blocked it affects what happens on the Earth's surface. Students will be asked to use their prior knowledge to predict where they would stand depending on if they wanted to be warmer or cooler. In order to do this, students will need to understand how shadows work.

The creation of shadows is explained in the book, *Light, Sound and Electricity.* It is essential for students to understand that different types of materials allow different amounts of light to pass through them. **Transparent** materials, like clear glass, allow the full amount of light to pass through them and thus do not create any shadows. Nor do **translucent** objects, like frosted glass. No light passes through **opaque** objects, and therefore a shadow is created. Depending upon the amount of light, a **penumbra** and an **umbra** are formed. Umbras are the dark parts of the shadow where no light reaches. Penumbras are the grey areas surrounding the umbra, as some light reaches that area.[19] Other effects on shadows are caused by the size and **intensity** of the light source. A smaller light source will create more of an umbra than a penumbra. If an object is farther

[16] STEMscopes. 2019.
[17] STEMscopes. 2019
[18] STEMscopes. 2019.
[19] See Appendix 3

from the light source, the light is less intense, as "light spreads out as it travels farther from the source."[20] This creates a longer, but less intense shadow.

Teaching Strategies

The teaching strategies that are incorporated in the following lessons are turn and talk, notice and wonder, collaborative pairs, anchor charts, science talks, and hands-on activities that include completion of an investigation. My students have a science partner or a collaborative pair, that they always work with during our science time. The pairs are chosen by the teacher in this case, so that there is a more heterogeneous grouping. It is interesting to observe how certain pairs work together. One student may be strong in one area or have a stronger personality; however, when completing hands-on tasks the playing field is evened out.

Many of the lessons have students turn and talk to a shoulder partner. This allows students time to share their opinions or answer a given question with evidence. Every student is given a voice and a time to get to share their ideas whether or not they are called on during the whole group lesson. After the students talk, a few pairs are asked to share out what they discussed. It is important for students to state a reason behind their answers or to give evidence to back up their statements. Students are not only asked to share out what they think, but what their partner thinks as well.

Anchor charts are very important for the teacher to record the student's observations of what they know and what they have learned. It is added to throughout the lessons and is posted in a place where students can refer to it any time. When teaching science it is very important for the teacher to become more of a facilitator rather than a teacher. It is important for the students to come up with their own thoughts or notice and wonders of a phenomena. Anchor charts can be created before the lessons to address what students know and can be used as a summarizer to follow up with what they have learned. This is a great way to address any misconceptions that students may have. Anchor charts compliment science talks. Science talks are a wonderful way for students to talk about science. Science talks need to be set-up as safe environments where students feel comfortable sharing their ideas of science. Students learn that they can add on to another students' ideas or they can politely disagree with someone's ideas when they give evidence.

[20] Rogers, K et al. *Light, Sound and Electricity.* 2002.

Completing hands-on investigations in science is extremely beneficial for students of any age. Students learn by doing and when asked to plan and carry out an investigation they learn value skills not only about the content but about how to solve problems. During the engineering and design activities, the students learn to plan out a solution to a problem, decide what materials they are going to use, construct the design, test out their solution and have time to revise their solutions. During this time students learn valuable lessons about working cooperatively with others.

Lesson 1: K-PS3-1 Make observations to determine the effect of sunlight on the Earth's surface.

Science & Engineering Practices/Science Essentials from NGSS

Students will ask questions based on observations to find more information about the designed world. (*Asking questions and defining problems)* Students will also plan and carry out investigations to answer questions or test solutions to problems. In K-2 this builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. (*Planning and Carrying out Investigations)* Modeling in K-2 builds on prior experiences and progresses to include using and developing models that represent concrete events or design solutions. (*Developing and Using Models)* Students will use tools and materials provided to design and build a device that solves a specific problem or solution to a specific problem. (*Constructing explanations and designing solutions)* The crosscutting concept that is addressed is, *Cause and Effect.* Students will begin to understand that events have causes that generate observable patterns. (Teacher Note: Sunlight on the soil causes it to be warm) The Disciplinary Core Idea is *Conservation of Energy and Energy Transfer.* The "big idea" that we want students to understand is "Sunlight warms Earth's surface."

Before the activity begins, the teacher will provide two containers of each; soil, sand and water and take them outside, placing one set in a sunny location and the other set in a shady location.

Activator: In the classroom students will freely explore a container of soil, sand and water and discuss how they feel, using relative temperature words such as, hot, warm/cool or cold. Teacher will pose the question to the students, "What if we wanted to change the temperature of the soil?" Students will share out some ideas and the teacher can record them. After the discussion, tell the students that you have placed containers of

soil, sand and water outside (preferably this is done on a warm, sunny day). Students will make predictions about what they think each kind of surface will feel like in the sun and in the shade. A "predictions t-chart" would be premade along with name stickers to make recording easy.

Activity: Take the students outside and let them feel all of the surfaces. Allow them to record their findings on a premade "observations t-chart" with name stickers. How does the soil, sand and water feel? What do we notice? (We want to see if students can make connections about "where" the containers were located.)

Summarizer: Back in the classroom have students work in collaborative pairs (teacher will record the discussion on an "observations anchor chart":
"Turn and talk to a partner about where you felt the soil was the warmest/hottest. Why do you think it was hot/warm?"
"What do you notice? Why does the soil, sand, water feel different? Document on chart paper using pictures."

Activator Part 2: Show the students a photograph of a park bench located under a tree. Ask the students to go onto the left side of the classroom if they believe they would be cooler in the sunny location. Have the students who think they would be cooler on the bench located under a tree go to the right side of the classroom. Have students give evidence as to why they chose the area they did.

Teach Part 2: During this group Science Talk you are discussing sunlight and shade. "We said that light from the sun warms things up." Draw a sun, (where the rays are dramatically coming off of the sun) as the students are discussing the sun and shade – You are illustrating their ideas. You are giving a visual representation (model/diagram) of their ideas. Define shade to the class as a screen from direct light. (Less light not dark! Which is why there can still be some warmth in the shade.) Lead a discussion about sunscreen blocking the sunlight. (You will want to keep this "observations chart" and add labels as needed for a class reference).

Summarizer Part 2: Collaborative Pairs: "Turn to a partner and discuss the model/diagram of sunlight."

Activity Part 2: Take students outside and have them participate in this same activity by standing in a sunny location or a shady location to be cooler. Back in the classroom lead a discussion to help the students understand the relation to the shaded area and the lighted area to the relative temperatures of warmer/cooler.

Summarizer/Assessment Part 2: Students are asked to draw a picture of what warms the Earth's surface. Students should emphasize that the heat is coming from the light of the sun.

Lesson 2: **K-2 ETS1-1** Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

Activator Part 1: Show students a smartboard slide that has many different kinds of light sources (examples would be televisions, cell phones, candles, lamps, flashlights, sun etc.). In collaborative pairs have students discuss what they see.

Teach Part 1: The teacher will show students a heat lamp and tell the students that we have a new light for the classroom. (After you place the light, place an object under it.) Have students make a prediction about what will happen to the object that is under the lamp. Students will be asked to put their hand directly under the light and on the table next to the light. Later in the day: Have students touch the object that has been sitting under the heat lamp. Ask, "What do you notice?"

Summarize Part 1: Students will draw a model of the light and the object. They will be answering the question, "What happened?" (Light caused the object to become warm.)

Activator Part 2: Tell students that we are going to gather more evidence to prove the claim, "light caused the object to become warm" to be true. Remind students of our new lamp and show them a counting bear. Have students pass around a counting bear and have them share out about the relative temperature of the bear. Ask the students what we could do if we wanted to warm the bear up. When students come to the conclusion of placing the bear under the heat lamp, place it under the light.

Teach Part 2: "What if the bears were too warm?" " How could we protect them?" Have students share out. Ask students if they have heard of an engineer; ask "what are the different jobs of an engineer?" Define the words, **problem, solution, materials, design, re-design, structure, and engineer**.

Activator Part 3: Teacher says: "Today we are going to complete an investigation. Our problem is that the bear is too hot sitting under the heat lamp. How can we protect the bear from the light with the materials at your table?"

Teach Part 3: Students will first discuss with their partner how they can solve the problem. Explain that they will be designing a structure. Student pairs will draw a model of the structure they plan to create. (They will use an engineering design form). Students will draw a picture of what they will build with the materials. After drawings are "teacher approved" the students may begin building. Each pair will be given a counting bear and a mini flashlight to conduct tests on their own as they construct their designs (to make sure the light is being blocked). Building materials that students may choose from, 4 index cards, 1 piece of construction paper, 1 piece of wax paper, 1 piece of foil, 4 straws, a small amount of tape, 2 rubber bands and 20 unifix cubes. Allow the students 15 minutes to construct their structures.

Summarize Part 3: When the time is up, each group will present their designs. Students will report on the problem, design solution and they must describe why the structure worked or didn't. Students will do a gallery walk of the different structures and provide feedback of which structures provided the best protection from the light. If time allows, students will be able to redesign a failed structure.

Vocabulary: Structure, Design, Approved, Model, Test, Prediction

Materials: Heat Lamp, Counting Bears, Materials for construction i.e. blocks, paper (Classroom materials), Flashlights

Lesson 3: **K-PS3-1** Make observations to determine the effect of sunlight on the Earth's surface. **K-PS3-2** Use tools and materials provided to design and build a structure that will reduce the warming effect of sunlight on Earth's surface.

Modified from Mystery Science lesson - How could you walk barefoot across hot pavement without burning your feet?[21]

Activator: Ask students if they have ever walked across a hot pool area in the summer. “What did the concrete feel like when you got out of the pool to go back to your towel?” “What did the water feel like when you got back in?”

Teach: Hand each pair of students a map of a pool area that includes the pool, concrete area around the pool, snack bar and seating area. Have the students map out the best way to keep their feet cool while walking back from the pool to their towel and from the pool to the snack bar. Allow students to share their plans and discuss why they chose the path they picked.

Summarize: We know that the light from the sun warms things up. If we want to cool off, where would we want to be? If we wanted to warm up, where would we want to be?

Assessment: Mark the place on the page with an “x” where you could stay cool.

[21] “Open-and-Go Lessons That Inspire Kids to Love Science.” Mystery Science.

Appendix

Image 1

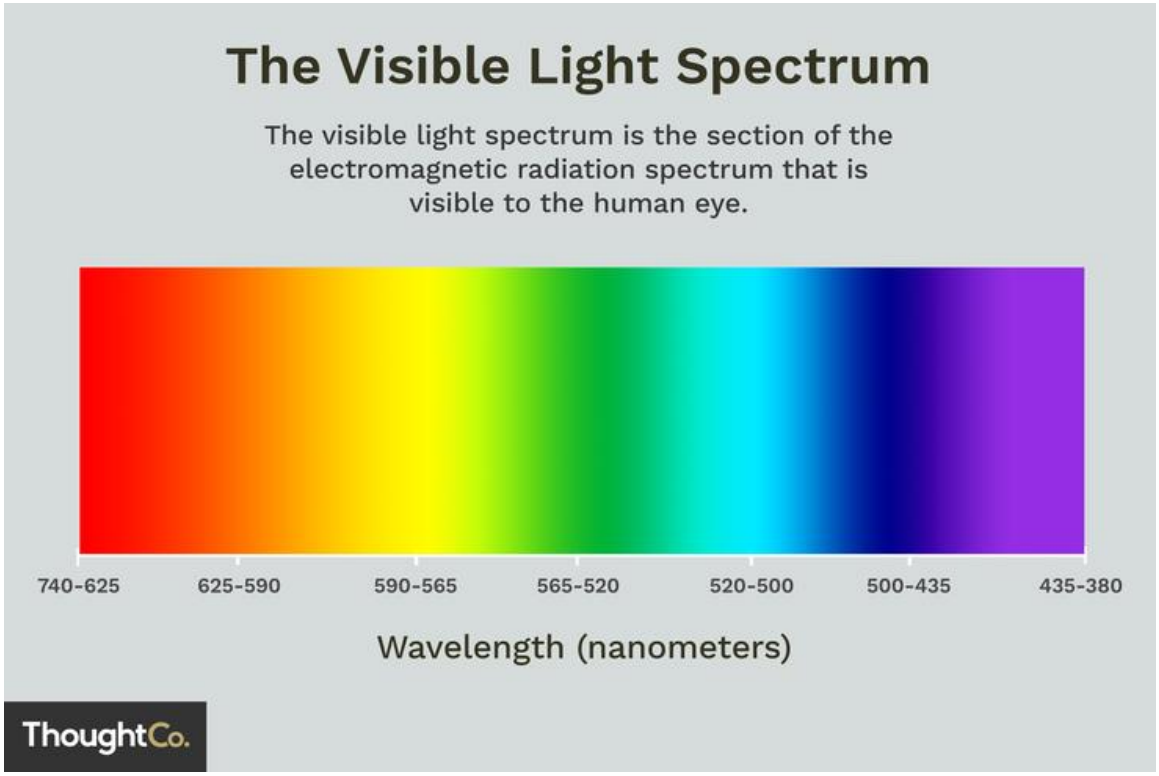

The Visible Light Spectrum
The visible light spectrum is the section of the electromagnetic radiation spectrum that is visible to the human eye.
740-625
625-590
590-565
565-520
520-500
500-435
435-380
Wavelength (nanometers)
ThoughtCo.

Image 2

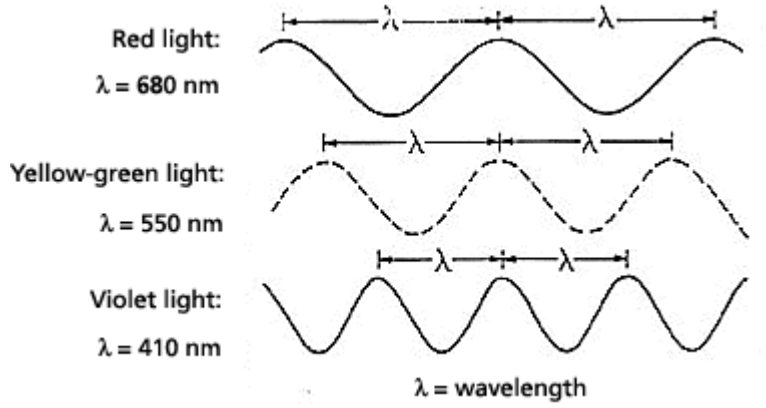
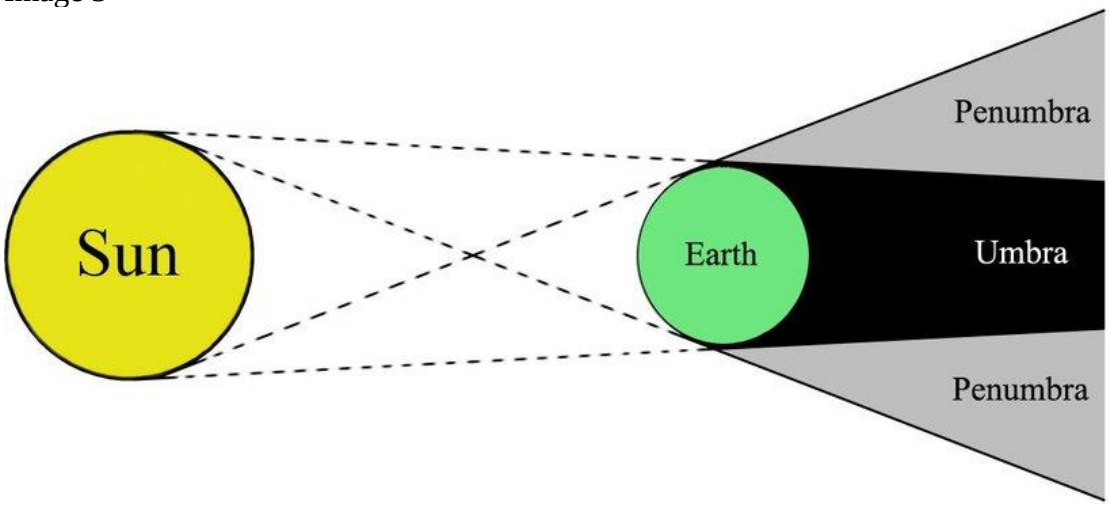

Red light:
λ = 680 nm
Yellow-green light:
λ = 550 nm
Violet light:
λ = 410 nm
λ = wavelength

Image 3


Sun
Earth
Penumbra
Umbra
Penumbra

Citation Page

A Wave Representation of Three Different Light Hues: Red, Yellow-Green and Violet, Each with a Different Wavelength , Which Represents the Distance between Wave Crests. Patterns in Nature. Arizona State University. Accessed December 15, 2019. https://www.asu.edu/courses/phs208/patternsbb/PiN/rdg/color/color.shtml.

Achenbach, Joel. "Light Article, Photonics Information, Star Creation Facts -- National Geographic." Light Article, Photonics Information, Star Creation Facts -- National Geographic, May 31, 2016. https://www.nationalgeographic.com/science/space/universe/power-of-light/.

National Geographic is a dependable and respected source for relevant and reliable information for all ages. The main website contains numerous topics and varied media resources. The source cited above relayed in-depth information about what light is and the many different ways we define and use light and photonics.

Arcand, Kimberly, and Megan Watzke. Light the Visible Spectrum and Beyond. New York, NY: Black Dog & Leventhal Publishers, 2015.

Kimberly Arcand and Megan Watzke spent their careers in science and technology. Arcand is the visualization lead for NASA's Chandra X-ray Observatory and Watzke is the press officer for the same organization. The Chandra X-ray Observatory is headquartered in Cambridge, Massacusettes at the Smithsonian Astronomical Observatory. Watzke specializes in communicating astronomy with the public, while Arcand's speciality is in images and data representation. Both authors are widely published and accomplished. Their book was used as the basis for our seminar and this unit.

Berger, Melvin. *All about Light A Do-It-Yourself Science Book*. New York: Scholastic, Incorporated, 1995.

Melvin Berger specializes in juvenile non-fiction. He is an award winning author of over two hundred books concentrating on popular science, as well as, other non-fiction topics. His book provided a nice blend of information and practical experiments that children could investigate further using easy experiments.

Choi, Charles Q. “Earth's Sun: Facts About the Sun's Age, Size and History.” Space.com. Space, November 14, 2017. https://www.space.com/58-the-sun-formation-facts-and-characteristics.html.

Space.com is a website featuring articles about space and astronomy. It’s parent company is Future. It was founded by former CNN anchor Lou Dobbs. The website is credited with being reliable and evidence based.

“Fun Facts OnSun Energy.” Fun Facts on Sun Energy for kids. Accessed October 13, 2019. http://www.fun-facts.org.uk/energy_facts/sun_energy.htm.

Fun-Facts.org.uk website provided quick information that was helpful and concise. The bulleted list would be easy for early learners to glean facts on numerous topics and various subjects.

Halpern, Monica. *All about Light*. Washington, DC: National Geographic, 2006.

Monica Halpern is a children’s author and wrote several National Geographic Science Chapter Series books. National Geographic is a leading source of non-fiction titles. Her book was helpful in explaining light in kid-friendly terms. This book gave easy experiments that students could do to further their understanding of the topic of light.

“Introducing STEMscopes.” STEMscopes. Accessed October 13, 2019. https://stemscopes.com/.

STEMscopes is an award-winning research based curriculum designed for PK through grade 12. It is created by Accelerate Learning, Inc. in partnership with Rice University. Our school district has adopted this curriculum and we are using it with fidelity. The lessons are NGSS aligned and support learning through hands-on inquiry based activities.

“Next Generation Science Standards.” Next Generation Science Standards, October 7, 2019. https://www.nextgenscience.org/.

The Next Generation Science Standards are the state standards that set the expectations that students in multiple states throughout the country are to know.

The standards blend three dimensions of learning by using science practices, disciplinary core ideas and cross-cutting concepts.
"Open-and-Go Lessons That Inspire Kids to Love Science." Mystery Science. Accessed December 15, 2019. https://mysteryscience.com/.

Mystery Science is a free resource of science lessons that use hands-on activities, is NGSS aligned and supports the Common Core. The website was created by a science teacher who incorporates stories, images and videos with investigations.

Research Gate. Research Gate. Accessed December 15, 2019. https://www.researchgate.net/figure/Umbra-and-Penumbra-region-of-Earth-Sun-system_fig2_310737375.

Rogers, Kirsteen; Clarke, Phillip; Smith, Alastair & Henderson, Corinne. *Light, Sound & Electricity - Usborne Internet-Linked Library of Science Series The Usborne Internet-Linked Library of Science*. New York, NY: Scholastic Inc., n.d.

Usborne Books provides a wealth of engaging books on various fiction and non-fiction titles for children of all ages. Usborne has been in business for over 40 years and has a catalogue of over 2500 titles. This particular source incorporated non-fiction text and provided links to many internet sources. It was an in-depth reference book that spanned everything relating to light, sound and electricity.

Thought Co. December 5, 2019. *Thought Co*. https://www.thoughtco.com/the-visible-light-spectrum-2699036.

Trumbauer, Lisa. *All about Light*. New York: Scholastic, 2013.

Scholastic Inc. provides both fiction and non-fiction books for students of all ages. It is a leading company for parents and teachers alike. This particular title offers a look at the physical science topic of light for early learners. It offers a glimpse of what light is and how light travels.

"What Is Light?" TheSchoolRun. Accessed December 15, 2019. https://www.theschoolrun.com/what-is-light.

The School Run website is a resource for parents and teachers to supplement various school subjects. The articles are written by experienced primary school teachers that help support learning.

Yasuda, Anita, and Brian Stone. Explore Light and Optics! White River Junction, VT: Nomad Press, 2016.

Anita Yasuda is an award winning author of over 100 children's books. The source cited above was a great introduction to the topic of optics. She included scientific notions along with historical facts and included 25 projects for readers to engage in to further their knowledge of the subject matter.