Optical Illusions: Rainbows and Mirages

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This curriculum unit is recommended for Science Grade 6

Keywords: optical illusion, image, refraction, reflection, rainbow, mirage

Teaching Standards: See Appendix 1 for teaching standards addressed in this unit.

Synopsis: This curriculum unit will make a significant contribution by exploring how optical illusions teach us about how our eyes and brain work together to see. We live in a three-dimensional world, your brain gets clues about depth, shading, lighting and position to help you interpret what you see. When you look at a two-dimensional image, your brain can be fooled because it doesn't get the same clues. Optical illusions are extremely important for everyday life, people use them for jobs such as pilots, fashion designers, architects and landscapers. Optical illusions also known as visual illusions involve visual deception. The arrangement of images, effect of colors, and impact of the light source all contribute to the misleading nature of visual effects. When we view a visual illusion, we may see something that is not there or sometimes we do not see something that is there. There is a disconnect between perception and reality. Visual illusions prove that the brain could fail to re-create the physical world. Illusions are also explained as mind games. Scientists are fascinated by illusions because by figuring out how the eye and brain can be tricked; they can better understand the normal workings of the visual system.

I plan to teach this unit during the coming year to 100 6th grade science students.

Introduction

Rationale

This unit will be taught during my science class. One definition of an optical illusion is that it is something that deceives the eye by appearing to be other than it is. A simpler definition would be it involves visual deception. The impact of a light source is one of the variables that causes the misleading visual effects that can be seen. Optical illusions work because your brain sometimes needs a little rest. Teaching on this topic and how light plays a part in it ties into my curriculum. The ultimate goal is to introduce my students as to why optical illusions exist and how they teach us how our eyes and brain work together to see. The students will compare different optical illusions and learn how illusions occur in the natural world. They will learn how a rainbow is an optical illusion and how light plays an important role in the display of optical illusions.

I am creating this unit because I am interested in how our eyes play tricks on us. My students and I will look at several optical illusions and see if we all see the same images. My curriculum includes teaching the three main types of optical illusions and how optical illusions include rainbows. I want them to know the basic principles of visual processing. I will introduce them to various visual illusions and provide interactive demonstrations.

My topic connects with my students' lives because of the color, light and patterns used to create images. Students might not see what is being advertised. For example, if you see an old woman and others see a young man, it will influence what meaning individuals might assign to a product using such a visual on a package. Animation, films and online videos all rely on an optical illusion. Also, many jobs involve optical illusions. The best real-life examples of a perceptual illusion are the moon and rainbows which are seen by my students. They will understand how refraction and reflection are tied into the appearance of optical illusions. Optical illusions are used today to perform studies that can help us understand the modern-day world.

Demographics

I am a 6th Grade Science Teacher at Northridge Middle School. I have 30 students in my class, and I have more males than females in my class. It is a Title 1 6-8 middle school and is located in the Southeast Learning Community of the Charlotte Mecklenburg school system. It offers a free and reduced lunch program. Northridge is a magnet school. Coding is incorporated into all subjects. Scholars are offered a variety of programs like AVID and foreign languages that target high academic performers. Special needs students are clustered at each grade level. Each grade level comprises one Super Team. The student population is 994. Students are comprised of: 56.2% Black or African American, 33.3% Hispanic/Latino, 4.3% white and 2.8% Asian or Asia Pacific Islander. We have one principal, 2 vice-principals, one Dean of Students, two counselors, one psychiatrist and one Family Advocate worker. Out of 62 classroom teachers, 81% are certified and many of the staff are enrolled in classes, attend/and or present at conferences and are members of curriculum development teams

Unit Goals

This unit is designed to be taught to my students in sixth grade to understand the characteristics of energy transfer and interaction of matter and energy. They will understand how refraction and reflection affect optical illusions. Teaching about optical illusions will expose my students to different types and not to believe everything that they see. They will explore why and how rainbows exist and how optical illusions are seen in everyday occurrences. We will review the information and have open discussions as well as have fun looking at different images.

Content Research

Optical illusions are fascinating! They play tricks in our minds. They are proof that we cannot believe everything we see. In order to understand the science behind optical illusions we must first understand that light plays an important role in its existence. Did you know that a rainbow is an optical illusion? Exactly how are optical illusions even possible?

Because of the two-dimensional representation of our three-dimensional world, sometimes images can be visually deceptive and create what are known as optical illusions. The human brain, which was originally programmed for interpreting moving 3-D objects instead of stationary images on flat surfaces, must make sense of a world in which everyday objects are normally distorted by perspective. Unfortunately, mankind is using more flat surfaces, such as paper and screens, to communicate with each other, causing he human brain to make an extra effort to transform two-dimensional images into three-dimensional ideas. This seems to be one of the causes why the spatial perception of students in the 21st century seems not to be highly developed. (Galindo)

Optical Illusions are fascinating to view. Some optical illusions such as the distortion effects in architectural structures of large extent, or the moon illusion have been known for along time. In the moon illusion, there is an apparent change in the size of the moon when it is close to the horizon versus high in the sky. The moon appears to be larger when it is close to the horizon compared to when it is high in the sky (see Figure 1). The moon does not change size as it moves across the sky. Instead, our brain perceives the moon to be larger in size when it is viewed in comparison to other objects close to the horizon. Some illusions are considered classic and are taught in schools. Many new illusory patterns have been created in the last few years.

Figure 1: The moon appears to be larger When it is viewed close to the horizon Compared to when it is seen high in the sky.

According to the Merriam-Webster Online Collegiate Dictionary, an illusion is 1. Something that deceives or misleads intellectually; 2. Perception of something objectively existing in such a way as to cause misinterpretation on its actual nature.

Optical illusions are a form of art presented in such a clever way that somehow it fools the human eye. For example, in one of the most popular optical illusion we either see the image of a white vase in a dark background or the image of two dark silhouettes facing each other. Another example is the image of several parallel lines that don't look parallel because intersecting lines are positioned in an inclined and alternate pattern that make them appear to be curved lines (Gilando).

An optical illusion is a type of illusion characterized by visually perceived images that are deceptive or misleading. Information gathered by the eye is interpreted by the brain to give the perception that something is present when it is not. There are physiological illusions, that occur naturally, and cognitive illusions, that can be demonstrated by specific visual tricks that show particular assumptions in the human perceptual system. (Optical, 2006)

How does refraction cause optical illusions? Many optical illusions are produced by refraction (bending) of light as it passes through one substance to another in which the speed of light is significantly different. A ray of light passing from one transparent medium (air) to another (water) is bent as it emerges. Let us look at the broken pencil effect for example. A visual distortion is witnessed if you look at a pencil submerged in a glass half-filled with water (see Figure 2). When you look through the side of the glass at the part of the pencil located above the water's surface, light travels directly from the pencil to your eye. This light does not change medium, so it will not refract. When you look at the portion of the pencil that was submerged in the water, light travels from water to air. The light ray changes medium and therefore undergoes refraction. As a result, the image of the pencil appears broken. Also, the portion of the pencil that is submerged in water appears to be wider than the portion of the pencil that is not submerged.

Figure 2: Refraction of light causes the pencil to look broken. (image in public domain)

The optical illusion that the refraction of light produces causes us not to know exactly where the object we see is located, so it is important to be aware of the effects of refraction in order to make the necessary adjustments. For example, when fishing it is important to understand that the fish are not at the point you see (see Figure 3),or at sunset, when what we see is the light refracted by the particles of our atmosphere and the real sun has set itself for some time. (Azeheb, 2022).

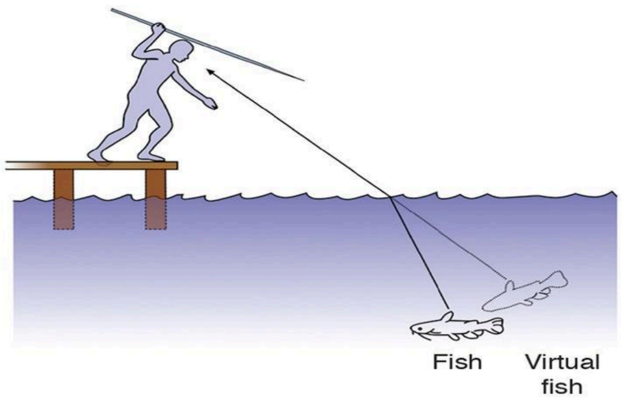


Figure 3: The fisherman must throw the spear in front of the virtual fish to hit the actual fish. *(Illustration developed by Kevin M. Miller, MD, rendered by Jonathan Clark, and modified by Neal H. Atebara, MD.)*

Optical illusions stimulate us by challenging us to see things in a new way. They are interesting within scientific disciplines because they lie on the border of what we are able to see. According to Al Seckel (2000), they "…are very useful tools for vision scientists, because they can reveal the hidden constraints of the perceptual system in a way that normal perception does not.

We assume there is a necessary correspondence between certain properties of the object (such as wavelength of reflected light, measured size, geometric shape) and those of its perceived image (color, apparent size, form) …If one or more these assumed correspondences proves incorrect, we term the perception an illusion. Accordingly, the illusions simply indicate the inadequacies of the assumed correspondence. (Held, 1974).

Sometimes, an illusion occurs when there is not enough information in the image to resolve the ambiguity. For example, important clues that would normally be present in the real world, and which would have resolved the ambiguity, are missing. Other illusions take place because an image violates a constraint based on an underlying regularity of our world. In other cases, illusions occur because two or more different constraints are in conflict. Even though the image on your retina remains constant, two interpretations may perceptually flip back and forth. Illusions are very useful tools for vision scientists, because they can reveal the constraints of the perceptual system in a way that normal perception does not. (Seckel, 2000)

To understand optical illusions, we must know about the concepts of sensation and perception. Our eyes have special cells called sensory receptors that detect light and transmits a signal to the brain. The reception of this signal is called perception. Sometimes our interpretation is incorrect. This is called an optical illusion.

There is no one explanation for all the many optical illusions. There are several reasons why the images fool us – there is not scientific explanation yet. It is necessary to find a way to classify them.

Rainbows

A rainbow is produced by dispersion (how much light refracts in a material depends on the wavelength of the light and this can separate colors) and internal reflection of light in water droplets in the atmosphere. White light from the sun enters a spherical raindrop. The different colors are refracted through different angles, reflected off the back of the drop, and then refracted again when they emerge from the drop. The white light now has been dispersed into its component colors, and the different colors travel in slightly different directions. You see red light coming from water droplets higher in the sky than violet light. The other colors are found between these, making a rainbow.

How many rainbows have you seen lately? Unless you live in Hawaii, which is an oceanic island, you probably do not see them on a daily basis. They occur frequently but the conditions have to be right. Even though everyone thinks that the Sun plus rain equals a rainbow what they may not realize is that the Sun must be close to the horizon and the rain must be in the opposite side of the sky (see Figure 4).

Figure 4: For a rainbow to form, the sun must be in the opposite direction of the rain. (image in public domain)

Let's discuss why rainbows are optical illusions. Rainbows are the result of the refraction and the reflection of light. Refraction and reflection are phenomena that involve a change in the wave's direction. A refracted wave may appear "bent" while a reflected wave might seem to "bounce back" from a surface or other wave front (Encyclopedia Britannica, 2022). As the sun's rays pass through rain, the droplets separate (refract) the white light into its component colors (see Figure 5). As rays of white light from any source pass through a prism, they are refracted to give the appearance of a spectrum of color.

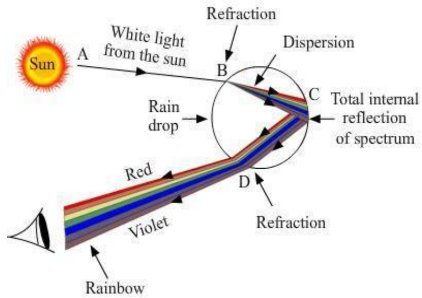


Figure 5: How light travels though a raindrop and this results in the formation of a rainbow. (image in public domain)

A rainbow is a multicolored arc made by light striking water droplets. The most familiar type of rainbow is produced when sunlight strikes raindrops in front of a viewer at a precise (45 degree) angle (encyclopedia). It does not actually exist in a specific spot in the sky. You will see a rainbow depending on where you are standing and where the sun or another light source is shining.

The center of a primary rainbow is the antisolar point which is the imaginary point exactly opposite the sun. Rainbows are in reality full circles. If you are viewing them for an aircraft, you can sometimes see these circular rainbows. If you are viewing from the ground you can only see the light reflected by the raindrops above the horizon. Because each person's horizon is a little different, no one actually sees a full rainbow from the ground. In fact, no one sees the same rainbow-each person has a different antisolar point, each person has a different horizon. Someone who appears below or near the "end" of a rainbow to one viewer will see another rainbow extending from his or her own horizon. Objects reflect the light that falls on them and the eye forms inverted images of the object on the retina. The brain interprets the image, and we perceive the object to be what it really is. In case our perception does not match with the physical dimensions of the object, it is surely an optical illusion (ScienceStruck, 2020).

Total Internal Reflection

Total internal reflection is also an important phenomenon in the formation of rainbows and also plays a key role in the formation of mirages (another optical illusion). After light enters a raindrop, the light reflects off the back surface of the drop (see Figure 5). Rainbows and mirages are examples of a total internal reflection which occurs in nature, giving rise to a play of light and colors. While travelling from a denser to a less dense medium, if the angle of incidence of a ray of light is more than the critical angle, then instead of refracting into the rarer medium, the ray of light is reflected back into the denser medium (see Figure 6). This phenomenon is known as total internal reflection. So, for total internal reflection to happen, the following two necessary and sufficient conditions should be met:

a. The ray of light should be travelling from a denser (refractive index, n_1) to a less dense medium (refractive index, n_2) such that $n_1 > n_2$.
b. The angle of incidence should be more than the critical angle (embibe, 2022).

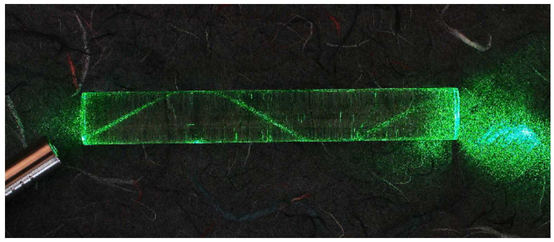


Figure 6: Light is totally internally reflected at the boundary of glass and air. (Image in public domain)

Mirages

Another illusion that depends on atmospheric conditions is a mirage, in which, for example, the vision of a pool of water is created by light passing through layers of air above the heated surface of a highway. Under certain conditions, elaborate mirages that look like cities, forests, or "unidentified flying objects" may appear on the horizon, or ships in a nearby body of water may appear to be plying the sky of a desert (Britannica).

> We've all seen that part in the movie where the weary desert wanderer has been walking for hours and is dying of thirst. Then he happens upon a vast body of water on the horizon. He runs towards the water, it grows closer and closer, until he springs himself into the air only to land back down in the sand and no water in sight. You might think the traveler was hallucinating, but mirages are a naturally occurring optical illusion. In cartoons, a mirage is often depicted as a peaceful, lush oasis lying in the shade of swaying palm trees, but in reality it is more likely to just look like a pool of water (sciencemadefun, 2016)

A mirage is an optical illusion arising from the refraction of light as it passes through air layers of different temperature and densities, plus total internal reflection. The condition most likely to produce a mirage is a layer of hot air lying immediately above the ground with cooler air above it (this is quite usual during the day because the ground becomes so hot) (Darling, 2016). The best-known example of a mirage is seeing what looks like a pool of water on a hot road (see Figure 7). When you see water on the roadway there are three possible explanations: 1) there is a mirror on the road 2) there is a glass window on the road or 3) there is water on the road. Only one makes sense. Glass windows and mirrors can reflect light, but they are not on the roadway. When you experience a very hot day phenomenon, you can look downward at the roadway and see an object located above the road due to the reflection of the light. It may look like water on the road, but you have just experienced an illusion.

Figure 7: On a hot day it can appear that there is a pool of water on the road. This is an example of a mirage. (image in public domain)

Superior and Inferior Mirages

There are two main types of mirages: inferior and superior mirages. The formation of both types depends on refraction and total and internal reflection of light. The water on the roadway illusion shown in Figure 7 is an example of an inferior mirage. It occurs when a hot surface heats the layer of air above it, placing it below a colder and denser layer of air (Flatearth, 2020). The “pool of water” is actually a reflection of the sky. Sometimes other objects can be seen and look like they are being reflected in the pool of water. These objects are usually upside down (Soffar, 2015). Figure 8 shows an inferior image in the desert. The reflected image of the sky is the “water” and the rocks seem to reflect in the pools of water. As seen in Figure 8, at the boundary of the warm air (lower density) and the cooler arir above it, light is totally internally reflected. This means light from the sky that was headed for the surface is re-directed upward toward an observer. The person sees a reflected image of the sky and other objects (like the trees in Figure 8). This only works because the light is totally internally reflected above the hot surface.

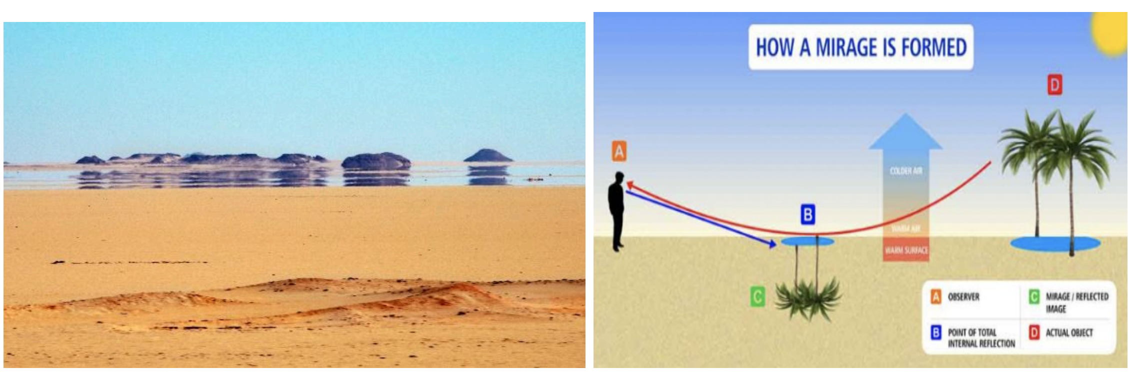


Figure 8: An example of an inferior mirage (at left). Light is re-directed upwards toward an observer by total internal reflection to form the mirage (at right). (images in public domain)

Superior mirages are most often seen at sea or in polar regions. A superior mirage may take the form of a ship floating in the air or the lights of a faraway city shining in the sky (see Figure 9). The conditions needed to produce this type of mirage are opposite of those required for an inferior mirage. It requires a layer of cold air lying immediately above the surface with warmer air above it (Darling, 2016). Light rays traveling upward are refracted and totally internally reflected at the boundary between the warm and cold air, but in this case the light is directed down toward the observer as seen in Figure 9. (Darling, 2016). The object, such as a ship, may be out of sight as it is hidden by the curve of the Earth, but the observer will see an image of the object that looks like it is suspended in air. Superior mirages can be right-side up or upside down depending on the distance of the true object and the temperature gradient (Soffar, 2015).

Figure 9: An example of a superior mirage (at left). Light is re-directed down toward an observer by total internal reflection to form the mirage (at right). (images in public domain)

Instructional Implementation

Teaching Strategies

Introduction of Topic
The first assignment will be a discussion of what is an optical illusion? Students will create a K-W-L chart to share with the class.

Differentiation
Lessons will be modified according to student needs.

Entrance Ticket
The purpose of the Entrance ticket will be for the students to use critical thinking skills as the teacher monitors student learning and introduces or reviews instruction. This task is to be done immediately as the students arrive in the classroom.

Exit Ticket
Monitor student’s thinking and what they have learned at the end of a lesson.

Whole Group Teaching
Instruct and model concepts for all students at once. It gives every student a good introduction and foundational knowledge of skills.

Small Group
Address gaps in students' knowledge, allow students to discover and engage with a range of perspectives, ideas and backgrounds and assist students in clarifying their attitudes and ideas about the subject matter, as they test their own ideas and attitudes against those of others.

Independent Work Time
Students will work on assignments either with a partner or individually to complete a given assignment.

Cornell Notetaking
Helps organize class notes. The main point, details, study cues, and summary are all written in one place. Notes will focus on an essential question.

Google Slides
Allows the teacher to create dynamic, interactive presentations that really engage their students.

Interactive Notebooks
Students will use composition books to take notes and glue in graphic organizers.

Classroom Lessons/Activities and Assessment

Lesson 1: What do you know about optical illusions?

Entrance Ticket: KWL chart (Appendix 2)

Objective: Students will be able to organize information that they learn before, during, and after a lesson by creating a 3-column template.

Activity: Students will create a KWL chart in their notebook and write down their thoughts in the appropriate column before, during and after the lesson. Students will then talk in their table groups to discuss their information.

Exit Ticket: What is 1 new piece of information you learned today about the lesson?

Lesson 2: Introduce Unit Vocabulary (Appendix 3)

Entrance Ticket: Students will create a Frayer Model for the vocabulary word "Optical Illusion" (Appendix 4).

Objective: Students will be able to define target vocabulary and apply their knowledge by generating examples and non-examples, giving characteristics, and/or drawing a picture to illustrate the meaning of the word.

Activity: Students will be given the unit vocabulary to create a Frayer model for each word in their interactive science notebook.

Exit Ticket: Students will share one definition of their Frayer Model with the class.

Lesson 3: Close Readings on Rainbows

Entrance Ticket: I will project a picture of a rainbow to get my students thinking about the time they may have seen a rainbow. This is to activate their prior knowledge and experiences. Students will share some things they know about light, and how a rainbow is created.

Objective: Students will be able to develop a deep understanding and a precise interpretation of an informational passage.

Activity: Students will read and apply strategies to an informational close reading activity

Exit Ticket: Students will write a 3-5 sentence summary of the information text in their interactive notebook.

Lesson 4: Creating a Rainbow

Objective: Students will be able to collect observations and observe actions to try to answer a question or solve a problem.

Activity: Experiment: What Happens When Light Passes Through Water?
https://www.funology.com/make-a-rainbow/

1. Students will read a text and take notes in the margin on the close readings.
2. Students will do an experiment in their groups and write down observations in their science interactive notebook and an illustration of the results.

Exit Ticket: Reflect on the experiment today. What did you learn?

Lesson 5: Viewing a Prezi: Rainbows and Mirages

Entrance Ticket: Create a two-column graphic organizer with the definition, facts and visuals of rainbows and mirages.

Objective: Students will be able to demonstrate how rainbows and mirages are different.

Activity: https://prezi.com/qu95nuqbw3zs/rainbows-and-mirages/

Exit Ticket: Student will display their finished products for a gallery walk.

Assessment Plans

1. Reflection/Refraction
   file:///C:/Users/vashtia.mosby/Downloads/ReflectionandrefractionoflightQuestionsfordeeperunderstanding-1.pdf
2. Students will create a google slideshow of 8-10 slides using the vocabulary words to demonstrate understanding of the unit. Each slide must have a definition, 3 key facts or details and 2 visuals.

Appendix 1: Implementing Teaching Standards

6.P.3 Content Standard: Understand characteristics of energy transfer and interactions of matter and energy.

“I Can Statements””

- Illustrate the transfer of heat energy from warmer objects to cooler ones using examples of conduction, radiation and convection and the effects that may result
- Explain the effects of electromagnetic waves on various materials to include absorption, scattering, and change in temperature.
- Explain the suitability of materials for use in technological design based on a response to heat and electrical energy

Essential Questions:

- What is absorption and how does it affect the energy of material?
- How does the type of surface affect how light reflect off of it?
- What is the electromagnetic spectrum?

Appendix 2: KWL Chart

KWL Chart

Before you begin your research, list details in the first two columns. Fill in the last column after completing your research.

Topic ______________________________

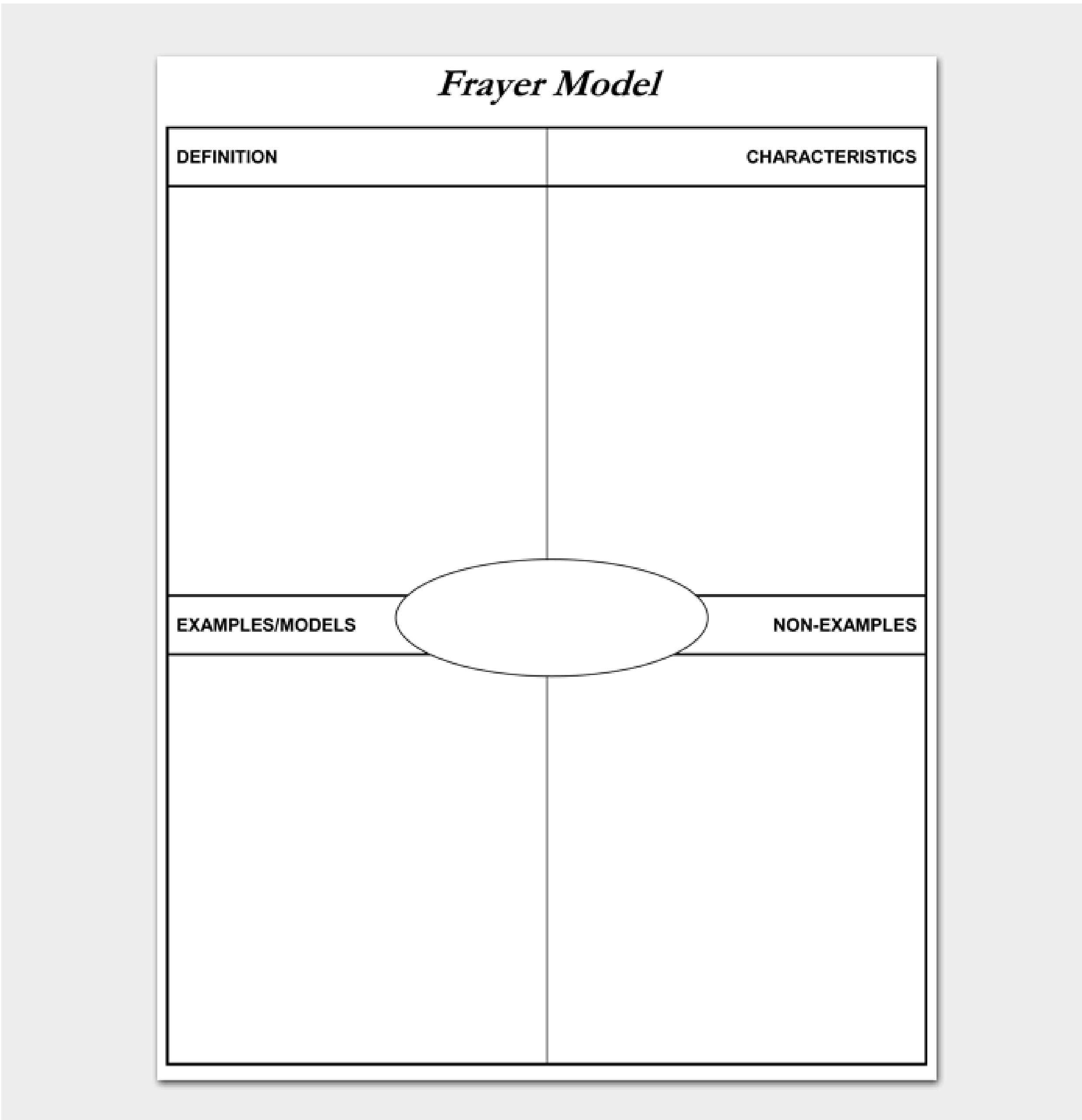
What I Know	What I Want to Know	What I Learned

Appendix 3: Unit Vocabulary

Optical illusion
Image
Refraction
Reflection
Rainbow
Mirage
Superior Mirage
Inferior Mirage
Total Internal Reflection
Dispersion

- The above vocabulary words for this unit should be written in their interactive science notebook or teacher's website
- Students will create a Frayer Model for each vocabulary word (Appendix 4)
- Academic conversations will require students to use the unit vocabulary as they engage in classroom discussions

Appendix 4: Frayer Model



Appendix 5: Close Reading

Over the Rainbow

A

Have you ever seen a rainbow? If so, you know you see rainbows when the sun is shining but it is raining, misting, or it has just stopped raining. A rainbow is formed when water droplets are floating in the air. Rainbows are generally seen in summer months; they are almost never present in winter time.

B

What are the colors of a rainbow?

When you see a rainbow or draw a rainbow you always use stipes of many colors. The colors you see in a rainbow are actually sunlight that is refracting *(or bending)* the colors of light. You can remember the colors of a rainbow in order by using the name ROY G. BIV-red, orange, yellow, green, blue, indigo, and violet. In addition, red is always at the top of a rainbow because it is the longest wavelength of sunlight and does not refract, or bend, very much. Violet is always at the bottom of rainbow because it is the shortest wavelength of sunlight and refracts, or bends, the most. The more a color can be refracted the more it arcs. The shorter the wavelength of color in sunlight, the less the color arcs. When you see a rainbow, the sunlight is always behind you. For instance, you are seeing a reflection of sunlight that is behind you bouncing off the back of water droplets and then back to you. Another mind blowing, cool fact is no one sees exactly the same rainbow! What you see depends on where you are standing because everyone's eye is receiving a different reflection and refraction of light bouncing of water droplets.

A

A Rainbow is not an arc but a circle!

Did you know that a rainbow is actually a complete circle? We always see it as an arc or "bow" because the horizon cuts off our view. Standing on the ground you can only see half of the circle. However, if you were in an airplane you might just be able to see the entire circle as you are above the horizon.

B

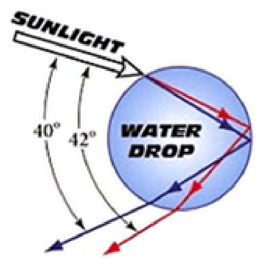
Double the Beauty

If you are lucky, you may see a fainter, double rainbow. This happens when sunlight is reflected twice inside the water droplets and the colors are completely reversed with red being on the bottom and violet being on the top. Most people only see the primary rainbow with ROY G. BIV when light is reflected at 42 degrees, but if conditions are just right you may very well see VIB G. YOB in a secondary rainbow. Secondary rainbows are caused by a second reflection in the water droplet at a different angle of 50 degrees. Rainbows are truly an optical phenomenon because in reality, rainbows do not exist as a thing we can touch or feel; they are simply just light that is refracting from a reflection of sunlight passing through water.

Appendix 6

When sunlight goes in a drop of water in the air it can make a colorful rainbow because the amount that light rays are bent as they pass in and out of the raindrop depends on the color of the light. Sunlight contains the full spectrum of colors that are visible to human eyes, but when nearly equal amounts of all these colors are mixed together, the result is white (or nearly white) light. Passing white light from a distant source through a raindrop is one way to separate the colors.

The diagram illustrates what happens to a single ray of sunlight as it passes through a spherical water drop (actual raindrops are not exactly spherical). Upon entering the drop, the light ray is refracted (or bent) into an angle that depends on color. Blue light is bent more than red light, with green and yellow in between. The diagram uses a red ray and a blue ray to illustrate light is bent in different directions.



Contributor: Lawrence D. Woolf

At the back of the drop, some of the light is reflected (what the diagram does not show is that much of the light passes into the air and continues traveling to the right). When the reflected light passes back into the air, it refracts (bends) again, which causes the colors to separate even further. The specific angle depends on the purity of the water and the exact color being considered.

If you look carefully at the blue and red light rays exiting the lower left portion of the water drop in the figure, you might realize that your eye cannot usually see both red and blue from a single drop. If there really was only one raindrop, you would have to move your head up and down to see the colors change from red to blue. In fact, you can experience this by looking up close at a drop of water hanging from a flower or blade of grass with the sun behind you. In the case of a rainbow, there are many raindrops in the air, some at the right angle to send red light to our eye, some at the right angle to send blue light to our eye, and some at the right angle to send other colors to our eye.

Contributor: Joseph Shaw

http://www.optics4kids.org/home/content/what-is-optics/refraction/what-is-a-rainbow/

List of Material for Classroom Use

Materials for Students and Teachers

Chromebook/Desktop Computer
The teacher and the students will use their electronic device to complete all activities in the classroom or remotely. Students will navigate through all the activities as directed.

Google Drive
Using Google Drive enables the teacher and the student to write on and share digital copies used throughout the unit. It will allow students to organize and save their work.

Computer Headphones
Headphones are recommended for this unit due to virtual lessons/labs. It will block out any noise whether inside or outside. The headphones will facilitate listening skills and help students to focus while reading each text.

Interactive Notebook
A composition or spiral notebook that students develop over the course of a class where students can organize their notes and their learning to be used as a study tool.

Resources for Students

KWL Chart
This graphic organizer will be used to help students organize information before, during, and after a unit or lesson.
https://www.readwritethink.org/sites/default/files/KWL%20Chart.pdf

Google Slides
Students will create and format presentations and collaborate with other students.
https://www.google.com/slides/about/

Frayer Model
A graphic organizer for building student vocabulary.
https://doe.virginia.gov/testing/sol/standards_docs/english/2010/vocabulary/graphic_organizers/frayer_model.docx

Resources for Teachers

Close Reading
These informational texts will be used for students to use a strategy that requires critical analysis of a short but complex text. Students will be able to find the main idea and supporting details (Appendix 5 and 6)

Rainbow Experiment
This experiment will have students explore what happens to light when it passes through water. https://www.funology.com/make-a-rainbow/

Prezi
This multimedia presentation tool allows for panning and zooming to various parts of the canvas to emphasize the ideas presented there.
https://prezi.com/qu95nuqbw3zs/rainbows-and-mirages/

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