Senior High School

Physical Science

Quarter 2 – Module 4:
Phenomena of Light

ALTERNATIVE DELIVERY MODE

ADM

Department of Education • Republic of the Philippines

Science – Grade 12
Alternative Delivery Mode
Quarter 2 – Module 4: Phenomena of Light
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Physical Science

Quarter 2 – Module 4:
Phenomena of Light

This instructional material was collaboratively developed and reviewed by educators from public and private schools, colleges, and or/universities. We encourage teachers and other education stakeholders to email their feedback, comments, and recommendations to the Department of Education at action@deped.gov.ph.

We value your feedback and recommendations.

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Introductory Message

For the facilitator:

Welcome to Physical Science Grade 11/12 Alternative Delivery Mode (ADM) Module on the Phenomena of Light!

This module was collaboratively designed, developed, and reviewed to assist the teachers/facilitators in helping the learners meet the standards set by the K to 12 Curriculum while overcoming their personal, social, and economic constraints in schooling.

This learning resource hopes to engage the learners in guided and independent learning activities at their own pace and time. Furthermore, this also aims to help learners acquire the needed 21st - century skills while taking into consideration their needs.

In addition to the material in the main text, you will also see this box in the body of the module:

Notes to the Teacher

This contains helpful tips or strategies that will help you in guiding the learners.

As a facilitator, you are expected to orient the learners on how to use this module. You also need to keep track of the learners' progress while allowing them to manage their learning. Furthermore, you are expected to encourage and assist the learners as they do the tasks included in the module.

For the learner:

Welcome to Physical Science 11/12 Alternative Delivery Mode (ADM) Module on the Phenomena of Light!

Our hands are the most represented parts of the human body. It is often used to depict skill, action, and purpose. With our hands, we create, accomplish and learn. Hence, you are capable and empowered to successfully achieve the relevant competencies and skills at your own pace and time. Your academic success lies in your own hands!

This module was designed to provide you with fun and meaningful opportunities for guided and independent learning at your own pace and time. You will be able to process the contents of the learning resource while being an active learner.

This module has the following parts:

 **What I Need to Know**	This will give you an idea of the skills or competencies you are expected to learn in the module.
 **What I Know**	This part includes activity that will check what you already know about the lesson. If you get all the correct answer (100%), you may decide to skip this module.
 **What's In**	This is a brief drill or review to help you link the current lesson with the previous one.
 **What's New**	In this portion, the new lesson will be introduced to you in various ways such as a story, a song, a poem, a problem opener, an activity, or a situation.
 **What is It**	This section provides a brief discussion of the lesson. This aims to help you discover and understand new concepts and skills.
 **What's More**	This comprises activities for independent practice to solidify your understanding and skills of the topic. You may check the answers to the exercises using the Answer Key at the end of the module.
 **What I Have Learned**	This includes questions or blank sentences/paragraphs to be filled in to process what you learned from the lesson.
 **What I Can Do**	This section provides an activity that will help you transfer your new knowledge or skills into real-life situations.
 **Assessment**	This is a task which aims to evaluate your level of mastery in achieving the learning competency.

 **Additional Activities**	In this portion, another activity will be given to you to enrich your knowledge or skill of the lesson learned.
 **Answer Key**	This contains answers to all activities in the module.

At the end of this module you will also find:

References	This is a list of all sources used in developing this module.

The following are some reminders in using this module:

1. Use the module with care. Do not put unnecessary mark/s on any part of the module. Use a separate sheet of paper in answering the exercises.
2. Don't forget to answer *What I Know* before moving on to the other activities in the module.
3. Read the instruction carefully before doing each task.
4. Observe honesty and integrity in doing the tasks and in checking your answers.
5. Finish the task at hand before proceeding to the next activity.
6. Return this module to your teacher/facilitator once done.

If you encounter any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator. Always bear in mind that you are not alone.

We hope that through this material, you will experience meaningful learning and gain a deep understanding of the relevant competencies. You can do it!

What I Need to Know

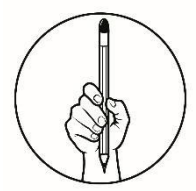
After going through the previous module, you gained a more profound understanding of the nature of light. In this module you will appreciate how light plays a vital role in different fascinating phenomena observable in nature. No doubt that you are captivated whenever you look at the fiery red horizon as the sun is setting down. Or you might marvel how the arrays of colors is arranged in a rainbow. When you look in a mirror, you maybe puzzled why at times you look upright, other times you look inverted. You can name countless of these phenomena you can observe in nature that can be attributed to the properties of light. This module will help you understand the properties of reflection, refraction, absorption, transmission and scattering of light as seen on the things around us. You will be provided with different activities to understand each. Use this module along with your Physical Science textbook or other learning resources to help you master the concepts and deepen your love for science!

This module has a single lesson:

- Lesson 1 – Phenomena of light (**S11/12PS-IVh-66**)

After going through this module, you are expected to:

1. Describe different light phenomena
2. Explain how different light phenomena occurs
3. Relate properties of light to different natural phenomena



What I Know

Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. What can be said of the image formed in the bulging reflecting surface of a spoon?
   a. Virtual upright, and larger than the object
   b. Virtual, inverted, and larger than the object
   c. Virtual, upright and smaller than the object
   d. Virtual, inverted, and smaller than the object
2. Where should the object be positioned to have a smaller and inverted image in a concave mirror?
   a. At the focus
   b. At the center of curvature
   c. Beyond the center of curvature
   d. Between the curvature and focus
3. When you see a "wet spot" mirage on the road in front of you, what are you most likely seeing?
   a. Sky
   b. Hot air
   c. Water
   d. Fragment of your imagination
4. White light goes through a filter that can absorb blue light; what color of light can pass through as perceived by an observer?
   a. Blue b. Green c. Red d. Yellow
5. When green light shines on a red rose, why do the petals look black?
   a. It absorbs green light
   b. It reflects the color black
   c. It reflects green light
   d. It absorbs all the colors of light.
6. For you to see a rainbow, where should the sun be positioned?
   a. In front of you
   b. On your left side
   c. Behind you
   d. On your right side
7. Which is scattered by very small particles present in the atmosphere?
   a. All wavelengths of light
   b. Medium wavelength of light
   c. Smaller wavelength of light
   d. Larger wavelength of light
8. Which explains why the sky is blue?
   a. Blue light is not easily scattered by the atmosphere
   b. Blue light is not easily absorbed by the atmosphere
   c. Air molecules scatter blue light more readily than other colors
   d. Blue light is reflected off the world's oceans into the atmosphere
9. Which explains why sunsets are red?
   a. Air molecules scatter red light more readily than others
   b. Red light is of shorter wavelength than other colors of light
   c. Red light survives the absorption of the particles in the atmosphere
   d. Red light is scattered the least and is transmitted the most in the atmosphere
10. What do you call the colored spots of light that developed due to the refraction of light through ice crystals?
    a. Halo
    b. Sundog
    c. Sunspot
    d. Rainbow

Lesson 1 Phenomena of light

Light have different properties and characteristics. It can be reflected or refracted. It can be transmitted, absorbed or dispersed. You can observe these properties one at a time, or two or more of these properties can be exhibited at once. Whenever these properties of light are demonstrated in nature, we can observe various phenomena that can be a feast not only for our sight but also for our curious mind.

Here are some of light phenomena that we are going to investigate:

- Your reflection on the concave and convex sides of a spoon looks different
- Mirages
- Light from a red laser passes more easily through red cellophane than green cellophane
- Clothing of certain colors appear different in artificial light in sunlight.
- Haloes, sundogs, primary rainbows, secondary rainbows, and supernumerary bows
- Why clouds are usually white and rainclouds dark
- Why the sky is blue, and sunsets are reddish

Do not be overwhelmed by these phenomena. The concepts behind these are not new concepts. You have learned it already from your previous lessons. You just need to integrate your previous understanding of light to these phenomena to get a deeper insight.

What's In

Light plays a role in the interesting processes in nature. When light coming from the sun enters the atmosphere, it exhibits behavior that demonstrates its wave nature or particle nature. Light could be reflected, transmitted or absorbed. Reflection plays a vital role in our ability to see things and appreciation of colors. Transmission paved a way on the use of filters. Absorption of light can help sustain life supporting cycles in our environment.

Aside from these, light can also refract as it enters varying medium. This results to a display of spectrum of colors. At times it could also create optical illusions. There is so much to learn about light. Let us begin by understanding phenomena related to it.

What's New

Activity 1: My mirror spoon.

You will need a very useful dining tool in our activity, a *spoon*. No, we are not going to eat, but yes, we will use it as a mirror. So, put on your best pose, hold a spoon in front of you and look at yourself in your "*mirror spoon*".

Try to look for an image of yourself both in the inner and outer side of the spoon. Adjust the distance of the spoon from your face to see a clearer image. Observe what happens as you move the spoon closer or farther from your face.

By A. Manzano - Own work

Figure 1

Guide questions:

1. Can you see an image of yourself in your mirror spoon? Describe the image.

2. In which side of the spoon can you see an upright image of yourself? An inverted image of yourself?

3. Will adjusting the distance of the spoon from yourself varies the image formed in the spoon? Why? Why not?

4. What do you think is the kind of reflecting surface demonstrated by the inner side of the spoon? By the outer side of the spoon?

Activity 2: Can you believe your eyes?

Examine the two figures. Are the squares in *Figure 2* of the same size? Or are they not? How about the squares in *Figure 3*? Do the squares have the same colors? Or are they not?

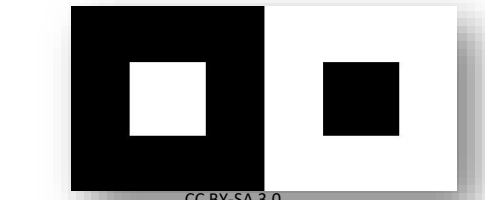


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Figure 2

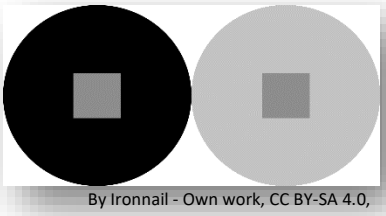

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Figure 3

Sometimes, our brain interprets the things our eyes are seeing differently. It is called *optical illusion*. There are number of illusions in nature and one of them is *mirage*.

Analyze *Figure 4* and label the numbered parts to understand how mirage occurs. You can select from the given words inside the box.

Direct sunlight	***Bent light from the sky***	***Cool air***	***Observer***
Hot air	***Mirage***	***Hot ground***	***apparent path of light***

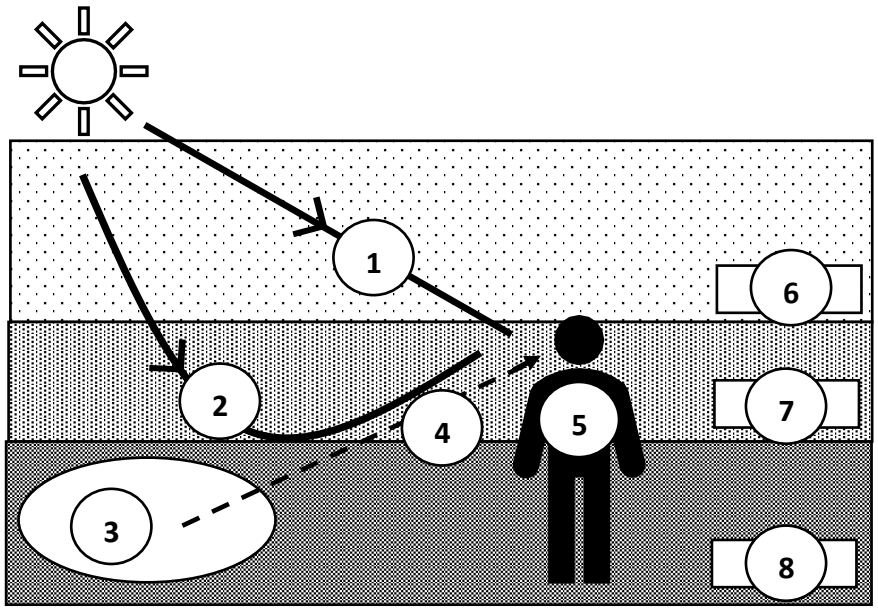

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Figure 4

Guide questions:

1. How can you describe the temperature of the air above the ground?
2. What happens to light as it passes through air with varying temperature?
3. What do you call the bending of light?
4. Apparently, where does the light that reaches the eye of the observer originates?
5. In your own words, how can you explain the occurrence of mirage?

Activity 3: Color me beautiful!

Whether you are an artist, a photographer or just an ordinary student who is appreciative of nature's beauty, you are surely fascinated with colors! Let us see the magic of it in this activity.

Analyze and study *Figure 5* and *Table 1*. Both shows how the colors of light are added. Familiarize yourself with it and use it as a reference in answering the activity.

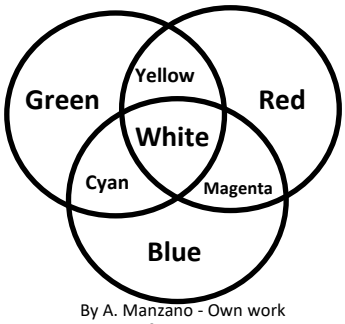

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Figure 5

Primary Colors of Light	Complementary colors of light	Adding colors of light	Result
Red *Green* *Blue*	*Magenta* *Yellow* *Cyan*	Red + Blue + green	White
		Red + Blue	Magenta
		Red + Green	Yellow
		Blue + Green	Cyan
		Magenta + Green	White
		Yellow + Blue	White
		Cyan + Red	White

Table 1

Using *Figure 6* as reference, complete *Table 2* and determine what color will pass through the filter and what color will the object reflect.

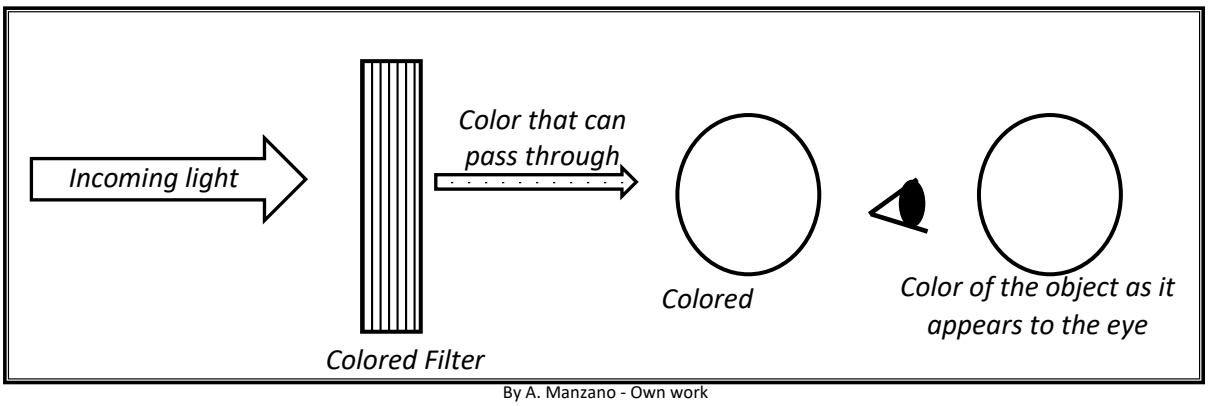

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Figure 6

Incoming Light	***Colored Filter***	***Color that can pass through***	***Colored object***	***Color of the object as it appears to the eye***
White	Absorbs blue light		Blue	
Yellow	Absorbs green light		Red	
White	Absorbs red light		Yellow	
Magenta	Absorbs yellow light		Cyan	
White	Absorbs cyan		Magenta	
Cyan	Absorbs magenta		Green	
White	Absorbs blue		White	

Table 2

Activity 4: Rainbow connections

Another amazing optical illusion in nature is the formation of rainbow. How we see a rainbow depends on how light behaves as it interacts to the water droplets in the sky. In this activity, try to determine the processes that take place for a rainbow to form. Use *Figure 7* as your reference in completing *Table 3*.

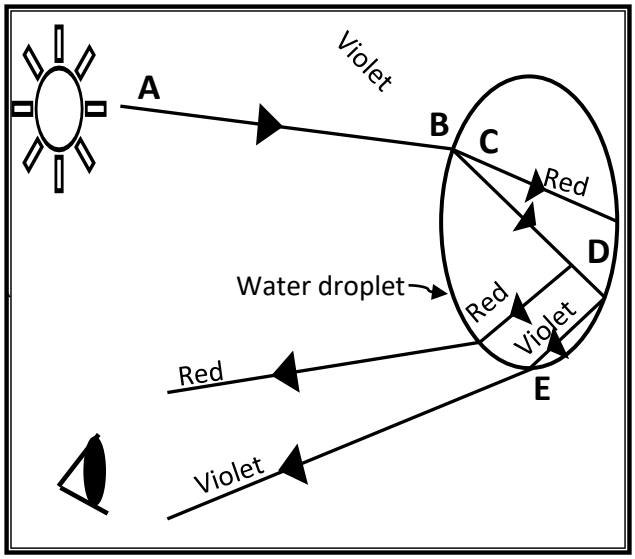

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Figure 7

Processes in rainbow formation	Corresponding letter in the diagram
Light is refracted as it exits the water droplet	
The white light is dispersed into array of colors	
Light is refracted as it enters the water droplet	
White light coming from the sun strikes the surface of a water droplet	
Total internal reflection occurs in the inner surface of the water droplet	

Table 3

Sometimes light entering a raindrop undergoes two internal reflections and refractions. This will result to *secondary rainbow*. In *Figure 8* label which is the *primary* or *secondary rainbow* and determine the arrangement of colors in each. You can use any coloring material.

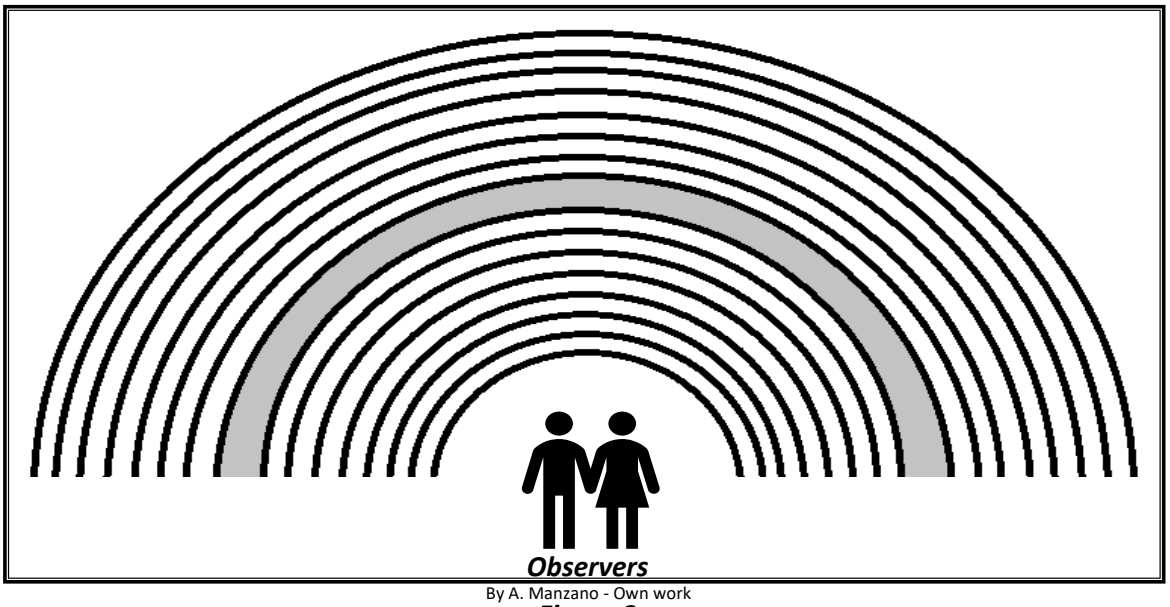

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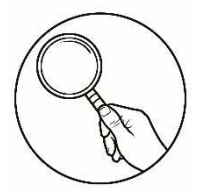
Figure 8



What is It

Phenomena of light

Smooth reflecting surfaces are often associated with mirrors. There are two kinds of mirror, a *plane mirror* and a *spherical mirror*. In our activity we used a spoon. It is an example of a spherical mirror because it has a curved reflecting surface.

There are two types of spherical mirror, the *convex* and the *concave* mirror. Convex mirror is the one that bulges outward. It usually shows things the right way up and smaller. The concave mirror on the other hand is hallowed inwards. The appearance of the image depends on how close the object is to it. If the object is close to a concave mirror, the image appears bigger and right way up. If the object is further away it may look smaller and inverted.

When you look at the reflecting surface of a spoon, the outer bulging part acts like a convex mirror. You will see an upright and smaller image of yourself. *Figure 9* demonstrates how the image is formed in a convex mirror like your observations when you look in the bulging part of the spoon.

The inner hallowed part of the spoon acts like a concave mirror. You saw an inverted, smaller image of yourself because you are located beyond the curvature of the spoon. *Figure 10* demonstrates how the image is formed in a concave mirror like your observations when you look at the caving part of the spoon.

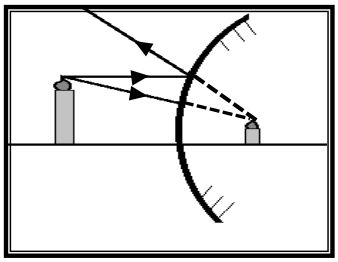


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Figure 9

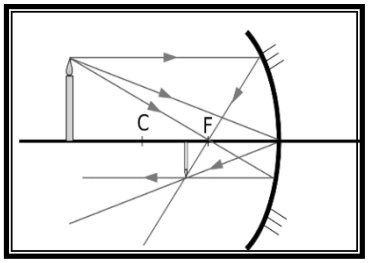

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Figure 10

Another phenomenon associated with reflection is our seeing of *colors*. The colors of the object we see depends on its ability to *reflect* or to *transmit* the light incident to it. It is dependent on the object's natural vibrating frequencies.

If the object is *opaque*, some of the frequency of the visible light is *absorbed*, while others reflected. If the object is *transparent,* some of the frequencies of light are also absorbed while allowing some to pass through. This tells us the color of the object whether it is opaque or transparent. This is called *selective reflection* and *selective transmission*. It is inherent to the object.

For example, a red laser shines on a transparent red cellophane. The red cellophane is capable of absorbing other frequencies of light except red. As a result, the red cellophane can transmit the red frequency of light, allowing it to pass through. If we

use instead a green laser on a red cellophane, it cannot pass through. The green light will be absorbed.

Sometimes you might also wonder why your clothes of a certain color appears differently under artificial light and natural sunlight. Your clothes will absorb and reflect frequency of light depending on the source. Natural sunlight, the visible light is composed of the complete range of frequencies. Artificial lights on the other hand sometimes have a limited range of frequencies. This will affect what the object can absorb and reflect.

For example, your light source is an incandescent bulb. It is yellowish in color. It emits more light in the lower than in the higher frequencies. If it shines on a blue object, the object will not appear blue. Instead it will appear black. The object is not capable of reflecting yellow light or its constituent color of red and green. It will be absorbed by the object. As a result, nothing is reflected, and the object will appear black.

It is important to note that the primary colors of light are red, blue and green. Adding all of this will give us white light. The complimentary colors on the other hand are magenta, yellow and cyan. Remembering this will help you identify colors of objects when selective reflection and transmission takes place.

Refraction too plays a role in different light phenomena. It explains optical illusions found in nature like *mirage* and *rainbow*. It is also the reason behind the halos around the sun or moon.

Refraction as you already learned is the bending of light as it passes through mediums of varying density. The bending occurs because of light speeding up or slowing down. This is illustrated in the formation of mirage.

Mirage is a natural optical illusion. A common example is when a desert wanderer thought he or she saw a vast body of water or an oasis, only to realize later that it doesn't exists. *Figure 11* shows an example of a desert mirage. Another common experience is when you are driving or seated in front of a car during a sunny day. You may think there is a puddle of water some distance in front of the car. But as you approach it, you realized that it was just an illusion.

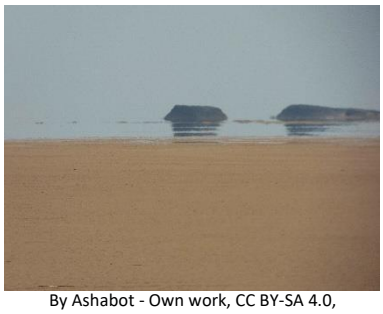

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Figure 11

The heating of the ground during hot sunny days results to atmospheric refraction. As the ground absorbs energy form the sun, its temperature increases. The energy is then transferred to the air molecules near the ground. Which in turn are also heated, creating temperature gradient. The air molecules near the ground are warmer than the air molecules higher above. The difference in temperature results to a varying optical density. As a result, light coming from the sun is bent. However, our brain perceives light as traveling in a straight path. Instead of seeing the bent light because of refraction, we see a straight light path coming from the ground reflecting the sky. This what appears like puddle of water!

Mirage is not the only observable phenomenon of light due to refraction. Another interesting optical illusion is the *rainbow*. It can be seen around fog, sea spray, waterfalls or during a drizzle.

A rainbow is a mosaic of light sent to you by plenty of raindrops in a seemingly concert-like synchrony. To understand it, you must look at what happens in each water droplets or raindrops.

As light enters a water droplet, it is refracted. As a result, the visible light is dispersed into spectrum of colors. It then reaches the back of the water droplet at a certain angle and it will be reflected. *Total internal* reflection occurs. It will then head back out exiting the water-air interface, where refraction will take place once more. Light is dispersed into an array of colors we see as rainbow.

To see a rainbow, there must be suspended water droplets in the sky. You should also consider your position relative to the source of light. The light should be shining behind you and angle must be considered. Only those water droplets before you that are on 42˚ circle centered about the antisolar point can give you a concentrated rainbow light. An interesting thing to note is that when you are admiring a rainbow with a friend, you are both seeing different rainbows! Each of you receives scattered light from different set of water droplets. Isn't it amazing!

Sometimes when light enters a water droplet, two total internal reflection and refraction occurs. This will result to the formation of a *secondary rainbow*. It is the one that appears outside and higher than the *primary rainbow* as shown in *Figure 12*. This rainbow is fainter, and its color sequence is opposite of the primary. Red is on the inside of the arc while violet is on the outside. This is due to the light rays exiting the water droplets at a higher angle.

By Double-alaskan-rainbow.jpg: Eric Rolphderivative work: ed g2s • talk - Double-alaskan-rainbow.jpg, CC BY-SA 2.5, https://commons.wikimedia.org/w/index.php?curid=1087346

Figure 12

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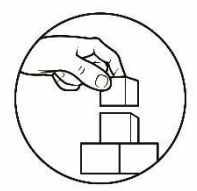
Figure 13

Aside from secondary rainbows, at times you could also see *supernumeraries*. These are thin, pastel colored bands or fringes appearing below the primary rainbow adjacent to the violet band as shown on *Figure 13*. This is due to the *interference* of light. Sometimes the slightly different path of light through a water droplet yields a slightly different path lengths and larger exit angles. This difference will result to constructive or destructive interference of each color in the spectrum. This is displayed as band of colors called supernumeraries.

Refraction also plays a role in the formation of *haloes* or ring of light around the sun or moon. This takes place as light refracts from *hexagona*l ice crystals present in *cirrus clouds* acting like prism with a cross-section of an equilateral triangle. These prism-like crystals can produce haloes of various size, but most commonly has an angular radius of *22 degrees*. If the hexagonal crystals are oriented with their flat faces horizontal, then a *sundog* is observed.

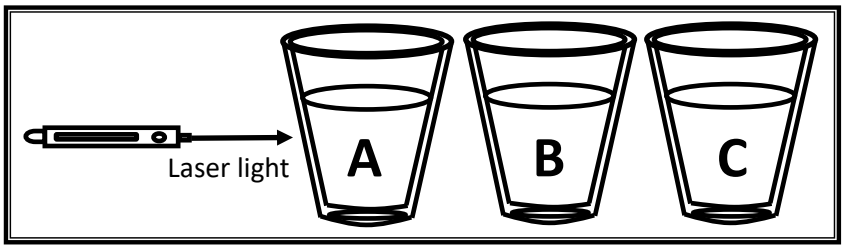
A *sundog* or a mock sun are white or colored patches of light to one or both sides of the sun. It is also known as *parhelia* which means with the sun. It typically appears when the sun is low like sunrise and sunset.



What's More

Activity 1: Now you see me, now you don't

Why are the skies blue? Why are sunsets red? Why are clouds white? You can answer these questions when you understand how light is scattered. This experiment will demonstrate the effect of scattering light. All you need here are 3 clear glasses of water, spoonful of sugar and milk and a laser pointer. If laser light is not available, you can use an ordinary flashlight.



By A. Manzano - Own work

Figure 14

What you need to do:

1. Prepare the materials and set it up like *Figure 14*.
2. Fill each glass with distilled water.
3. Turn on the laser pointer and observe the path of light as it passes through each glass.
4. Put a spoonful of sugar to the glass labelled B. Stir until all the sugar granules are dissolved completely.
5. Turn on the laser pointer and again observe the path of light as it passes through each glass.
6. Put two spoonsful of liquid milk to the glass labelled C. Stir until there is consistency in the liquid.
7. Again, turn on the laser pointer and observe the path of light as is passes through each glass.

Guide questions:

1. Describe what happens as the laser light passes through each glass with only distilled water in it.
2. What happens when a spoonful of sugar was dissolved in glass B and the laser light passes through it? When milk is added in glass C and laser light passes through it?
3. Do you think the particles present in each glass plays a role in how the laser light behaves?
4. How does the size of the particles affect the behavior of light as it interacts with it?
5. Do you think the size of the particles affects how certain frequencies of light are scattered?

What I Have Learned

- The outer bulging reflecting surface of a spoon acts like a *convex* mirror.
- Convex mirror produces an image that is virtual, upright and smaller than the object.
- The hallowed reflecting surface of the spoon acts like *concave* mirror.
- The appearance of the image in a *concave* mirror depends on how close the object is to it.
- The colors of the object we see depends on its ability to *reflect* or *to transmit* the light incident to it.
- *Selective reflection* takes place on opaque objects when light is incident to it.
- *Selective transmission* takes place on transparent objects when light is incident to it.
- *Refraction* plays a role in optical illusions like *mirages* and *rainbows*.
- *Mirage* is an optical phenomenon that creates illusion of water that results from the bending of light because of the gradient in the air temperature.
- *Rainbows* are formed because of *refraction*, *reflection* and *dispersion* of light as it passes through water droplets acting as tiny prisms. It appears in the section of the sky directly opposite from the sun.
- A *secondary rainbow* is formed when two total internal reflections and refraction occur in the water droplets. It appears outside and higher than the *primary rainbow* with an opposite color sequence.
- *Supernumeraries* are thin, pastel colored bands or fringes appearing below the primary rainbow adjacent to the violet band due to the *interference* of light.
- A *halo* is a ring of light that forms around the sun or moon due to the refraction of light in the suspended ice crystals in the atmosphere.
- *Sundogs* are bright white or colored patches of light developed because of refraction of light through ice crystals. They are also known as mock suns or *parhelia* which means “with the sun”
- Small gas particles in the atmosphere scatters blue light because of *Rayleigh scattering* resulting to blue sky.
- Clouds are made up of water droplets which are larger than air molecules, thus all colors are scattered equally. All colors combined to make white light.
- Sunlight must travel through more of the atmosphere during sunset. More blue light is scattered, leaving red light transmitted. Only light of lower frequencies survives, producing red sunsets.

What I Can Do

Now that you have learned how properties of light can explain various optical phenomena, it's your turn to apply what you learned. Answer the following questions using the concepts you learned.

1. What kind of mirror should be used in the *rearview mirror* of a car? In the *side view mirror* of the car?

2. What is the use of colored *photography filters*?

3. Using the concept of *scattering of light*, how can you answer the questions: "Why is the sky blue?" or "Why are clouds white?" or "Why are sunsets red?"?

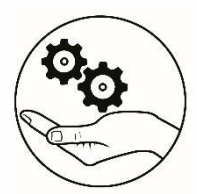
4. Why do you think the colors red, green and yellow are the one used for *traffic lights*?

5. An *archer fish* can prey on land-based insect and other small animals by spitting water from their specialized mouths. Explain how refraction occurs in the water-air boundary of the fish. Draw a diagram.

Assessment

Multiple Choice. Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

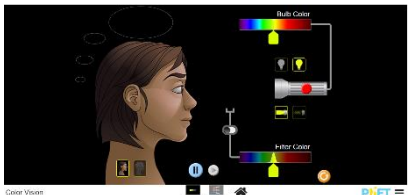
1. What can be said of the image formed in the bulging reflecting surface of a spoon?
   a. Virtual upright, and larger than the object
   b. Virtual, inverted, and larger than the object
   c. Virtual, upright and smaller than the object
   d. Virtual, inverted, and smaller than the object
2. Where should the object be positioned to have a smaller and inverted image in a concave mirror?
   a. At the focus
   b. At the center of curvature
   c. Beyond the center of curvature
   d. Between the curvature and focus
3. When you see a "wet spot" mirage on the road in front of you, what are you most likely seeing?
   a. Sky c. Water
   b. Hot air d. Fragment of your imagination
4. White light goes through a filter that can absorb blue light; what color of light can pass through as perceived by an observer?
   a. Blue b. Green c. Red d. Yellow
5. When green light shines on a red rose, why do the petals look black?
   a. It absorbs green light c. It reflects green light
   b. It reflects the color black d. It absorbs all the colors of light.
6. For you to see a rainbow, where should the sun be positioned?
   a. In front of you c. Behind you
   b. On your left side d. On your right side
7. Which is scattered by very small particles present in the atmosphere?
   a. All wavelengths of light c. Smaller wavelength of light
   b. Medium wavelength of light d. Larger wavelength of light
8. Which explains why the sky is blue?
   a. Blue light is not easily scattered by the atmosphere
   b. Blue light is not easily absorbed by the atmosphere
   c. Air molecules scatter blue light more readily than other colors
   d. Blue light is reflected off the world's oceans into the atmosphere
9. Which explains why sunsets are red?
   a. Air molecules scatter red light more readily than others
   b. Red light is of shorter wavelength than other colors of light
   c. Red light survives the absorption of the particles in the atmosphere
   d. Red light is scattered the least and is transmitted the most in the atmosphere
10. What do you call the colored spots of light that developed due to the refraction of light through ice crystals?
    a. Halo c. Sunspot
    b. Sundog d. Rainbow



Additional Activities

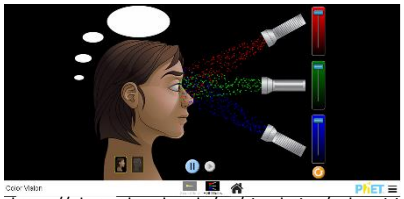
A. Color Vision

Explore more about colors of light. *Visit https://phet.colorado.edu/en/simulation/color-vision* to master the skills of color addition and subtraction. Use the simulation to see how colors can be perceived under different filters or sources.



https://phet.colorado.edu/en/simulation/color-vision

Figure 15



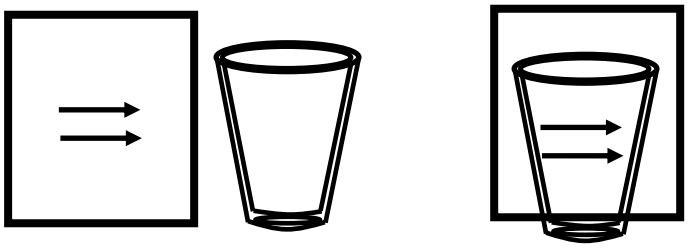
https://phet.colorado.edu/en/simulation/color-vision

Figure 16

B. Can you reverse the arrow?

Are you ready for a magic trick? You can amaze yourself and even your peers by performing a simple experiment involving refraction of light.

Draw two straight arrows pointing to the right in a white cardboard or bond paper. Place it behind a clear drinking glass. Position the bond paper enough to see the arrow at the center of the glass. Refer to *Figure 17*.



By A. Manzano - Own work

Figure 17

Slowly pour water inside the glass. Observe how the arrow's direction will change.

C. Create your own rainbow!

You can create your own rainbow. Remember you just need water droplets to act as prisms and a light source behind you. Try this in your backyard, maybe while you are watering your plants. Position yourself in a source of light, connect a water hose to a faucet, turn it on and aim it in front of you. You maybe lucky to see your rainbow! You can be more successful if you will try this early in the morning or late in the afternoon when the sun is not on its highest position.

Answer Key

What I Know		Assessment
C		C
C		C
A		A
D		D
A		A
C		C
C		C
C		C
D		D
B		B

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