Nature of Light

This lesson is designed for 3rd – 5th grade students in a variety of school settings (public, private, STEM schools, and home schools) in the seven states served by local power companies and the Tennessee Valley Authority. Community groups (Scouts, 4-H, after school programs, and others) are encouraged to use it as well. This is one lesson from a three-part series designed to give students an age-appropriate, informed view of energy. As their understanding of energy grows, it will enable them to make informed decisions as good citizens or civic leaders.

This lesson plan is suitable for all types of educational settings. Each lesson can be adapted to meet a variety of class sizes, student skill levels, and time requirements.

Setting	Lesson Plan Selections Recommended for Use
Smaller class size, higher student ability, and /or longer class length	• The "Modeling" Section contains teaching content. • While in class, students can do "Guided Practice," complete the "Recommended Item(s)" and any additional guided practice items the teacher might select from "Other Resources." • NOTE: Some lesson plans do and some do not contain "Other Resources." • At home or on their own in class, students can do "Independent Practice," complete the "Recommended Item(s)" and any additional independent practice items the teacher selects from "Other Resources" (if provided in the plan).
Average class size, student ability, and class length	• The "Modeling" Section contains teaching content. • While in class, students complete "Recommended Item(s)" from "Guided Practice" section. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.
Larger class size, lower student ability, and/or shorter class length	• The "Modeling" Section contains teaching content. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.

Electrical Safety Reminder: Teachers should remind students that electricity is dangerous and that an adult should be present when any recommended activities or worksheets are being completed at home. Always obey instructions on warning labels and ensure one has dry hands when touching electronics or appliances.

Public School System Teaching Standards Covered

State Science Standards

- GA S4P1 4th
- KY SC-4-ET-U-4 4th
- KY SC-5-ET-U-4 5th
- NC 4.P.3.2 4th
- TN SPI 0407.10.2 4th
- TN SPI 0407.10.3 4th
- VA 5.3 5th

Common Core Language Arts/Reading

- ELA.CCSS.W.4.1 TN, KY, GA, NC 4th
- ELA.CCSS.W.5.1 KY, VA 5th

Performance Objectives

By the end of this lesson, students will be able to:

- **Explain the nature of light.**
- **Understand that light is a form of energy and that it can be characterized as a wave.**

I. Anticipatory Set (Attention Grabber)

Essential Question

What is the result of light hitting an object/interacting with matter?

II. Modeling (Concepts to Teach)

Dual-Nature of Light

Light can be treated as a wave or a particle.

Speed of Light

Light travels at the very fast speed at 3.0×10^8 m/s. This why it takes 8 minutes for the sun's light to reach Earth even though the sun is 93 million miles away. It's interesting to think that when someone looks up at the sun, he/she is seeing what happened 8 minutes ago. When discussing objects in our universe that are even farther away, a light-year is used. A light-year is defined as the distance light travels in one year. So, the light from Proxima Centauri, the star nearest to our sun, takes 4.24 years to reach the Earth. It is 4.24 light years away. Imagine it! When looking at Proxima Centauri, the observer is seeing it as it was over 4 years ago! Wow!

Interaction of Light with Matter – (Light as a Wave)

A wave doesn't just *stop* when it reaches the end of the medium. Rather, a wave will undergo certain behaviors when it encounters the end of the medium. These behaviors include Reflection, Refraction, and Diffraction.

Reflection

When a light wave reaches the boundary between two media, some (or all) of the wave bounces back into the first medium. If the first medium is air and the second medium is a mirror, nearly all of the light that hits the mirror will reflect back. The angle of the light hitting the mirror (incident light), Θ_i, equals the angle of the light that is reflected, Θ_r with respect to the normal (N). This is referred to as The Law of Reflection or Snell's Law.

See this animation: http://www.physicsclassroom.com/mmedia/optics/lr.cfm

Refraction

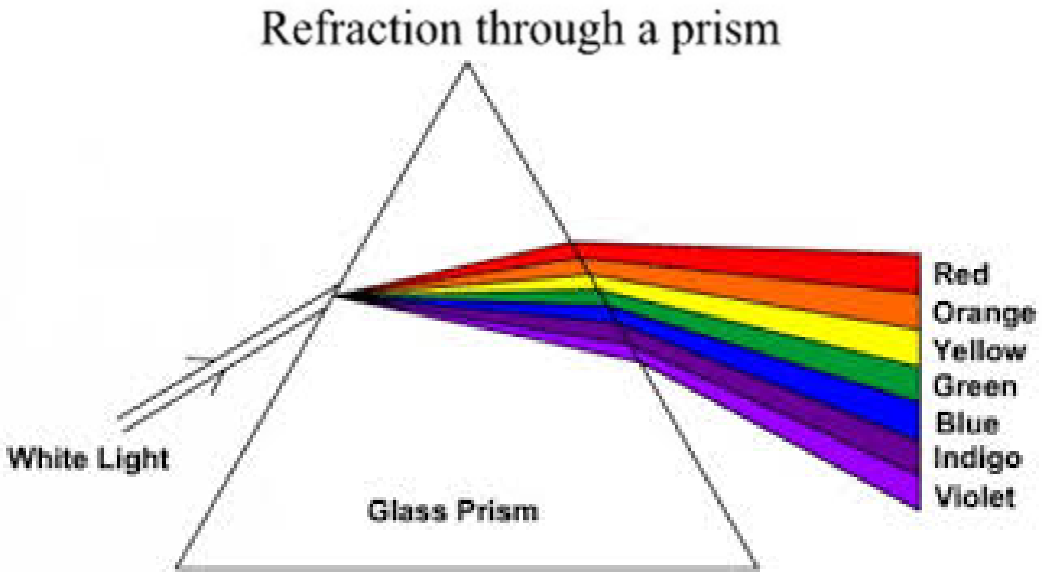
When a light wave reaches the boundary between two media, some of the light is transmitted and undergoes refraction (or bending) if it approaches the boundary at an angle. The direction of "bending" is dependent upon the index of refraction of the two media. A wave will bend one way when it passes from a medium in which it travels slowly (high index of refraction) into a medium in which it travels fast (small index of refraction); and if moving from a *fast medium* to a slow medium, the wave front will bend in the opposite direction.

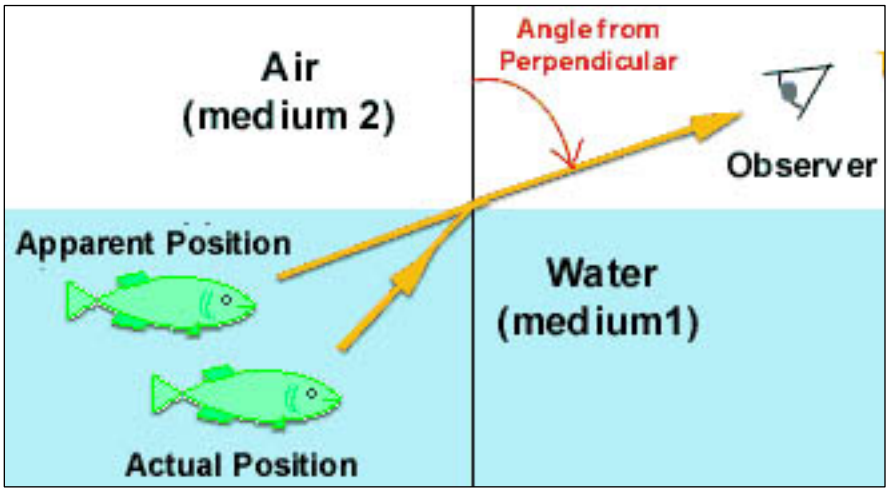
INDEX OF REFRACTION	
Medium	**Refractive Index**
Vacuum	1
Air	1.00
Water	1.33
Alcohol	1.36
Sugar Solution (80%)	1.49
Perspex	1.50
Glass	1.50 – 1.70
Diamond	2.42

Examples of Refraction:

1. There is a noticeable difference between the pencil in the empty glass and the one in the full glass of water. The one in the empty glass doesn't appear to be bent because the light from the pencil is only traveling through one medium, air. When viewing a straw in a glass of water it appears to be bent because the light from the straw travels through water (first medium) then through air (second medium). This happens because the average speed of light in water is slower in water than it is in air. The light bends away from the normal (N) as it travels from the water to the air.

2. Sunlight is composed of all the colors that appear in a rainbow: violet, blue, green, yellow, indigo, orange, and red. Each of these colors has a different range of wavelengths. As a result, each color is refracted (bent) at a different angle when sunlight enters a raindrop. Red is bent the least, violet the most. When the colors strike the far side of a raindrop, they are reflected. As they leave the raindrop and enter the air again, they are again refracted. **http://science.howstuffworks.com/rainbow-info.htm**





III. Checking for Understanding

Teachers can ask students these questions to determine understanding of concepts.

REMEMBER	How and when does a light wave end? (Class discussion. Answer: Never, it reflects, refracts or diffracts when it hits the end of the medium.)
UNDERSTAND	Restate the definition of reflection. Restate the definition of refraction. (Class discussion)
APPLY	What happens when light must travel through more than one medium, like air and water? (Class discussion. Answer: The light refracts or bends and this happens because the average speed of light in water is slower than it is in air. The light bends away from the normal (N) as it travels from the water to the air.)
ANALYZE	Why do you think an image is distorted in a fun house mirror? (Class discussion. Answer: Because the mirror is curved, not flat. For more information: **http://www.learner.org/teacherslab/science/light/lawslight/funhouse/funhousebackground.html**).
CREATE	Create a drawing of light reflection or refraction and label it. (Teachers can ask students to draw their pictures on a sheet of paper. Ex: a person in a mirror – reflection; a pencil in half a glass of water – refraction.)

IV. Guided Practice Ideas

Recommended Items

Create a Spectrometer; Models of Light; Bend a Straw Experiment (see below)

Experiments

- **Create a Spectrometer to View Spectrum of Light Experiment: http://www.pinterest.com/pin/450711875177725942/**
  - **Create a Spectrometer: http://www.euhou.net/index.php/exercises-mainmenu-13/classroom-experiments-and-activities-mainmenu-186/178-a-home-made-spectroscope**
- **Models of Light and Young's Experiment**: **http://www.hsphys.com/light_and_matter.html**
- **Bend a Straw Experiment: http://www.sciencekids.co.nz/experiments/strawbending.html**
- Distinguish Between Light Source and Reflectors Experiment: **http://www.teachingideas.co.uk/science/reflectors.htm**
- Playing with Mirrors Experiment: **http://www.teachingideas.co.uk/science/playingwithmirrors.htm** (how light travels)
- Reflection Investigation Experiment: **http://www.teachingideas.co.uk/science/reflectioninvestigation.htm**

V. Independent Practice Ideas

Recommended Items

- **Writing Activity: What happens when light interacts with matter?** (see below)
- **At-Home Scavenger Hunt: Reflect or Refract?** (see below)

Other Resources

Personal Practice

- Writing Activity: Teachers write the following question on the board and ask students to copy and answer the question on a sheet of paper: What happens when light interacts with matter?
- What is Light? Worksheet and Answer Key provided
- What is Light? – A Type of Energy We Can See Worksheet: **http://www.mrcollinson.ca/4 science/light and sound/4_science_light_sound_what_is_light.pdf**

Practice That May Involve Parents or Guardians

- At-Home Scavenger Hunt: Reflect or Refract? Teachers instruct students to find three objects in their home that reflect light and three objects that refract light. Write them on a sheet of paper and label them as reflect or refract. (Ex. Reflect – mirror, spoon, bell; Refract – magnifying glass, eye glasses, fish tank).

VI. Assessment

These items provide a check for understanding so teachers can easily determine whether concepts need to be reinforced. These items can be graded, if desired.

- What is Light? Worksheet and Answer Key is provided
- Writing Activity: What happens when light interacts with matter? (if completed as Independent Practice, as shown above)
- At-Home Scavenger Hunt: Reflect or Refract? (if completed as Independent Practice, as shown above)

VII. Materials Needed

The following materials are needed for the **Bend a Straw Experiment** in “Recommended Items” in Guided Practice & Independent Practice sections.

- A glass half filled with water
- A straw
- 2 eyes (preferably yours)

VIII. Closing the Lesson

In addition to the Essential Question shown below, teachers can reference Performance Objectives at the top of the Lesson Plan.

Essential Question

What is the result of light hitting an object/interacting with matter?

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WORKSHEET FOR NATURE OF LIGHT LESSON 2.6 **NAME:** _____

What is Light?

Objective: Students will be able to explain the nature of light and understand that light is a form of energy and that it can be characterized as a wave.

1. **Explain the nature of light.**

_____

_____

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2. **Identify and explain the part of the electromagnetic spectrum that humans can see.**

_____

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3. **How does light interact with a mirror?**

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4. **Identify and explain the behaviors of light encountering an object.**

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5. **Draw an example of how light travels as a wave.**

Answer Key

ANSWER KEY FOR WORKSHEET: WHAT IS LIGHT?

1. **Explain the nature of light.**

   Ex. Light travels as a particle and a wave at the same time.

2. **Identify and explain the part of the electromagnetic spectrum that humans can see.**

   Ex. The part of the electromagnetic spectrum that humans can see is visible light. Humans can see only a small part of the spectrum.

3. **How does light interact with a mirror?**

   Ex. Light reflects off the mirror back into the medium (air, water) it came from.

4. **Identify and explain the behaviors of light encountering an object.**

   Ex. When encountering an object, light will either reflect (bounce back) or refract (bend if it approaches a boundary at an angle).

5. **Draw an example of how light travels as a wave.**

Example