Light Waves

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Subject: Physics

Grade Level: 6-8

Standards: Next Generation Science Standards (www.nextgenscience.org)

MS-PS4-2 Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

Schedule: 2-3-60 minute classes

CCMR Lending Library Connected Activities:

Objectives:	**Vocabulary:**
Learn about absorption, transmission, reflection, refraction, scattering, and diffraction through experiments.	Reflection Absorption Refraction Diffraction
Students Will: By working in independent groups, students will: Learn more about how light behaves. Use experimental observations to define new vocabulary.	**Materials:** **For each group:** -Plastic box -Laser -Incense stick -Aluminum foil -Tissue paper -Wax paper -Cardboard -Acrylic Blocks -Poster board -Pins -Protractors -Color paddle set -Wood block **For each student:** -Properties of light activity sheet -Light waves activity sheet -Reading **For teacher:** -Links for presentation and activities **Provided by teacher/student:** -Notebook paper -Graph or printer paper -Rulers -Lighter
Safety	Students should be reminded of the ***dangers associated with lasers*** and to ***avoid pointing lasers directly into their eyes!***


Science Content for the Teacher:

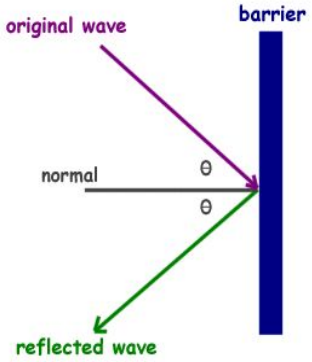
"Light" (more precisely, *visible* light) is the type of electromagnetic radiation that is detectable by the human eye. Light, as with all matter, can be described either as a wave or as a particle (a "photon"). On this page we will describe some of the wave behaviors of light.

Absorption

Light is *absorbed* by a material if the frequency of the wave is near some resonant frequency characteristic of the material. This frequency can describe the difference between atomic energy levels, the vibration of molecular bonds, or the vibration of atoms in a crystal lattice. We can think of the vibrational energy, this jiggling of atoms, as heat. For example, when we "soak up the sun," the sunlight we absorb excites a resonance in our skin and heats us up.

Reflection

One of the most important wave-like behaviors of light is *reflection*. We see things by detecting the light that is *reflected* off of objects, and the color of objects we see is determined by light reflected back to us or transmitted through a transparent material. When light reaches an interface between two different mediums, some of the wave will bounce off the surface. The properties of the two mediums determine the intensity and frequency of reflected light. The *law of reflection* states that the angle of incidence and angle of reflection are equal, as sketched to the side.



Transmission

Any light that is not absorbed or reflected at an interface is *transmitted*. For example, if the frequency of light does not excite a resonance of the material, it is not absorbed, but rather transmitted. The amount of light transmitted depends on the speed of light in the medium.

Refraction

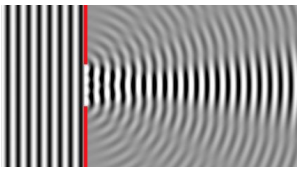
Light travels at different speeds in different materials. Because of this, the path of the light will change directions as it passes from one material to another. We call this sudden change in direction *refraction*, and it is a characteristic of all waves (e.g. sound). A classic example of refraction is a straw sticking out of a glass of water (see figure).

Scattering

Scattering is similar to reflection, but it is a common special case that doesn't strictly follow the law of reflection. *Scattering* describes the interaction of light with small particles. Because these particles are so small, light essentially gets reflected in all directions. This effect allows us to see dust particles floating in air when they are illuminated.

Diffraction

When light interacts with some sort of obstacle or slit, it forms distinct *diffraction* patterns that reveal the wave-like nature of light. Diffraction is not something usually seen in everyday life, but its properties have both a physical and technological importance.



Classroom Procedure:

Formative: Activity 1 - Properties of Light
Have students do the pre-lab activity the day before, either in class or at home (they will require a computer with Internet access).

Link: http://goo.gl/eH0k80
Full URL: http://www.pbslearningmedia.org/asset/npe11_int_lightbehaviors/

Have the students follow the ***Properties of Light*** activity and perform the demos, investigating how the properties of light are manifested through studying different materials.

Summative: Activity 2 - Light Waves

Before starting, review terms from Activity 1 again to make sure students understand what they mean and what examples best describe these phenomena.

Use the presentation to introduce the activity to students, and guide them through the various parts to investigate further the properties they learned about in the first activity.

Resources:

Illustrations of absorption, reflection, transmission for different colors of light: goo.gl/H44ShM
http://www.easycoursesportal.com/basicphotographycourseiii/coursec/Less-8.htm

Overview of refraction from HyperPhysics: goo.gl/g9H3iP
http://hyperphysics.phy-astr.gsu.edu/hbase/geoopt/refr.html

Non-destructive testing overview (handout provided): goo.gl/AMkOF9
https://www.nde-ed.org/AboutNDT/aboutndt.htm

YouTube video about non-destructive testing: goo.gl/bnZZQB
https://www.youtube.com/watch?v=tlE3eK0g6vU

Additional Activity "Make a Light Fountain": goo.gl/4eECRj
http://www.optics4kids.org/home/content/classroom-activities/medium/make-a-light-fountain/

Assessment:

The following rubric can be used to assess students during each part of the activity. The term "expectations" here refers to the content, process and attitudinal goals for this activity. Evidence for understanding may be in the form of oral as well as written communication, both with the teacher as well as observed communication with other students. Specifics are listed in the table below.

1= exceeds expectations
2= meets expectations consistently
3= meets expectations occasionally
4= not meeting expectations

	Engage	Explore	Explain
1	Shows leadership in the discussion and activity, displays good understanding of physic terms.	Completes work accurately while providing an explanation for what is observed. Works very well with partners.	Provides an in-depth explanation of findings. Makes excellent and thoughtful comparisons to everyday life. Completes activity sheet.
2	Participates in the discussion and activity; shows an understanding of physic terms.	Completes work accurately and works cooperatively with partners.	Provides clear explanation of findings. Notes good correlations to everyday life. Completes activity sheet.
3	Contributes to the discussion and activity, but shows little understanding of physic terms.	Works cooperatively with partners, but makes some mistakes with the procedure.	Provides a limited explanation of findings. Struggles to make comparisons to everyday life. Completes some of the activity sheet.
4	Does not participate in discussion and/or activity.. Shows no understanding of physic terms.	Has trouble working cooperatively. Does not complete work..	Provides little to no explanation of findings. Struggles to make comparisons to everyday life. Does not complete the activity sheet.