Facilitator's Guide

Grade: 5
Unit: Light Energy
Title: Conservation of Energy

Topic:	Conservation of Energy - Absorption of Light
Lesson Summary:	The law of conservation of energy states that the total amount of energy coming into a system must be equal to the total amount leaving a system if no work is done on or by the system. In other words, energy is not created or lost during the interaction. It merely changes form. In this lesson, students will conduct investigations to demonstrate that all of the light energy coming into a system will be reflected, refracted, or absorbed.
Arkansas Frameworks:	http://www.arkansased.org/teachers/word/science_k-8_011006.doc
Science Standards	PS.7.5.1 Summarize how light can interact with matter through absorption, refraction, and reflection. PS.7.5.2 Investigate how light travels and interacts with an object or material. PS.7.5.4 Design and conduct investigations of transparent, translucent, and opaque as applied to light. NS.1.5.1 Make accurate observations. NS.1.5.2 Identify and define components of experimental design used to produce empirical evidence: hypothesis, replication, sample size, appropriate use of control, use of standardized variables. NS.1.5.4 Interpret scientific data using, data tables/charts, bar graphs, circle graphs, line graphs, stem-and-leaf plots, Venn diagrams. NS.1.5.5 Communicate results and conclusions from scientific inquiry. NS.1.5.6 Develop and implement strategies for long-term, accurate data collection. NS.1.5.9 Define and give examples of hypotheses.
Math Integration	DAP.15.5.1 Interpret graphs such as line graphs, double bar graphs, and circle graphs. DAP.16.5.1 Make predictions and justify conclusions based on data. DAP.17.5.1 Identify and predict the probability of events within a simple experiment. DAP.14.5.2 Collect numerical and categorical data using surveys, observations and experiments that would result in bar graphs, line graphs, line plots and stem-and-leaf plots. DAP.14.5.3 Construct and interpret frequency tables, charts, line plots, stem-and-leaf plots and bar graphs.
Literacy Integration	OV.3.5.1 View a variety of media (e.g., posters, film clips, periodicals, charts, cartoons, etc.) to enhance and show understanding of a specific topic. OV.3.5.3 Use visual aids to convey information. W.4.5.2 Organize ideas by using such graphic organizers as webbing, mapping, and formal outlining with main topics. IR.12.5.4 Gather information from a source appropriate to purpose and topic.
National Frameworks: Science Standards	**Science as Inquiry** Demonstrate abilities necessary to do scientific inquiry. 1. Use appropriate tools and techniques to gather, analyze, and interpret data. 2. Develop descriptions, explanations, predictions, and models using evidence. 3. Think critically and logically to make the relationships between evidence and explanations. 4. Communicate scientific procedures and explanations. **Physical Science** 1. Document that light can be treated as if it travels in a straight line until it strikes an object. Light can be reflected by a mirror, refracted by a lens, or absorbed by the object; and 2. Document that light interacts with matter by transmission (including refraction), absorption, or scattering (including reflection). An object is only seen if it emits or scatters light. **Science and Technology** 1. Demonstrate abilities of technological design. 2. Implement a proposed design. 3. Evaluate completed technological designs or products.

Objectives:	Students will pull together and connect ideas about various scientific concepts about light including: light absorption, refraction, and reflection. Students will make a correlation between visible light and heat absorption.
Focus Question:	How does light react as it travels through different mediums?
Background Information:	All waves are traveling energy. Energy comes in different forms such as: light energy, sound energy, and heat energy. The law of conservation of energy states that the total amount of energy remains constant in an isolated system. Therefore, energy is not created or destroyed. The law of conservation of energy would indicate the total amount of light energy in a system will be equal to the amount of light that is reflected, refracted and/or absorbed. Energy in an isolated system can change form, for instance, light energy from the sun changes to heat energy when it reaches our skin. This is why our skin feels warm when directly exposed to sunlight. The sun is our major source of light. The sun emits waves through space and enters Earth's atmosphere to reach everything on Earth. As a result, the waves from the sun light up our day; change to heat energy to warm our air and water; and are stored as energy in green plants. Light waves are energy in the form of electric and magnetic fields. In most cases, light expands on a spherical wave front and does not need a medium to travel through. Light travels in waves. If we are far enough away from the light source, the wave front appears "flat" and we can use the "ray model" to demonstrate light traveling in straight lines. Light from the sun travels in waves, but the light wave behaves as if it travels in a straight line. This model can be used to describe how light reacts to different types of matter. However, it does not explain why it reacts in this manner. Waves travel in a series of frequencies. In absorption the frequency of the incidental (incoming) light wave is near the amount of energy needed to move the electrons in the material to the next orbital energy level. Matter comes in four forms: solids, liquids, gases and plasma. In solids, the molecules are packed very tightly; in liquids, molecules are packed less tightly; in gases, molecules move more freely; and in plasma atoms have so much energy and are moving so much, their outsides come off! This is important to the absorption of light because when light hits a material where the frequency of the incoming light is near the energy level of the electrons in the material, the electrons of that material take in the energy from the light wave and are able to move to the next energy level. When the electrons are held tightly, they pass the energy on to the nuclei of the atoms. This speeds up the atoms which cause them to hit other atoms in the material. The energy from the vibrations is transferred to heat energy. The material may then feel warm to the touch or may transfer that heat energy to other materials behind it. This is why wearing dark clothing is not a good option in the summer months when the sunlight reaches us more directly.
Essential Vocabulary	**absorption** - when light waves pass through a substance, the energy of certain colors may be taken in by the substance and converted to a different form of energy (ADE framework) **reflection** – a change in the direction of a light ray as it bounces off an object (ADE framework) **refraction** - a bending of a light ray when it passes at an angle from one substance into another substance in which its speed is different (such as when it passes through air into water) (ADE framework)
Timeline:	Elicit & Engage: 20 minutes Explore: 45 minutes Explain: 20 minutes Elaborate: 30 minutes Extend: 1-2 weeks at home project

	Instruction	Facilitator's Notes
Materials:	**Elicit & Engage - *Sponge/Block*** • Dropper • Small block of wood • Sponge **Explore - *Pop Goes the Temperature*** **Variation 1** • Tape – scotch or masking • Thermometers or temperature probe • Sheets of red, yellow, blue, white, & black colored construction paper • Aluminum foil • Wax paper **Variation 2** • Empty pop bottles • Clay or playdough type material • Thermometers or temperature probe • Sheets of red, yellow, blue, white, & black colored construction paper • Aluminum foil • Wax paper **Explain – *Human Concept Definition Map*** • Concept strips (laminate stability) • Yarn or kite sting • 12 Binder clips or clothes pins **Elaborate -** • Student Data Form "Design Plan for Solar Homes **Extend -** • Various recycled materials to create solar homes	
	1. **Laser lights, Sunlight, Flashlights, or Maglites -** looking directly into the light or pointing the light in the eye can cause serious permanent damage to the retina. Only the teacher should use the laser light during the experiments. 2. **Hairspray -** be sure to aim the can away from face and eyes. Goggles should be used for young children. 3. **Light bulbs -** heat generated by the bulbs can cause serious burns / bulbs made of glass can break and cut the skin or eyes (especially halogens) / salt and oils from bare hands can cause bulbs to shatter when turned on. 4. **Mirrors -** be aware of sharp edges 5. **Lenses and Mirrors -** can magnify the intensity of the light. Teacher should monitor students carefully to avoid reflection into someone's eyes or causing heat which will burn. 6. **Batteries -** should not be installed backwards, put in fire, or mixed with other battery types. This may cause exploding or leaking. 7. **Broken bulbs or old batteries -** should be handled by the teacher and not the student. 8. **Disposal of bulbs or batteries -** wrap glass bulbs before throwing them away / recycle batteries in the proper place (The local post office may have a battery recycling box). 9. **Eating** should be avoided in the science lab area. 10. **Arrange room** and put away unneeded items to avoid tripping and allow for free movement of students during the experiences that require the room to be dark.	
Teacher Preparation:	**Explore** – (If using variation 2) After the pop bottles have been cleaned and dried, poke a small hole in the top of the lid large enough to stick in a thermometer. Place the clay around the thermometer so that no air escapes. **Explain** – Teacher needs to copy "Human Concept Definition Map" pages (attached), and cut apart each light fact. Each concept strip, except for the main concept (Light), should have a long string attached to it affixed with a binder clip or clothes pin on the end of the string. Laminating these cards before the string is attached will keep the concept card from ripping.	

Elicit High-Yield Strategies	**Sponge/Block** The teacher will hold a dropper of water above the block and drop water onto it. Students will observe how the water reacts when a drop lands on the block of wood. Each student will record these observations in their science notebook.	Then the teacher will repeat the experiment using the sponge and students will once again record their results.
Engage High-Yield Strategies	**Sponge/Block** (cont.) What happened to the water as it landed on the sponge/block? How can this be compared to light? Is there a connection between how light and water react to matter? The students should observe that one surface absorbed the water and the other caused it to splatter. This observation should lead into the development of the understanding of how light is absorbed by certain materials.	(Be sure that students make a connection with the vocabulary word absorption – the sponge absorbs the water).
Explore Inquiry High-Yield Strategies	**Pop Goes the Temperature** Variation 1: Follow the procedure for variation 2 using different colors of construction paper folded to form a pocket instead of wrapping the construction paper around the bottle. Variation 2: Students will wrap the teacher-prepared pop bottle with one of the different materials provided (construction paper, wax paper or aluminum foil) and then place the lids on the bottles with the thermometer/temperature probe already in them and set them in the sun or a heat lamp may also be used. Have students' record initial temperature of their bottles in Celsius. Record temperature change every five minutes for a total of 20 minutes. Record the temperature in student notebooks.	* Refer to teacher preparation section for how to prepare the bottle before the class period. Upon returning to class, graph the results (see Absorption Exploration Table sheet) for the entire class and have students determine which color/material absorbed more light energy that was converted to heat energy.
Explain High-Yield Strategies Formative Assessment	**Human Concept Definition Map** Students complete a "Human Concept Definition Map" to tie in absorption, reflection, and refraction concepts. 1. Print off the "Human Concept Definition Map" pages (attached) 2. Cut apart the light facts. 3. Each concept strip, except for the main concept (Light), should have a long string attached to it affixed with a binder clip or clothes pin on the end of the string. 4. Pass out the slips to various students and students must decide which fact is the main concept/idea. 5. Student with main concept (Light) will stand in the middle of the room. 6. Students who have the secondary concepts will link up to the main concept using their attached string. They should spread out to four different areas around the main concept. 7. Students with the remaining supporting facts will link up with their correct secondary concepts.	The map will provide a connection between these concepts and can be connected to the Conservation of Energy model. Be sure to discuss the concept as a class afterwards to ensure students have correct understanding. Option: Repeat the process with students who did not participate the first time. Option: After this class activity, ask the students to fill in the "Concept Definition Map" hardcopy to keep in their notebook for reference or individual grade.

Elaborate High-Yield Strategies Formative Assessment	**Design Solar Home Model** Students will use the knowledge that they have acquired from the study of reflection, refraction, and absorption to design (and build if time allows in the extension) solar homes for a specific biome/scenario. Students must decide if their home should allow for absorption to increase the inside temperature or reflection so the inside temperature will stay cool. This will be determined by the biome/scenario they select. The students will draw their designs in class using the "Planning Your Own Scientific Investigation" sheet for organization of student projects. Construct Solar Home Model	Students will continue with the Solar Home Project by constructing a house. This can be done as a class completion or as a major science project. Students should be encouraged to use recycled (green) materials. Upon completion of the solar houses, students will conduct tests to determine if his/her house meets the prediction.
Evaluate High-Yield Strategies	**Use Designing a Structure:** Solar Home Design and Construction rubric to evaluate students understanding of all unit concepts (reflections, refraction, and absorption).	Students will also demonstrate comprehension of the concepts of light by completing Concept Definition Map in the explanation section.
Extend Formative Assessment	After students have tested their solar house, they may change one variable in the design and make that change, Students can create an advertisement about their solar home as a conclusion to the lesson.	
Cross-Curricular Integrations:	Math Language Arts Social Studies – Students will build their solar homes for specific biomes in which students study in their social studies frameworks. * Refer to Learning Guide for additional integrations.	
Technology	Light probes	
Resources:		
Parental/Community Involvement	Host a parent night in which students display and present their Solar Homes.	
Notes:		
Document Links:	Elicit / Engage: Science Notebook Reflection student page Explore: Absorption Exploration Table student page Explain: "Human Concept Definition Map" pages *(Prepare following teacher preparation directions above.)* "Concept Definition Map" student page Elaborate: "Planning Your Own Scientific Investigation" student page Evaluate: Designing a Structure: Solar Home Design and Construction Rubric	