Facilitator's Guide

Grade: 5
Unit: Light Energy
Title: Reflection

Topic:	Reflection of Light
Lesson Summary:	The purpose of this lesson is for students to look at the way light may or may not reflect from different types of matter. In the following activities reflection as it is applied to light energy is explored.
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.7.5.3 Conduct investigations demonstrating how an object can be seen. PS.7.5.4 Design and conduct investigations of transparent, translucent, and opaque. 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 table/charts, bar graphs, circle graphs, line graphs, stem-and-leaf plots and Venn diagrams. NS.1.5.5 Communicate results and conclusions of the scientific inquiry.
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:	To explore the different ways in which light can be reflected or scattered depending on the matter it strikes with its ray.
Focus Question:	How does light interact with matter?

Background Information:	**When Light Hits an Object** When a light wave hits an object, what happens to it depends on the energy of the light wave, the natural frequency at which electrons vibrate in the material and the strength with which the atoms in the material hold on to their electrons. Based on these three factors, four different things can happen when light hits an object: 1) The waves can be reflected or scattered off the object; (2) The waves can be absorbed by the object; 3) The waves can be refracted through the object; 4) The waves can pass through the object with no effect. More than one of these possibilities can happen at once. **When light is reflected?** The atoms in some materials hold on to their electrons loosely. In other words, the materials contain many free electrons that can jump readily from one atom to another within the material. When the electrons in this type of material absorb energy from an incoming light wave, they do not pass that energy on to other atoms. The energized electrons merely vibrate and then send the energy back out of the object as a light wave with the same frequency as the incoming wave. The overall effect is that the light wave does not penetrate deeply into the material. In most metals, electrons are held loosely, and are free to move around, so these metals reflect visible light and appear to be shiny. The electrons in glass have some freedom, though not as much as in metals. To a lesser degree, glass reflects light and appears to be shiny, as well. A reflected wave always comes off the surface of a material at an angle equal to the angle at which the incoming wave hit the surface. You can see for yourself that reflected light has the same frequency as the incoming wave. Just look at yourself in a mirror. The colors you see in the mirror's image are the same as those you see when you look down at yourself. The colors of your shirt and hair are the same as reflected in the mirror as they are on you. If this were not true, we would have to rely entirely on other people to tell us what we look like! **When light is scattered?** Scattering is merely reflection off a rough surface. Incoming light waves get reflected at all sorts of angles, because the surface is uneven. The surface of paper is a good example. You can see just how rough it is if you look at it under a microscope. When light hits paper, the waves are reflected in all directions. This is what makes paper so incredibly useful -- you can read the words on a printed page regardless of the angle at which your eyes view the surface. Another interesting rough surface is Earth's atmosphere. You probably don't think of the atmosphere as a surface, but the atmosphere is "rough" to incoming white light. The atmosphere contains molecules of many different sizes, including nitrogen, oxygen, water vapor and various pollutants. This assortment scatters the higher energy light waves, the ones we see as blue light. This is why the sky looks blue. The website **www.science.howstuffworks.com/light.htm** has some excellent pictures that are moving and can show several areas of this.
Essential Vocabulary	**light** - the thing that allows us to see objects. Light can be modeled as rays, electromagnetic waves, or photons. **light energy** - the form of electromagnetic energy that is visible to the human eye. **light ray** - represents a thin beam of light which helps illustrate how light works **energy** - the capacity to cause change and do work (ADE framework) **reflection** - change in the direction of a light ray as it bounces off an object (ADE framework) **scattering** - the action of light bouncing in different directions from an object or the process of light being absorbed, and then re-radiated by atoms and molecules Optional Vocabulary **interference colors** – one of the characteristics of light waves is their ability to interfere with one another, under certain circumstances such as: light reflecting from a CD; light reflecting from a film of oil floating on water; or soap bubble reflecting a variety of colors when illuminated by a light source. http://www.olympusmicro.com/primer/lightandcolor/interference.html **interference patterns** - patterns that are made when light is reflected off or passes through something.
Timeline:	This lesson should take one to two 50 minute periods of time to complete.

	Instruction	Facilitator's Notes
Materials:	**Elicit – *Reflection Anticipation Guide*** (1copy per student) Pre - assessment: Light Probe (reflection) **Engage - *Reflecting Rainbows*** • Compact disc (also known as a CD) • Sunlight (or a bright flashlight and a room that you can make dark) • Piece of white paper **Explore – *Light Burst*** • Laser • Smooth surface mirror • Rough (scratched) surface mirror • OWL sheet **Explain –** • Vocabulary Map (1 copy per student) • Access to www.howstuffworks.com/light.html or non-fiction passage about reflection **Evaluate -** • *Student lab notebooks* **Elaborate & Extend – *Reflection with Light Box*** • Light Box, Mirrors (on binder clips) • Aluminum foil (smooth and wadded) • Wax paper (smooth and wadded) • Diffracting Grates, Black Construction Paper • White cardstock screen • Water • Clear rectangular box • Food coloring • Clear plastic sheet – similar to an overhead transparency • Any other materials you want to test (Cotton balls, bubble wrap, etc.)	
	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:	• Creating the light box in workshop. • Gathering materials. • Darkening room to allow light to be seen clearly. • Copy the vocabulary map (1 copy per student) • Make ½ of the mirrors rough by scratching them against a rough surface (concrete sidewalk works great!).	

Elicit Formative Assessment	**Anticipation Guide – Reflection** An anticipation guide is a series of statements to get the students to think about what they already know about a concept. The guide should be given prior to teaching to assess background knowledge, help to recognize misconceptions, arouse interest, and encourage students to form questions of their own. It can be used as a springboard for class discussion. A grade should NOT be given. At the end of the unit, students should revisit this anticipation guide to evaluate how well they understood the concept and to correct possible misconceptions.	
Engage Inquiry	***Reflecting Rainbows*** When light reflects off something with many small ridges or scratches, you often get rainbow colors and interesting patterns. This is a guided inquiry lesson and the students should be allowed to experiment with CD's and a Mini-Mag Light or flashlight. www.exploratorium.edu/science_explore/reflecting_rainbows.html 1. Take the CD out of its case and take a look at the blank side (the side that doesn't have any printing on it). You'll see bands of shimmering color. 2. Tilt the CD back and forth and the colors will shift and change. 3. Hold the CD in the sunshine. Or if it's a cloudy day, turn out the lights and shine your flashlight at the CD. 4. Hold your piece of white paper so that the light reflecting off the CD shines onto the paper. The reflected light will make fabulous rainbow colors on your paper. 5. Record your observations in your science notebook.	Why does a CD reflect rainbow colors? What will happen when you shine the light source onto the CD? What are interference colors and patterns?
Explore Inquiry	**Explore: Light Burst** Students will explore the term "scattering." Students will compare light interaction with a smooth mirror surface and a rough mirror surface. The scattering of light occurs when the light waves/rays hit a rough surface and bounce around back toward the source. The scattering can be modeled in this activity. You may use various objects from the classroom to extend the learning, such as aluminum foil, paper, wax paper. This can be a guided or full inquiry. Procedure: Use the OWL format for this activity. 1. Position the smooth mirror and direct the laser toward the mirror. 2. Record your observations in your science notebook through a drawing of what is happening. 3. Position the rough mirror and direct the laser toward the mirror. 4. Record your observations in your science notebook through a drawing of what is happening.	What is scattering? What happens to a laser beam when it is shone against a smooth surface mirror? What happens to a laser beam when it is shone against a rough surface mirror? Hint: The light scatters best if the foil is loosely wadded up instead of flat.

Explain High-Yield Strategies	**Vocabulary Map** Students will use the knowledge gained through the elicit, engage, and explore sections of the 7E instructional plan to complete the vocabulary map which leads to developing a definition of "reflection" in the students' own words.	Students can also use non-fiction reading materials to add information to their vocabulary map. They may NOT copy definitions from the textbook. Copying definitions from the textbook is NOT an effective way to be sure students comprehend the term.
Elaborate Inquiry	**Reflections using Light Box** 1. Set up light box. 2. Place the diffracting grates in clear plastic sheet to block all but a thin narrow strip of light. 3. Place a mirror in front of the light ray and describe what happens on the lab sheet. 4. Repeat number 3 using two mirrors. Make the light ray reflect from one mirror to another? 5. Repeat number 3 using 3 mirrors. 6. Can you get the light ray to reflect from one mirror to another to another? 7. If you have extra mirrors, keep adding them to see what happens. 8. Start again with the mirrors; moving them closer to the light box and closer to each other.	After each manipulation and observation, ask the students to use a description or drawing to describe what happens. These entries can be placed on the Science Lab Notebook- experiment page (provided).
Evaluate High-Yield Strategies	Students use vocabulary map to write a definition of the concept including all key or defining characteristics. Responses to questions during lab experiments will be recorded in student lab notebooks.	
Extend Inquiry	**Reflections using Light Box (cont.)** 1. Set up light box. 2. Place the diffracting grates in clear plastic sheet to block all but a thin narrow strip of light. 3. Place a flat sheet of aluminum foil in front of the light ray. 4. Repeat number 3 using the wadded up sheet of aluminum foil. 5. Repeat number 3 using the flat wax paper. 6. Repeat number 3 using the wadded up wax paper. 7. Start again with the previous objects; moving them closer to the light box. 8. Test again with objects; moving them farther away from the light box. 9. Repeat any of these steps using the various materials that are included on the list. 10.Use the clear cylinder empty; with water; with colored water.	You may use various objects from the classroom to extend the learning. This is a pure inquiry lesson and the students should be allowed to experiment with various objects. After each manipulation and observation, ask the students to use a description or drawing to describe what happens. These entries can be placed on the Science Lab Notebook- experiment page (provided).
Cross-Curricular Integrations:	Refer to Science Learning Guide	
Technology	Light Box	

Resources:	
Notes:	
Document Links:	Elicit: Anticipation Guide student page Engage: Student Notebook Reflection Log Explore: "OWL" student page Explain: "Vocabulary Map" or Science Terms in Science Notebook Elaborate: Student Notebook Experiment Log