

# SOUND ENERGY

## **BIG IDEA 10: FORMS OF ENERGY**

### **BENCHMARKS AND TASK ANALYSES**

**SC.3.P.10.1** Identify some basic forms of energy such as light, heat, sound, electrical, and mechanical.

The student:

recognizes that energy comes in many different forms.

- recognizes that energy comes in many different forms.
- identifies forms of energy such as light, heat, sound, electrical, and mechanical.

**SC.3.P.10.2** Recognize that energy has the ability to cause motion or create change.

**SC.3.N.1.1** Raise questions about the natural world, investigate them individually and in teams through free exploration and systematic investigations, and generate appropriate explanations based on those explorations.

The student:

- poses and investigates questions individually and collaboratively through free exploration and systematic investigations.
- draws conclusions based on the results of the explorations.

**SC.3.N.1.2** Compare the observations made by different groups using the same tools and seek reasons to explain the differences across groups.

The student:

- works in a group using the same tools as other groups to gather common data.
- compares groups' data and explains differences.

**SC.3.N.1.3** Keep records as appropriate, such as pictorial, written, or simple charts and graphs, of investigations conducted.

The student:

- records in a science notebook, pictorial or written information or simple charts and graphs of investigations conducted.

### **KEY QUESTIONS**

What is energy?

How is sound energy?

### **TEACHER BACKGROUND INFORMATION**

Energy is the ability to cause a change or to create motion. There are many forms of energy including sound, light (radiant), heat (thermal), electrical, and mechanical (motion).

Sound energy is the motion of molecules back and forth. Sound is actually vibration. Sound moves through solids, liquids, and gases. Sound travels faster through solids.

Light, a form of radiant energy, is necessary in order for us to see. What the human eye sees as light, such as the glow from a candle, is actually radiant energy, also referred to as electromagnetic radiation. Light radiates outward in straight lines in all directions from a source, such as the sun or a lamp, to an object, such as a tree. The light is reflected to our eyes, where it stimulates special nerve receptors on the retina at the back of the eyeball, which then transmit information through the optic nerve to the brain. When light strikes an object, it is not reflected in



just a certain direction, but is scattered in all directions. This allows the object to be seen from different viewing positions.

## **MATERIALS**

### **Per Teacher**

tuning fork

### **Per group**

tuning fork

ping pong ball on string

cup half full of water

### **Per student**

rubber band

science notebook

## **SAFETY**

Tuning forks can break if students hit them on the table too hard. Remind students to take care when using tuning forks.

Always follow OCPS science safety guidelines.

## **TEACHING TIP**

Prepare the ping pong balls ahead of time by taping a piece of string approximately a foot long onto the ball.

## **ENGAGE**

1. Strike a tuning fork on the table. Ask students to use their senses and describe their observations.
2. Tell students that they just experienced sound energy.
3. Ask: *What does the word energy mean to you?* (listen to all answers)
4. Ask: *Are there different uses of the word energy?* (yes, refer to answers from above)
5. Ask: *Does sound energy move?* (listen to ideas- this is the focus of the exploration so it is not important if they really understand that sound energy does move yet)
6. Ask: *Does sound energy make a change?*
7. Tell students that you want them to explore sound energy with a focus on finding out if it moves and if it makes a change.

## **EXPLORE**

1. Provide students time to complete the following tasks:
  - Strike the tuning fork on your hand and observe using your senses.
  - Strike the tuning fork on your hand and place it gently in the cup of water. Observe what happens using your senses.
  - Strike the tuning fork with your hand and hang the ping pong ball so it gently touches the tuning fork.
2. Tell students to share their observations with their group members and to make observational notes in their science notebook.

### **EXPLAIN**

1. Have groups report out their findings.
2. Ask: *Did all groups have the same results?*
3. Ask: *Should the groups have had the same results?* (yes, if they were using the same materials and following directions)
4. Ask: *If all groups did not get the same results, what could explain that?* (someone changed something from the instructions- didn't hold the tuning fork correctly, etc.)
5. Ask: *Do you think we would get different results if we used a different tool for sound energy?*
6. Ask: *Did the sound energy from the tuning fork cause a change in any of the investigations?* (yes, it made the water and the ping pong ball move)
7. Ask: *Did the sound energy from the tuning fork create motion in any of the investigations?* (yes, the water and the ping pong ball moved)
8. Ask: *If energy is the ability to create a change or to cause motion, would sound be energy?*

### **EXTEND AND APPLY**

1. Have students hang a tuning fork on a string. Ask them to strike the tuning fork and listen. Then have them place the ends of the string on their ear and listen. Ask: *Was there a difference in the sound? Did the sound energy move?*

### **ASSESSMENT**

Evaluate science notebooks for complete observations.



# HOW CAN OUR SENSES HELP US OBSERVE ENERGY IN ACTION?

## **BIG IDEA10: FORMS OF ENERGY**

### **BENCHMARKS AND TASK ANALYSES**

**SC.3.P.10.1** Identify some basic forms of energy such as light, heat, sound, electrical, and mechanical.

The student:

- recognizes that energy comes in many different forms.
- identifies forms of energy such as light, heat, sound, electrical, and mechanical.

**SC.3.P.10.2** Recognize that energy has the ability to cause motion or create change.

**SC.3.N.1.1** Raise questions about the natural world, investigate them individually and in teams through free exploration and systematic investigations, and generate appropriate explanations based on those explorations.

The student:

- poses and investigates questions individually and collaboratively through free exploration and systematic investigations.
- draws conclusions based on the results of the explorations.

**SC.3.N.1.2** Compare the observations made by different groups using the same tools and seek reasons to explain the differences across groups.

The student:

- works in a group using the same tools as other groups to gather common data.
- compares groups' data and explains differences.

**SC.3.N.1.3** Keep records as appropriate, such as pictorial, written, or simple charts and graphs, of investigations conducted.

The student:

- records in a science notebook, pictorial or written information or simple charts and graphs of investigations conducted.

### **KEY QUESTIONS**

What is energy?

How can our senses help us observe energy in action?

### **TEACHER BACKGROUND INFORMATION**

Energy is the ability to cause a change or to create motion. There are many forms of energy including sound, light (radiant), heat (thermal), electrical, and mechanical (motion).

Sound energy is the motion of molecules back and forth. So, sound is actually vibration. Sound moves through solids, liquids, and gases. Sound travels faster through solids.

Light, a form of radiant energy, is necessary in order for us to see. What the human eye sees as light, such as the glow from a candle, is actually radiant energy, also referred to as electromagnetic radiation. Light radiates outward in straight lines in all directions from a source, such as the sun or a lamp, to an object, such as a tree. The light is reflected to our eyes, where it stimulates special nerve receptors on the retina at the back of the eyeball, which then transmit information through the optic nerve to the brain. When light strikes an object, it is not reflected in



just a certain direction, but is scattered in all directions. This allows the object to be seen from different viewing positions.

## **MATERIALS**

### **Teacher**

balloon

### **Per group**

flashlight

### **Per student**

rubber band

balloon

science notebook

## **SAFETY**

Always follow OCPS science safety guidelines.

Students should wear goggles when dealing with balloons.

## **TEACHING TIP**

Remind students not to share balloons.

## **ENGAGE**

1. Tell students to close their eyes and to listen.
2. Blow up a balloon and then let it go.
3. Ask students to open their eyes.
4. Ask: *What did you observe? What senses did you use to make that observation?*
5. Ask: *What senses do we use in science to make observations?*
6. Ask: *Why do we have to use our senses in science?* (because we have to have evidence for the investigations, we cannot just guess)
7. Tell students that you want them to work in groups and to use their senses to explore the objects you are giving them: balloon, rubber band, and flashlight.
8. Remind students that they should not share balloons.
9. Tell students to share their observations with their group members and to make observational notes in their science notebook.

## **EXPLORE**

Provide students time to explore. Circulate around the room and ask questions to guide them back to the key questions. Ask questions similar to those in the Explain section to help guide students to understanding.

## **EXPLAIN**

1. Have groups report out their findings.
2. Ask: What is energy?
3. Ask: *How did you use your senses to investigate energy?*
4. Ask: *Which sense do you mostly use to explore sound energy? (hearing)*
5. Ask: *Which sense do you mostly use when exploring light energy from the flashlight? (sight or touch)*
6. Ask: *Which senses did you use when exploring sound energy with the rubber band? (touch, hearing, sight)*



7. Ask: *Did the balloon have energy? Did it cause a change or create motion? (yes)*
8. Ask: *Did the rubber band have energy? Did it cause a change or create motion? (yes)*
9. Ask: *Did the flashlight have energy? Did it cause a change or create motion? (yes)*
10. Ask: *Did the rubber band have sound energy? (yes) Did the rubber band have light energy? (no) Did the rubber band have heat energy, did it get hot? (yes)*
11. Ask: *Did the flashlight have sound energy? (yes) Did the flashlight have light energy? (yes) Did the flashlight have heat energy, did it get hot? (yes)*
12. Ask: *Did the balloon have sound energy? (yes) Did the balloon have light energy? (no) Did the balloon have heat energy, did it get hot? (yes)*

### **EXTEND AND APPLY**

1. Have students make observations of the classroom and to discuss with their group examples of sound, light, and heat energy.

### **ASSESSMENT**

Evaluate science notebooks for complete observations.



# HOW DOES LIGHT INTERACT WITH OBJECTS?

## **BIG IDEA 10: FORMS OF ENERGY**

### **BENCHMARKS AND TASK ANALYSES**

**SC.3.P.10.2** Recognize that energy has the ability to cause motion or create change.

**SC.3.P.10.4** Demonstrate that light can be reflected, refracted, and absorbed.

**SC.3.N.1.1** Raise questions about the natural world, investigate them individually and in teams through free exploration and systematic investigations, and generate appropriate explanations based on those explorations.

The student:

- poses and investigates questions individually and collaboratively through free exploration and systematic investigations.
- draws conclusions based on the results of the explorations.

**SC.3.N.1.2** Compare the observations made by different groups using the same tools and seek reasons to explain the differences across groups.

The student:

- works in a group using the same tools as other groups to gather common data.
- compares groups' data and explains differences.

**SC.3.N.1.3** Keep records as appropriate, such as pictorial, written, or simple charts and graphs, of investigations conducted.

The student:

- records in a science notebook, pictorial or written information or simple charts and graphs of investigations conducted.

### **KEY QUESTION:**

How does light interact with objects?

### **TEACHER BACKGROUND INFORMATION**

Light is a form of energy that travels at very high speeds. Light can pass through air, water, glass, and many other materials. Light can easily pass through materials that are transparent, like clear window panes. Some materials, such as opaque objects, do not permit light to pass through them. Opaque objects are usually solid materials, such as books or wooden blocks. Light that hits an opaque object is blocked. A shadow is then formed in the shape of the object blocking the light. Transparent, translucent, and opaque objects can all create shadows. An opaque object casts a shadow that looks totally dark because it blocks all of the light rays falling on it; no light passes directly behind the object. A transparent or translucent object casts a lighter shadow because it blocks only some of the light rays falling onto it.

Photosensitive paper is used in this activity. Photosensitive paper works because the paper is coated with a thin film of a chemical that is changed by the ultraviolet rays that are absorbed from the sun. You can see this change when the color of the paper changes from blue to off-white.



## **MATERIALS**

### **Teacher/Class**

light bulb and portable socket  
variety of magnifiers  
overhead projector  
several shallow pans of water  
assortment of paper  
(colored tissue, construction paper,  
acetate, foil, and notebook paper)  
scissors

### **Per student**

1 black, construction paper folder containing 2  
pieces of sun-sensitive paper  
1 piece of black construction paper (9" X 12")  
1 piece of white construction paper (9" X 12")  
tape

## **SAFETY**

Student should use caution when coming near light bulbs.  
Always follow OCPS science safety guidelines.

## **TEACHING TIPS**

1. The black and white construction paper should be the same thickness to control variables.
2. Photosensitive paper can be purchased at local school supply stores and through science catalogs.
3. Cut photosensitive paper into 10 cm-squares prior to the lesson. Florescent light damages paper. Cut sun sensitive paper in a dark place and store it in a dark folder made from folded black construction paper or the activity may not work. (Each student will need a black, construction paper folder containing two pieces of sun-sensitive paper.)
4. Go outside ahead of time and choose a suitable area for the activity. Place several shallow pans of water in the activity area.

## **ENGAGE**

1. Turn on the light bulb that you have in a portable socket.
2. Ask: *What do you see?* (light)
3. Ask: *Is light energy?* (yes, it causes a change or creates motion)
4. Ask one student to come near the light bulb and hold his hand near the bulb but do not touch it. Ask the student what they feel. They should be able to feel some heat.
5. Ask: *Is heat energy?* (yes, it causes a change)
6. Tell students that many things have many forms of energy and that many objects give off light energy and heat energy.

## **EXPLORE Part 1**

1. Distribute construction paper to students.



2. Instruct students to fold the paper in half to make a rectangle 6" X 9" and to tape or staple one of the shorter sides closed and one of the longer sides closed. They should do this for both pieces of construction paper.
3. Students should be able to put their hand inside the construction paper hand warmers.
4. Take students outside and tell them to put the paper hand warmers on their hands and to hold them up toward the sun.
5. Ask students to observe the temperature of the hand warmers after about a minute.
6. Return to the class and have students make observations in their science notebook.

### **EXPLAIN Part 1**

1. Ask: *What happened? Did you feel a change in temperature?*
2. Ask: *Did all groups have the same observation? Why or why not?*
3. Ask: *Where did the heat come from? (the Sun)*
4. Ask: *Could we see the heat from the Sun? (no)*
5. Ask: *What can we see? (light)*
6. Ask: *Is light energy? Did it cause a change? (yes)*
7. Ask: *Is heat energy? Does it cause a change? (yes) Explain.*
8. Ask: *When the light came from the Sun, where did it go? (some of it must have gone into the hand warmer)*
9. Tell students that when light hits something and is taken into it to make heat, we say that the light energy was absorbed by that object.

### **EXPLORE Part 2**

1. Explain to students that they are going to explore how special light-sensitive paper absorbs light. Demonstrate how to use the materials they will be using outside.
2. Give sun-sensitive paper in a protective folder and a magnifier to each student.
3. Take students outside. Tell them to remove the sun paper from the folder and place it on a hard, flat surface.
4. Have students immediately place the magnifier on top of the paper. (Note: Students should be using different kinds of magnifiers, so different effects can be seen.)
5. Have students leave the paper and the magnifier in the light until the paper turns almost white (approximately 3-5 min. or longer).
6. Students should place the paper in a pan of tap water for about one minute.
7. Have students lay their papers on a flat surface to dry and watch the images appear!
8. Return to the classroom and have students write their observations in their science notebook.

### **EXPLAIN Part 2**

1. Ask: *Was there a change? (yes)*
2. Ask: *If energy is the ability to cause a change, what kind of energy was used to make the paper change? (light and maybe heat)*
3. Ask: *Where did this light and heat energy come from? (the Sun)*
4. Ask: *What happened to the light energy? (it was absorbed by the paper and made a change)*

### **EXTEND AND APPLY**

Encourage students to design another experiment. Students will need another sheet of sun-sensitive paper in the dark construction paper folder and assorted squares of opaque,



transparent and translucent paper from which to choose. (See materials list.) Students can explore to see how much light can pass through the different materials.

**ASSESSMENT**

Evaluate science notebook responses.



# HOW DOES LIGHT TRAVEL?

## **BIG IDEA10: FORMS OF ENERGY**

### **BENCHMARKS AND TASK ANALYSES**

**SC.3.P.10.1** Identify some basic forms of energy such as light, heat, sound, electrical, and mechanical.

- The student: recognizes that energy comes in many different forms.
- identifies forms of energy such as light, heat, sound, electrical, and mechanical.

**SC.3.P.10.2** Recognize that energy has the ability to cause motion or create change.

**SC.3.P.10.3** Demonstrate that light travels in a straight line until it strikes an object or travels from one medium to another.

The student:

- demonstrates that light travels very rapidly in straight lines.

**SC.3.N.1.1** Raise questions about the natural world, investigate them individually and in teams through free exploration and systematic investigations, and generate appropriate explanations based on those explorations.

The student:

- poses and investigates questions individually and collaboratively through free exploration and systematic investigations.
- draws conclusions based on the results of the explorations.

**SC.3.N.1.2** Compare the observations made by different groups using the same tools and seek reasons to explain the differences across groups.

The student:

- works in a group using the same tools as other groups to gather common data.
- compares groups' data and explains differences.

**SC.3.N.1.3** Keep records as appropriate, such as pictorial, written, or simple charts and graphs, of investigations conducted.

The student:

- records in a science notebook, pictorial or written information or simple charts and graphs of investigations conducted.

### **KEY QUESTION**

How does light travel?

### **TEACHER BACKGROUND INFORMATION**

Light, a form of radiant energy, is necessary in order for us to see. What the human eye sees as light, such as the glow from a candle, is actually radiant energy, also referred to as electromagnetic radiation. Light radiates outward in straight lines in all directions from a source, such as the **sun** or a lamp, to an object, such as a tree. The light is reflected to our eyes, where it stimulates special nerve receptors on the retina at the back of the eyeball, which then transmit information through the optic nerve to the brain. When light strikes an object, it is not reflected in just a certain direction, but is scattered in all directions. This allows the object to be seen from different viewing positions.

Light always travels in straight lines until it strikes an object or surface. Evidence that light travels in straight lines is provided by the fact that shadows are the same shape as the objects



that cast them. When light strikes an object, the direction of its straight-line path may change. The fact that a beam of light can be reflected from a mirror or converged by a lens are examples of how light may change its direction upon striking an object or surface. Light may also bend around the edges of an object or as it passes through a small opening.

When light passes from one medium to another, light changes direction slightly. This is called refraction. Refraction occurs because light travels at different speeds through different materials.

## **MATERIALS**

### **Teacher**

1 flashlight  
1 plain index card for the screen  
1 ruler  
scissors  
*The Wonder of Light*, Jan Adkins, Ranger Rick

### **Per group**

3 prepared index cards  
1 laser light  
1 flashlight  
clay  
1 metric ruler

### **Per student**

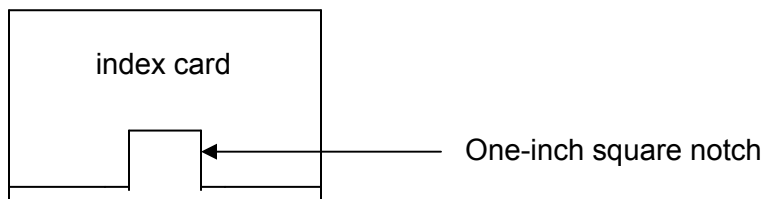
science notebook

## **SAFETY**

Remind students not to shine the flashlight or laser pointer in anyone's eyes.

## **TEACHING TIP**

- The laser lights can be bought at office supply stores or stores like WalMart. If you want a laser that has a supportive base, you can find those at Home Depot.
- It is important to ensure that students are anchoring the index cards in a straight line so that the light will go through the squares.
- When students are doing the experiment, it is easier for them to see the light if the room is dark.
- Prepare index cards ahead of time. (See illustration.)



## **ENGAGE**

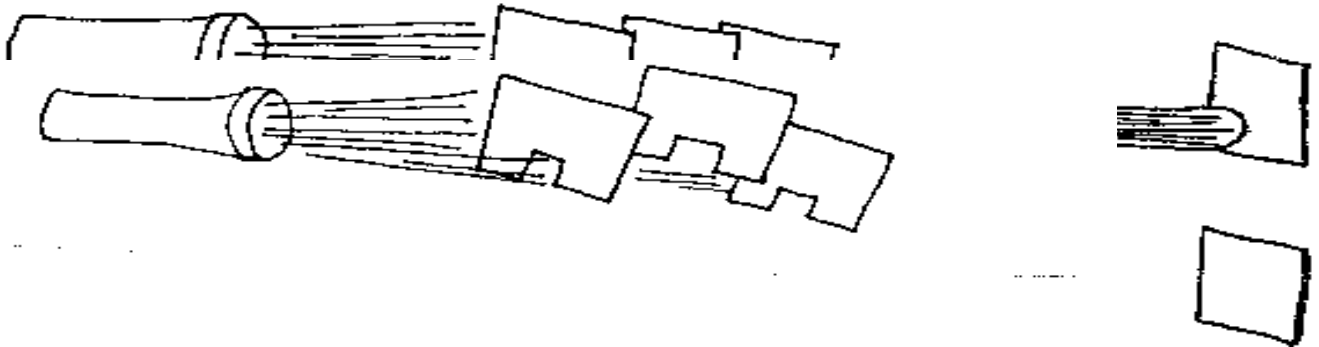
1. Flash the lights on and off.
2. Ask: *What did you notice when the lights were on? What did you observe when the lights were off?*
3. Ask: *Was there a change?*
4. Tell students to stare at their pencil and not to move it at all. Flash the lights on and off again.
5. Ask: *Was anything different about your pencil when the light was on and when the light was off? (I could see my pencil much better when the light was on than when it was off.)*



6. Ask: *Was there a change?*
  - Turn on the laser. Ask: *What do you notice when I turn this laser on? (it has a light beam)*
  - Ask: *Was there a change?*
  - Tell students, "You just experienced how light energy can make a change. Now, you are going to explore light energy a little more."

### **EXPLORE Part 1**

1. Tell students that they are going to be investigating the path in which light rays travel. Ask for ideas on how they could conduct such an investigation. (Try some of the ideas, if possible.)
2. Organize the students into groups.
3. Show students how to use clay to anchor the index cards to the table about 10 cm apart with the square notches aligned in a straight line.
4. The student holding the flashlight should lay it on the table behind the notch of one of the end cards.
5. Have the students use clay to anchor an index card screen at the end opposite the flashlight.
6. Darken the room so students can observe any light pattern on the index card screens.
7. Have students record observations in their science notebooks.
8. Next, tell students to move the index cards so the notches are not in a straight line and then observe any light patterns on the screen.
9. Students should record observations in their science notebooks.



### **EXPLAIN Part 1**

1. Have groups report out their findings.
2. Ask: *Did the light energy reach the last index card? Which trial?*
3. Ask: *Did all groups have the same results?*
4. Ask: *Should the groups have had the same results? (yes, if they were using the same materials and following directions)*
5. Ask: *If all groups did not get the same results, what could explain that? (someone changed something from the instructions- didn't hold the cards correctly, the flashlight wasn't positioned right, etc.)*
6. Ask: *Do you think we would get different results if we used a different tool for light energy?*

7. Tell students that they are now going to explore the same ideas using a laser light instead of a flashlight.

### **EXPLORE Part 2**

1. Have students complete the same exploration as earlier using the laser.
2. Students should continue collecting data and making observations.

### **EXPLAIN Part 2**

1. Have the groups report out their findings.
2. Ask: *Did the light energy reach the last index card? Which trial? How were the index cards arranged when the light rays reached the screen?*
3. Ask: *Why did the light rays reach the screen when the notches were aligned?*
4. Ask: *What happened when the notches were not aligned?* (When the notches were in a straight line, the rays were able to pass through the openings, but the rays were blocked by the card when the notches were unaligned.)
5. Ask: *Does light energy move?* (yes, it moved through the holes in the cards to the end)
6. Ask: *Did the light energy shine in a straight line or did it shine in a circular pattern?* (straight line)
7. Ask: *Did the light energy shine in a straight line or in a zigzag?* (straight line)
8. Ask: *What does this tell us about the way that light energy moves?* (it moves in a straight line)
9. Ask: *Was there a difference between the trials with the flashlights and the laser?* (the only difference should have been that the laser light was easier to see)

### **EXTEND AND APPLY**

1. Periscopes are used for seeing around corners. Allow students to make periscope models.
2. Ask students to reflect on this idea: *How would shadows be affected if light did not travel in a straight line?* (If light could go around corners, there would be no shadows. Objects could not block light; the light would just travel on around the object.)
3. Read *The Wonder of Light* by Jan Adkins.

### **ASSESSMENT**

Ask students to write a reflection on why we cannot see around corners. (Light only travels in straight lines. It cannot travel around a corner without the help of a reflector.)



# REFLECTION

## **BIG IDEA 10: FORMS OF ENERGY**

### **BENCHMARKS AND TASK ANALYSES**

**SC.3.P.10.1** Identify some basic forms of energy such as light, heat, sound, electrical, and mechanical.

The student:

- recognizes that energy comes in many different forms.
- identifies forms of energy such as light, heat, sound, electrical, and mechanical.

**SC.3.P.10.2** Recognize that energy has the ability to cause motion or create change.

**SC.3.P.10.3** Demonstrate that light travels in a straight line until it strikes an object or travels from one medium to another.

The student:

- demonstrates that light travels very rapidly in straight lines.

**SC.3.P.10.4** Demonstrate that light can be reflected, refracted, and absorbed.

The student:

- demonstrates that light can be reflected, refracted, and absorbed based on the object.

**SC.3.N.1.1** Raise questions about the natural world, investigate them individually and in teams through free exploration and systematic investigations, and generate appropriate explanations based on those explorations.

The student:

- poses and investigates questions individually and collaboratively through free exploration and systematic investigations.
- draws conclusions based on the results of the explorations.

**SC.3.N.1.2** Compare the observations made by different groups using the same tools and seek reasons to explain the differences across groups.

The student:

- works in a group using the same tools as other groups to gather common data.
- compares groups' data and explains differences.

**SC.3.N.1.3** Keep records as appropriate, such as pictorial, written, or simple charts and graphs, of investigations conducted.

The student:

- records in a science notebook, pictorial or written information or simple charts and graphs of investigations conducted.

**SC.3.N.1.4** Recognize the importance of communication among scientists.

The student:

- understands the importance of communicating results.

### **KEY QUESTION**

How does light travel?

What is reflection of light?

### **TEACHER BACKGROUND INFORMATION**

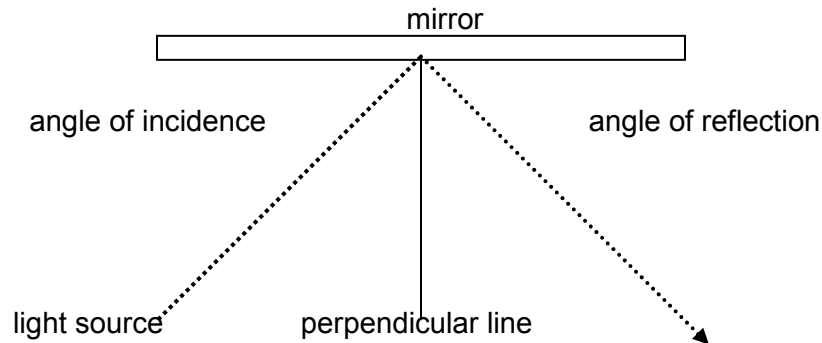
Light energy travels in a straight path. When light is reflected from a shiny, smooth surface, it behaves very much like a bouncing ball. A ball will bounce off a wall at the same angle at which it is thrown. Light will bounce off a mirror at the same angle at which it hits the mirror.



Law of Reflection: The law states that the angle of reflection is equal to the angle of incidence. This means that the angle at which light bounces off a surface (angle of reflection) will be the same as the angle at which it strikes the surface (angle of incidence). The angles will be equal,



but in the opposite direction. The angle of incidence is the angle formed by the incoming ray of light and a line perpendicular to the mirror. The angle of reflection is the angle formed by the reflected ray of light and a line perpendicular to the mirror.



The law of reflection applies even when light strikes rough surfaces, but when light shines on a rough surface, the light rays get reflected at many different angles. That is why you cannot use a rough surface as a mirror.

### **MATERIALS**

#### **Teacher/Class**

1 ball

#### **Per student**

science notebook

#### **Per group**

several small mirrors

flashlight

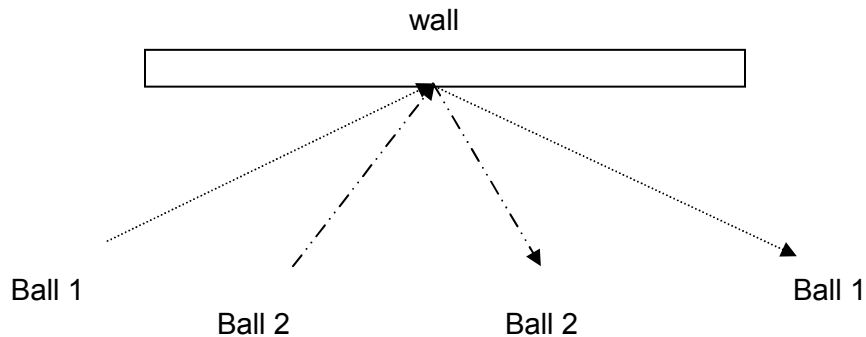
laser light

### **SAFETY**

Always follow OCPS science safety guidelines.

### **ENGAGE**

1. Have one student roll a ball against a wall while the class observes. Ask: *Where did the ball travel after it hit the wall?*
2. Ask students to predict where the ball will travel when it is rolled so that it hits the wall head on. (The ball will roll directly back to the student.)
3. Ask students to predict where the ball will travel when it is rolled so that it hits the wall at an angle. (The ball will strike the wall at an angle and roll back at the same angle but away from the student.)
4. Have students line up and then sit down parallel to the wall and a few feet from it. Place a mark on the wall at which students should aim.
5. Hand the ball to one student. Ask students to predict which one of them will catch the ball when it is rolled to the mark by that student. Have the student roll the ball.
6. Repeat this process several times from different angles.



### **EXPLORE Part 1**

- Ask: *In our earlier activity, we learned that light traveled in a straight line. Do you think it always travels in a straight line?*
- Tell students to think about the activity they just did with the ball. Say, *the ball had energy and it moved. Ask: Did it move in a straight line?*
- Ask: *What about when it hit the wall?*
- Tell students that they will now explore if light does the same thing- bounces off of solids.
- Provide groups with both a laser and a flashlight. Ask them to go around the room and “bounce” the light off of objects. Tell students to make observations about how the light moved in their science notebook.
- Give students plenty of time for exploration.

### **EXPLAIN Part 1**

1. Ask: *What observations did you make?* (have each group report out)
2. Ask: *Did each group have the same observations?*
3. Ask: *Why did we want to share this information with each other?* (scientists do this to verify their observations to check their information; plus each group may have looked at different objects and they can share with each other to get more information)
4. Tell students to think about their observations.
5. Ask:
  - *Did the light always travel in a straight line?*
  - *In what cases did it not travel in a straight line?*
  - *Were there any times when the light bounced off like the ball bounced off the wall? Why do you think that happened?*
6. Tell students the following:
  - Light travels in a straight line unless it hits some objects.
  - Some objects allow light to pass through easily and light continues in a fairly straight line.
  - Light can be absorbed (remind students of the hand warmers activity)
  - Light can be reflected (like when it bounces off objects similar to the ball)



- Light can be refracted (it passes through objects but bends as it passes)

### **EXPLORE Part 2**

1. Place a mirror on the wall where the marker, from the Engage section, was located. (Students should still be seated parallel to the wall and a few feet from it.)
2. Hand a flashlight to someone in the group. Ask the students to predict where the light will be reflected when that student shines the flashlight on the mirror.
3. Ask the student to shine the flashlight on the mirror so the other students can see where the light is reflected. Continue by having students pass the flashlight to different people and allow each one to predict on whom the light will shine.
4. Vary the activity by:
  - having students predict who should hold the flashlight in order to have it reflect on a certain person.
  - distributing more than one flashlight to the group.
  - allowing students to also use a laser light.

### **EXPLAIN**

1. Ask: *Is the light going through the mirror? How can you tell?*
2. Ask: *If the light is not going through the mirror, where is it going?* (The mirror blocks the light and prevents it from passing through. The light hits the mirror, bounces off, and is thrown to another place. When light is “thrown” by an object, like a mirror, the light is said to be reflected.)
3. Ask: *How is rolling the ball against the wall similar to a light beam hitting a mirror?* (Light behaves like a bouncing ball, because it reflects off a surface to another place. It travels in a straight line, just as the ball does.)
4. How could you predict accurately where the ball would bounce or where the light would be reflected?

### **EXTEND AND APPLY**

1. Ask students to think of other things that cause mirror-like reflections. (Examples may include chrome on cars, shiny surfaces, and water.)
2. Let students experiment with mirror writing (writing that can be read correctly only when held in front of a mirror).
3. Have students shine a beam of light on a concave and/or a convex lens and observe. Discuss their observations.

### **ASSESSMENT**

In their science notebooks, have students draw illustrations of instances when light is absorbed and reflected.



# REFLECTION AND REFRACTION

## **BIG IDEA 10: FORMS OF ENERGY**

### **BENCHMARKS AND TASK ANALYSES**

**SC.3.P.10.1** Identify some basic forms of energy such as light, heat, sound, electrical, and mechanical.

- The student: recognizes that energy comes in many different forms.
- identifies forms of energy such as light, heat, sound, electrical, and mechanical.

**SC.3.P.10.3** Demonstrate that light travels in a straight line until it strikes an object or travels from one medium to another.

The student:

- demonstrates that light travels very rapidly in straight lines.

**SC.3.P.10.4** Demonstrate that light can be reflected, refracted, and absorbed.

The student:

- demonstrates that light can be reflected, refracted, and absorbed based on the object.

**SC.3.N.1.1** Raise questions about the natural world, investigate them individually and in teams through free exploration and systematic investigations, and generate appropriate explanations based on those explorations.

The student:

- poses and investigates questions individually and collaboratively through free exploration and systematic investigations.
- draws conclusions based on the results of the explorations.

**SC.3.N.1.2** Compare the observations made by different groups using the same tools and seek reasons to explain the differences across groups.

The student:

- works in a group using the same tools as other groups to gather common data.
- compares groups' data and explains differences.

**SC.3.N.1.3** Keep records as appropriate, such as pictorial, written, or simple charts and graphs, of investigations conducted.

The student:

- records in a science notebook, pictorial or written information or simple charts and graphs of investigations conducted.

### **KEY QUESTION**

How does light energy travel?

What is refraction?

### **TEACHER BACKGROUND INFORMATION**

A swimming pool appears shallower than it really is. A pencil in a glass of water appears bent. These effects are caused by the change in the speed of light and the change in the direction of light when it passes from one material to another. These effects are due to the refraction (bending) of light. Refraction occurs when light enters a medium, like oil or water, at a slant (at any angle other than a right angle). Each time the light enters or leaves one clear substance and travels diagonally into another, the slanted light beam penetrates the next clear substance at a slightly different angle. This gives the illusion that the object is broken or bent. The degree of refraction depends on the type of material. Light slows down when it enters a more viscous



(slower-flowing) medium and speeds up when it leaves the medium. The difference in speed at surfaces also causes light to bend. Refraction may also make objects in liquids appear closer and/or bigger than they really are.

Light is refracted, or bent, as it passes through a prism, a transparent object with flat faces that refracts light. A prism breaks visible, white light, into a spectrum, a light arrangement separated according to wave length, frequency and energy. Color is the way the human eye perceives various wavelengths of light. If the wavelengths are in the visible portion of the family of wavelengths and all the same kind, a color of the spectrum is seen: red, orange, yellow, green, blue, indigo, or violet (ROY G BIV). A mixture of visible light wavelengths produces other colors such as brown, purple, olive green, etc.

## **MATERIALS**

### **Per group**

flashlight  
shoebox with ball (see Teaching Tips)  
prism (see Teaching Tips)  
1 Styrofoam cup  
1 pencil or straw  
water  
scissors  
1 coin  
small amount of vegetable oil  
1 clear plastic cup

### **Teacher/Class**

ball  
duct tape

## **SAFETY**

Always follow OCPS science safety guidelines.

## **TEACHING TIP**

- Use a real shoe box made out of cardboard and not the clear plastic shoe boxes.
- Prepare the shoe box by cutting a very small hole in it so students can look through. The hole should be small enough that when the student looks through, there is no light shining in the box. Place the ball or another object inside the box and seal it. You may want to tape the shoe box up with duct tape to ensure limited light gets in.
- The prisms that are used should be colorless and transparent, have flat sides, and no sharp edges.

## **ENGAGE**

1. Distribute the boxes with the ball (or other object, see Teaching Tips) inside. Show students a ball similar to the one in the box.
2. Ask: *What do you see?*
3. Tell students that the same type of ball is in the box. Ask them to take turns looking in the box to make observations.
4. Ask: *What did you see?*
5. Ask: *What is different about the ball I am holding and the ball in the box?* (the presence of light)
6. Ask: *How does light affect our ability to see objects?* (the reflection of the light off of objects causes us to be able to see them)



7. Ask: *What types of objects reflect light?* (through discussion, help them understand that all objects reflect light)
8. Tell students that light can be absorbed, reflected, and refracted.
9. Ask: *Who can tell me what it means when I say "light can be absorbed by objects"?* (the object takes in the light- remind students of the hand warmers activity)
10. Ask: *Who can tell me what it means when I say "light can be reflected off objects"?* (the light bounces off- remind students of the mirror activity)
11. Ask: *Who can tell me what it means when I say "light can be refracted when it comes in contact with objects"?* (listen to answers but remember that they will be doing exploration of refraction in this activity)

### **EXPLORE Part 1**

1. Give each groups of students the aluminum foil, prism, flashlight, and laser.
2. Tell them that you want them to explore reflection, refraction, and absorption of light.
3. Remind them that reflection is when the light bounces off of the object in a fairly straight light.
4. Tell them that refraction is when light bounces off or passes through but is broken up when it does it- you can connect this to the word "fraction" which is a part of a number and the prefix "re" which means "again". Therefore, the word refraction is to break up again. The light will bounce off and/or go through but the beam will be broken again and again.
5. As students explore, circulate and check for misconceptions. You may want to help them understand that smoothing the aluminum foil and crinkling it will cause two different reactions when the light is shined on the foil.

### **EXPLAIN Part 1**

1. Ask student groups to share their results.
2. Ask: *Did all groups have the same observations? Why or why not?*
3. Ask: *In what situations did you see the light being reflected?*
4. Tell students that reflection happens when light hits an object and bounces off.
5. Ask: *In what situations did you see light being refracted?*
6. Tell students that refraction is when light is bent.

### **EXPLORE Part 2**

1. Remind students that it was decided that all objects reflect light.
2. Ask: *If I look at something in the water, am I seeing any light reflection? (yes)*
3. Distribute a Styrofoam cup and a coin to each pair of students. Tell students to place the cup with the coin in it on a flat surface.
4. Have students look at the coin and then slowly move the cup away until the coin is beyond their line of vision.
5. Leaving the cup in place, one partner should begin to slowly pour water into it, until the student who is observing can see the coin once again. (Both students should try this.)
6. Ask: *When were you able to see the coin again?* (when the water rose to a certain level in the cup)
7. Students should remove the coin and pour the water into the clear plastic cup. Have them add a small amount of oil to the cup of water. Have students observe the layers of water and oil and discuss the layer of air that is on top of the oil. Discuss how the three layers are different from each other.



8. Ask: *Do you think light will travel through all three layers in the same way?*
9. Have students place a straw or pencil into the water and oil so that it is resting in a diagonal position. Encourage them to share their observations. (The straw will look as though it has been broken. This is called refraction, the bending of light.)

### **EXPLAIN Part 2**

1. Discuss students' observations.
2. Explain that light is refracted, or bent, as it passes through a prism. A prism breaks visible, white light, into a spectrum, a light arrangement separated according to wave length, frequency and energy. Color is the way the human eye perceives various wavelengths of light. If the wavelengths are in the visible portion of the family of wavelengths and all the same kind, a color of the spectrum is seen: red, orange, yellow, green, blue, indigo, or violet. When light passes through a prism, each wavelength, or color, is bent at a different angle. This is because the color of light is an indication of its energy; blue light is more powerful than red light, so it bends more than red light. Green light, in the middle of the spectrum, refracts at a greater angle than red light, but at a lesser angle than blue light.

### **EXTEND AND APPLY**

Discuss rainbows.

1. *Where have you seen rainbows?*
2. *What may have caused the rainbows to appear?* (When conditions are right, water in the air, such as raindrops, can act as prisms and refract the sunlight as it passes through, causing the light to separate into the spectrum of colors.)
3. Bend white light by shining a light onto a mirror submerged in water. Tilt the mirror so that reflected light strikes a white surface. *What do you see on the white surface?*

### **ASSESSMENT**

In their science notebooks, have students draw examples of light being absorbed, reflected, and refracted.