**Lesson 1: Sources of Light**

**Big Ideas of the Lesson**

* A light source is an object that makes its own light.
* Some objects only reflect light and are not considered light sources.
* Light sources create a shadow when something an object is held in front of it.

**Abstract**

In this lesson students identify various light sources. Using the sun, flashlights, light bulbs, and glow sticks, students observe the properties of light including its ability to create shadows.

**Grade Level Context Expectation(s)**

Students will:

* identify light as a form of energy (P.EN.03.11).
* demonstrate that light travels in a straight path and that shadows are made by placing an object in a path of light (P.EN.03.21).
* explain how we need light to see objects; light from a source reflects off objects and enters our eyes (P.PM.03.52).
* describe how people have contributed to science throughout history and across cultures (S.RS.03.19).

**Key Concept(s)**

light source

shadow

**Instructional Resources**

## Equipment/Manipulative

Baggies (1 per group)

Candle

Construction paper

Flashlight

Foil

Glow stick

Glue

Lamp

Markers

Mirror

Pictures of the sun and other lighted objects (light sources and objects that reflect light)

Poster board

## Student Resource

Bailey, Gerry. *Light and Color: Discover Science Through Facts and Fun.* Strongsville, OH: Gareth Stevens Publishing, 2008.

Gardner, Robert. *Experiments with Light and Mirrors.* Berkeley Heights, NJ: Enslow Publishers, 2006.

Hewitt, Sally. *Amazing Light.* New York: Crabtree Publishing, 2008.

Keteyian, Linda, and Juliana Texley. *Supplemental Materials (SC03020101.doc).* Teacher-made material. Waterford, MI: Oakland Schools, 2009.

Lauw, Darlene. *Light.* New York: Crabtree Publishing, 2002.

Lynette, Rachel. *Experiments with Light.* Portsmouth, NH: Heinemann, 2008.

Rosinsky. *Light: Shadows, Mirrors, and Rainbows.* Mankato, MN: Picture Window Books, 2004.

Royston, Angela. *Color.* Chicago: Heinemann, 2002.

---. *Light and Dark.* Chicago: Heinemann, 2002.

Taylor, Barbara. *Light, Color, and Art Activities.* New York: Crabtree Publishing, 2002.

##### Teacher Resource

Alexander, Sally Hobart. *Mom Can’t See Me*. New York: Macmillan, 1990.

Gertz, Susan E., Dwight J. Portman, and Mickey Sarquis. *Teaching Physical Science through Children’s Literature.* New York: Learning Triangle Press, 1996.

Henderson, Kathy. *In the Middle of the Night*. New York: Macmillan, 1992.

Keteyian, Linda, and Juliana Texley. *Grade 3 Unit 2 Teacher Background (SC030200TB.doc).* Teacher-made material. Waterford, MI: Oakland Schools, 2009.

Nelson, Robin. *A Sunny Day.* Minneapolis, MN: Lerner Publications, 2001.

Sarquis, Mickey. *Exploring Matter with Toys: Using and Understanding the Senses*. New York: McGraw-Hill, 1997.

Watson, N. Cameron. *The Little Pigs’ Puppet Book*. Boston: Little, Brown, 1990.

# Sequence of Activities

Advance Preparation: Prior to this investigation check all flashlights and batteries to make certain they are in working condition. Go through old magazines and cut out pictures of things that produce or reflect light. Prepare baggies containing pictures for each group.

1. Capture students’ imagination with a literature reading or an oral story. (*A Sunny Day* or other reference in *Teaching Physical Science through Children’s Literature* or any story where a child finds him/herself in the dark and then finds a light will set the mood.)
2. Have students list everything they know about light on the board. Accept all ideas as tentative at this point.
3. Ask them what kinds of things produce light. List the things they consider to be light sources. Explain that a light source produces its own light. Things that only reflect light are not considered light sources.
4. Have the flashlight, lamp, picture of the Sun, foil, candle, glow stick, and mirror laid out so students can see them easily. Ask them which of these materials should be considered light sources. Ask students to put their ideas on the Student Pages. Then draw a chart on the board to help them summarize their ideas.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Material | Produces its own light | Reflects light from another source | Creates a shadow when an object is held in front of it | Light Source(Yes or No) |
| Flashlight | Yes | No | Yes | Yes |
| Mirror | No | Yes | No | No |
| Candle | Yes | No | Yes | Yes |
| Foil | No | Yes | No | No |
| Glow stick | Yes | No | Yes | Yes |
| Sun | Yes | No | Yes | Yes |
| Lamp | Yes | No | Yes | Yes |

1. Divide the class into groups of four or five. Pass out poster board, markers, glue, and baggies for each group. Explain that students are going to create a picture chart that shows light sources. Have students make a T-chart on their construction paper. Tell them to glue the pictures found in their baggie onto the correct side of the T-chart.
2. Allow students to present their charts to the class.

7. Read the selection on Thomas Edison in the Student Pages together or independently.

# Assessment

Students should be able to critique other students’ T-charts.

# Application Beyond School

Students can continue to explore various light sources by looking at how the sky is filled with “stars” but some of the lights we see are actually planets. We know the difference because a star produces its own light while a planet reflects light from the sun. (Planets do not blink.)

# Connections

## English Language Arts

When learning about light and shadows students can use informational text to further their knowledge.

**Lesson 1: Sources of Light**

### **Complete the Chart**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Material | **Produces its own light** | **Reflects light from another source** | **Makes a shadow when you hold something in front of it** | **Light Source****(yes or no)** |
| Flashlight |  |  |  |  |
| Sun |  |  |  |  |
| Foil |  |  |  |  |
| Candle |  |  |  |  |
| Mirror |  |  |  |  |

**Lighting the Night**

 Did your lights ever go out in a storm? Was your house very dark? You might have used a candle or a lantern. Today we have light whenever we need it.

 Can you imagine a time when there were no electric lights? Only 100 years ago most houses burned oil lamps at night. They were smoky and expensive. So most people got up and went to bed with the Sun. But then things changed.

 Thomas Edison was born in Ohio in 1847. He grew up near Port Huron, Michigan. There he had many jobs. For a while he worked on a train. But Edison was always experimenting. He mixed chemicals and caused a fire on the train. That was the end of his job there.



 Edison had several more jobs. He ran a telegraph, sending messages along wires in code. He improved the telegraph, and at age 21 had an invention that actually made money.

 For the rest of his life Edison worked on inventions. He built the phonograph, a dictating machine, and an electric pen. But his most famous invention was the light bulb.

 Edison’s light bulb made it easy for people to light their homes. They could work in the evenings. They could read without hurting their eyes. Edison’s work changed our cities and our world.

 Edison said his work was more “perspiration” than “inspiration.” He meant you have to work hard to achieve. Read more about Edison at <http://www.thomasedison.com/>.

**Lesson 2: Let’s Get It Straight**

**Big Ideas of the Lesson**

* Light travels in a straight path.
* Light is blocked when an object is put in front of it. This creates a shadow.

**Abstract**

In this lesson students conclude that light travels in a straight line. They relate this property to the shadows created by light when it is blocked by an object.

**Grade Level Context Expectation(s)**

Students will:

* identify light as a form of energy (P.EN.03.11).
* demonstrate that light travels in a straight path and that shadows are made by placing an object in a path of light (P.EN.03.21).
* explain how we need light to see objects: light from a source reflects off objects and enters our eyes (P.PM.03.52).

**Key Concept(s)**

light source

shadow

**Instructional Resources**

## Equipment/Manipulative

Baggies (1 per group)

Chalk dust (from classroom erasers)

Clay (“Golf ball” sized glob per group)

Computer access (optional)

Flashlight (1 per group)

Hole puncher

Markers

Meter stick or yard stick (1 per group)

Note cards (3 x 5, 4 per group)

## Student Resource

Gardner, Robert. *Experiments with Light and Mirrors.* Berkeley Heights, NJ: Enslow Publishers, 2006.

Hewitt, Sally. *Amazing Light.*  New York: Crabtree Publishing, 2008.

Keteyian, Linda, and Juliana Texley. *Supplemental Materials (SC03020201.doc).* Teacher-made material. Waterford, MI: Oakland Schools, 2009.

Lauw, Darlene. *Light.* New York: Crabtree Publishing, 2002.

Lynette, Rachel. *Experiments with Light.* Portsmouth, NH: Heinemann, 2008.

Royston, Angela. *Color.* Chicago: Heinemann, 2002.

---. *Light and Dark.* Chicago: Heinemann, 2002.

##### Teacher Resource

Gertz, Susan E., Dwight J. Portman, and Mickey Sarquis. *Teaching Physical Science through Children’s Literature.* New York: Learning Triangle Press, 1996.

Keteyian, Linda, and Juliana Texley. *Grade 3 Unit 2 Teacher Background (SC030200TB.doc).* Teacher-made material. Waterford, MI: Oakland Schools, 2009.

Sarquis, Mickey. *Exploring Matter with Toys: Using and Understanding the Senses*. New York: McGraw-Hill, 1997.

# Sequence of Activities

Advance Preparation: Prior to this investigation check all flashlights and batteries to make certain they are in working condition. Because students have some difficulty punching holes it is a good idea to punch the holes in the flashcards in advance. Hold three cards together and punch the holes through them all at once so the holes line up. Place these three cards along with the fourth card (no holes in that one) and some clay into a baggie. Make one baggie per group.

1. Have students review what they know about light. Place their answers on the board. [They will probably come up with things like: Lets us see; Makes things hot; Comes from the Sun, etc.] Ask them: “How does light get from one place to another? Does it travel in one direction or can it go around corners?” [Light always travels in a straight line. At this point, accept all ideas.]
2. Using two chalk-covered erasers (with lots of chalk dust!) have a student hold a flashlight and bang the erasers in the light. (This works better with the lights off.) Observe the direction the light follows. Ask students to draw the path of the light on their Student Pages, and describe in words how light travels.
3. Explain that the class is going to investigate how light travels.
4. Divide the class into groups of four or five. Pass out the baggies, flashcards, clay, and flashlights. Have students use a piece of the clay as a holder for each of the flashcards. To do this exercise students will need about a meter of flat surface. If you have slanted desks instead of tables, you may wish to move the desks aside and use the floor or do this exercise on library tables. Have students place the card with no hole at the end of the desk to act as a screen. Line the other three cards up using the meter stick as a guide, so that the holes line up. Shine the flashlight at one end of the line so light passes through the holes and creates a dot on the screen. Have students draw a small mark on the last card to show the light. Ask students why the dot appears on the screen. [Light is traveling through the holes.]
5. Have students move one of the cards. Ask: “What does this do to the dot? Where did it go?” Students should conclude that the cards are now blocking the light. Ask: “What does this tell us about how light travels?” Students should notice at this point that light is traveling in a straight line. “Are there any shadows on the cards? What is causing them?” Students should conclude that the light from the flashlight is being blocked due to the card being moved.
6. Ask: “How far can light travel?” If students have computer access, ask them to research the answeronline. [Light can travel virtually forever, but from a student standpoint the longest distance they might envision is from the Sun to the Earth or from a star to the Earth.] Give the class time to complete their Student Pages.

# Assessment

Use the completed Student Pages as a formal assessment.

# Application Beyond School

Students can continue to explore how light travels through the exploration of outside illumination. Due to the fact that light travels in a straight line there is a need for many streetlights on each street. Parking lot lights must be strategically placed to cover all areas. (Some streetlights are reflected down so that city-dwellers can still see the stars at night.)

# Connections

## Mathematics

When learning about light students can consider angles of reflection.

**Lesson 2: Let’s Get It Straight**

A dusty experiment! Show how light looks in chalk dust:

Line up your flashlight to shine through holes in note cards, following your teacher’s directions. What happened when you shined the flashlight through the lined up holes?

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Draw a picture of what you saw.

What happened when you moved one of the cards?

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What does this tell you about how light travels?

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**Lesson 3: Me and My Shadow**

**Big Ideas of the Lesson**

* A shadow is the darkness that shows when light is blocked.
* A shadow takes the outside shape of the object that is blocking the light.
* Shadows are longer in the early morning and late at night because the light of the sun comes at an angle.
* Shadows are shorter at noon because the sun is overhead.

**Abstract**

In this lesson students explore how shadows are made. By observing the shape of the shadows made by various objects, students conclude that shadows are created when light is blocked by an object.

**Grade Level Context Expectation(s)**

Students will:

* identify light as a form of energy (P.EN.03.11).
* demonstrate that light travels in a straight path and that shadows are made by placing an object in a path of light (P.EN.03.21).
* explain how we need light to see objects: light from a source reflects off objects and enters our eyes (P.PM.03.52).

**Key Concept(s)**

light source

shadow

**Instructional Resources**

## Equipment/Manipulative

Butcher paper or other projecting surface

Flashlights (1 per group)

Pencils (soft, drawing, 1 per group)

Sidewalk chalk

Variety of materials for making shadows: pencils, crayons, toys, plants, etc.

## Student Resource

Hewitt, Sally. *Amazing Light.* New York: Crabtree Publishing, 2008.

Keteyian, Linda, and Juliana Texley. *Supplemental Materials (SC03020301.doc).* Teacher-made material. Waterford, MI: Oakland Schools, 2009.

Rosinsky. *Light: Shadows, Mirrors, and Rainbows.* Mankato, MN: Picture Window Books, 2004.

Royston, Angela. *Color.* Chicago: Heinemann, 2002.

---. *Light and Dark.* Chicago: Heinemann, 2002.

##### Teacher Resource

Gertz, Susan E., Dwight J. Portman, and Mickey Sarquis. *Teaching Physical Science through Children’s Literature.* New York: Learning Triangle Press, 1996.

Keteyian, Linda, and Juliana Texley. *Grade 3 Unit 2 Teacher Background (SC030200TB.doc).* Teacher-made material. Waterford, MI: Oakland Schools, 2009.

# Sequence of Activities

Advance Preparation: Prior to this investigation check all flashlights and batteries to make certain they are in working condition.

1. Read the story on the Student Pages aloud. Make the atmosphere as scary as possible. Ask students to answer the questions. Discuss student answers as a class.
2. Tell the class: “Today we are going to explore how shadows are made.” Divide the class into groups of four or five. Each group should choose four items from the classroom (books, bookbags, toys, etc.) to use to make shadows. On the Student Page, they should predict what they think each item’s shadows will look like.
3. Pass out one sheet of butcher paper to each group of students and have them tape the paper onto a section of the classroom wall. Place a desk in front of the paper to serve as a place to hold each item.
4. Darken the room as much as possible. Each group should place the first item onto the desk and shine the flashlight on the item. One student from each group should draw the shadow it makes on the butcher paper.
5. Repeat Step 4 with each of the remaining items, with a new student drawing each time. There should be four shadow pictures on the butcher paper at the end of Step 5.
6. Relight the classroom. As each group presents its shadow drawings, other students should guess what they are. Ask students to complete the task on the Student Page, “Me and My Shadow.”
7. Ask students: “Where else have you seen shadows? How do shadows change during the day?” [They are longer in early morning and late at night because the light of the sun comes at an angle.]
8. Just before recess, take students outside to trace their shadows on the sidewalk or asphalt for other students in the school to share.

# Assessment

As an assessment, review student answers to “Here’s how to make a shadow…” to determine if they understand that light travels in a straight line and is blocked by an object to make a shadow.

# Application Beyond School

Students can continue to explore shadows by looking for various shadows in the outside environment.

# Connections

Mathematics

When learning about shadows students can consider angles of reflection.

**Lesson 3: Me and My Shadow**

The Scary Dream

 It must have been the morning heat. Jeremy was supposed to be collecting leaves for school. He only had an hour before lunch. But the grass was so soft. The wind was gentle and the sun was warm. Jeremy thought he would just lie down for a little while by a large tree.

 Jeremy fell fast asleep. Then he had a scary dream. Leaves were falling all around him. The wind was howling. A large stranger was watching him from behind a tree. He couldn’t see the stranger, but he could see a shadow. The stranger was taller than anyone Jeremy had ever seen!

 In his dream, Jeremy tried to run. He slipped on the grass and fell down. There were too many leaves. Then suddenly Jeremy woke up. He looked around. There were leaves all around him. On the grass there was a shadow. It was very long—longer than any person could be. Jeremy was confused. Was he still dreaming? Should he run? Why was the shadow so long?

Then the wind got stronger. The sky got dark. Then Jeremy heard a familiar voice. “Oh, there you are. We were looking for you.”

## **Questions**

What clue could tell you how long Jeremy slept?

Why did the shadows disappear?

Choose four objects. Draw the shadow you think each object will make.

|  |  |
| --- | --- |
| Object | Shadow |
|  |  |
|  |  |
|  |  |

Here is how to make a shadow:

 ­­­­­­­­­­­­­­­­­­­­­­­­­­­­

**Lesson 4: What’s the Angle?**

**Big Ideas of the Lesson**

* A sundial uses shadows from the sun to show the time of day.
* Shadows are on the opposite side of an object from the sun.

**Abstract**

In this lesson students observe the relationship between the angle of the Sun and the shadows it makes. By observing the position of the Sun at different times during the day, and correlating it with the size and position of the shadow it makes, students conclude that shadows are created when an object blocks light. They also make a sundial.

**Grade Level Context Expectation(s)**

Students will:

* identify light as a form of energy (P.EN.03.11).
* demonstrate that light travels in a straight path and that shadows are made by placing an object in a path of light (P.EN.03.21).
* explain how we need light to see objects: light from a source reflects off objects and enters our eyes (P.PM.03.52).

**Key Concept(s)**

light source

shadow

**Instructional Resources**

## Equipment/Manipulative

Chalk (sidewalk, 5 colors per group)

Clay (plasticene, about a “golfball” size mass per group)

Compass (or map, to determine the direction “North” on your playground)

Overhead projector

Styrofoam (A triangular piece about 15 cm on each side works best, for each group)

Sundial

## Student Resource

Keteyian, Linda, and Juliana Texley. *Supplemental Materials (SC03020401.doc).* Teacher-made material. Waterford, MI: Oakland Schools, 2009.

Lynette, Rachel. *Experiments with Light.* Portsmouth, NH: Heinemann, 2008.

Royston, Angela. *Color.* Chicago: Heinemann, 2002.

---. *Light and Dark*. Chicago: Heinemann, 2002.

##### Teacher Resource

Keteyian, Linda, and Juliana Texley. *Grade 3 Unit 2 Teacher Background (SC030200TB.doc).* Teacher-made material. Waterford, MI: Oakland Schools, 2009.

# Sequence of Activities

Advance Preparation: This activity will take most of the day. It can be done in between other assignments. Plan your other lessons around outside trips at five different times. This lesson requires a sunny day to work. Check the weather report and be prepared to be flexible. You will need a concrete section of the schoolyard for the day. Make arrangements with the custodian to have a section roped off if possible. Inform the principal and other staff members, who may want to come out and observe.

Safety Precautions: *Never* look directly at the Sun.

1. Begin the lesson by making some hand shadows. (Everyone can make a rabbit.) This works well if you use the light from an overhead projector, but you can also use another source of light such as a desk lamp with an adjustable stem. Ask students to make some shadows. (They may be very creative.)
2. Remind students that light comes from the Sun, and travels in a straight line. Ask: “Where is the Sun now?” [If it is morning, it will be in the east or southeast depending upon the time of year.] Say: “It is never safe to look at the Sun. So how could we tell where the Sun is?” [Look at your shadow.] Remind students of the story “The Scary Dream” in SC030203 Student Pages.
3. Show students a sundial and explain how it works. Then tell students that today they are going to create their own sundials in the schoolyard. Explain that this activity will require using the schoolyard at five different times during the school day. Set up some rules for moving from one activity to another. This will make the transitions much easier. Take the students outside. Have them make note of the time on their way out. They should take their Student Pages and a pencil with them. You will also need clay and a piece of Styrofoam for each group.
4. Establish a location on concrete for each group to work. With sidewalk chalk, draw a compass rose for the group showing the cardinal points (North, East, South, and West). Tell students to set up the *gnomon* of their sundial by setting their Styrofoam straight up on the sidewalk using clay as “glue.” (Do not use the hypotenuse but one of the sides.)
5. Have students record the direction of the shadow from the gnomon and write the time of day above it on the sidewalk. Then they should record the same information on the Student Pages.
6. Return to your sundials four to five times in the same day. Each time, record the time and the direction of the shadow.
7. At the end of the day, review the results in the classroom or outside by having students physically point to the position of the sun. Say: “If the shadow was here, where was the Sun?” [Students should point, but *never* look directly at the Sun.] Review questions on Student Pages.

 Question #1: “How can we tell where the Sun is by a shadow?” [Light travels in a straight line.]

 Question #2: “Would a sundial work the same way every day of the year?” [No, the position of the Sun changes with the seasons. In the winter in Michigan, the Sun is far south and the shadows would only be pointing north, northeast, or northwest. **Note:**  This is a very difficult concept for third graders.]

# Assessment

Use the completed data sheet as a formal assessment. Have students draw the shadow made by a sundial at noon during the summer.

# Application Beyond School

Students can continue to explore shadows by investigating how sundials were used. The most ancient of clocks was a sundial that used shadows to tell time. Today, people use their knowledge of shadows to decide where to place their trees to provide the best shade at the hottest time of day.

# Connections

## Social Studies

While learning about shadows, students can review the main compass directions on the schoolyard. As an extension, they may draw a map of the schoolyard correctly placing the school.

**Lesson 4: What’s The Angle?**

How do you make a shadow?

Record the shadows made by the *gnomon* of your sundial here. Put a time near each shadow to show when it was made.

 North

**Lesson 5: Can You Believe Your Eyes?**

**Big Ideas of the Lesson**

* An optical illusion is a trick to the eye.
* A penny appears to move when it is in water.
* A pencil appears to bend when it is in water.
* Light bends when it passes from one substance to another.

**Abstract**

In this lesson students observe the bending of light. They relate the bending of light to changes in the way we see the object. Students learn that rainbows and prisms also bend light.

**Grade Level Context Expectation(s)**

Students will:

* identify light as a form of energy (P.EN.03.11).
* explain how we need light to see objects: light from a source reflects off objects and enters our eyes (P.PM.03.52).
* observe what happens to light when it travels from air to water (a straw half in the water and half in the air looks bent) (P.EN.03.22).

**Key Concept(s)**

light source

**Instructional Resources**

## Equipment/Manipulative

Aquarium (optional, can be replaced with a large glass bowl)

Clear plastic cups

Pencil

Penny

Water

## Student Resource

*Amazing Optical Illusions.*  3 March 2009 <<http://www.optillusions.com/>>.

Bailey, Gerry. *Light and Color: Discover Science Through Facts and Fun.* Strongsville, OH: Gareth Stevens Publishing, 2008.

Hewitt, Sally. *Amazing Light.* New York: Crabtree Publishing, 2008.

*The Joy of Visual Perception.* 3 March 2009 <<http://www.yorku.ca/eye/thejoy.htm>>.

Keteyian, Linda, and Juliana Texley. *Supplemental Materials (SC03020501.doc).* Teacher-made material. Waterford, MI: Oakland Schools, 2009.

*Optical Illusions.*  3 March 2009 <<http://www.eyetricks.com/>>.

Rosinsky. *Light: Shadows, Mirrors, and Rainbows.* Mankato, MN: Picture Window Books, 2004.

Royston, Angela. *Color.* Chicago: Heinemann, 2002.

---. *Light and Dark*. Chicago: Heinemann, 2002.

Taylor, Barbara. *Light, Color, and Art Activities.*  New York: Crabtree Publishing, 2002.

##### Teacher Resource

Dispezio, Michael. *Optical Illusion Magic: Visual Tricks and Amusements.* New York: Sterling, 2000.

Keteyian, Linda, and Juliana Texley. *Grade 3 Unit 2 Teacher Background (SC030200TB.doc).* Teacher-made material. Waterford, MI: Oakland Schools, 2009.

# Sequence of Activities

Advance Preparation: As with any activity, try this out first to get an idea of what you are looking for.

1. Begin by showing students an optical illusion. You can allow students to explore the web sources if you have computer time, or use the book *Optical Illusion Magic: Visual Tricks and Amusements*.
2. Explain that you are going to investigate what happens to light when it passes through water.
3. Divide the class into groups of four of five. Pass out cups filled 2/3 full of water and a penny.
4. Have students place the penny into the water and look directly down into the cup. Ask: “What do you see?”
5. Now have students slowly move down the cup with their line of vision. Ask where the penny is at various intervals. As the students’ line of vision changes, the penny’s position will appear to change as well. Have them stop moving when the penny disappears from view. Ask: “What caused the penny to disappear?” Have students record their ideas on Student Pages.
6. Have students remove the penny from the cup. Place the pencil in the center of the cup holding it so it stands upright. Now have students hold the cup so their line of vision is even with the water level. Ask: “What do you notice about the pencil?” [It should appear to be crooked or bent.] “Why does it look this way? What does this tell you about what happens to light when it passes through water?”
7. If you have an aquarium in the room, have students experiment catching a fish with a soft net (or a leaf that has been in the aquarium for awhile). Compare the visual images.
8. Explain to students that light is bent (refracted) when it passes from one substance to another. (You can use the analogy of running toward the water at the beach. You intend to run straight in, but when you hit the water you slow down and the waves make you run at an angle.)

# Assessment

Given another item students should be able to predict the appearance of the object when placed in a jar of water.

# Application Beyond School

Students can continue their exploration of light and its affects on water with their family by exploring how various items “change” when placed in the bathtub or swimming pool.

# Connections

Mathematics

When learning about light and its ability to bend, students can consider angles of reflection.

**Lesson 5: Can You Believe Your Eyes?**

Draw a picture of the cup and penny in each box.

|  |  |
| --- | --- |
| **View** | **Position of penny** |
| Directly overhead |  |
| Water level |  |
| From the bottom |  |

Draw a Pencil in a Cup

What happens to light when it passes through water?

What did you see happen that makes you think so?

**Lesson 6: Scattering Light**

**Big Ideas of the Lesson**

* Light passes through glass and crystals and makes a spectrum.
* A transparent material lets light pass through.
* A translucent material lets some of the light pass through and some of the light reflect back.
* An opaque material blocks all light.

**Abstract**

In this lesson students explore various materials to see how light passes through them. They identify materials that reflect or bend light and offer evidence to support their conclusions.

**Grade Level Context Expectation(s)**

Students will:

* identify light as a form of energy (P.EN.03.11).
* explain how we need light to see objects: light from a source reflects off objects and enters our eyes (P.PM.03.52).

**Key Concept(s)**

light source

opaque

reflection

translucent

transparent

**Instructional Resources**

## Equipment/Manipulative

Clay (potters, a “pea” sized piece per group)

Clear soda (e.g., Sprite™ – one cup per group)

Coca cola™ (one cup per group)

Coffee stirrers

Crystals (from lamps or other sources, for demonstration)

Cups (8 ounce, clear plastic, four per group)

Eyedropper (per group)

Flashlight (per group)

Lenses (from old glasses, for demonstration)

Milk (1/8 pint per student)

Oil (cooking, a dropperful per student)

Water

## Student Resource

Bailey, Gerry. *Light and Color: Discover Science Through Facts and Fun.* Strongsville, OH: Gareth Stevens Publishing, 2008.

Gardner, Robert. *Experiments with Light and Mirrors.* Berkeley Heights, NJ: Enslow Publishers, 2006.

Keteyian, Linda, and Juliana Texley. *Supplemental Materials (SC03020601.doc).* Teacher-made material. Waterford, MI: Oakland Schools, 2009.

Lynette, Rachel. *Experiments with Light.* Portsmouth, NH: Heinemann, 2008.

Rosinsky. *Light: Shadows, Mirrors, and Rainbows.* Mankato, MN: Picture Window Books, 2004.

Royston, Angela. *Color.* Chicago: Heinemann, 2002.

---. *Light and Dark.* Chicago: Heinemann, 2002.

##### Teacher Resource

Keteyian, Linda, and Juliana Texley. *Grade 3 Unit 2 Teacher Background (SC030200TB.doc).* Teacher-made material. Waterford, MI: Oakland Schools, 2009.

# Sequence of Activities

Advance Preparation: Prior to this activity practice with the materials yourself to get a feel for the kinds of colors your students will see. Ask parents for lenses from old glasses and bits of crystal for demonstration. If you have crystal jewelry or a tie pin, wear it to school. Fill one cup per group with Coca cola™ (half way), one cup per group with clear soda (such as Sprite™), and two cups with water.

1. Introduce the behavior of a crystal. Show a piece of jewelry or a piece of crystal from a lamp. Ask students to brainstorm all of the times they have seen “rainbows” or spectra. Include those experiences that have been conducted in class, as well as experiences at home.
2. Make a chart of the students’ answers on the board. Include the material through which the light passed. Here is an example:

|  |  |
| --- | --- |
| Where you saw the spectrum | What caused the spectrum |
| Classroom counter | Fishtank |
| Grandmother’s wall | Crystal lamp |
| Garage floor | Oil |
| Mom’s end table | Crystal vase |

1. Summarize that light passes through different materials in different ways. Tell students that they are going to test a number of materials together.
2. Ask each group to carefully carry the two cups of soda and two cups of water to their seats. Students should explore how light travels through each of the materials and record their observations on their Student Pages. Distribute flashlights.
3. Students should add a little clay to one cup of water and stir thoroughly. Add a dropper of milk to the other cup of water, and stir thoroughly. Add a dropper of cooking oil to the clear soda, and observe all three.
4. Introduce the terms *transparent, translucent,* and *opaque.*  Clear soda and water are normally transparent. Milk and water with clay are translucent. Some of the particles of clay will bounce (reflect) light, as will the bubbles in the soda. Oil will refract (bend light) like a prism.
5. Ask students to divide the materials into three categories on the board: Materials that let light pass through (transparent), materials that let some of the light pass and reflect some back (translucent), and materials that block all light (opaque).
6. Ask students to imagine they were designing a room in which absolutely no light can enter. They must choose opaque materials. What materials would they choose? Discuss other times (dark rooms for developing film, projection rooms) when rooms must have opaque covers.

# Assessment

Ask students to design a lightproof chamber. Then ask them to put transparent windows in the room.

# Application Beyond School

Students can identify transparent, translucent, and opaque objects in their school, neighborhood, and community.

# Connections

## Social Studies

While studying about light, students can investigate the structure of medieval castles and pioneer homes, and what they used for windows.

**Lesson 6: Scattering Light**

How did light travel through the material?

|  |  |
| --- | --- |
| Clear Water | Cola |
| Clear Soda | Water with Clay |
| Water with Milk | Soda with Oil |

What materials are transparent?

What materials are translucent?

What materials are opaque? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Lesson 7: Mirror, Mirror**

**Big Ideas of the Lesson**

* The proportion of the body that can be seen in a mirror does not change with distance.
* Light reflects away from a mirror at the same angle that it hits the mirror.
* The angle of incidence is equal to the angle of reflection.
* Two mirrors can create multiple reflections.
* The image in the mirror is backwards.

**Abstract**

In this lesson students explore reflection in mirrors. They establish the relationship between the angle at which light hits the mirror and the angle of reflection, and reaffirm that light travels in a straight line.

**Grade Level Context Expectation(s)**

Students will:

* identify light as a form of energy (P.EN.03.11).
* demonstrate that light travels in a straight path and that shadows are made by placing an object in a path of light (P.EN.03.21).
* explain how we need light to see objects: light from a source reflects off objects and enters our eyes (P.PM.03.52).

**Key Concept(s)**

light source

opaque

reflection

translucent

transparent

**Instructional Resources**

## Equipment/Manipulative

Chalk dust on erasers

Flashlight (1 per group)

Hand mirror (with handle, one per group)

Meter stick (one per group)

## Student Resource

Gardner, Robert. *Experiments with Light and Mirrors.* Berkeley Heights, NJ: Enslow Publishers, 2006.

Hewitt, Sally. *Amazing Light.* New York: Crabtree Publishing, 2008.

Keteyian, Linda, and Juliana Texley. *Supplemental Materials (SC03020701.doc).* Teacher-made material. Waterford, MI: Oakland Schools, 2009.

Rosinsky. *Light: Shadows, Mirrors, and Rainbows.* Mankato, MN: Picture Window Books, 2004.

Royston, Angela. *Color.* Chicago: Heinemann, 2002.

---. *Light and Dark.* Chicago: Heinemann, 2002.

*Through the Looking Glass.*  Ed. Lewis Carroll. 1991. Gutenberg Project. 4 March 2009 <<http://www.cs.indiana.edu/metastuff/looking/lookingdir.html>>.

##### Teacher Resource

Keteyian, Linda, and Juliana Texley. *Grade 3 Unit 2 Teacher Background (SC030200TB.doc).* Teacher-made material. Waterford, MI: Oakland Schools, 2009.

# Sequence of Activities

Advance Preparation: Ask parents to loan hand mirrors (the sort that is used in hairdressing) for the day. You may be able to borrow several from a hairdresser.

1. Begin by reading aloud or having children read online a little of the classic book, *Through the Looking Glass* by Lewis Carroll.

Let's pretend there's a way of getting through into it, somehow, Kitty. Let's pretend the glass has got all soft like gauze, so that we can get through. Why, it's turning into a sort of mist now, I declare! It'll be easy enough to get through -- ' She was up on the chimney-piece while she said this, though she hardly knew how she had got there. And certainly the glass WAS beginning to melt away, just like a bright silvery mist.

In another moment Alice was through the glass, and had jumped lightly down into the Looking-glass room. The very first thing she did was to look whether there was a fire in the fireplace, and she was quite pleased to find that there was a real one, blazing away as brightly as the one she had left behind. `So I shall be as warm here as I was in the old room,' thought Alice: `warmer, in fact, because there'll be no one here to scold me away from the fire. Oh, what fun it'll be, when they see me through the glass in here, and can't get at me!'

Ask students to imagine what it would be like to be inside a mirror. “Does light go through the mirror?” [No.] “Can you see through a mirror from behind?” [No.] Tell students they are going to answer four questions about mirrors through an investigation.

1. Introduce the first question: “Does the amount of you that can be seen in a mirror change as you move back and forth?” Have students hold mirrors for one another. When they are about 1m from the mirror, they should carefully record how much of their bodies can be seen in the mirror. Then they should move 2m from the mirror and record the part of their body that can be seen. Ask students to describe how the light travels to the mirror and how it returns to their eyes on their Student Pages. [The proportion of the body that is seen does not change with distance.]
2. Ask students to explore how light travels to and from a mirror. Darken the room as much as possible. Ask students to shine a flashlight into the mirror on an angle, and find out where the reflected spot lands in the classroom. (Do not use laser pointers to do this exercise because they can damage the eyes.)
3. The third question will require groups to cooperate. Ask: “Can a mirror reflect a reflection?” Two students should bring their mirrors about 1m apart and see if they can catch multiple reflections in the mirror.
4. The fourth question requires writing: “Is the image in the mirror frontwards or backwards?” Ask students to write a message on their Student Pages that they can read in a mirror.
5. As a demonstration, help students observe again that the angle at which the light hits the mirror (angle of incidence) is equal to the angle of reflection. Darken your room as much as possible. Stand on a high platform holding your mirror facing down. Ask one student to sit on the floor below you about .5m to your right, and another to stand .5m to your left. The first student should shine a flashlight up toward your mirror at an angle. The second should make chalk dust through which the flashlight beam should show. Mark the point on the floor that the reflected beam hits. Ask students to draw the reflected light on their Student Pages.
6. Check for student understanding with constructivist dialogue: “How do you know that light travels in a straight line?” [They should cite observations.] “Can we bend light?” [Yes, but the paths are still straight lines.]

1. End the lesson with reading more of *Through the Looking Glass* or another literature connection.

# Assessment

Ask students to position a mirror in such a way that a specific spot is illuminated as a performance task.

# Application Beyond School

Students can explore how mirrors and their reflections are used in everyday life, such as in the adjustment of the rear and side-view mirrors on a car.

# Connections

## Mathematics

While learning about mirrors, students can explore how the angle of incidence is equal to the angle of reflection.

**Lesson 7: Mirror, Mirror**

Solve these problems using your mirror.

1. How much of you can you see? Does this change if you move farther away?

 1 meter 2 meters

2. How does light travel to and from a mirror?

3. Can you see a mirror in a mirror?

 4. Write a message you can read in a mirror.

**Lesson 8: Using Light as Art**

**Big Ideas of the Lesson**

* A mobile can be created by groups of students with information learned about light and shadows.

**Abstract**

In this lesson students use their knowledge of light sources, reflection, refraction, and transmission of light to create a mobile.

**Grade Level Context Expectation(s)**

Students will:

* identify light as a form of energy (P.EN.03.11).
* demonstrate that light travels in a straight path and that shadows are made by placing an object in a path of light (P.EN.03.21).
* explain how we need light to see objects: light from a source reflects off objects and enters our eyes (P.PM.03.52).

**Key Concept(s)**

light source

opaque

reflection

translucent

transparent

**Instructional Resources**

## Equipment/Manipulative

Beads and bits of glass from old jewelry

Cardstock

Cellophane

Foil

Glue

Hangers

Hole punch

Nail polish (clear)

Scissors

String

Tape

Wood dowels

## Student Resource

Keteyian, Linda, and Juliana Texley. *Supplemental Materials (SC03020801.doc).* Teacher-made material. Waterford, MI: Oakland Schools, 2009.

Royston, Angela. *Color.* Chicago: Heinemann, 2002.

---. *Light and Dark.* Chicago: Heinemann, 2002.

Taylor, Barbara. *Light, Color, and Art Activities.* New York: Crabtree Publishing, 2002.

##### Teacher Resource

Keteyian, Linda, and Juliana Texley. *Grade 3 Unit 2 Teacher Background (SC030200TB.doc).* Teacher-made material. Waterford, MI: Oakland Schools, 2009.

# Sequence of Activities

Advance Preparation: Ask parents to help collect crystals, translucent beads, smoked glass, pieces from old jewelry, etc. by explaining the project in your school newsletter. Explain to parents the terms “transparent,” “translucent” and “opaque” in your communication so that they can help students search for unique pieces to add to their mobile. Ask your art teacher to help integrate the lesson by posting photos of unique pieces of art that use light creatively. If you think your class has never seen a mobile, you may want to make one in advance to show them the idea or ask the art teacher to have one on display.

1. Challenge students: “In groups we are going to make mobiles. Each mobile must have at least one element that is opaque, one that is transparent, and one that is translucent. You must have one item that reflects and one that bends light like a prism.” A plan for the mobile should be recorded on the Student Pages before each group begins.
2. Help students begin by making an element that both reflects and bends light. They should cover a piece of card stock (no larger than 10cm diameter) with foil. On the foil they should paint designs with clear nail polish and let it dry. Finally, punch a hole at one end of the element and attach a bit of string (10cm works well). Explain: “The light enters the nail polish and bends, then is reflected by the foil.” Allow some time for students to examine the dried elements in sunlight to see if they can catch a spectrum of light in them.
3. Help students make a shadow portrait for a second element. In a semi-darkened room, shine a flashlight past a student’s profile and draw the profile on cardstock. Cut out the shadow portrait for the mobile.
4. Ask groups to design the rest of their mobile. They should agree on the elements, and label them on their Student Pages before they begin construction.
5. Have students explain their designs in class. Create a display of the light design mobiles for guests. You may wish to set up spotlights to feature the reflective and refractive elements.

# Assessment

To demonstrate understanding students should present their mobile.

# Application Beyond School

Students can explore light through the architecture of Frank Lloyd Wright that often featured unique use of glass. Church windows also use transparent, translucent, and opaque panels together.

**Connections**

## Arts

While learning about light students can explore how noted artists, such as Vermeer and Monet, used light to create effects.

**Lesson 8: Using Light as Art**

Draw the design for your mobile. Then label each part “Reflection,” “Transparent,” “Translucent, “Opaque,” or “Prism.”