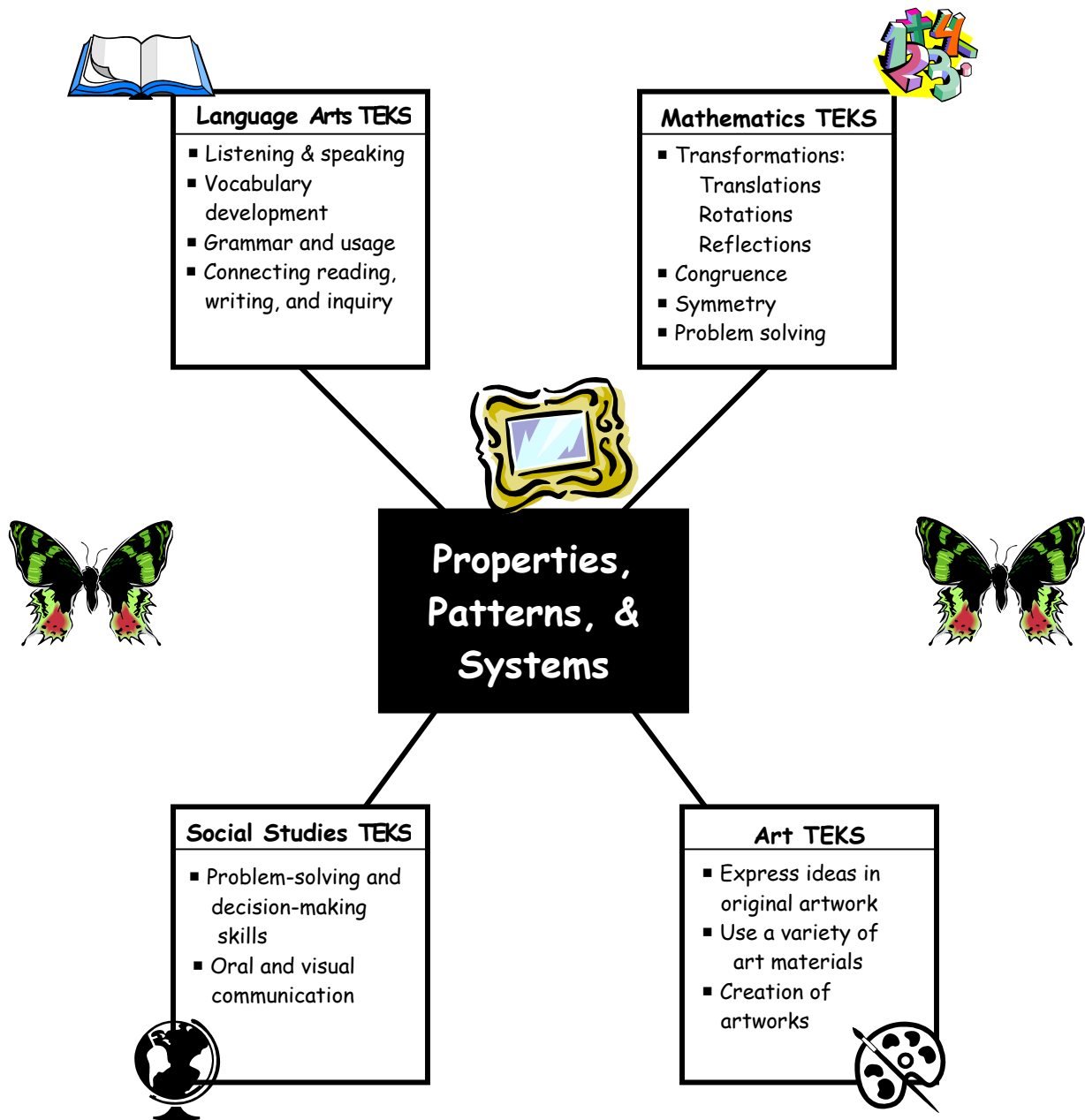


Interdisciplinary Connections

See pages 26-29 for complete wording of the Texas Essential Knowledge & Skills for each content area addressed in this learning experience.



Overview of Learning Experiences

TEKS	<p>4.6 The student knows that change can create recognizable patterns. The student is expected to: (A) identify patterns of change (B) illustrate that certain characteristics of an object can remain constant even when the objects is rotated like a spinning top, translated like a skater moving in a straight line, or reflected on a smooth surface; and (C) use reflections to verify that a natural object has symmetry.</p>
Engage	<ul style="list-style-type: none"> ◆ Students devise a system to show that light travels in straight lines. ◆ Students observe properties of a mirror, and predict what will happen if a flashlight shines on it.
Explore	<ul style="list-style-type: none"> ◆ Students design and test a system that will allow light from the flashlight to be reflected between two mirrors before it hits a bull's eye target. ◆ Students design a system to reflect light across the room using four mirrors.
Explain	<ul style="list-style-type: none"> ◆ Students investigate how light is reflected by surfaces with different properties.
Elaborate	<ul style="list-style-type: none"> ◆ Students perform tests to verify that light travels in straight lines unless reflected by an object such as a mirror. ◆ Students verify the symmetry of objects using a tool called a MIRA™, folded patty paper, or by doing a mirror painting. ◆ Students construct a mirror maze that allows light to be directed around corners.
Evaluate	<p style="text-align: center;">SUMMATIVE ASSESSMENT</p> <ul style="list-style-type: none"> ◆ The student designs and constructs an operating periscope out of available materials to demonstrate the ability to identify recognizable patterns including symmetry.

ENGAGE

1. Show students a picture of light shining through a forest so they can observe straight light rays passing through the haze near the forest floor.
2. Darken the room. Gently pat two erasers together and shine a flashlight through the suspended particles so that students can observe the straight light rays.
3. Distribute materials to each group, and ask students to design a system with the cards, flashlight, and mirror to show that light travels in straight lines or rays.

Materials (details p. 22)

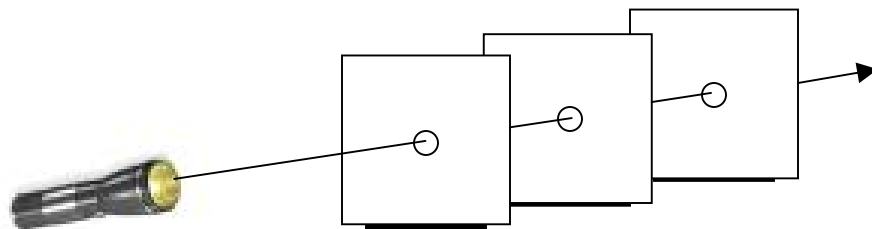
For the class:

- photo or slide of light rays passing through a haze, Master A
- two chalk-filled erasers
- flashlight

For each group:

- 3 pre-punched index cards
- flashlight
- mirror stands or binder clips
- mirror

Students may design a system similar to the diagram below.

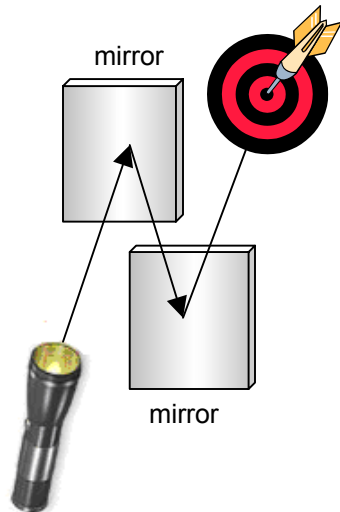


- What are the properties of the parts of your system?
- Does your test provide evidence that light travels in straight lines?
- What would happen if the position of one of the cards was changed in the system?
- What would happen if a mirror replaced the first card?
- What are the properties of a mirror? (*shiny, reflective*)
- Does light continue to travel in straight lines when it hits a mirror? (*No, it bounces or reflects off the mirror like a ball.*)

EXPLORE

1. Review the properties of a mirror that students observed in the Engage section. Challenge students to devise a system that will allow light from the flashlight to be bounced or reflected from mirror to mirror until it finally hits the bull's eye pattern. Students may change the position of the mirrors or the bull's eye until they create a working system that uses all of the available materials. Both mirrors must be used to hit the target!

2. One solution may look like the system below, but allow students time to explore and find their own solutions. Each group should draw their system on chart paper.



3. Reflection Challenge: Working with the other pair of students at their table, students combine all four mirrors to construct a system that reflects light as far as possible. The team that reflects light the farthest is the winner. Students should prepare to tell the class about both reflection systems, using their chart paper drawings as a visual.

Materials (details p. 22)

For each group of students:

- two mirrors
- flashlight
- bull's eye pattern, Master B
- binder clips
- meter stick

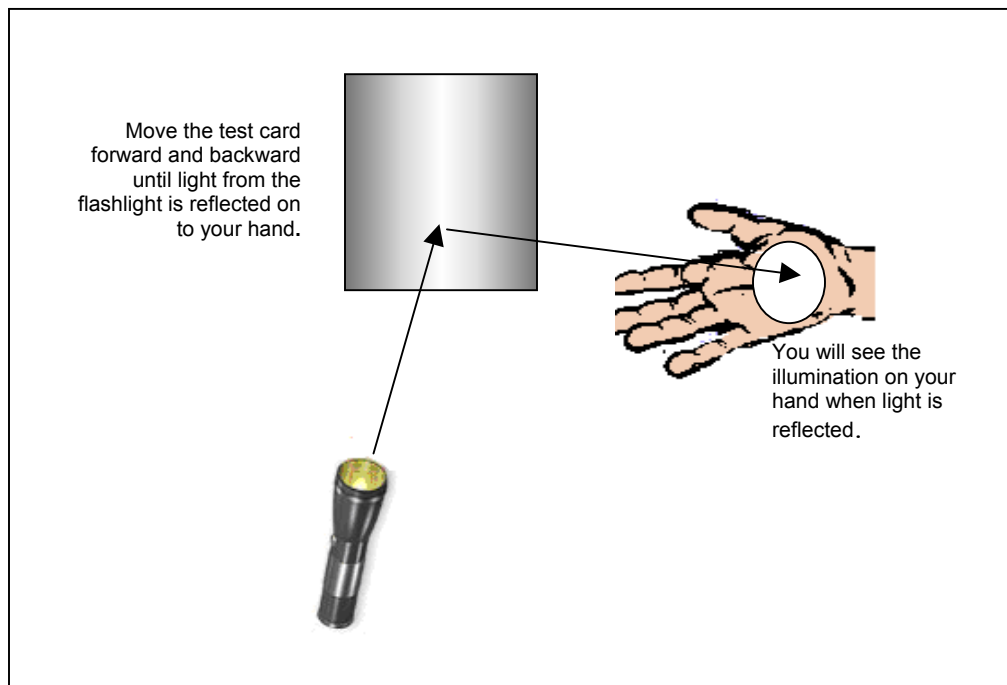
- How were the parts of your bull's eye system arranged?
- What happened to the light that struck the surface of the mirrors? (*It bounced or reflected off the shiny surface of the mirror and traveled in a straight line to the next mirror.*)
- The target surface is not a mirror. What are its properties? (*It is a dark paper circle with a circular pattern.*)
- Does the paper bull's eye reflect light? (*Yes, because light from the target must reflect into our eyes in order for us to see it.*)
- How far did your team reflect light? In meters? In centimeters?
- What design features were similar in the reflection systems that seemed to help reflect light the farthest?
- Do all materials reflect the same amount of light? How could we test materials to find out how much light they reflect? What materials would we need?

EXPLAIN

1. Distribute to each group a flashlight, mirror, unlined white index card, and index cards covered with black construction paper, dark cloth, and aluminum foil. Students should record predictions in journal about which material will reflect the most and least amounts of light using a number system, with 1 being most reflective, and 5 being least reflective. Darken the room, and have students shine a flashlight on the mirror at an angle to see how much light it will reflect onto their hand. They may have to move the mirror toward or away from their hand to get the position needed for reflection. After recording mirror observations, students will test covered cards in exactly the same way, and record observations in journal.

Materials (details p. 22)

- flashlights
- binder clips
- index cards covered with black construction paper, aluminum foil, and dark fabric
- white unlined index card

EXPLAIN

- Which surface reflected the most light? (*mirror*)
- How could you tell? (*A bright, definite spot of light was reflected on my hand*)
- Which surface reflected the least light? (*card covered in dark cloth*)
- How could you tell? (*reflected light was not bright, and was hard to see*)
- Did all of the surfaces reflect at least a little light? (*Yes, but the dark surfaces seemed to absorb most of the light.*)
- What properties did the least reflective surfaces have in common? (*dull surfaces*)
- What properties did the most reflective surfaces have in common? (*silvery, smooth, shiny surfaces*)
- What material would you use if you wanted to produce the best reflection, or bouncing off of light rays? (*mirror*)

ELABORATE

1. Ask students to hold a mirror at eye level so they can see themselves. Then ask them to move the mirror to the side until they can see the person behind them in the mirror.

Can they still see themselves if they can see someone else? (*No*)

2. Using the *Zigzag Rays* student data sheet, have students color the lines as directed on the sheet and follow the instructions.

Questioning Strategies

- When looking in a mirror, when can you see your own face and someone else's face in the same mirror? (*When person is standing directly behind you, so light can reflect off both people.*)
- How many bears did you see when the mirror was placed on the blue line? (*1*)
- How many bears did you see when two mirrors were placed on the red lines? (*3 bears because light bounces or reflects from one mirror to the other making multiple bear images*)
- How many bears could you see when the two mirrors were on the green lines? (*None because the bear was not in a position for light to bounce off of it and into the mirror. Light travels in straight lines, and does not bend around corners.*)
- Can you think of a way that we could place mirrors so that light could be reflected around a corner? (*The mirrors could be placed at an angle so light can bounce around the corner.*)

Materials (details p. 23)

- 1 mirror per student
- Zigzag Rays*, Masters C-H
- Crayons
- Bear counter
- Scissors
- Glue stick
- Sharpie pen
- Patty paper or transparency for each student
- Mirror
- Large binder clips
- MIRA™ for each pair of students
- Patty paper for each student
- Mirror
- Poster paints in assorted colors
- Legal sized white paper
- Paintbrushes

ELABORATE

3. Have students construct a table periscope system, using two mirrors, and Masters E-H. Demonstrate how to glue the two Zigzag Ray sheets together, noting the labels for the placement of the large and small light tunnels. The corners for the mirrors are labeled; however, students must determine how and where to place the mirrors to reflect light around the corners.

Ask students to place the bear counter at one end of the periscope and adjust their mirrors so that light can travel down the light tunnels and make the bear visible at the other end of the periscope. After students see the bear, ask them to trace the position of the mirrors.

Questioning Strategies

- How did you place the mirrors in each corner? *(mirrors were at angle)*
- What would happen if you placed the mirrors parallel to the light tunnels? *(bear's image could not be reflected because the mirrors would be at the wrong angle.)*
- Would you be able to see the bear with one mirror? *(No, there are two corners so light must be redirected twice by a mirror.)*
- Could you switch positions with the bear, and still be able to see it? *(If I place my eye where the bear is, and the bear where my eye is, I can still see the bear, as long as the mirrors don't change position.)*
- Ask your partner to predict what would happen if his/her eye replaced the bear. Repeat the activity. What did you see? *(my partner's eye)*



4. Have students print a sentence in all capital letters with a sharpie pen on patty paper. The sentence must explain something they have learned about reflection of light and contain a subject, a verb, at least one adjective, and end with a period.

5. Have students turn the patty paper over and ask their partners to read it.
6. Have each partner use a mirror to read the reversed sentence so the image of the writing is reflected. Students should then reverse roles, and read the other person's sentence.
7. Place a white sheet of paper in front of a mirror, and try writing a familiar word like your name just by looking in the mirror. Write each letter so it looks correct in the mirror. Does mirror writing take longer?

Questioning Strategies

- What do you notice about the writing? (*Some letters are reversed!*)
- Which letters are not reversed?
- Why are these letters not reversed in mirror writing? (*There are two parts of the letters that match up, or are exactly the same, so it doesn't matter if they are reversed.*)
- What is a word for an object that has two sides that are exactly the same? (*Symmetrical*)
- *If a letter or an object is symmetrical, a line of symmetry divides it into two equal parts*

Symmetry is another kind of constancy—or more generally, invariance—in the midst of change. But more typically, symmetry implies a pattern whose appearance stays the same when it undergoes a change.

Benchmarks for
Science Literacy, p. 271

8. Have students explore 3 different types of isometric transformations:

- 1) Translation- **sliding** an image along a straight path without turning it
- 2) Rotation- **turning** the image
- 3) Reflection- **flipping** the image.

Glide reflection combines a translation (slide) with a reflection (flip).

9. To model a reflection, have students place the MIRA™ vertically along the line where the longhorn picture was cut in two making sure the bottom, beveled edge is facing the longhorn picture. Using the reflection in MIRA™, have students complete the other side of the longhorn picture and then the snowflake.

10. Have students use another way to complete the longhorn picture using patty paper. Trace the half that is on the page, and then fold the patty paper vertically along the line where the picture was cut in two. Trace the reflected, or flipped half of the longhorn onto the folded section of patty paper. Unfold, and the whole longhorn appears!

11. After tracing the longhorn, a rotation can easily be modeled by placing a dot on the paper, and placing a pencil point on the dot. Rotate the patty paper around the pencil point, which simply changes the orientation of the longhorn.

12. Have students use either the MIRA™ or the patty paper test to determine if the four objects at the bottom of the page are symmetrical. If the object is symmetrical, ask students to draw a dotted line on the line of symmetry.

Grades 3-5

Students should know that some features of things may stay the same even when other features change. Some patterns look the same when they are shifted over, or turned, or reflected, or seen from different directions.

Benchmarks for Science Literacy, p. 272

ELABORATE

13. Use the MIRA™ to model a glide reflection, which combines a reflection and a slide. Have students guide the reflection of the car into the garage, and put hair on the person's head by gliding the reflection. Show the direction of the glide with an arrow.

Questioning Strategies

- How many lines of symmetry can be drawn through the longhorn? (*1*)
- Can you think of other objects or organisms that have only one line of symmetry? (*People, fish*)
- How many lines of symmetry could be drawn through the snowflake? (*At least two*)
- Can you think of other objects that have more than one line of symmetry? (*Circles, squares, clover patterns*)
- What characteristics of the longhorn remain constant even when it is rotated on the pencil? (*It is the same size and shape, but its position and orientation changes as it is rotated.*)
- The MIRA™ reflected an image of the car and made it appear to be moving in a straight line toward the garage in the picture. Was the car actually moving? How do you know?

Grades 3-5

Notions of symmetry can begin with identifying patterns whose appearance stays the same when they undergo some change (such as rotation, reflection, stretching, or displacement). Children are generally interested in exploring the shapes of things and looking for regularities of shape.

Benchmarks for
Science Literacy, p. 273

ELABORATE



14. Leonardo Da Vinci was a famous Italian artist who lived in the late 1400's. He was also an inventor, scientist, and engineer. His most famous painting was the Mona Lisa, but he was also known for his early designs of things that were actually not invented until hundreds of years later, such as the airplane and helicopter. Da Vinci wrote almost all of his journals in mirror writing, but experts are not sure if he was trying to keep his designs secret, or if he really just wrote backwards.

Place newspapers on the table to catch any paint spills. Ask students to fold their white paper in the middle.

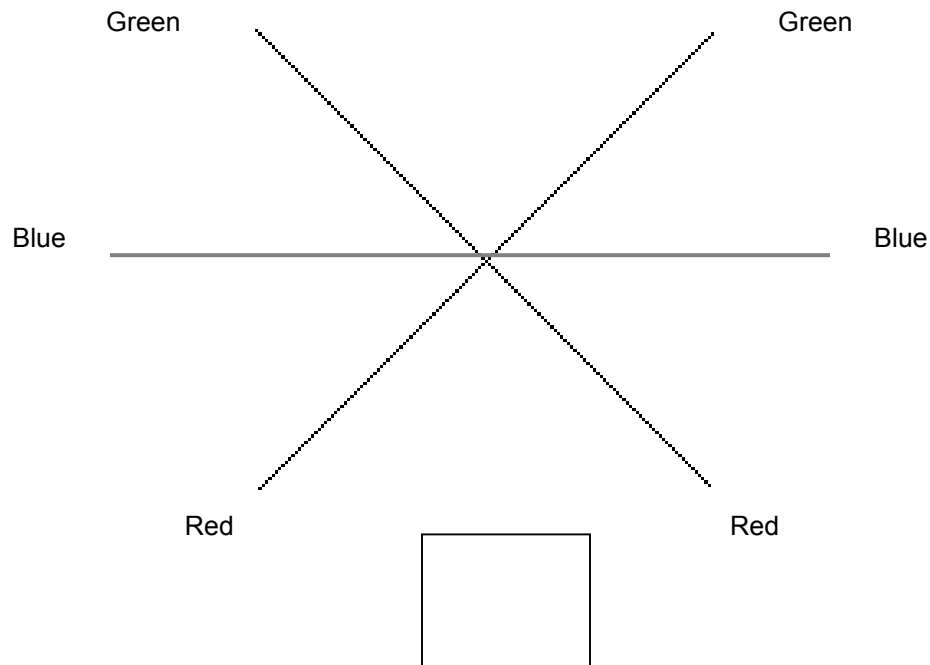
Using their choice of colors and design, ask students to make a design on the right side of the paper that they think will "paint" a symmetrical shape on the left side of the paper when the paper is folded together. Using a fairly thick coating of poster paint is important, so there will be enough paint for both sides of the paper.

ELABORATE

Zigzag Rays (See Masters C-D)

Student Data Sheet

Color the lines as marked. Place a bear in the box with its feet facing you.



1. Stand a mirror up on the blue line. What part of the bear do you see in the mirror? _____

2. Working with a partner, place two mirrors on the red lines making them touch where the two red lines intersect. How many bears do you see? Why?

3. Place two mirrors on the green lines, making them touch where the two green lines intersect. How many bears do you see? Why?

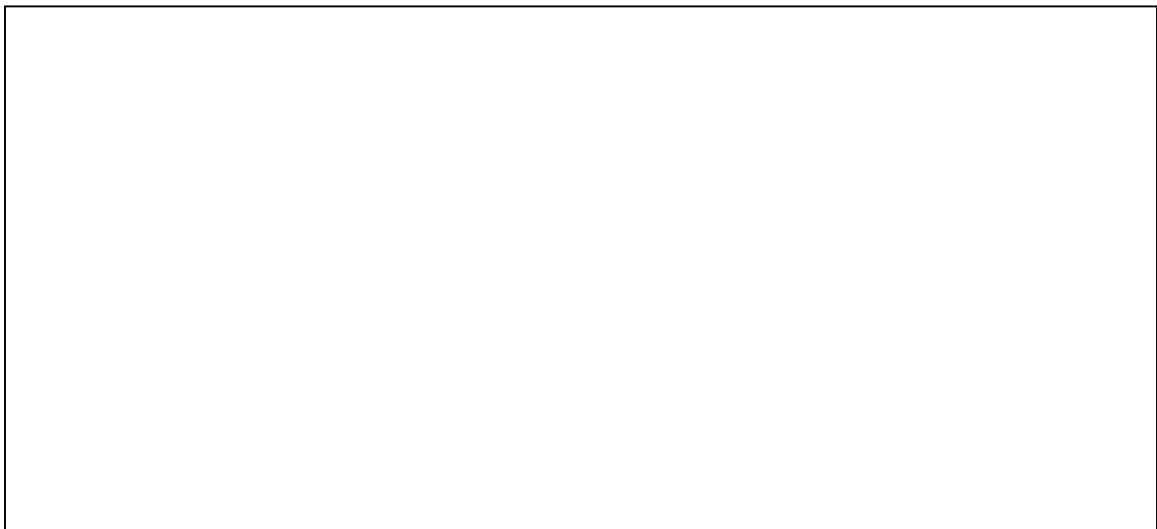
Working with a partner, construct a system that allows you to see around corners!

Instructions:

1. To make mat: Find the page marked "left side" and fold under its right margin on the dark line. Lap the "left side" on top of the "right side" so that the white turn spaces matches up on both sheets.
2. Tape or glue the "left side" onto the "right side" of the mat.
3. Trim around the two short tunnel patterns, roll into the size of a toilet paper tube and tape along the edges.
4. Trim around the long tube, roll into the size of a paper towel tube, and tape on the edge.
5. Place the tubes in the labeled areas on the mat.
6. Place a counting bear in front of one of the short tunnel tubes just off the mat. Have one partner place his/her eye at the end of the other short tunnel.
7. Can you see the bear? Why or why not? _____

-
8. Place a mirror in each marked area moving them until you can see the bear through the tubes.
 9. Draw the position where the mirrors were placed in the corners of the diagram.

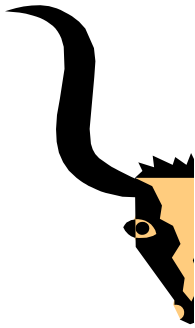
Draw the system you have created in the box below. **Label** all parts, and be sure to **draw the position of the mirrors** in the corners on the mat.



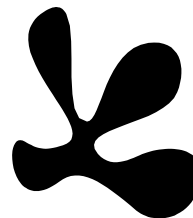
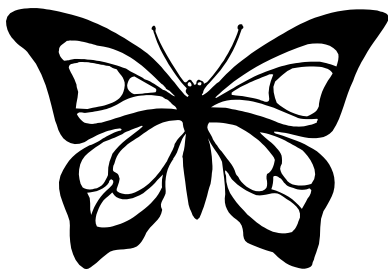
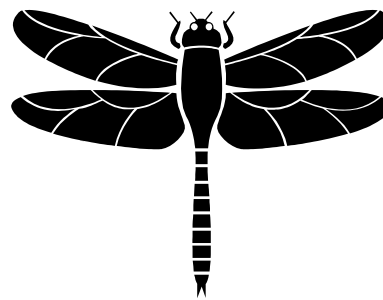
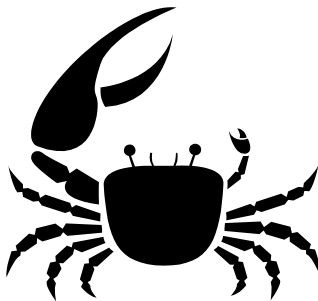
Symmetry (See Masters I-J)

Student Data Sheet

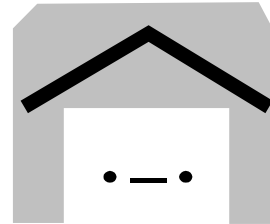
Draw a dotted line showing the area where the picture was cut in two. This is the line of reflection or symmetry. Test the pictures below for symmetry by placing the MIRA™ on the line of reflection and drawing the missing part of the picture. The object is symmetrical if the drawn part "mirrors" the first half and completes the picture. Trace each completed picture with patty paper and use it to discover another test for symmetry.



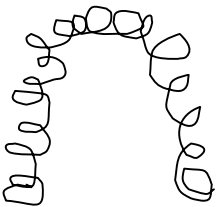
Use the MIRA™ or your patty paper test to determine if each of the objects below is symmetrical. Draw a dotted line to show the line of symmetry.



4. Move the MIRA™ in a straight line to park the car in the garage. Show the direction you had to glide the reflected image of the car with a line and an arrow.



5. Move the MIRA™ in a straight line to place hair on the person's head. Show the direction you had to glide the reflected image of the face with a line and an arrow.



6. Create your own drawings to use with a MIRA™ in the space below. Show the direction to slide the MIRA™ with a line and an arrow.

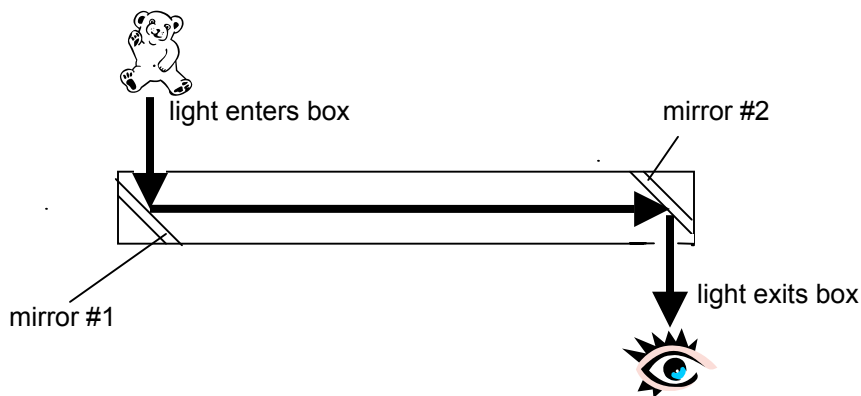
EVALUATE

1. Have students complete the Reflection and Symmetry Assessment which includes the construction of their own portable, operating periscope.

* A periscope, like the ones used on submarines, is an example of an application of reflection. To make a homemade periscope, cut small rectangular holes at the top and bottom of opposite sides of a long, rectangular box, such as spaghetti box. In the corner directly behind each hole, place a small mirror at a 45-degree angle. The hole at the top end allows light to enter, where it is reflected off the mirror and down into the periscope to the second mirror, which then reflects the light to the observer's eye. The periscope can be used to see around corners and over tall walls.

Materials (details p. 23)

- 2 mirrors per student
- variety of boxes and tubes
- glue
- scissors
- Student Assessment sheets, Masters K-L
- Rubric, Master M



Light reflects off bear and enters the box. Light hits mirror #1 and is reflected down the length of the box. Light hits mirror #2 and is reflected out of the box and into the eye.

Reflection and Symmetry (See Masters K-L) Assessment

1. Rank the objects below according to how much light they will reflect. A rank of 1 is most reflective, and a 3 is least reflective. List two **reflective** properties of each object that helped you to rank them.

Rank

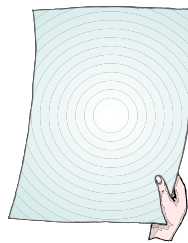
List Two Properties of Object



mirror



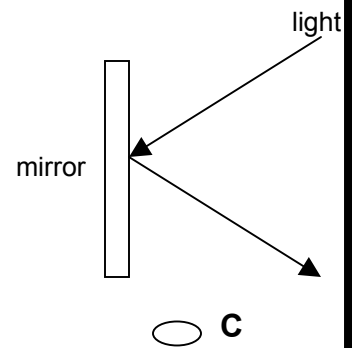
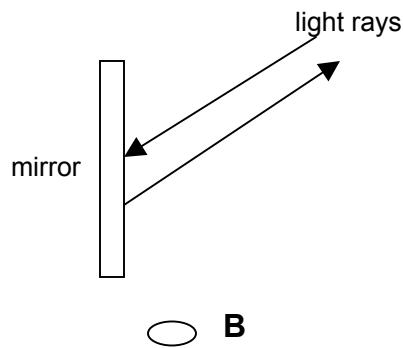
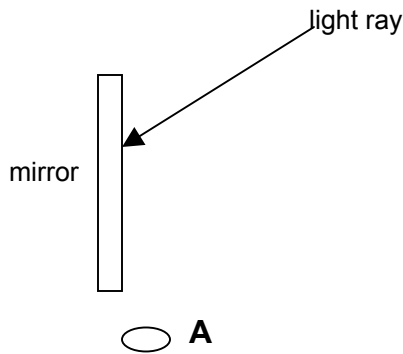
black cloth



white paper

EVALUATE

2. Which diagram below shows how light is reflected off a mirror? Bubble the letter of the correct choice.



3. Draw a picture of a symmetrical object in the box. Show the line of symmetry with a dotted line.



4. Use two mirrors and any of the materials provided to make a sturdy model of a periscope that can be used to see around corners. The periscope must be portable, and will be tested to see around a corner. Use the white space below to plan your periscope. For safety, please ask for help when you are ready to cut holes in the container.

Reflection and Symmetry Assessment

Scoring Rubric

TASK	CRITERIA	1	2	3	4
Identify Properties & Patterns	1. Ranks and lists light reflective properties of surfaces	Ranks two surfaces out of order, lists no properties	Ranks one surface out of order, lists properties	Ranks surfaces 1, 3, 2 and lists most properties	Ranks surfaces 1, 3, 2 and lists all properties
	2. Identifies patterns of mirror/light reflection	Identifies light ray absorbed by mirror	Identifies light ray reflecting back to light	Identifies light ray reflecting straight off mirror	Identifies correct direction of light ray reflecting off mirror
Communicate understanding through drawing	3. Draws symmetrical object, with line of symmetry & congruent sides	Attempts to draw symmetrical object, no line of symmetry	Draws fairly symmetrical object with nearly congruent sides, no line of symmetry	Draws fairly symmetrical object with congruent sides, shows line of symmetry	Clearly draws symmetrical object, showing line of symmetry and congruent sides
Analyze parts of a system	4. Constructs and presents a portable, durable, operating periscope that can be used to see around a corner. Chooses materials suited for the task.	Attempts to construct an operating periscope that can be used to see around a corner. Poor choice of materials and improper placement of mirrors are design flaws.	Constructs and presents a somewhat portable, operating periscope that can be used to see around a corner. Acceptable choice of materials.	Constructs and presents a portable, somewhat durable, operating periscope that can be used to see around a corner. Good choice of materials.	Constructs and clearly presents a portable, durable, operating periscope that can be used to see around a corner. Excellent choice of materials.

EVALUATE

Materials Detail Sheet

ENGAGE

For the class:

- photo or slide of light rays passing through a haze
See Master A
- two chalk-filled erasers
- flashlight

For each group:

- 3 pre-punched index cards
Use a hole punch to insert one hole in the center of each card.
 - flashlight
 - mirror stands or binder clips
 - mirror
-

EXPLORE

For each group of students:

- two mirrors
 - flashlight
 - bull's eye pattern
See Master B
 - binder clips
-

EXPLAIN

For the class:

- flashlights
- binder clips
- index cards covered with black construction paper, aluminum foil, and dark fabric
- white unlined index card

For each student:

- journal

Materials Detail Sheet

ELABORATE

For each group of students:

- 1 mirror per student
- crayons
- bear counter
- scissors
- glue stick or tape
- Zig Zag patterns, See Masters E-H
- sharpie pen
- patty paper or transparency for each student
- mirror
- large binder clips
- MIRA™ for each pair of students
- Patty paper for each student
- Mirror
- Symmetry Student Data sheet, See Masters I-J

For each student:

- Zig Zag Student Data sheets, See Masters C-D
- poster paints in assorted colors
- legal sized white paper
- paintbrush

EVALUATE

For each group of students:

- variety of boxes and tubes
- glue
- scissors

For each student:

- Reflection and Symmetry Assessment, See Masters K-L
- Reflection and Symmetry Rubric, See Master M
- 2 mirrors per student

Background Information for Teachers

"The important but abstract ideas of science, such as atomic structure of matter and the conservation of energy, all begin with observing and keeping track of the way the world behaves. When carefully observed, described, and measured, the properties of object, changes in properties over time, and the changes that occur when materials interact provide the necessary precursors to the later introduction of more abstract ideas in the upper grade levels. By experimenting with **light**, heat, electricity, magnetism, and sound, students begin to understand that phenomena can be observed, measured, and controlled in various ways." (National Science Education Standards, p. 126)

Light is a form of energy that travels in waves that we see as thin beams of light called rays. A light ray travels in straight lines, unless an object or material is in its path. When a light ray hits an object, it can be reflected, refracted, or absorbed, depending on the properties of the object in the light's path. Light can reflect or bounce off objects. Most objects reflect some of the light that hits them. We can see objects when they reflect light, and the reflected light enters our eyes. We can't see objects in the dark, because there is not enough light reflected from them.



The surface of a material or an object determines how much light will be reflected or absorbed. A rough surface causes light to be reflected in many directions, so that light is spread out or diffused. A mirror, on the other hand, has a shiny, smooth silver surface that reflects up to 96 percent of the light that strikes it. Mirrors allow beams of light to bounce off, or reflect, in the same pattern that they hit the mirror. The properties of mirrors allow reflected light to follow very specific patterns.

Mirrors can reflect images of objects because light rays bounce off an object, travel in a straight line to a mirror, bounce off the mirror, and then travel to the eye of an observer. If you can see someone in a mirror, be aware that they can see you, too! This is also why everything seems reversed when we look at ourselves in a mirror. We can see this easily by writing a word on paper, and holding the paper in front of a mirror. Most letters will appear backwards in the mirror. Some letters will not change, however, because they are symmetrical, with sides that match up exactly when folded or divided down the middle.

A symmetrical letter or object can be cut or divided by the line of symmetry into two identical parts. A geometry tool called a MIRA™ can be placed along the imaginary line as a test for symmetry. If the reflected image is identical to the half hidden by the mirror, the object is symmetrical. Patty paper or tracing paper can also be used to test for symmetry. The object or letter can be traced on patty paper, and folded in the middle. If the sides match up exactly, the object is symmetrical.

Targeted



Texas Essential Knowledge & Skills



Science TEKS

4.1 The student conducts field and laboratory investigations following home and school safety procedures and environmentally appropriate and ethical practices. The student is expected to:

(A) demonstrate safe practices during field and laboratory investigations; and

4.2 The student uses scientific inquiry methods during field and laboratory investigations. The student is expected to:

(A) plan and implement descriptive investigations including asking well-defined questions, formulating testable hypotheses, and selecting and using equipment and technology;

(B) collect information by observing and measuring;

(C) analyze and interpret information to construct reasonable explanations from direct and indirect evidence;

(D) communicate valid conclusions; and

(E) construct simple graphs, tables, maps, and charts to organize, examine, and evaluate information.

4.4 The student knows how to use a variety of tools and methods to conduct science inquiry. The student is expected to:

(A) collect and analyze information using tools including calculators, safety goggles, microscopes, cameras, sound recorders, computers, hand lenses, rulers, thermometers, meter sticks, timing devices, balances, and compasses; and

(B) demonstrate that repeated investigations may increase the reliability of results.

4.6 The student knows that change can create recognizable patterns. The student is expected to:

(A) identify patterns of change such as in weather, metamorphosis, and objects in the sky

(B) illustrate that certain characteristics of an object can remain constant even when the object is rotated like a spinning top, translated like a skater moving in a straight line, or reflected on a smooth surface

(C) use reflections to verify that a natural object has symmetry



Language Arts TEKS

4.2 Listening/speaking/ purposes. The student listens actively and purposefully in a variety of settings. The student is expected to:

- (A) interpret speakers' messages (both verbal and nonverbal), purposes, and perspectives

4.5 listening/speaking/audiences. The student speaks clearly and appropriately to different audiences for different purposes and occasions. The student is expected to:

- (E) give precise directions and instructions such as in games and tasks
- (F) clarify and support spoken ideas with evidence, elaborations, and examples

4.9 Reading/vocabulary development. The student acquires an extensive vocabulary through reading and systematic word study. The student is expected to:

- (E) study word meanings systematically such as across curricular content areas and through current events

4.13 Reading/inquiry/research. The student inquires and conducts research using a variety of sources. The student is expected to:

- (A) form and revise questions for investigations, including questions arising from interests and units of study

4.15 Writing/purposes. The student writes for a variety of audiences and purposes, and in a variety of forms. The student is expected to:

- (A) write to express, discover, record, develop, reflect on ideas, and to problem solve
- (C) write to inform such as to explain, describe, report, and narrate

4.18 Writing/grammar/usage. The student applies standard grammar and usage to communicate clearly and effectively in writing. The student is expected to:

- (B) write in complete sentences, varying the types such as compound and complex to match meanings and purposes

4.25 Viewing/representing/production. The student produces visual images, messages, and meanings that communicate with others. The student is expected to:

- (A) select, organize, or produce visuals to complement and extend meanings



Mathematics TEKS

4.8 Geometry and spatial reasoning. The student identifies and describes lines, shapes, and solids using formal geometric language. The student is expected to:

(A) identify models of parallel and perpendicular lines

4.9 Geometry and spatial reasoning. The student connects transformations to congruence and symmetry. The student is expected to:

(A) demonstrate translations, reflections, and rotations using concrete models

(B) use reflections to verify that a shape has symmetry.

4.14 Underlying processes and mathematical tools. The student applies Grade 4 mathematics to solve problems connected to everyday experiences and activities in and outside of school. The student is expected to:

(C) select or develop an appropriate problem-solving strategy, including drawing a picture, looking for a pattern, systematic guessing and checking, acting it out,

(D) making a table, working a simpler problem, or working backwards to solve a problem

4.15 Underlying processes and mathematical tools. The student communicates about Grade 4 mathematics using informal language. The student is expected to:

(A) explain and record observations using objects, words, pictures, numbers, and technology



Social Studies TEKS

4.23 Social Studies skills. The student communicates in written, oral, and visual forms.

The student is expected to:

(C) express ideas orally based on research and experiences

(D) create written and visual material such as journal entries, reports, graphic organizers, outlines, and bibliographies

(E) use standard grammar, spelling, sentence structure, and punctuation.

4.24 Social studies skills. The student uses problem-solving and decision-making skills, working independently and with others, in a variety of settings. The student is expected to:

(A) use a problem-solving process to identify a problem, gather information, list and consider options, consider advantages and disadvantages, choose and implement a solution, and evaluate the effectiveness of a solution



Art TEKS

4.2 Creative expression/performance. The student expresses ideas through original artworks, using a variety of media with appropriate skill. The student is expected to:

(C) invent ways to produce artworks and to explore photographic imagery, using a variety of art media and materials

Reading Connections

The following books are recommended as literary resources for teachers to share with grade 4 students. **Teachers are cautioned, however, to remember that "reading about science" is not "doing science."** These books can enhance students' study of reflection and symmetry but cannot replace the learning that occurs by active engagement in the learning experiences.

Explorabook: A Kid's Science Museum in a Book. John Cassidy. Klutz Press, 1991.

Let's Fly a Kite: Level 2 Symmetry. Murphy, Stuart J. Harper Collins Children's Books, 2000. (ISBN 0064467376)

Student Internet Links

Beakman and Jax Science Stuff

<http://www.beakman.com/>

Bill Nye the Science Guy

<http://nyelabs.kcts.org/>

Energy Quest

<http://www.energy.ea.gov/education/index.html>

Interactive Reflection Tutorial

<http://micro.magnet.fsu.edu/primer/lightandcolor/reflection.html>

Optics for Kids

<http://www.opticalres.com/kidoptx.html>

Up Periscope!

http://www.exploratorium.edu/science_explorer/periscope.html

References

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- Benchmarks for Science Literacy*. Oxford University Press, New York, 1993.
- Britton, Jill. *Symmetry and Tessellations*. Dale Seymour Pub., 1999.
- Broekel, Ray. *Experiments with Light*. Children's Press, Chicago, 1986.
- Burnie, David. *Light*. Dorling Knendersley, 1992.
- Kirkby, David. *Patterns*. Rigby Education, 1996.
- Hillen, Judith and Mercier, Sheryl. *Primarily Physics*. Aims Education Foundation. 1990.
- Levine, Shar, and Johnstone, Leslie. *The Optics Book*. Sterling Publishing Co. Inc, 1998.
- National Science Education Standards*. National Academy Press, Washington, DC, 1996.
- Stewart, Ian. *What Shape Is a Snowflake?* Hen Holt & Company, Inc. 2001.
- Taylor, Barbara. *Shadows and Reflections*. Warwick Press, New York, 1990.
- Wilson, Jim. "Rays Around the Corner." *Aims*, Volume XIII, Number 7, February, 1999.
- Wood, Robert W. *Physics for Kids: 49 Easy Experiments with Optics*. TAB Books, 1990.

Websites

Exploratorium

<http://www.exploratorium.edu/>

Explore Science

<http://www.explorescience.com/>

Marshall Brain's How Stuff Works: How Light Works

<http://www.howstuffworks.com/light5.htm>