THINKING AND ACTING LIKE A SCIENTIST

TEACHER'S GUIDE

When Can You See?

What is the relationship between light and the ability to see?

GRADE 4

Physical Science

VAN ANDEL EDUCATION INSTITUTE
VAEI.ORG

INQUIRY-BASED SCIENCE

Physical

When Can You See?

Grade Level/ Content	4/Physical Science
Lesson Summary	In this lesson, students will explore the connection between light and sight.
Estimated Time	2, 45-minute class periods
Materials (per team)	shoebox with lid, 2 cardboard squares, flashlight, 4 blank cards, crayons or markers, 2 small mirrors (about 3 inches square), 24 inches of string, yarn, or thread, Observation Form, Investigation Plan, journal
Secondary Resources	DK Find Out: What Is Light? Tour of the Electromagnetic Spectrum
NGSS Connection	**4-PS4-2** Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.
Learning Objectives	• Students will describe causal relationships between light and the ability to see. • Students will develop a model of the relationship between light reflection and visibility of objects and will identify its components. • Students will use the model to describe what is needed for a person to see an object, and the effects of removing, blocking, or changing the light source; closing the eye; and changing the path of the light (e.g., by using mirrors or barriers).
Cross-Curricular Project Connections	Eclipse, Sleep Under the Stars

What is the relationship between light and the ability to see?

Everyone with sight knows that darkness makes it hard to see objects. How often, though, do we think about the role of light in our ability to see? We cannot see an object unless light from a light source reflects off the object and into our eyes. All objects reflect some light.

Humans have studied light and optics for thousands of years, even making lenses as early as 750 B.C. An understanding of the relationship between vision and light began to develop in the Middle Ages. In this lesson, students will explore that relationship and develop a model to describe it.

Investigation is based on the Van Andel Education Institute (VAEI) Instructional Model for Inquiry-Based Science. In all investigations:

Students don't know the "answer" they are supposed to get.

Students play a driving role in determining the process for learning.

Teachers and students construct meaning together by journaling.

Students are working as hard as the teacher.

Part 1

INVESTIGATION SETUP

Each group of 4 students will need the following:

- shoebox with lid
- 2 cardboard squares
- flashlight
- 4 blank cards (to use as objects and obstacles)
- crayons or markers
- 2 small mirrors (about 3 inches square)
- 24 inches of string, yarn, or thread to trace paths between parts of the test arrangements
- Investigation Plan
- Observation Form
- journal

Cut a small eyehole in the side of the shoebox, near the middle. In one end, cut a hole the size of the flashlight head. In the lid, cut a square hole about 2 inches by 2 inches. Cut squares of cardboard big enough to completely cover the holes at the end and in the lid.

Part 2

INVESTIGATION FACILITATION

Question

Introduce the investigation question.

What is the relationship between light and the ability to see?

CURIOSITY

Hold up a book. Ask whether students can see it. Warn students that you are going to turn off the lights. Turn the lights off and ask, "Can you see it now?" Turn the lights back on and put the book behind a larger object. Ask again whether students can see it.

Personal Knowledge

Students capture what they already know about light and vision.

Have students reflect on what they already know about light and vision.

- Find out what students already know about the conditions under which they can see or cannot see an object.

COLLABORATION

Conduct an *Alphabet Knowledge* to ensure all students participate. Have a group of 3-4 students write each letter of the alphabet on a large piece of paper. Tell them to write a word or short phrase that connects to light and vision for each letter of the alphabet. Discuss this list as a class.

Prediction

Students communicate an expected outcome, based on prior knowledge.

Show students the materials they will be working with to explore how objects can be seen.

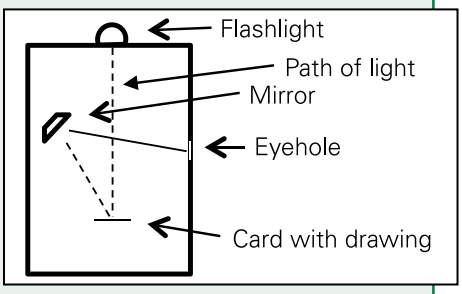
- Have students think independently about the conditions under which they can or cannot see an object.
- Ask them to predict what the relationship is between light and visibility by using the prompt: *I predict _____ because _____.*

Investigation Plan

Students conduct trials to determine the conditions under which an object can be seen or cannot be seen.

Introduce the investigation.

- Review the materials with the class.
- Divide the class into teams of 4. Give each team its materials.
- Ask teams to follow the Investigation Plan.
- Students will use the materials to explore the relationship between light and vision. They will test their initial arrangement and improvise and test other arrangements.
- On the Observation Form, teams will answer the questions, sketch a diagram of each setup they try, and write next to each diagram what they observed. Provide extra forms if needed.



Sample Diagram

CRITICAL THINKING

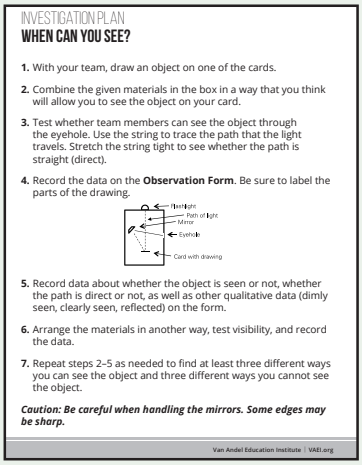
Use the Fair Test checklist to help students think critically about the investigation plan. Help them understand that a good investigation plan must include a test that is repeatable, generates quality data, and minimizes error. The more critically students think about their investigation plan, the more confident they can be in their results.

CREATIVE THINKING

Encourage students to try different ways of making an object visible or invisible. Challenge them to think of other materials that might enhance or impede visibility.

COLLABORATION

Urge students to continue the investigation until all team members have observed at least two arrangements in which they could see the object and two in which they could not. Explain that scientists often collaborate to verify their findings.



INVESTIGATION PLAN

WHEN CAN YOU SEE?

1. With your team, draw an object on one of the cards.
2. Combine the given materials in the box in a way that you think will allow you to see the object on your card.
3. Test whether team members can see the object through the eyehole. Use the string to trace the path that the light travels. Stretch the string tight to see whether the path is straight (direct).
4. Record the data on the **Observation Form**. Be sure to label the parts of the drawing.

5. Record data about whether the object is seen or not, whether the path is direct or not, as well as other qualitative data (dimly seen, clearly seen, reflected) on the form.
6. Arrange the materials in another way, test visibility, and record the data.
7. Repeat steps 2–5 as needed to find at least three different ways you can see the object and three different ways you cannot see the object.

Caution: Be careful when handling the mirrors. Some edges may be sharp.

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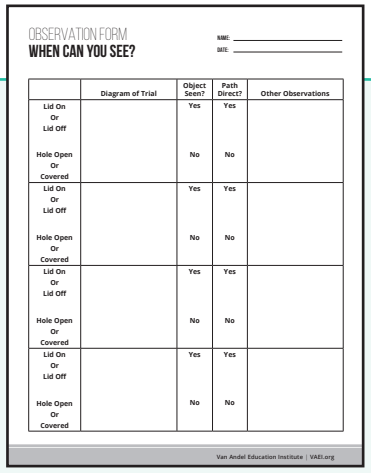
Investigation Plan

Observation

Students record their observations.

Ask students to record their observations using the **Observation Form**. Encourage them to label their drawings carefully.



OBSERVATION FORM

WHEN CAN YOU SEE?

NAME: _____

DATE: _____

	Diagram of Trial	Object Seen?	Path Direct?	Other Observations
Lid On Or Lid Off		Yes	Yes	
Hole Open Or Covered		No	No	
Lid On Or Lid Off		Yes	Yes	
Hole Open Or Covered		No	No	
Lid On Or Lid Off		Yes	Yes	
Hole Open Or Covered		No	No	
Lid On Or Lid Off		Yes	Yes	
Hole Open Or Covered		No	No	

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Observation Form

Part 3

INVESTIGATION ANALYSIS AND DEVELOPMENT OF CLAIM

Data Analysis

Students make sense of their data by organizing it and representing it visually.

Have students analyze their data. They may wish to use the Data Analysis prompt as a guide.

- Have students **evaluate** their data for trustworthiness.
- Then, have them analyze their data to find patterns and trends. They may **organize** the data and/or **represent** it visually to construct meaning.
- Cutting apart the **Observation Form** to permit physical grouping of similar data may help students see patterns. For example, they can group the trials in which the object was visible and the ones in which it was not.
- Have students **interpret** what the identified patterns or trends mean.
- Ensure they have enough data that it can be used as evidence to support a claim.

Secondary Knowledge

Students use secondary sources to understand the way light travels, and the process by which it makes objects visible.

- Use these resources (or your own) to develop students' understanding of reflection and how the eye is a sense organ that collects information from the environment.
  DK Find Out: What Is Light?
  Tour of the Electromagnetic Spectrum
- Engage students in a class discussion of what light is, how it travels, and how it makes objects visible. Lead them to see the connections between this information and the data they collected in the investigation.
- After reviewing these resources and discussing as a class, students should understand the causal relationship between light and visibility, specifically that light enters the eye, allowing objects to be seen. Light reflects off of objects, and then can travel and enter the eye. Objects can be seen only if light follows a path between a light source, the object, and the eye.

RICH LANGUAGE

Encourage the use of new vocabulary they may have encountered in secondary sources, and challenge them to use rich language to describe light and visibility (e.g., *illuminate, appear, hazy, transparent, crisp,* etc.)

Explanation

Students write a claim and provide evidence and reasoning to support it.

- Have students use what they've discovered from their analyzed data to write an explanation that answers their investigation question. Students may wish to use the Explanation prompt as a guide. Have them write their explanation in their Lab Journal.
- Have students develop a **Claim** to answer the question: What is the relationship between light and the ability to see?
- Then, have them add **Evidence** (the analyzed data) to support their claim.
- Finally, have them add **Reasoning** to their claim. Reasoning should include the information obtained from this investigation as well as science principles they have learned.

Claim

We claim that light and visibility are related in such a way that objects can only be seen if light follows a direct, unobstructed path between a light source, the object, and the eye.

Evidence

The evidence that supports our claim comes from the drawings we made of different setups and the data we recorded about whether an object was visible. Covering and uncovering the openings in the box, adding a light source, placing the object in different positions, and sometimes including a mirror, allowed us to change whether the object was visible and how clearly we could see it. We could see the object when there was a direct path from the light source to the object and from the object to the eye. We could also see the object when there was a direct path from the source to the object, from the object to a mirror, and from the mirror to the eye. We could not see the object when an obstacle blocked any part of a direct path between the parts.

Reasoning

Investigation: Each member of our team observed at least two setups in which the object was visible and two in which it was not. We followed the plan. We made sure our box sealed out light when it was closed and the holes were covered. Our flashlight worked during the whole investigation. We made sure our diagrams showed the correct positions of the parts we used in each setup. We used string to check that the paths between the parts were straight.

Science: We learned from readings and class discussion that for a person to see an object, light waves reflected by the object must enter the person's eye. If no light strikes the object, the object cannot be seen. If the light reflected by the object cannot enter the eye, the object cannot be seen. A mirror can also reflect light from an object to the eye. These facts support our claim.

- Once the explanation is written, have students discuss their results using a Present and Defend.

DISCOURSE

Have students conduct a Present and Defend to develop presentation skills as well as audience participation. Research teams present a summary of their investigation to the class. The class analyzes the information presented and asks clarifying questions, challenges and/or supports the arguments made, and even presents alternative explanations as appropriate. Research teams defend their explanation with evidence and reasoning. If students are doing the same investigation plan, choose 1 or 2 groups to share.

Evaluation

Students reflect on the investigation.

- Ask students how confident they are in their results.
- Ask students what question they would like to pursue next.

RISK-TAKING

Invite students to present to the class their ideas of other ways to explore the relationship between light and vision. Everyone should listen and consider all ideas. Encourage respectful questions and comments from the class.

Part 4

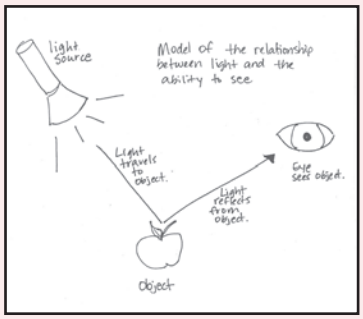
INVESTIGATION ASSESSMENT AND EXTENSION

Application

Students make a model showing relationship between light and visibility.

Have students make a model (a diagram that represents a phenomenon) to show how objects are able to be seen by the eye. Models should include:

- Light source
- Object
- Path that the light follows
- The eye



Model Showing Relationship between Light and Sight

Students use this model to describe what is needed for a person to see an object and what the effects are of removing, blocking, or changing the light source, closing the eye; and changing the path of the light (e.g., by using mirrors or barriers). **Note: The box arrangements used in the investigation plan are not the models students will be creating. They will use the information they learned from testing their various setups to develop a model that represents how objects are seen by the eye.**

CONSTRUCTION OF MEANING

Invite students to share their experiences with and understanding of models. Engage them in a discussion of the characteristics and usefulness of different kinds of models. Steer the discussion to a focus on what students know about scientific models. Connect this knowledge to their application experience.

Assessment

- Students provide an explanation (**claim**, **evidence**, and **reasoning**) that clarifies the relationship between light and the ability to see.
- Students make a model to represent how objects are able to be seen by the eye and use that model to describe what is needed for a person to see an object and what the effects are of removing, blocking, or changing the light source; closing the eye; and changing the path of the light (e.g., by using mirrors or barriers).

Take This Lesson Across the Curriculum

Eclipse

Rarely, Earth passes between the sun and the moon, blocking sunlight from reaching the moon. That darkening of the moon is called an eclipse. Even more rare is an eclipse of the sun, when the moon blocks sunlight from reaching Earth. In this lesson, students will explore how an eclipse occurs and how it affects people on Earth.

Reading/Language Arts	Math	Science	Social Studies
Report the Facts Read two short books or articles about eclipses. Write a brief report. CCSS.ELA-LITERACY.RI.4.9 CCSS.ELA-LITERACY.W.4.7	**How Far?** The moon is about 238,900 miles from Earth. The sun is about 92,956,000 miles from Earth. How much farther away is the sun than the moon? CCSS.MATH.CONTENT.4.MD.A.2	**When Can You See?** To understand how an eclipse occurs, let's make a model that shows how light and vision are related. NGSS: 4-PS4-2	**Ancient Tales** Watch the videos at NASA's 2016 site Eclipse: In a Different Light to learn how ancient cultures explained eclipses. NCSS: D2.His.4.K-2

Sleep Under the Stars

Romance and adventure are associated with sleeping outdoors in the wild, but camping trips require planning and preparation. In this lesson, students will plan and prepare for an imaginary camping trip.

Reading/Language Arts	Math	Science	Social Studies
Make a Plan Write a plan for an imaginary camping trip. Include details about where you will go, what you will do there, and what you will take with you. Don't forget to take food! CCSS.ELA-LITERACY.W.4.10	**What's for Breakfast?** You are planning a camping trip with a group of 18 people. You want to bring oranges to eat at breakfast. Oranges come in packages of 4. How many packages must you buy in order for each person to get at least one orange? CCSS.MATH.CONTENT.4.OA.A.3	**When Can You See?** Will you be able to see at night at your campsite? Make a model to show what you need in order to see objects. NGSS: 4-PS4-2	**Camp as Home** Some groups of people, called nomads, move often to find food for themselves or their herds. Their homes must be easily packed, like camping tents. How is the situation of people without homes in modern cities similar to that of nomads? NCSS: D2.Geo.8.K-2

For additional lessons or to customize this lesson, go to www.nexgeninquiry.org.

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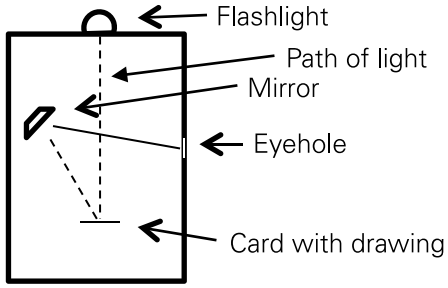

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