

WELCOME TO AKA SCIENCE!



AKA Science is a fun, hands-on afterschool science enrichment program for grades K-8. With inquiry-based, interactive activities, students are encouraged to work together, ask questions, and dive deep into the wonders of science. From biology, chemistry, and physics to engineering, earth science, and environmental science, we playfully discover the world around us and make connections that last a lifetime. ALL KIDS ARE SCIENTISTS and together we help them see themselves as the next generation of innovators, inventors, and experimenters!

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BEFORE YOU START:

- **NOTHING from the AKA Science kit should go in one's mouth, nose, eyes, or ears.** Mystery substances can be harmful, and even familiar substances can be contaminated. If a student ingests a non-food product, call **Poison Control: 1-800-222-1222**, 911, or alert your manager.
- **Ensure that the *Take-Home Supply Advisory* goes home** into the hands of your students' parents, guardians, and caring adults so that they can anticipate what exciting and potentially messy supplies may be coming home.
- **The AKA Science website (www.akascience.org)** has copies of worksheets, curriculum, teaching resources, and parent/guardian forms. Below are QR codes for specific parent/guardian forms in other languages:



Arabic

Chinese

English

Russian

Spanish

Vietnamese

- **Utilize the newspaper included in your kit box.** It is helpful for covering desks or laying flat on the floor to catch any spills.
- **Encourage students to use their Lab Notebooks** to plan, record, and reflect on observations.
- **You may not have time to do every activity in the curriculum with your class**—and that's okay! It's up to you which activities to shorten, lengthen, or skip if needed.
- **Throughout the curriculum, all materials will be in BOLD when it's time to pass them out and all vocabulary words will be UNDERLINED.**
- **A BLACK STAR at the beginning of an activity means the lesson is associated with a post-survey question.** We encourage you to emphasize the specific word/phrase during the lesson.
- **In science, making mistakes is part of the process!** If a student is feeling discouraged because an experiment didn't work, we invite you to try the following:
 1. *What happened today that made you try hard? What did you learn from this?*
 2. *What other strategies or improvements could you try next time?*

CLASS 1: SURPRISING EYES

Supplies (in class bags)	#
Butcher Paper (sheet, folded) <i>in bottom of kit box</i>	1
Crayons, black	4
Crayons, box	2
Cups, 10oz	4
Lab Notebooks	16
LED light, blue	4
LED light, green	4
LED light, red	4
LED light, white	4
Lenses, concave	4
Lenses, convex	4
Markers, black, washable	2
Mirror boards	4
Pencils	16
Ping pong balls	20
Pipe cleaners, ½ size	16
Pushpins	4
Tape, Scotch rolls	1
Worksheets (in envelope)	#
Consent Form for Publication (Media Release)	16
How Lenses Bend Light	2
Supply Advisories	16

PREP STEPS:

- **Act 3. (optional):** Poke two holes across from each other in 16 ping pong balls. Note – there are extra ping pong balls in case any are damaged.
- **Act 5.** Fill four 10oz cups about $\frac{3}{4}$ full of water.

VOCABULARY:

- **Concave:** Having an outline or surface that curves inward like the interior of a circle or sphere.
- **Convex:** Having an outline or surface that curves outward like the exterior of a circle or sphere.
- **Hypothesis:** A prediction of the outcome of a test. A hypothesis must be testable through experimentation or observation.

- **Optic Nerve:** Large cranial nerve that connects the eye to the brain. The optic nerve is responsible for transmitting information from the retina to the vision center of the brain via electrical impulses.
- **Pupil:** Opening in the eye that allows light to enter. Pupils change size depending on how much light is available.
- **Retina:** A layer of tissue at the back of the eyeball containing cells that are sensitive to light and that trigger nerve impulses that pass via the optic nerve to the brain, where a visual image is formed. The retina has rods that differentiate between light and dark, and cones that allow us to see colors.

ACTIVITY 1: SET THE TONE

TIME: 15 Minutes

Supplies	#
Butcher Paper (sheet, folded)	1
Marker, black washable	1

GOAL: Establish your class community by doing a group check-in, learning names, and creating class agreements.

PROCEDURES:

NOTE: Start calling all of the students “scientists” throughout the program. This will encourage them to see themselves as the scientists they naturally are!

a) Thumb Check (OPTIONAL at the beginning of each class) (1 minute):

1. Gather students in a circle.
2. Do a quick “thumb check” to see how everyone is doing (e.g., students silently show how they’re doing by using their thumb as a gauge/meter. Thumb up is rating something highly, thumb down is rating something lowly, and feelings in between are rated as a thumb pointed towards the middle.)
3. First, ask students how they are feeling physically (e.g. thumb up = energized/ready to run a marathon and thumb down = sick/tired/injured.)
4. Next, ask students how they are feeling emotionally (e.g. thumb up = happy/glad/proud/interested and thumb down = sad/mad/bored.)
5. Thank students for sharing!

b) Name Game (4 minutes)

- Gather students in a circle and facilitate a Name Game. We recommend **NAME TOSS** (Page 103) but you may choose whichever you like or come up with your own!

c) Class Agreements (10 minutes)

- Once the Name Game is completed, retrieve your **butcher paper and marker** and facilitate a discussion among students to establish a set of class agreements. Class agreements are useful “rules” on how we will all work together in the classroom space and ensure everyone feels heard and respected.

Example questions:

- We have limited supplies in class. How can we share?*
- How do we safely use science supplies?*
- What is appropriate/inappropriate behavior in class?*
- How do we want to be treated in class?*
- How can we be our best selves in class?*
- What happens if someone breaks one of our agreements?*
- What are the clean-up procedures?*

- Once agreements are established, have students sign their name directly onto the paper, or use a stamp pad and thumb print.



ACTIVITY 2: ICEBREAKER

TIME: 10 Minutes

GOAL: Icebreakers are a great way to build community and a sense of belonging among your students. Plus, they're fun!

PROCEDURE:

- Select an icebreaker from the AKA Science Icebreaker Guide (Page 101).
- We recommend **COMMON GROUND** (Page 106) as your first icebreaker, but you are welcome to use any of the icebreakers listed in the guide or come up with your own.

ACTIVITY 3: PAIR & SHARE

TIME: 10 Minutes

Supplies	#
Pencils	16
Lab Notebooks	16
Worksheets	#
Consent Form for Publicity	16
Supply Advisories	16

GOAL: Gauge students' knowledge of today's subject and invite questions

PROCEDURE:

1. Pass out **a notebook and a pencil** to each scientist.
2. Ask a question that relates to today's subject. Have your scientists think about the question by drawing or writing in their notebooks or simply thinking about it.

Example Questions:

- *What is science?*
 - *What is physics?*
 - *How is color and/or light related to science?*
 - *Can you name the parts of our eyes?*
 - *How does a lens help you see?*
3. Ask the scientists to discuss their ideas with their neighbor before inviting students to share what they came up with. This is a "challenge by choice" opportunity and no one is required to share with the class if they are not comfortable.
 4. If they ask you questions and you don't know the answer, that's OK! Tell your scientists that you can find out together, either by looking up the answer or trying the class experiments. Showing children that adults don't always have the answer shows them that we are always learning, even when we are grown up.
 5. Be sure to pass out the **Consent Form for Publicity and the Supply Advisory** to all students either now or at the end of class. It is important to send these home on the first day.

ACTIVITY 4: MODEL EYE

TIME: 15 Minutes

SOURCE: bit.ly/451XwGT

Supplies	#
Crayons (black)	4
Crayons (box)	1
LED Lights (blue)	4
LED Lights (green)	4
LED Lights (red)	4
LED Lights (white)	4
Ping Pong Balls	16
Pipe Cleaners (half size)	16
Pushpins	4

BACKGROUND:

Our eyes are complex organs that allow us to see the world. Light enters through the pupil and is projected on the back of your eye. The image is translated into a signal that travels down the optic nerve attached to the back of each eye. The optic nerve sends the images from the eye to your brain. Scientists are trying to build prosthetic eyes! Prosthetics are eye replacements that can wire to the brain and help blind people regain their vision. They're getting better, but because your vision is so complex, engineers are still learning about how to connect a prosthetic eye to the brain through the optic nerve. If only it was as simple as using a pipe cleaner! (bit.ly/3OjwwLO)

SURVEY CONNECTION:



This activity is linked to the following survey question:

Q. Select the hypothesis (Circle one):

A. Mirrors reflect objects and bounce light rays.

GOAL: To create a simple model of the eye so scientists can visualize how our bodies process images.

WHAT GOES HOME: Finished model eye.

PROCEDURE:

1. **Tell scientists:** Dr. Patricia Bath was a famous eye doctor (ophthalmologist) and scientist. As the first black woman ophthalmologist in America, she invented a way to use lasers to cure some types of blindness! Today we are going to study how our eyes work, just like Dr. Bath.
2. Put scientists into four groups. Give each group **a pushpin, a black crayon, and a few colored crayons.**
3. Give each scientist **a ping pong ball and a half piece of pipe cleaner.**
4. Have students use a black crayon to draw a pea-sized circle in the center of the ball (this is the pupil). If the holes were prepared beforehand, have students draw the black circle around one of the holes. Color the circle to make it solid black.
5. If the holes weren't prepared, have students take turns using pushpins to carefully poke a hole through the black circle on the ping pong ball. After the hole is poked, wiggle the pin around to widen the hole to the size of a pencil tip (Photo 1.1).
6. Have students draw a larger circle with any color they choose (this is their iris) around the smaller pea-sized black circle.
7. Have students stick one end of the pipe cleaner into the back of the ping pong ball. If needed, they can use the pushpin to create the hole, then thread the pipe cleaner through it. The pipe cleaner represents the optic nerve. Have students guess which pieces represent which parts of the eye before you reveal the answers (Photo 1.2).
8. Hand each student **one LED light**. Try to make sure the students in each group have different colors of LED lights.
9. Go over LED light safety with students. Shining LED lights directly into an eye can cause damage and temporary blindness. Students should only turn their lights on when instructed to do so and should turn them off immediately after they use them for a task. Lights should always be pointed at the ground unless students are instructed otherwise.

Discussion Prompts:

- *What part of the eye do you think the white part represents?*
 - *The pipe cleaner?*
 - *The small pea-sized dot?*
 - *The larger circle around it?*
10. Turn off the lights.
 11. Have students point their LED lights at the ground then switch them on. If a light is dim or out, try squeezing, shaking, or tapping the light. Usually, the wiring just isn't perfectly lined up, and those actions will realign it.
 12. Explain to your scientists that a hypothesis is a testable question used in science. Tell them that as scientists, they will be making hypotheses throughout the AKA Science program. Hypotheses are sometimes in the form of an If-then statement, such as "If (I do this), then this

(will happen)." They can also sound more like a statement. Either way, they must contain wording about something you can test!

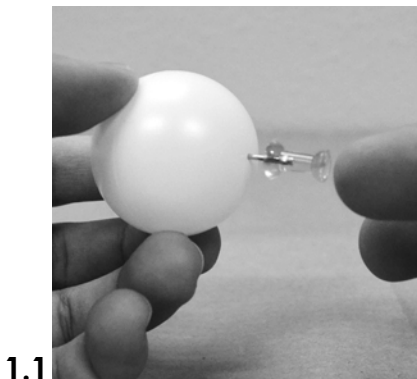
- "I think a mirror is useful" is an opinion.
- "Can a mirror reflect objects?" is a question.
- "If I shine a light in a mirror, then the light rays will bounce off it" is a hypothesis.
- "Mirrors reflect objects and bounce light rays" is a hypothesis statement.

13. Ask students to make a hypothesis about where the light will shine when we point it into their model eye.

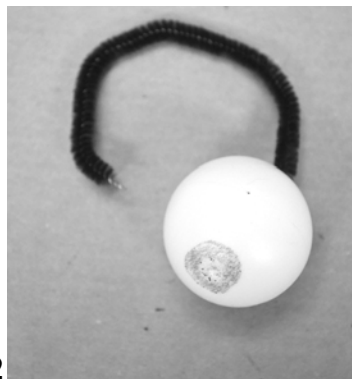
14. Have students hold their model eye in one hand with the pupil pointed towards the light. Being careful not to shine their lights in anyone's eyes, have them shine the light through the pupil hole into the model eye. The light will cause a bright spot to appear inside the ping pong ball (this is the retina, which receives the light after it passes through the pupil and lens then sends signals along the optic nerve to the brain) (Photo 1.3).

TIP: Practice making hypotheses with your class every time you see the word "hypothesis" or "hypothesize" in the curriculum!

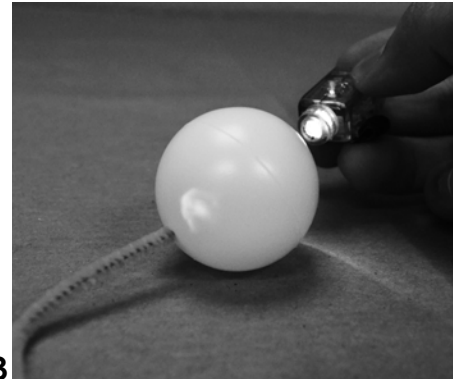
ACTIVITY PHOTOS:



1.1



1.2



1.3

ACTIVITY 5: LENS-A-PALOOZA

TIME: 15 Minutes

SOURCE: Sarah Andersen, Oregon Health Career Center

Supplies	#
Cups (10oz, plastic, tall)	4
LED Lights (blue)	4
LED Lights (green)	4
LED Lights (red)	4
LED Lights (white)	4
Lenses (concave)	4
Lenses (convex)	4
Mirror Boards	4
Water	
Worksheets	#
How Lenses Bend Light	2

BACKGROUND:

Light travels in a straight line, until it encounters something like water, glass, or plastic. These substances slow the ray of light and “bend” it before it continues along its path. This is how lenses work, whether they are the lenses of our eye or made of plastic and used for glasses. Light traveling through the air enters the lens, and depending on the type of lens, the light is bent in a certain direction. In convex lenses, light is bent together so it converges to a point in front of your eyes. In concave lenses, the light is bent so that when it leaves the lens, it scatters away in different directions. Devices like microscopes and telescopes use compound lenses, which combine multiple lenses to highly magnify the object being viewed (bit.ly/3s0ET7t).

SURVEY CONNECTION:



This activity is linked to the following survey question:

Q. What happens to light when it passes through things like water or binoculars?

A. The light bends

GOAL: To examine how lenses and water can change the path of light.

WHAT GOES HOME: Nothing

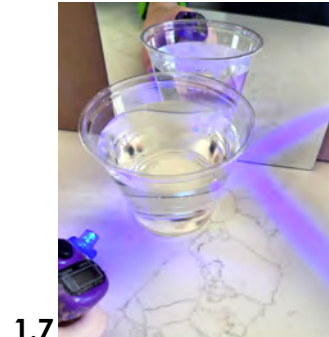
PROCEDURE:

1. Group students into four groups. Provide each group with **one of each type of lens (convex and concave), 4 LED lights (one of each color), a cup for water (from prep), and a mirror board**. Warn students that the glass lenses are delicate, so they should try not to drop them. Further, the lenses will work best if they avoid getting their fingerprints on the glass. Demonstrate holding the lens by its sides.
2. Have the students start by examining and comparing their two lenses, and then discuss what they notice.
3. Discuss the difference between concave and convex lenses (concave lenses bend inward, convex bulge outward).

Discussion Prompts:

- *Can you think of any everyday objects that use lenses?*
 - *How are the two lenses in front of you different and similar? Do you think they bend light in the same way?*
4. Have the students hypothesize what will happen with each lens when a light is shined through it. Will the color of the LED make an impact?
 5. Show students the **How Lenses Bend Light worksheet**. Place the two copies around the room so that each student can see one of them.
 6. Have the groups hold their lenses so they are positioned in front of the mirror board. The mirror board can be either propped against a wall or held by one scientist in each group.
 7. Have the students experiment with shining their LED lights through each lens. It may be helpful to dim the lights in the room for this (Photo 1.4).
 8. Challenge the students to try to use one of the lenses to focus the flashlight beam into a single point on the wall. Have them compare their attempts with each of the lenses.
 9. Encourage the students to experiment with the distance between the flashlight and their lenses as well as the distance between their lenses and the wall.
 10. Have the students line up both lenses at once in front of the flashlight beam and see what happens. Try this in both configurations (i.e., convex in front concave, and concave in front of convex).
 11. Now have the scientists switch to shining the light through the cup of water onto the mirror board. Which made a bigger impact on focusing the beam of light – the cup of water or one of the lenses (Photo 1.5)?
 12. What happens if they use a lens and the water (Photo 1.6)? Does the ray of light change? Does the color of the LED matter (Photo 1.7)?
 13. Have the students pass the lenses around in their group and look through them. Encourage the students to notice if objects look larger, smaller or the same size.

ACTIVITY PHOTOS:



ACTIVITY 6: DAILY DEBRIEF

TIME: 5 Minutes

GOAL: Reflect on what was explored during the activities and relate to students' own lives.

PROCEDURE:

1. Gather students in a circle.
2. Ask questions that facilitate a thoughtful reflection of the day's lessons. Questions may be considered in a Pair & Share model.
3. If you are short on time, have students think about the questions while they are cleaning up from the activities.

Example questions:

- *What happened today?*
- *What would it be like to have a third eye?*
- *What was a challenge that you overcame?*
- *What would we do if we had more time?*
- *How does what we learned today apply to your personal life?*

CLEAN UP: Implement a fun, daily clean-up routine so that students practice being "truly helpful" to their AKA Science community.

WHAT TO SAVE: Some items will carry over into future classes and others will require proper disposal. We have created a table to help organize your materials by when they will be used again. If an item has a number in the column marked "move to:", all the items used today should be moved to the

Fun Physics: Color & Light (Grades 6-8)

Class 1: Surprising Eyes

new class bag. If marked "send home", the items are to go home with your scientists. "Save for SUN, recycle, or discard" means the items can be kept for use by your site or discarded as needed.

*****Remember to send home the Supply Advisory and Consent Form for Publicity with each person today. If the Consent Form for Publicity is returned, you can take pictures of students doing activities!*****

Supplies	Move to:	Send home	Save for SUN, recycle, or discard
Butcher Paper (sheet, folded)	Kit box		
Crayons, black	Class 2		
Crayons, box	Class 2		
Cups, 10oz	Class 4		
Lab Notebooks	Class 2		
LED light, blue	Class 4		
LED light, green	Class 5		
LED light, red	Class 4		
LED light, white	Class 4		
Lenses, concave			X
Lenses, convex			X
Markers, black, washable	Class 3		
Mirror boards	Class 5		
Pencils	Class 2		
Ping pong balls		X	
Pipe cleaners, ½ size		X	
Pushpins	Class 3		
Tape, Scotch rolls	Class 3		
Worksheets			
Consent Form for Publication (Media Release)		X	
How Lenses Bend Light			X
Supply Advisories		X	

GRAND TOTAL OF WHAT GOES HOME: Model eye, supply advisory, consent form for publication.

CLASS 2: EYE ON THE PRIZE

Supplies (in class bags)	#
3D glasses	16
Crayons, black	4
Crayons, blue	4
Crayons, box	2
Crayons, red	4
Cups, dixie	8
Eye patches	16
Lab notebooks	16
Pencils	16
Pennies	16
Scissors (site provides)	16
Worksheets (in envelopes)	#
3D Images (double-sided half sheet)	16
Blind spot strips	16
Paper, white, full sheet	16
Secret Decoder Message (quarter sheets)	16

PREP STEPS:

- None!

VOCABULARY:

- **Peripheral vision:** What is seen on the side, above, or below by the eye when looking forward, without moving your head.

ACTIVITY 1: THUMB CHECK-IN (Optional)

TIME: 2 Minutes

GOAL: To encourage community building, provide an opportunity to reflect on the day, and create a safe space for students to feel like they belong.

PROCEDURE:

1. Gather students in a circle.

2. Do a quick "thumb check" to see how everyone is doing (e.g., students silently show how they're doing by using their thumb as a gauge/meter. Thumb up is rating something highly, thumb down is rating something lowly, and feelings in between are rated as a thumb pointed towards the middle.)
3. First, ask students how they are feeling physically (e.g. thumb up = energized/ready to run a marathon and thumb down = sick/tired/injured.)
4. Next, ask students how they are feeling emotionally (e.g. thumb up = happy/glad/proud/interested and thumb down = sad/mad/bored.)
5. Thank students for sharing!

ACTIVITY 2: LAND ACKNOWLEDGEMENT

TIME: 5 Minutes

Supplies	#
Pencils	16
Lab Notebooks	16

GOAL: A Land Acknowledgement acknowledges not only the ancestral lands, but also the historical and complex intersections of settler impacts on Indigenous histories, economies, ecologies, livelihood, well-being and governance structures. Land Acknowledgements are an expression of gratitude and appreciation to those whose territory you reside on, and a way of honoring the Indigenous people who have been living and working on the land from time immemorial. We share the Land Acknowledgement with our students to create space for reflection and to inspire support for Indigenous communities.

PROCEDURE:

1. Ask the scientists if they know what a Land Acknowledgement is.
2. Read the following Land Acknowledgement aloud to your class:

We recognize the unique and enduring relationship that exists between Indigenous People and their traditional territories. We acknowledge that we are on the historic homeland of the Multnomah, Wasco, Cowlitz, Kathlamet, Clackamas, Bands of Chinook, Tualatin, Kalapuya, Molalla tribes. Let this acknowledgement serve as a reminder of our ongoing efforts to recognize, honor, reconcile and partner with the Indigenous peoples whose lands and water we benefit from today.

TIP: If you would like a different Land Acknowledgement to read to your class, please check akascience.org for more resources.

Discussion Prompts:

- *Who lives in our community?*
 - *How do members interact to form our community?*
 - *How do organisms in the natural world interact to form a community?*
 - *How can we interact with our natural environment's resources in a way that is respectful and enduring?*
3. Scientists can discuss these questions out loud or use their notebooks to write or draw their ideas.
 4. Tell everyone that later in class they will learn about some Indigenous practices that have been used for many years. These practices show how physics can be used in everyday life!

ACTIVITY 3: ICEBREAKER

TIME: 10 Minutes

GOAL: Icebreakers are a great way to build community and a sense of belonging among your students. Plus, they're fun!

PROCEDURE:

1. Select an icebreaker from the AKA Science Icebreaker Guide (Page 101).
2. We recommend **HEAD HONCHO** (Page 104), but you are welcome to use any of the icebreakers listed in the guide or come up with your own.

ACTIVITY 4: PAIR & SHARE (Optional today)

TIME: 5 Minutes

Supplies	#
Pencils	16
Lab Notebooks	16

GOAL: Gauge students' knowledge of today's subject and invite questions

PROCEDURE:

1. Pass out **a notebook and a pencil** to each scientist.

2. Ask a question that relates to today's subject. Have your scientists think about the question by drawing or writing in their notebooks or simply thinking about it.

Example Questions:

- *How do our eyes work?*
 - *Would having eyes on the sides of our heads change the way we see?*
3. Ask students to discuss their ideas with their neighbor before inviting students to share what they came up with. This is a "challenge by choice" opportunity and no one is required to share with the class if they are not comfortable.

ACTIVITY 5: ARE TWO EYES BETTER THAN ONE?

TIME: 10 Minutes

SOURCE: *Science Works -65 Experiments that Introduce the Fun and Wonder of Science from the Ontario Science Center*

Supplies	#
Cups (Dixie)	8
Eye Patches	16
Pencils	16
Pennies	16

BACKGROUND:

Binocular vision is an adaptation we have that uses two eyes facing forward with overlapping fields of view to provide us with good depth perception. Having two eyes helps us determine the position and distance of things around us. The brain fixes an image with one eye (our dominant eye) and uses the information from the second eye to add dimension and depth. Humans aren't the only animals that use binocular vision. Other animals that use binocular vision are predators. Predators are animals that eat other animals. Some examples are hawks, lions, and wolves. They must be able to see what is in front of them clearly so they can catch their prey.

The Large Binocular Telescope is in Arizona. It looks like a face with two big telescopes for eyes - but this face is 25 yards wide! The two telescopes work together to get a better view of nearby planets, like Jupiter. (bit.ly/44W2swF, bit.ly/3KxcwnF)

GOAL: By using only one eye, we can demonstrate why the depth perception provided by having two eyes is important.

WHAT GOES HOME: Penny, eye patch

PROCEDURE:

1. Pair students.
2. Give each student an **eye patch and a pencil**.
3. Give each pair **two pennies and a Dixie cup**. Have each pair set the cup on a table.
4. Have one member in each pair stand about 9 feet away from the table.
5. Have the other member hold a penny as high as they comfortably can somewhere over the cup, but not directly above it (Photo 2.1).
6. Tell students that the job of the person standing back from the table is to look at the penny and tell their partner where to move their arm so the penny will fall into the cup when they drop it. The person giving directions must cover one eye with their eye patch (Photo 2.2).
7. The person giving directions can use phrases like, "towards me," and "away from me," and point to their right or left to tell their partner where to move the penny.
8. The partner moving the penny should move slowly and smoothly, like a claw machine. To resist helping their partner, they should look only at their partner, and not how close the penny is to the cup.
9. The partner giving directions can say, "Drop it!" when they think the penny is in line with the cup. Have students repeat with the second penny.
10. Have students repeat the activity using the other eye.
11. Have students give instructions with both eyes open.
12. Have students switch roles and repeat the activity.

Discussion Prompts:

- Which was easier: using one eye or both eyes?
- Why do you think we have two eyes?
- When is it useful to be able to judge position and depth?

OPTIONAL:

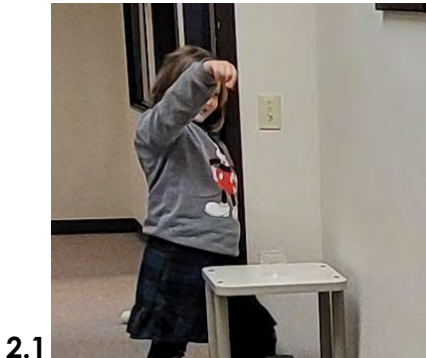
1. Tell students that even though our eyes work together, one eye is usually dominant.
2. Ask students to make a hypothesis about which eye they think is their dominant eye.
3. Have students make a circle with their thumb and index finger.
4. Focus on an object in the distance (like a corner of the ceiling).
5. While focusing on the object in the distance, move their finger circle so the object is in the middle of the circle.
6. Without moving their finger circle, use their other hand (or the eye patch) to cover one eye and see what happens. Then try the other eye.

7. Most people's right eye is dominant, meaning that the right eye will show the object in the middle of the circle.

Discussion Prompts:

- What happened?
- Which eye was dominant?
- Why do you think we have a dominant eye?
- What are some other ways we could test for eye dominance?
- When might it be important to know which eye is dominant?

ACTIVITY PHOTOS:



ACTIVITY 6: 3D!

TIME: 20 Minutes

SOURCE: www.rainbowsymphony.com

Supplies	#
3D Glasses	16
Crayons (black)	4
Crayons (blue)	4
Crayons (box)	1
Crayons (red)	4
Scissors (site provides)	16
Worksheets	#
3D Images (double-sided half sheets)	16
Paper (8.5inx11in, sheets, white)	16
Secret Decoder Message (quarter sheets)	16

BACKGROUND:

3D glasses can work in a few different ways. The ones in this activity have a red lens and a blue lens. This blocks either red or blue colors from your eyes. By creating the same image in two different colors and looking at it through these glasses, it forces your eyes to see two different images. This mimics what your eyes would see in real life, with each eye seeing a slightly different perspective or image. Your brain doesn't know it's being tricked, so it translates the two images into a 3D picture.

You can see 3D images in lots of different ways. Some 3D glasses use polarized filters; light waves move in different directions – some waves move up and down, and other waves move side to side. By blocking one or the other, polarized glasses can force your eyes to see a different image in each eye, so things look 3D. (bit.ly/47oBolk)

SURVEY CONNECTION:



This activity is linked to the following survey question:

Q. Select the hypothesis (Circle one):

A. Mirrors reflect objects and bounce light rays.

GOAL: To understand how colored filters affect what we see using 3D glasses.

WHAT GOES HOME: 3D glasses, 3D Image worksheet, Secret Decoder Message worksheet, Any drawings

PROCEDURE:

1. **Tell Students:** Valerie Thomas is a Black data analyst who was working for NASA when she invented a way to transmit 3D images onto a screen. Without this technology, we wouldn't have 3D movies! Let's explore how our eyes can see images in 3D, just like Dr. Thomas.
2. Give each scientist a pair of **3D glasses**, if they don't fit well on students' faces, have students simply hold the glasses in front of their eyes.

Discussion Prompts:

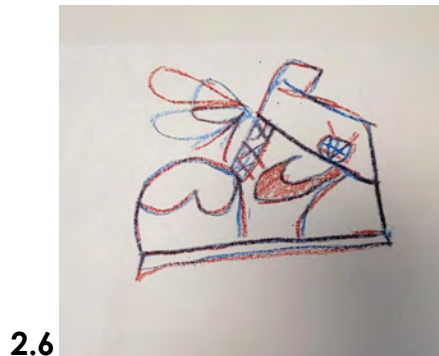
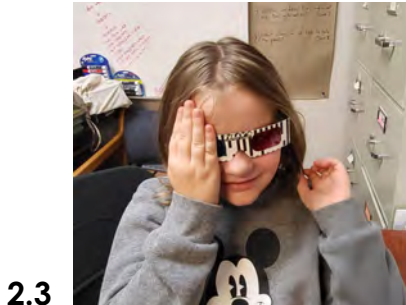
- *Have you ever used 3D glasses before?*
 - *How do you think they work?*
3. Have students close (or cover) one eye and look only through the red lens while exploring the room (Photo 2.3).

4. Point out some things in the room that are red, orange, yellow and white and have students look at them through the red lens. Discuss with the students what they see.
5. Have students look at the same items through the blue lens, and again discuss what they see.

Discussion Prompts:

- *What happens when you look at objects that are the same color as the lens you're looking through?*
 - *What about objects the opposite color of the lens? Why?*
6. Point out some things in the room that are blue, turquoise, and green, and have students look at the items through the blue lens and discuss what they see.
 7. Have students look at the same items through the red lens and discuss what they see.
 8. Give each student a **Secret Decoder worksheet**.
 9. Have students close one eye so they look only through the blue lens, then discuss what they see (Photo 2.4).
 10. Have students look at the picture through the red lens, then discuss what they see (Photo 2.5).
 11. Have students remove their 3D glasses in preparation for the next step.
 12. Give each scientist a **3D Images worksheet**, have them examine it without the 3D glasses on, and make a hypothesis about what they will see with the glasses on.
 13. Have students look at the worksheets through their 3D glasses. Note: the rock landscape can be slightly challenging to see. Students may need to adjust the focus of their eyes and/or hold the paper further away from them.
 14. Have the students discuss what they see and consider what features of the image work to make it appear 3D when seen through the glasses.
 15. Explain that when your right eye looks at the 3D drawings through the blue filter, the red/orange part of the picture looks black, and the blue part disappears. When your left eye looks at the drawing through the red filter, the blue part of the drawing looks black, and the red part disappears. This means your right eye sees one black drawing, while your left eye sees a slightly different black drawing. Your brain merges the two together to make a single 3D image.
 16. Hand out the **crayons** and give each student **a sheet of paper**. Have students try to make their own secret decoder messages and/or 3D images. Once they've finished creating their own image, have students share/pass around what they've made and try out their glasses on different illusions (Photo 2.6)!

ACTIVITY PHOTOS:



ACTIVITY 7: BLIND SPOT

TIME: 5 Minutes

SOURCE: *Biology Life on Earth - 7th ed. by Teresa & Gerald Audesirk & Bruce Byers*

Supplies	#
Pencils	16
Worksheets	#
Blind Spot (strips)	16

BACKGROUND:

As you learned from the eye model, the retina receives light and turns it into signals. However, at the spot where the optic nerve exits the eyeball—where your pipe cleaner is connected to your ping pong ball—the retina can't receive light, which creates a small blind spot in our field of vision. Usually, the brain fills in the gap with information from our environment and our other eye, so we're not aware that anything is missing. Some animals don't have blind spots! An octopus doesn't have a blind spot because the nerves in its eyes don't block any cells, so its whole eye is able to see. (bit.ly/3rKhwyK)

GOAL: Explore our natural blind-spots using a vision exercise

WHAT GOES HOME: Blind spot strip

PROCEDURE:

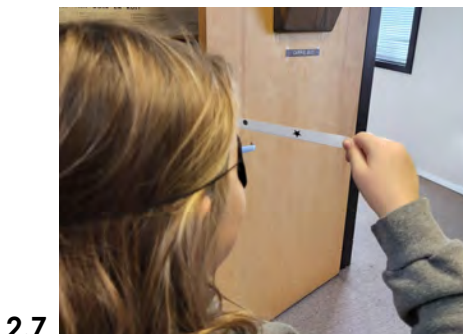
1. Give each scientist a **Blind Spot strip and a pencil**. Have them hold the strip so that the star is on the left and the dot is on the right.
2. Have students cover their left eye and hold the strip about an inch from their face, with the star on the left (Photo 2.7). They should:
 - a. Focus on looking at the star and notice the dot visible in their peripheral vision. *Make sure the star is on the same side as the covered eye, i.e., both on the left.*
 - b. Slowly move the paper away from their face, staring at the star, and watching for the moment the dot disappears and then reappears in their peripheral vision.
 - c. If any students don't see the dot disappear and reappear, they can try covering their right eye instead of their left.

Discussion Prompts:

- *What happened?*
 - *Why did the dot disappear?*
 - *Where else do we talk about blind spots?*
3. If time allows, have students draw a straight line between the star and the dot with a pencil, then repeat the activity. When the dot disappears, it looks like the line goes straight through the empty space!

TIP: If your scientists are having trouble with this activity, try taping the strip to the wall and have them move their bodies back and forth (Photo 2.8).

ACTIVITY PHOTOS:



ACTIVITY 8: DAILY DEBRIEF

TIME: 5 Minutes

GOAL: Reflect on what was explored during the activities and relate to students' own lives.

PROCEDURE:

1. Gather students in a circle.
2. Ask questions that facilitate a thoughtful reflection of the day's lessons. Questions may be considered in a Pair & Share model.
3. If you are short on time, have students think about the questions while they are cleaning up from the activities.

Example questions:

- *What happened today?*
- *How does 3D work?*
- *What was a challenge that you overcame?*
- *What would we do if we had more time?*

CLEAN UP: Implement a fun, daily clean-up routine so that students practice being "truly helpful" to their AKA Science community.

WHAT TO SAVE: Some items will carry over into future classes and others will require proper disposal. We have created a table to help organize your materials by when they will be used again. If an item has a number in the column marked "move to:", all the items used today should be moved to the new class bag. If marked "send home", the items are to go home with your scientists. "Save for SUN, recycle, or discard" means the items can be kept for use by your site or discarded as needed.

*****See next page for WHAT TO SAVE table and WHAT GOES HOME.*****

Fun Physics: Color & Light (Grades 6-8)

Class 2: Eye On the Prize

Supplies	Move to:	Send home	Save for SUN, recycle, or discard
3D glasses		X	
Crayons, black	Class 3		
Crayons, blue	Class 3		
Crayons, box	Class 3		
Crayons, red	Class 3		
Cups, dixie	Class 4		
Eye patches		X	
Lab notebooks	Class 3		
Pencils	Class 3		
Pennies		X	
Scissors (site provides)			X
Worksheets			
3D Images (double-sided half sheets)		X	
Blind spot strips		X	
Paper (8.5inx11in, sheets, white)		X	
Secret Decoder Message (quarter sheets)		X	

GRAND TOTAL OF WHAT GOES HOME: Pennies, eye patches, blind spot strips, 3D Glasses, and 3D worksheets/drawings.

If any new scientists joined your class this week, remember to send home the Supply Advisory and Consent Form for Publication with each student.

CLASS 3: ILLUSTRIOUS ILLUSIONS

Supplies (in class bags)	#
Crayons, black	4
Crayons, blue	4
Crayons, box	2
Crayons, red	4
Lab notebooks	16
Lubor's lenses	16
Markers, black	16
Pencils	16
Pushpins	4
Rulers, plastic	4
Scissors (site provides)	16
Tape, rolls Scotch	4
Wooden tops	16
Yarn, 4ft loops	16
Worksheets (in envelope)	#
Benham's Disk, cardstock quarter sheet	16
Fishbowl Thaumatrope, cardstock half sheet	16
Paper, white ¼ sheet	16
Paper, white ½ sheet	16

PREP STEPS:

- **Act 3. (optional):** Unwrap and assemble wooden tops.

VOCABULARY:

- **Afterimage:** An impression of a visual image retained after the stimulus has ceased (e.g. closing your eyes, looking away).
- **Illusion:** A thing that is or is likely to be wrongly perceived or interpreted by the senses.
- **Persistence of vision:** The retention of a visual image for a short period of time after the removal of the stimulus that produced it: the phenomenon that produces the illusion of movement when viewing motion pictures.
- **Thaumatrope:** A disk with a picture on each side is attached to two pieces of string. When the strings are twirled quickly between the fingers the two pictures appear to blend into one.

ACTIVITY 1: THUMB CHECK-IN (Optional)

TIME: 2 Minutes

GOAL: To encourage community building, provide an opportunity to reflect on the day, and create a safe space for students to feel like they belong.

PROCEDURE:

1. Gather students in a circle.
2. Do a quick "thumb check" to see how everyone is doing (e.g., students silently show how they're doing by using their thumb as a gauge/meter. Thumb up is rating something highly, thumb down is rating something lowly, and feelings in between are rated as a thumb pointed towards the middle.)
3. First, ask students how they are feeling physically (e.g. thumb up = energized/ready to run a marathon and thumb down = sick/tired/injured.)
4. Next, ask students how they are feeling emotionally (e.g. thumb up = happy/glad/proud/interested and thumb down = sad/mad/bored.)
5. Thank students for sharing!

ACTIVITY 2: ICEBREAKER

TIME: 10 Minutes

GOAL: Icebreakers are a great way to build community and a sense of belonging among your students. Plus, they're fun!

PROCEDURE:

1. Select an icebreaker from the AKA Science Icebreaker Guide (Page 101).
2. We recommend **TWO TRUTHS AND A LIE** (Page 103), but you are welcome to use any of the icebreakers listed in the guide or come up with your own.

ACTIVITY 3: PAIR & SHARE

TIME: 5 Minutes

Supplies	#
Pencils	16
Lab Notebooks	16

GOAL: Gauge students' knowledge of today's subject and invite questions

PROCEDURE:

1. Pass out **a notebook and a pencil** to each scientist.
2. Ask a question that relates to today's subject. Have your scientists think about the question by drawing or writing in their notebooks or simply thinking about it.

Example Questions:

- Have you ever seen an optical illusion before?
 - How do you think cartoons were made before computers?
3. Ask students to discuss their ideas with their neighbor before inviting students to share what they came up with. This is a "challenge by choice" opportunity and no one is required to share with the class if they are not comfortable.

ACTIVITY 4: FISHBOWL THAUMATROPE

TIME: 15 Minutes

SOURCE: *The Exploratorium Science Snackbook* by The Exploratorium Teacher Institute, *Science Works-65 Experiments that Introduce the Fun and Wonder of Science* from the Ontario Science Center

Supplies	#
Crayons (blue)	4
Crayons (box)	2
Crayons (red)	4
Scissors (site provides)	16
Tape (rolls, Scotch)	4
Yarn (4ft loops)	16
Worksheets	#
Fishbowl Thaumatrope	16

BACKGROUND:

Your eye and brain hold onto a visual image for about $1/30^{\text{th}}$ of a second - scientists call this phenomenon persistence of vision, because an image persists in our vision even after we can't see it anymore. The effect of the images on a thaumatrope combining happens because of persistence of vision. When you see one of the pictures, your eye holds onto that image for a fraction of a second, even after you spin the disc to see the other picture. As you keep spinning the disc, your brain blends each image with the next one, which makes it look like you're seeing them both at the same time!

Persistence of vision inspired the invention of animation! By flashing images quickly one after the other, animators fool your brains into thinking that you're seeing a moving image, or "motion picture," as movies were originally called. Disney's 1989 version of *The Little Mermaid* is made up of over one million drawings! (bit.ly/3DOFWyB)

GOAL: To introduce the concept of persistence of vision using a thaumatrope.

WHAT GOES HOME: Fishbowl Thaumatrope

PROCEDURE:

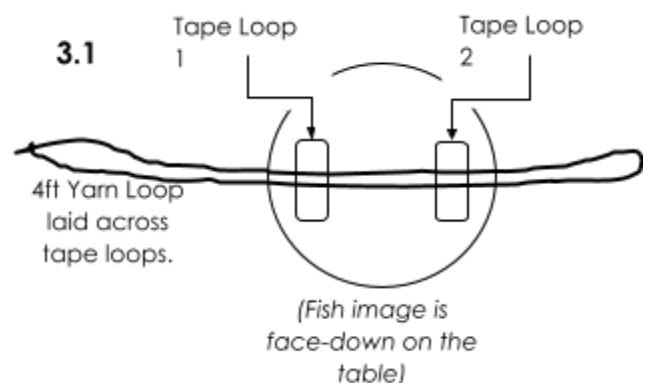
1. Give each student a **Fishbowl Thaumatrope worksheet**, a pair of scissors, and a 4ft yarn loop. Make **crayons** and **tape** available.

Discussion Prompts:

- Have you ever seen an optical illusion before?
- How do you think optical illusions work?

2. Have students:

- a. Use a blue, red or green crayon to color the fish on the worksheet. Fill in the shape with color completely, so it is a brilliant, solid color.
- b. Stare intently at the black dot of the fish's eye for about 30 seconds.
- c. Quickly look at the empty fishbowl on the worksheet.
- d. Discuss what happens! Students should see an afterimage of the fish in the bowl in the opposite color to the one they colored with.

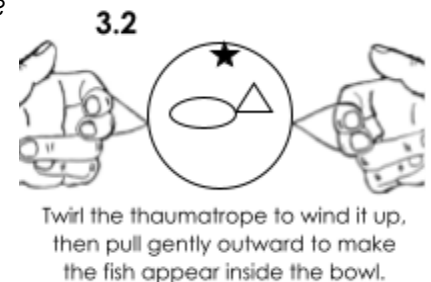


Discussion Prompts:

- What happens after staring at the black dot and looking away? What do you see?
 - Why do you think afterimages happen?
3. Explain that afterimages happen because our eyes have different types of sensors. Each sensor is responsible for detecting a particular type of color. If you focus on a single color for too long, those specific color sensors can become tired, so other sensors take over when you look away.
 4. Have students:
 - a. Cut out the fish and bowl circles along the border.
 - b. Flip the fish circle over.
 - c. Make two tape loops (sticky on both sides) and place one on each side of the circle (Diagram 3.1).
 - d. Lay the yarn loop across the tape loops. The yarn loop should be centered in the middle of the circle with the knot to one side. Make sure the yarn lines up with the lines at the edges of the circles (Diagram 3.1).
 - e. Place the bowl circle face-up on the tape loops so the image of the bowl is upside-down. The stars on the fish and bowl circles should be in the same position (i.e., both at the top) (Photo 3.1).
 - f. Press the circles together to make sure the tape sticks to both circles.

Discussion Prompts:

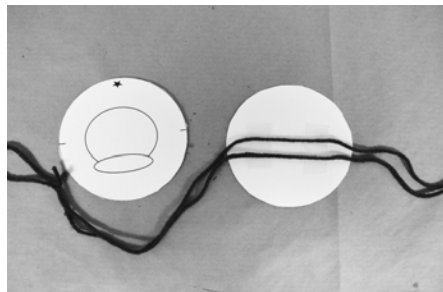
- How do you think cartoons were animated before computers?
 - How is the effect of our thaumatrope similar to animation?
5. Introduce this device as a thaumatrope. Thaumatrope were invented thousands of years ago. More recently though, they helped to inspire the first animations.
 6. Show students how to use the thaumatrope:
 - a. Hold one loop of string in two fingers of each hand (see diagram).
 - b. Twirl the thaumatrope in circles (10-12 times) to wind it up, then pull your hands apart (still holding the loops) to make the yarn quickly unwind (Diagram 3.2).
 - c. Have the students discuss what they see!



Discussion Prompts:

- What happens when you unwind your thaumatrope quickly? What do you see?
- Why do both of the images appear to combine into one when they spin?

ACTIVITY PHOTOS:



3.1

ACTIVITY 5: NOT IN KANSAS ANYMORE

TIME: 10 Minutes

SOURCE: Awesome Experiments in Light & Sound, Michael DiSpezio and Catherine Leary

Supplies	#
Pushpins	4
Scissors (site provides)	16
Tape (rolls, Scotch)	4
Wooden tops (spinners)	16
Worksheets	#
Benham's Disk (quarter sheets)	16

BACKGROUND:

The "Artificial Spectrum Top" invented by C.E. Benham was first released in 1894 as a toy to study optics. The disc is special because its rotating black and white pattern fools the viewer's brain into seeing color! Scientists are still debating why our brains perceive color in these circumstances. One of the top theories is related to persistence of vision and suggests the alternating black/white pattern triggers our eye's color sensors into thinking we're seeing color. Other Benham patterns are available online. Try them out and see what colors they reveal! (bit.ly/3OLgVWC)

SURVEY CONNECTION:



This activity is linked to the following survey question:

Q. Select the hypothesis (Circle one):

A. Mirrors reflect objects and bounce light rays.

GOAL: To show how the brain can be tricked into seeing black and white as color using Benham's Disk.

WHAT GOES HOME: Benham's Disk on wooden top

PROCEDURE:

1. Give each student a **Benham's Disk worksheet**. Make **scissors** available.
2. Have students cut out the disk as well as they can. The experiment works best with a perfect circle but will still work with slight unevenness.

Discussion Prompts:

- *What do you see when you look at this disk? What do you think we might use it for?*
 - *What might we see if we spin the disk very fast?*
3. Give each student one **wooden top** and invite them to practice spinning their top a few times in each direction.
 4. Make **pushpins** and **scotch tape** available. Have students gently poke their wooden spinners through the center of the paper Benham's Disk, so that the disk comes to rest on the topside of the spinner's base. The pushpins can be used to start a central hole on the paper disk, if students have trouble using the spinner to poke the hole. Tape can be used to secure the disk to the wooden spinner base, if the fit is not snug enough (Photo 3.2).
 5. Have the students hypothesize about what they think they'll see when they spin their wooden tops, then invite them to give their tops a whirl. Ask them to focus on the black bands and see if anything changes. Note that in order to see the effect, they will have to spin it consistently, evenly and pretty quickly. If some students are struggling, have them observe a student who has a consistent spin.
 6. Encourage your students to try spinning their top in both directions (clockwise and counter-clockwise) and note any differences.

Discussion Prompts:

- *Do you observe any differences when you spin the disk in the opposite direction?*
- *Why do you think we see colors when there aren't any?*
- *Do you think other patterns might create similar effects or optical illusions?*

OPTIONAL:

If there is extra paper readily available in your classroom, students are free to cut out their own blank disks to decorate or attempt to design their own optical illusion pattern to put on their wooden top and see what happens!

ACTIVITY PHOTOS:



ACTIVITY 6: LUBOR'S LENS

TIME: 10 Minutes

SOURCE: Dr. Carrie Buo, AKA Science

Supplies	#
Lubor's lenses	16
Markers, black	16
Worksheets	#
Paper, white ¼ sheet	16

BACKGROUND:

If you've ever wished to have an invisibility cloak, we have an activity just for you! Today you'll be using a small piece of plastic called a Lubor's lens. This lens is a type of Fresnel (pronounced fray-nel) lens that distorts the objects behind it using a series of grooves. A typical Fresnel lens is used to magnify a light source many times with less material - think the giant lenses used in lighthouses.

Chemical engineer and amateur magician Lubor Fiedler invented a new type of Fresnel lens that uses the grooves in the lens to redirect light waves and elongate objects, depending on how the lens is rotated. This gives the illusion of some objects disappearing behind the lens and others appearing from the background. Try the Lubor's lens with your class and see if they can figure out what is happening! (bit.ly/3QXlcb9, bit.ly/3OW1mdx)

GOAL: To explore optical illusions using a Lubor's lens.

WHAT GOES HOME: Lubor's lens, Any drawings

PROCEDURE:

1. **Tell the class:** A Czech chemist and amateur magician named Lubor Fiedler invented the item we will be using in our next activity. This lens, called Lubor's lens, is a type of lens that can redirect light waves and elongate objects with sometimes surprising results. Today we will explore a magic trick that is powered by science, just like Lubor Feidler.
2. Pass out a **1/4 piece of white paper and a black marker** to each scientist.
3. Have everyone draw two dark vertical lines and two dark overlapping horizontal lines, similar to a tic-tac-toe board (Photo 3.3).

Discussion Prompts:

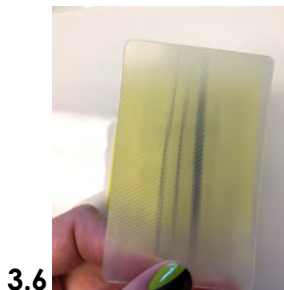
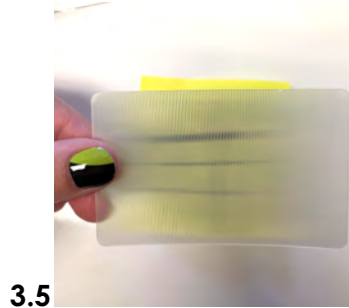
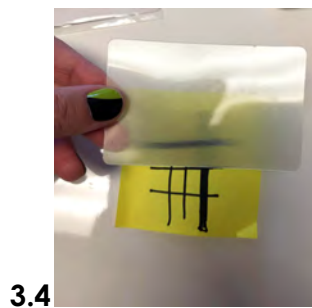
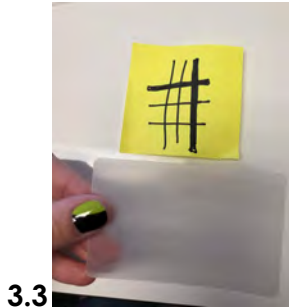
- *You have just drawn lines with permanent markers. How could you get rid of some of the marks?*
- *Can you think of a material that would make half of the lines disappear?*

3. Pass out a **Lubor's lens** to each scientist.
4. Have them hold the lenses about 6 inches above their drawing and look through them. Ask them to describe what they see. Only one set of lines, either vertical or horizontal, should be visible (Photo 3.4 - 3.5).
5. Have them turn their lenses 90 degrees. The visible set of lines should become invisible, and the invisible will become ones visible (Photo 3.6)!

Discussion Prompts:

- *Why do you think this is happening? (Answer in the background paragraph)*
 - *Would this have any practical applications in life? (Now it's used as a magic trick!)*
6. Now try holding the black marker behind the Lubor's lens. If held in front of another object, which one is visible?
 7. Have your scientists pair up and stack their lenses together. They should observe lines in the lenses when two are close together. This is a false magnification - it looks like several large, wide lines but they are actually very small lines. The light and the ridges on the lenses make the lines seem bigger than they actually are.
 8. If there is time, ask the scientists to draw other shapes (circle, star, triangle) and see how the Lubor's lens affects the way they look.

ACTIVITY PHOTOS:



ACTIVITY 7: 3D ILLUSION DRAWINGS

TIME: 10 Minutes

SOURCE: bit.ly/3s9raLL

Supplies	#
Crayons, black	4
Crayons, blue	4
Crayons, box	2
Crayons, red	4
Pencils	16
Rulers, plastic (optional)	4
Worksheets	#
Paper, ½ sheet white	16

BACKGROUND:

Even though we are 3-dimensional beings in a 3-dimensional world, our eyes are only capable of seeing in 2-D. Our brains take the 2-D image that we see and project the illusion of 3-D by adding depth to objects. This is why binocular vision is so useful - without two eyes your brain has a harder

time projecting depth onto the objects you look at. We can use the brain's ability to interpret depth to deceive ourselves into seeing a 2-D drawing as a 3-D object, using a little creativity and a simple drawing trick. (bit.ly/3qK55TC)

GOAL: To make a drawing of a simple object appear 3D.

WHAT GOES HOME: 3D Drawings

PROCEDURE:

1. Gather scientists into four groups. Pass out **a half sheet of white paper and pencil** to each scientist.
2. Provide each group with **a ruler and a box of crayons** to share.

Discussion Prompts:

- *Do you remember testing out 3D glasses in the first class? What happened?*
- *Can you think of another way we can see things in 3D?*

3. Have scientists draw a simple shape on their paper, an oval or triangle works well. They should sketch lightly with pencil and leave room all around the outside of the shape (Photo 3.7).
4. Starting at one far edge of the paper, scientists should draw a straight line across the paper until they reach the shape, using a dark colored crayon. They will then draw a smooth curve from one end of the shape to the other. Finally, draw a straight line from one side of the shape to the other far side of the paper. Rulers can be used, but it is not necessary to have perfectly straight lines (Photos 3.8 - 3.9).

TIP: If desired, scientists can use the rulers to make their lines straight. This is not required for an effective drawing! If preferred, scientists can only draw the straight lines at first and then go back and fill in all the curved lines at once.

5. Move slightly up the paper and repeat the process over and over until the paper is covered (Photos 3.10 - 3.11). **It will help to demonstrate this on a chalkboard or whiteboard.**

TIP: don't make the lines too close together, or it will take a long time to complete!

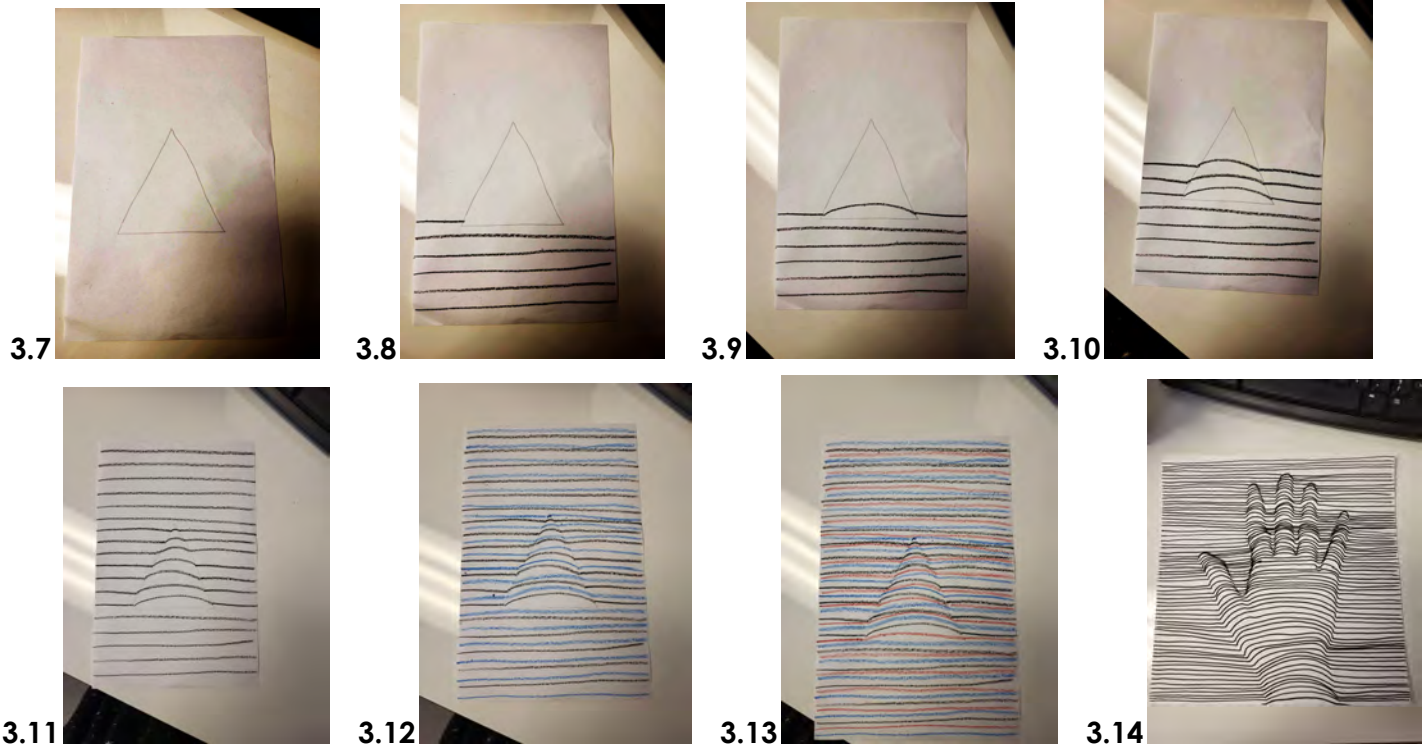
6. Erase any remaining pencil lines, then the drawing is complete!

Discussion Prompts:

- *Do your pictures look like they are in 3D? Why or why not?*
- *Do you think the color or thickness of the lines makes a difference?*

7. **OPTIONAL:** (if there is time and interest, you can add the following steps):
- Add additional stripes of color in between the original lines (Photos 3.12 - 3.13).
 - Try another drawing in a different size or line color.
 - Have students lightly trace their hands and use that to make a 3D drawing (Photo 3.14).

ACTIVITY PHOTOS:



ACTIVITY 8: DAILY DEBRIEF

TIME: 5 Minutes

GOAL: Reflect on what was explored during the activities and relate to students' own lives.

PROCEDURE:

1. Gather students in a circle.
2. Ask questions that facilitate a thoughtful reflection of the day's lessons. Questions may be considered in a Pair & Share model.
3. If you are short on time, have students think about the questions while they are cleaning up from the activities.

Example questions:

- What happened today?
- What did you learn about optical illusions?
- What would we do if we had more time?
- How does what we learned today apply to your personal life?

CLEAN UP: Implement a fun, daily clean-up routine so that students practice being “truly helpful” to their AKA Science community.

WHAT TO SAVE: Some items will carry over into future classes and others will require proper disposal. We have created a table to help organize your materials by when they will be used again. If an item has a number in the column marked “move to:”, all the items used today should be moved to the new class bag. If marked “send home”, the items are to go home with your scientists. “Save for SUN, recycle, or discard” means the items can be kept for use by your site or discarded as needed.

Supplies	Move to:	Send home	Save for SUN, recycle, or discard
Crayons, black	Class 6		
Crayons, blue	Class 6		
Crayons, box	Class 5		
Crayons, red	Class 6		
Lab notebooks	Class 4		
Lubor's lens		X	
Markers, black	Class 4		
Pencils	Class 4		
Pushpins	Class 4		
Rulers, plastic	Class 5		
Scissors (site provides)			X
Tape, rolls Scotch	Class 4		
Wooden tops		X	
Yarn, 4ft loops		X	
Worksheets			
Benham's Disk, cardstock quarter sheet		X	
Fishbowl Thaumatrope, cardstock half sheet		X	
Paper, white ¼ sheet		X	
Paper, white ½ sheet		X	

GRAND TOTAL OF WHAT GOES HOME: Fishbowl Thaumatrope, Bentham's Disk paper cutout on wooden top, Lubor's lens, 3D drawings.

CLASS 4: LIGHT SPLITTING

Supplies (in class bags)	#
CDs	8
Colored filters, blue	16
Colored filters, red	16
Colored filters, yellow	16
Cups, 10oz	8
Cups, 20oz	1
Cups, calibrated, 1oz	1
Cups, Dixie	4
Lab notebooks	16
LED lights, blue	4
LED lights, red	4
LED lights, white	4
Markers, black washable	2
Newspaper bundle – <i>in kit box</i>	1
Paper clips, jumbo	8
Paper towels, roll – <i>in kit box</i>	1
Pencils	16
Pipettes	4
Pitcher – <i>in kit box</i>	1
Plastic sheeting, black 4x4in squares	16
Powdered milk (bag)	2.5oz
Pushpins	4
Rainbow viewers	16
Rubber bands, size 16	16
Scissors (site provides)	16
Spoon	1
Tape, Scotch rolls	4
Water (oz)	47.5
Worksheets (in envelope)	#
Color Wheel	2
Paper, cardstock, white	8
Paper, construction, black	16

PREP STEPS:

- **Act. 2:** For each of the pieces of white cardstock, fold the bottom 1/3 inward. Bend each paperclip to form an "L" shape. Tape one paperclip to the inside fold of each piece of cardstock so the square stands upright, supported by the clip (see photo below). These are your cardstock walls.
- **Act. 4a:** In the 20oz cup, use the calibrated cup to add 7.5oz of water and 2.5oz of milk powder. Stir with the spoon until milk powder is dissolved. Divide the milk into 4 Dixie cups.
- **Act. 4b:** Fill eight 10oz plastic cups about $\frac{3}{4}$ full of water. With the black marker, label four of the cups "experimental" and the other four "control". Make sure to write near the top rim of the cups.



VOCABULARY:

- **Diffraction:** The bend or spreading of light waves around obstacles.
- **Rainbow:** An arch of colors formed in the sky in certain circumstances, caused by the refraction and dispersion of the sun's light by rain or other water droplets in the atmosphere.
- **Refraction:** Change in direction of a wave as a result of its traveling at different speeds, generally caused by passing through a medium (e.g. glass, plastic, water, air).

ACTIVITY 1: THUMB CHECK-IN (Optional)

TIME: 2 Minutes

GOAL: To encourage community building, provide an opportunity to reflect on the day, and create a safe space for students to feel like they belong.

PROCEDURE:

1. Gather students in a circle.
2. Do a quick "thumb check" to see how everyone is doing (e.g., students silently show how they're doing by using their thumb as a gauge/meter. Thumb up is rating something highly, thumb down is rating something lowly, and feelings in between are rated as a thumb pointed towards the middle.)
3. First, ask students how they are feeling physically (e.g. thumb up = energized/ready to run a marathon and thumb down = sick/tired/injured.)
4. Next, ask students how they are feeling emotionally (e.g. thumb up = happy/glad/proud/interested and thumb down = sad/mad/bored.)
5. Thank students for sharing!

ACTIVITY 2: ICEBREAKER

TIME: 10 Minutes

GOAL: Icebreakers are a great way to build community and a sense of belonging among your students. Plus, they're fun!

PROCEDURE:

1. Select an icebreaker from the AKA Science Icebreaker Guide (Page 101).
2. We recommend **FAMILY/CULTURE SHARE** (Page 107), but you are welcome to use any of the icebreakers listed in the guide or come up with your own.

ACTIVITY 3: PAIR & SHARE

TIME: 5 Minutes

Supplies	#
Pencils	16
Lab Notebooks	16

GOAL: Gauge students' knowledge of today's subject and invite questions

PROCEDURE:

1. Pass out **a notebook and a pencil** to each scientist.
2. Ask a question that relates to today's subject. Have your scientists think about the question by drawing or writing in their notebooks or simply thinking about it.

Example Questions:

- *Where can you find rainbows in nature?*
 - *What causes those rainbows?*
3. Ask students to discuss their ideas with their neighbor before inviting students to share what they came up with. This is a "challenge by choice" opportunity and no one is required to share with the class if they are not comfortable.

ACTIVITY 4: RAINBOW VIEWERS

TIME: 5 Minutes

SOURCE: *Physics for Every Kid* by Janice VanCleave; Sarah Andersen, OHCC

Supplies	#
CDs	8
Rainbow viewers	16

BACKGROUND:

White light is actually made up of lots of different colors. Rainbow viewers are made of plastic with lots of little grooves in it, called a diffraction grating. The grooves in the diffraction grating act like a net, letting light through some sections and not others. This breaks up the light into its different colors – so you see a rainbow. Prisms refract light so that it bends, revealing all of its colors, but these rainbow viewers diffract light.

Diffraction sounds like refraction, but they're actually two different phenomena! Refraction (like in Bending Light with the crooked pencil) describes how light changes when it enters a different substance. Diffraction describes how light changes when it's selectively blocked and forced through narrow openings.

Diffraction gratings are used in toys like your rainbow viewer, but they are also used in science experiments and in holograms. They're even found in nature. The color of your eye is actually a result of the way your iris diffracts light, which is why some eyes seem greener at certain times and bluer at others. Also, iridescence (the shimmery rainbow appearance of the metallic backs of beetles and the wings of blue morpho butterflies) is the result of microscopic diffractions. Isn't diffraction beautiful? (<https://bit.ly/3Q0XF6U>)

SURVEY CONNECTION:



This activity is linked to the following survey questions:

Q. White light can be split into a rainbow.

A. Yes

GOAL: To observe how light can be split into a spectrum of colors using diffraction rainbow viewers.

WHAT GOES HOME: Nothing

PROCEDURE:

1. Give each student a **rainbow viewer**.

2. Allow time for students to explore how the viewers work. The viewers work best when looking at something that gives off concentrated white light, like a light bulb or shiny surface (Photo 4.1).

Do not aim the rainbow viewer directly at the sun.

Discussion Prompts:

- What do you see looking through the rainbow viewer?
 - How do you think the viewers separate lights into different colors?
 - If you look very closely at the viewers, what do you see?
3. Explain to the students that the rainbow viewers have hundreds of tiny lines scratched into the plastic lenses. These scratches force white light to travel through tiny openings between the scratches. The different colors that make up white light exit the scratches at different angles, in a process called diffraction. Similar to the refraction that bends and separates light colors within a prism, diffraction shows us a rainbow.
 4. Pair scientists and give each pair a **CD** and have them observe the patterns on the CD's back surface. Moving the CD around within range of bright light will produce stronger rainbows (Photo 4.2).
 5. Discuss how a CD is similar to a rainbow viewer; both diffract white light into rainbows via very tiny scratches. The grooves on a CD are meant to record information, but inadvertently create rainbows.
 6. Set the viewers aside for the next activity.

ACTIVITY PHOTOS:



4.1



4.2

ACTIVITY 5: SPECTROSCOPE

TIME: 20 Minutes

SOURCE: bit.ly/3qiCW60

Supplies	#
Colored Filters (blue)	16
Colored Filters (red)	16
Colored Filters (yellow)	16
Pencils	16
Plastic Sheeting (black, 4inx4in squares)	16
Pushpins	4
Rainbow Viewers	16
Rubber Bands (size 16)	16
Scissors (site provides)	16
Tape (rolls, Scotch)	1
Worksheets	#
Color Wheel	2
Paper, construction, black	16

BACKGROUND:

A spectroscope is a device that separates light into its individual colors in a rainbow-like band called a spectrum. Spectroscopes are used by scientists to send a single beam of color through a sample. A beam of white light is sent through a diffraction grating, like the rainbow viewer, then filtered for a specific color, and what comes out of the other end is a single-color light, just like you'll see through your spectroscope. (bit.ly/441cR9k)

SURVEY CONNECTION:



This activity is linked to the following survey question:

Q. White light can be split into a rainbow.

A. Yes

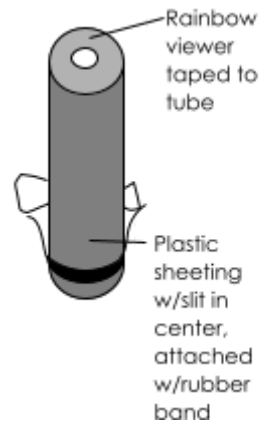
GOAL: To observe that white light can be split into colors and filtered by making a simple spectroscope.

WHAT GOES HOME: Spectroscope, Colored filter (blue,) Colored filter (red,) Colored filter (yellow)

PROCEDURE:

1. Give each student **a sheet of 8.5"x11" black construction paper, a piece of black plastic sheeting, a pencil, a rainbow viewer, and a rubber band.** Make **tape** and **pushpins** available.
2. Have students:

- a. Roll the black construction paper the short way into a tube. The diameter of the tube should be slightly smaller than the diameter of the rainbow viewer.
- b. Tape the tube so that it will hold its shape.
- c. Use a sharpened pencil or pushpin to poke through the center of the plastic sheeting.
- d. Poke a pair of scissors into the hole and cut a small, narrow slit (about half an inch long) (Photo 4.3).
- e. Place the plastic sheeting over one end of the tube so that the slit is centered over the opening of the tube.
- f. Secure the plastic to the tube with a rubber band (Photo 4.4).
- g. On the other end of the tube, tape the rainbow viewer over the circular opening (Photo 4.5).



3. Have students look through the "rainbow viewer" end of the tube and describe what they see.
DO NOT AIM THE SPECTROSCOPE DIRECTLY AT THE SUN.

Discussion Prompts:

- What do you see when you point your spectroscope at a bright light?
 - What is the purpose of the small slit?
 - What do you think will happen to what you see through your spectroscope when we put a color filter in front of the viewer? Why?
4. Give each student **three colored filters: one red, one yellow, and one blue,** and remind students of the significance of primary colors.
 5. Have students hold one of the colored filters in front of the slit as they aim the slit toward a bright light and continue looking through the rainbow viewer.
 6. Have students test different filters individually, then in combinations, and discuss what they see.

ACTIVITY PHOTOS:



ACTIVITY 6: SUNSET

TIME: 15 Minutes

SOURCE: *The Science Book of Color* by Neil Ardley

Supplies	#
Cup (1oz, calibrated)	1
Cups (10oz, plastic, tall)	8
Cups (20oz, plastic)	1
Cups (Dixie)	4
LED Lights (blue)	4
LED Lights (red)	4
LED Lights (white)	4
Markers (black, washable)	2
Newspaper	1
Paper (cardstock, 8.5inx11in) - cardstock wall from prep	8
Paper towels, roll	1
Paper Clips (jumbo) - cardstock wall from prep	8
Pipettes	4
Pitcher	1
Powdered Milk (oz)	2.5
Spoons (plastic)	1
Tape (rolls, Scotch)	4
Water (oz)	47.5

BACKGROUND:

As the sun travels in the sky from morning to night, its rays travel the shortest distance to our eyes around noon, and the longest distance in the morning and evening. That “distance” isn’t just empty space, though. It’s our atmosphere—a protective bubble of gas that surrounds the earth. The longer the distance the rays must travel, the more atmosphere they have to pass through to reach our eyes.

This experiment shows that some colors of light scatter more than others as they travel across distances! Blue scattered so much that after some milk was added to the cup of water, no blue light could pass through. Red, on the other hand, scattered the least, and continued to pass through the water. That’s why the sky looks pink and orange at sunset—those reddish colors are the ones that get the least scattered by particles in the air as they travel to your eyes!

If we wanted to make our experiment more like an actual sunset, we would have lengthened the amount of water the light had to pass through instead of adding milk to it. However, that’s difficult to do. Instead, we used milk to represent the “dirtiness” of the air. Our atmosphere is made up of gasses

like nitrogen, oxygen, and carbon dioxide, but it also contains all kinds of particles like dust, water, and smoke. These particles aren't noticeable at short distances, but have you noticed how mountains in the distance seem blurry? Over long distances, light is scattered by these particles. The more particles there are to scatter the light, the more colorful the sunset looks! (*The Science Book of Color*, Neil Ardley)

SURVEY CONNECTION:



This activity is linked to the following survey question:

Q. Select the hypothesis:

A. Mirrors reflect objects and bounce light rays.

GOAL: To illustrate light scattering using milk, water, & LEDs as a model of the sky.

WHAT GOES HOME: Nothing

PROCEDURE:

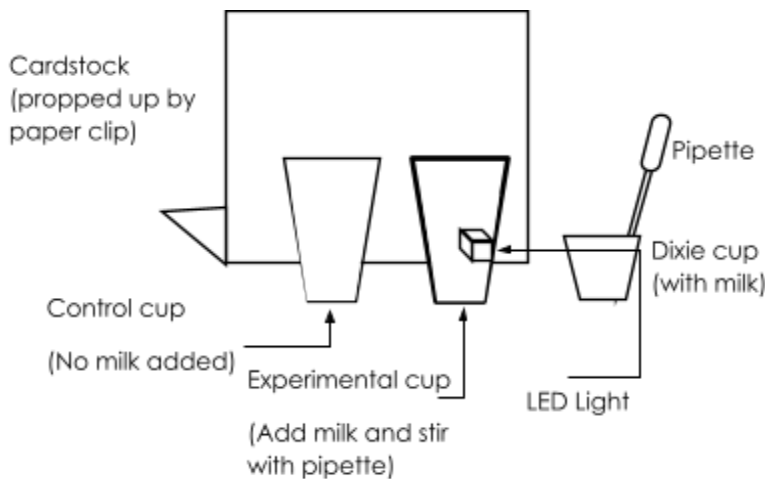
1. **Tell the scientists:** Three Japanese scientists, Isamu Akasaki, Hiroshi Amano, and Shuji Nakamura, recently discovered how to make blue LED lights, just like the ones we use in our experiments. This work was important because LED bulbs couldn't shine pure white before this discovery. Let's be physicists like these professors and explore how light works.
2. Put students in four groups. Give each group:
 - a. **Two 10oz plastic cups** filled about three-quarters full of water (one labeled "experimental" and the other labeled "control" as prep).
 - b. **One Dixie cup about half full of milk** (from prep).
 - c. **One blue LED light, one red LED light, and one white LED light.**
 - d. **One pipette.**
 - e. **One cardstock wall** from prep.

Discussion Prompts:

- *What happens when dust or smoke gets in the way of your vision?*
 - *How do you think light changes when it's blocked by dust, smoke, or other particles?*
 - *Have you ever seen a colorful sunset?*
 - *Where do you think those colors come from?*
3. Have students set up their supplies. (Photo 4.7 + Diagram below)
 - a. Place the control cup and experimental cup next to each other about 3-6 inches away from the cardstock. Each cup should be filled three-quarters with water. and 3-6 inches

away from the front of the propped-up cardstock (students can also use a light-colored wall in place of the cardstock if one is available next to a desk).

- b. The pipette will be used to add milk to the experimental cup from the Dixie cup, so place those next to the experimental cup.
- c. Throughout the experiment, students will shine an LED light through the control and experimental cups (Photo 4.8).



4. Explain to students the importance of having an “experimental” and a “control” cup while they set up their experiment. Scientists use controls so that they have something to compare their experimental subject to. Via comparison, scientists are better able to see how much change has occurred through their experimentation. Without control, it can be hard to tell if and how something has changed.
5. Allow students in each group to choose one of 4 roles: white LED light holder, red LED light holder, blue LED light holder, and milk mixer. Students can also rotate roles throughout the activity.
6. Have the white, red, and blue LED light holders take turns shining their light through the control cup, then through the experimental cup. A good technique is to start with the light nearly touching the water cup and then to slowly move it backwards until the light appears as a focused rectangle on the cardstock (Photo 4.8).
7. Have the milk mixers use the pipette to add 10-15 drops of **milk** (or one small squirt) to the experimental cup, mix the liquids together, then carefully return the pipette to the Dixie cup.

Discussion Prompts:

- What do you think happens when clear air becomes cloudy with particles?
- Before adding any milk: Does the light pass through the water in both cups and onto the cardstock equally? Will this be true if we add milk to one of the cups?
- Do you think each color of light will behave the same way? What are your hypotheses for the white light, red light, and blue light respectively as we add milk?

- After the first round of milk-adding: does light from the white LED look the same coming through the control and experimental cups?
 - What about the other colors of LED lights?
8. Have the white LED light holder shine their light through the experimental cup, then shine the light through the control cup to compare. As more milk is added to the experimental cup, the white light coming through to the cardstock will decrease in brightness and then turn from white to yellow to orange to red.
 9. Have the red LED light holder repeat step 7. The red light should remain red but become progressively dimmer as more milk is added to the cup.
 10. Have the blue LED light holder repeat step 7. The blue light should also remain blue but dim and then disappear much faster than the red and white lights.
 11. Repeat steps 6-9, along with the discussion questions that ask how the light changes.
 12. End the experiment when the white light fades to a faint red. Have the students discuss how the observed results compared with what they thought would happen (their hypotheses) and introduce the concept of diffraction (or light scattering).
 13. Save the cardstock "walls" for future classes.

ACTIVITY PHOTOS:



ACTIVITY 7: DAILY DEBRIEF

TIME: 5 Minutes

GOAL: Reflect on what was explored during the activities and relate to students' own lives.

PROCEDURE:

1. Gather students in a circle
2. Ask questions that facilitate a thoughtful reflection of the day's lessons. Questions may be considered in a Pair & Share model.
3. If you are short on time, have students think about the questions while they are cleaning up from the activities.

Example questions:

- *What happened today?*
- *What was a challenge that you overcame?*
- *What did you learn about color?*
- *How does what we learned today apply to your personal life?*

CLEAN UP: Implement a fun, daily clean-up routine so that students practice being "truly helpful" to their AKA Science community.

WHAT TO SAVE: Some items will carry over into future classes and others will require proper disposal. We have created a table to help organize your materials by when they will be used again. If an item has a number in the column marked "move to:", all the items used today should be moved to the new class bag. If marked "send home", the items are to go home with your scientists. "Save for SUN, recycle, or discard" means the items can be kept for use by your site or discarded as needed.

*****See next page for WHAT TO SAVE table and WHAT GOES HOME.*****

Fun Physics: Color & Light (Grades 6-8)

Class 4: Light Splitting

Supplies	Move to:	Send home	Save for SUN, recycle, or discard
CDs			X or send home
Colored filters, blue		X	
Colored filters, red		X	
Colored filters, yellow		X	
Cups, 10oz	Save 1 for Class 5		Discard all but 1
Cups, 20oz			X
Cups, calibrated, 1oz	Class 5		
Cups, Dixie			X
Lab notebooks	Class 5		
LED lights, blue	Class 5		
LED lights, red	Class 5		
LED lights, white	Class 5		
Markers, black washable	Class 5		
Newspaper bundle	Kit box		
Paper clips, jumbo – cardstock walls	Class 6		
Paper towels, roll – <i>in kit box</i>	Kit box		
Pencils	Class 5		
Pipettes	Class 5		
Pitcher	Kit box		
Plastic sheeting, black 4x4in squares		X	
Powdered milk (bag)	Class 5		
Pushpins	Class 8		
Rainbow viewers		X	
Rubber bands, size 16		X	
Scissors (site provides)			X
Spoon	Class 5		
Tape, Scotch rolls	Class 5		
Water (oz)			X
Worksheets			
Color Wheel			X
Paper, cardstock, white – cardstock walls	Class 6		
Paper, construction, black		X	

GRAND TOTAL OF WHAT GOES HOME: Spectroscope, Colored filters, CD(optional).

CLASS 5: REFRACTION & REFLECTION

Supplies (in class bags)	#
Beads, tri multi-colored acrylic	128
Bowls, large clear plastic – <i>in kit box</i>	4
Crayons, box	2
Cups, 1oz	16
Cups, 10oz	1
Cups, calibrated 1oz	1
Dowels	4
Lab notebooks	16
LED lights, blue	4
LED lights, green	4
LED lights, red	4
LED lights, white	4
Lids, 1oz	16
Markers, black	2
Mirror boards	16
Newspaper – <i>in kit box</i>	1
Paper towels – <i>in kit box</i>	1
Pencils	16
Pipettes	4
Pitcher – <i>in kit box</i>	1
Play doh, containers	4
Powdered milk (bag)	2.5oz
Rulers	4
Spoon	1
Sticky tack strip	1
Straw pieces	4
Tape, Scotch rolls	4
Water	
Worksheets	#
Circuit Permission Slips	16

PREP STEPS:

- **Act. 3a:** Divide sticky tack into 4 pieces.
- **Act. 3b:** Fill each large plastic bowl $\frac{3}{4}$ full of water.
- **Act. 4:** Using the calibrated cup, measure 2.5oz of powdered milk into the 10oz cup. Fill the 10oz cup $\frac{3}{4}$ full of water and stir with the spoon.

- **Act. 5a:** Place 8 beads in each of the 16 1oz cups. Place a lid on each cup.
- **Act. 5b (optional):** Draw lines on the backs of the 16 mirror boards with the black markers to help students fold them into thirds.

VOCABULARY:

- **Equilateral:** having all sides the same length. Most commonly used to describe triangles with three equal sides.
- **Reflection:** The throwing back by a body or surface of light, heat, or sound without absorbing it.

ACTIVITY 1: THUMB CHECK-IN (Optional)

TIME: 2 Minutes

GOAL: To encourage community building, provide an opportunity to reflect on the day, and create a safe space for students to feel like they belong.

PROCEDURE:

1. Gather students in a circle.
2. Do a quick "thumb check" to see how everyone is doing (e.g., students silently show how they're doing by using their thumb as a gauge/meter. Thumb up is rating something highly, thumb down is rating something lowly, and feelings in between are rated as a thumb pointed towards the middle.)
3. First, ask students how they are feeling physically (e.g. thumb up = energized/ready to run a marathon and thumb down = sick/tired/injured.)
4. Next, ask students how they are feeling emotionally (e.g. thumb up = happy/glad/proud/interested and thumb down = sad/mad/bored.)
5. Thank students for sharing!

ACTIVITY 2: ICEBREAKER

TIME: 10 Minutes

GOAL: Icebreakers are a great way to build community and a sense of belonging among your students. Plus, they're fun!

PROCEDURE:

1. Select an icebreaker from the AKA Science Icebreaker Guide.
2. We recommend **QUESTION OF THE DAY** (Page 102), but you are welcome to use any of the icebreakers listed in the guide or come up with your own.

ACTIVITY 3: PAIR & SHARE

TIME: 5 Minutes

Supplies	#
Pencils	16
Lab Notebooks	16
Worksheets	#
Circuit Permission Slip	16

GOAL: Gauge students' knowledge of today's subject and invite questions

PROCEDURE:

1. Hand out **circuit permission slips**. These must be returned by Class 7!
2. Pass out **a notebook and a pencil** to each scientist.
3. Ask a question that relates to today's subject. Have your scientists think about the question by drawing or writing in their notebooks or simply thinking about it.

Example Questions:

- How could you redirect or move a beam of sunlight?
 - Can you think of a way that mirrors help us see in places we normally can't?
4. Ask students to discuss their ideas with their neighbor before inviting students to share what they came up with. This is a "challenge by choice" opportunity and no one is required to share with the class if they are not comfortable.

*****Students must return the Circuit Permission Slip to take home finished circuits after Class 7. Keep the permission slips in a folder in the kit box.*****

ACTIVITY 4: SPEAR FISHING

TIME: 10 Minutes

SOURCE: Eagle Spirit Science Futures

Supplies	#
Bowls, large clear plastic	4
Dowels	4
Play doh (containers)	4
Rulers	4
Sticky tack strips	1
Straw pieces	4
Tape, Scotch rolls	1
Water	

BACKGROUND:

When you see things around you, light usually travels through the air to your eyes, which receive the light. However, light passes through other things as well: solids like glass and clear plastic, and liquids like water and oil. Each different substance affects the light passing through it differently. Light passes through most substances slower than it does through air. That means that it is bent more. The scientific word for bending light is refraction! When light rays bend, or refract, when they go from air to water, objects appear magnified and seem as though they are in different spots. Our eyes get tricked because we think the light rays should continue on the same straight line as when it travels through air. People who use fishing spears have to adjust for the fact that a fish's location underwater is slightly different than it appears. By learning how to adjust for the refraction of light through water, spear fishers can increase the likelihood of catching fish on the first try. (bit.ly/47Vd3tZ)

SURVEY CONNECTION:



This activity is linked to the following survey question:

Q. What happens to light when it passes through things like water or binoculars?

A. The light bends

GOAL: To explore light refraction through water by simulating spear fishing.

WHAT GOES HOME: Nothing

PROCEDURE:

1. **Tell students:** Spearfishing has been used by many Indigenous groups throughout the world, and people like Native Hawaiian Matt Sproat are carrying on the tradition. To spear a fish, the person fishing must understand light refraction and the way it changes how far away a fish looks when underwater. Let's see if we can use physics like Mr. Sproat to catch fish!
2. Divide scientists into four groups. Give each group **1/4 piece of sticky tack, one straw piece, one dowel, one container of playdoh, one ruler, and one bowl** filled $\frac{3}{4}$ full of water (from prep).

Discussion Prompts:

- *What usually separates us from anything we're looking at? (air)*
 - *Do you think things would look different if light traveled through something other than air?*
 - *What do you think the ruler will look like if we put it in the cup of water?*
3. Have each group place their ruler straight down into the bowl of water and observe how the ruler looks. This works best if one scientist holds the ruler while the rest of the group looks at the bowl from the side. Roles can be switched to allow each scientist to observe the ruler (Photo 5.7)

Discussion Prompts:

- *What does the ruler look like when part of it is in the water?*
 - *Why do you think this happens?*
 - *Do you think this will make it easier or harder to touch something under the water?*
4. Have groups remove a small amount of playdoh from the container (about $\frac{1}{4}$ of the total amount) and divide it into 4 pieces. Each scientist will use one piece to make a small fish. Collect the remaining playdoh - it will be used during Class 6.
 5. Tell the groups to select one of the fish to place in the bottom of the bowl of water. They will need to press down on the fish to help it stick (Photo 5.8).
 6. Have each group roll the piece of sticky tack into a ball and mount it on the side of the bowl. Once the sticky tack is in place, they can press the straw piece onto the sticky tack. If needed, secure the straw with tape (Photo 5.9).

Discussion Prompts:

- *Why is it important to catch the fish on the first try?*
 - *If you needed to catch a fish with a spear, how would you position your spear, so you don't miss?*
7. As a team, each group should position their straw so that it looks like it is pointing directly at the fish in the water below (Photo 5.9).

8. Ask the groups to make a hypothesis about whether they will be able to touch the fish underwater with their "spears".
9. Have one scientist in each group insert the dowel into the straw without moving the straw position. This scientist should then slowly slide the dowel into the water while observing the fish from above. Once the dowel looks like it should be touching the top of the fish, have the groups observe from the side of the bowl how far away the dowel is (Photos 5.10 - 5.11).

Discussion Prompts:

- *How close were you to touching the fish?*
 - *How could we change the angle of the straw to come closer to the fish?*
10. Use the ruler to measure the distance from the fish to the top of the water (this is your *fish depth*). Then measure from the dowel to the top of the water (this is your *dowel depth*).
 - a. Scientists can use either centimeters (cm) or inches (in), as long as they are consistent.
 11. Subtract the second measurement from the first measurement and write down the difference in lab notebooks (Photo 5.12).
 - a. Need a challenge? Calculate percent error using the following equation:

$$\frac{(\text{fish depth} - \text{dowel depth})}{(\text{fish depth} * 100)}$$

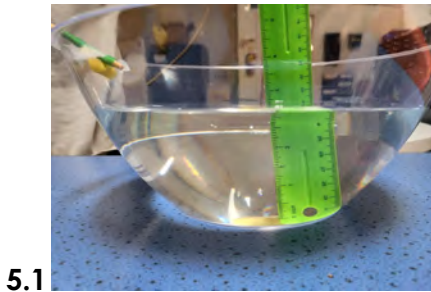
The answer is how close the scientist came to touching the fish with the spear.

12. Have groups adjust the straw to point just below the fish and try again. Measurements can be repeated by each group member.
13. Have your other scientists test the spear fishing, allowing them to switch the play doh fish to their own if they wish.

Discussion Prompts:

- *How difficult was it to touch the fish? Were you able to make it easier by adjusting the straw?*
 - *Would more or less water change how hard it was to touch the fish?*
 - *Why is this important for spearfishing?*
14. Clean up all materials, discarding wet playdoh, straw pieces, and sticky tack.

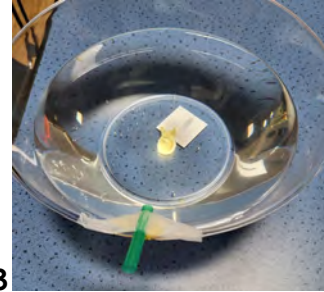
ACTIVITY PHOTOS:



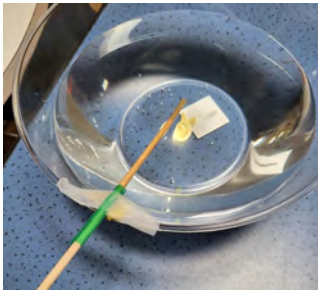
5.1



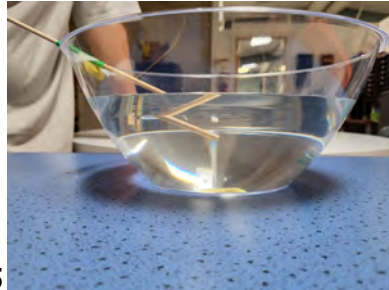
5.2



5.3



5.4



5.5



5.6

ACTIVITY 5: HOW LIGHT TRAVELS THROUGH WATER

TIME: 10 Minutes

SOURCE: Dr. Carrie Buo, AKA Science

Supplies	#
Bowls, large plastic	4
Cups, 10oz	1
Cups, calibrated 1oz	1
LED lights, blue	4
LED lights, green	4
LED lights, red	4
LED lights, white	4
Pipettes	4
Powdered milk (bag)	2.5oz
Spoon	1
Water	

BACKGROUND:

In the previous activity, we learned how when light passes through water it is refracted, changing the way objects in the water appear. But what about the beam of light itself? We know that when the light passes through water it bends, but can we see that happening? And can we make the light bend in a different way? Yes! All we need to do is add a particle to our water, like milk, and the light rays will be visible and will bend even more. This is because the light particles bounce off the fat particles in milk and bend more than if the water was clear. If you get the angle just right, you can see the light beam bounce off the surface of the water and go back toward the bottom of the bowl. The same experiment would work with other small particles like smoke or smog. (bit.ly/3OXWaWD)

SURVEY CONNECTION:



This activity is linked to the following survey question:

Q. What happens to light when it passes through things like water or binoculars?

A. The light bends

GOAL: To visualize light beams refracting in water.

WHAT GOES HOME: Nothing

PROCEDURE:

1. Have scientists form 4 groups. Give each group one of each LED light and a large plastic bowl of water.
2. Have scientists shine each color of LED light into the bowl. This should be done from the side of the bowl, holding the light against the side. They can take turns or go all at once.

Discussion Prompts:

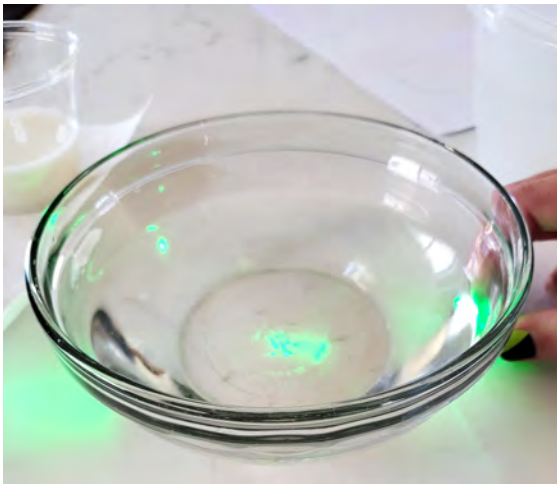
- *What do you see?*
 - *Can you see the path of the light beam?*
 - *Is there a way we could make the entire light beam visible?*
3. Walk around to each group and add one pipette full of milk solution to each bowl. Give the milk a bit of time to disperse.
 4. Now have scientists try each LED one at a time. The light beams should start to become visible with the added particles in the water. Different colors of LED may be more visible than others (Photo 5.7).
 5. Encourage students to try looking from the top and the sides of the bowl.

6. Have students make a hypothesis as a group about the amount of milk particles in the water and how much of the light beam they will be able to see.
7. Allow the groups to add more milk to their bowls, according to their hypotheses. This is best if they test in between each pipette of milk. There is a happy medium here - too much milk will obscure the light beam, not enough won't make the beam visible.
8. Have them try to shine the light at an angle from the lower side of the bowl toward the surface of the water. If they get the angle right, the light beam will bounce off the surface and go back down (Photo 5.8)!

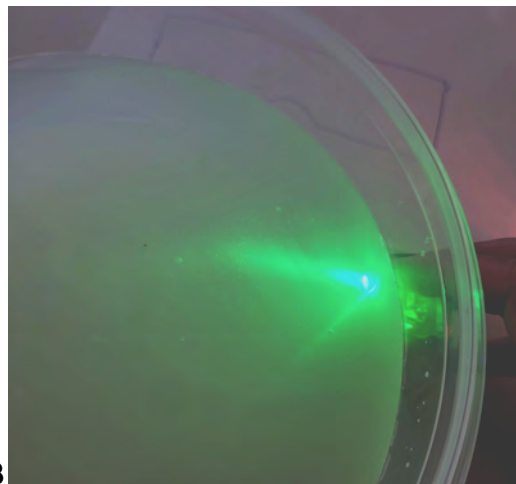
Discussion Prompts:

- *What happened to the light?*
- *Was your hypothesis correct?*
- *Did one color of light work better than the others? Why do you think so?*
- *How does this relate to the light refraction in the spear fishing experiment?*

ACTIVITY PHOTOS:



5.7



5.8

ACTIVITY 6: KALEIDOSCOPE

TIME: 20 Minutes

SOURCE: *Science for Fun Experiments* by Gary Gibson

Supplies	#
Beads (multi-colored, transparent)	128
Crayons (box)	2
Cups (1oz)	16
Lids (1oz)	16
Markers (black, washable)	2
Mirror Board Sheets	16
Tape (rolls, Scotch)	4

BACKGROUND:

A kaleidoscope is a toy made from three mirrors set in an equilateral triangle. There are small objects inside the kaleidoscope that move around as you twist the tube. The different ways the objects fall reflect differently, making lots of pretty pictures. Kaleidoscopes can be simple, like three mirrors in a cardboard tube, or fancy - some are decorated with gold and jewels and have sold for thousands of dollars! (bit.ly/47nIvRj)

SURVEY CONNECTION:



This activity is linked to the following survey question:

Q. Select the hypothesis (Circle one):

A. Mirrors reflect objects and bounce light rays.

GOAL: To apply the concept of mirror angles to create a simple kaleidoscope.

WHAT GOES HOME: Kaleidoscope

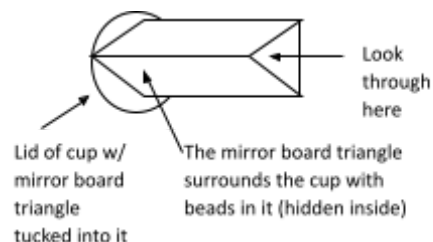
PROCEDURE:

1. Give each scientist **a mirror board and a lidded 1oz cup containing 8 beads** (from prep). Make **crayons, markers, and tape** available.

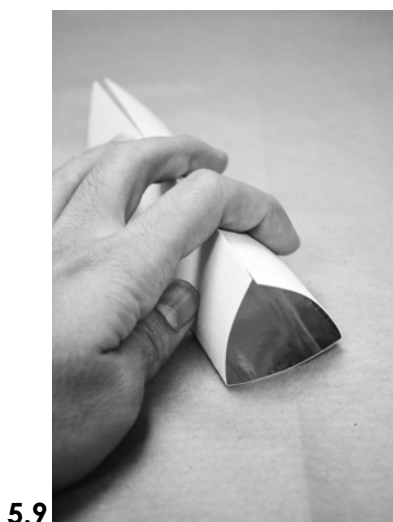
Discussion Prompts:

- What is a kaleidoscope? How might it work?
- Would a kaleidoscope work in total darkness? What is your hypothesis?

2. If time allows, students can decorate the back of their mirror boards (the non-reflective side) with crayons and markers. It's easiest to do the decorating first.
3. Have students:
 - a. Fold the mirror board into equal thirds lengthwise, with the reflective side in.
 - b. Tape the mirror board closed along the edge so it forms a triangular tube (Photo 5.9).
 - c. Turn the 1oz cup with beads upside down so that the lid is on the bottom.
 - d. Fit the triangular mirror board tube around the base of the cup, with the edge inside the lid. It's okay if the shape of the tube gets slightly rounded (Photo 5.10).
 - e. Tape the edge of the lid around the triangular tube to hold it in place (but don't cover the part where light will come through) (Photo 5.11).
4. Have students hold the tube pointed straight up (so that the cup of beads is at the top) and look through the opening at the bottom. Students can rotate the tube in their hand so that the beads move around. Allow students time to experiment with their kaleidoscopes.
5. Try the kaleidoscopes with the lights off. Do they work? Were your hypotheses correct?



ACTIVITY PHOTOS:



5.9



5.10



5.11

ACTIVITY 7: DAILY DEBRIEF

TIME: 5 Minutes

GOAL: Reflect on what was explored during the activities and relate to students' own lives.

PROCEDURE:

1. Gather students in a circle.
2. Ask questions that facilitate a thoughtful reflection of the day's lessons. Questions may be considered in a Pair & Share model.
3. If you are short on time, have students think about the questions while they are cleaning up from the activities.

Example questions:

- *What happened today?*
- *What was a challenge that you overcame?*
- *What would we do if we had more time?*
- *Do mirrors work without light?*

CLEAN UP: Implement a fun, daily clean-up routine so that students practice being "truly helpful" to their AKA Science community.

WHAT TO SAVE: Some items will carry over into future classes and others will require proper disposal. We have created a table to help organize your materials by when they will be used again. If an item has a number in the column marked "move to:", all the items used today should be moved to the new class bag. If marked "send home", the items are to go home with your scientists. "Save for SUN, recycle, or discard" means the items can be kept for use by your site or discarded as needed.

*****See next page for WHAT TO SAVE table and WHAT GOES HOME.*****

Fun Physics: Color & Light (Grades 6-8)

Class 5: Refraction & Reflection

Supplies	Move to:	Send home	Save for SUN, recycle, or discard
Beads, tri multi-colored acrylic		X	
Bowls, large clear plastic			X
Crayons, box	Class 6		
Cups, 1oz		X	
Cups, 10oz			X
Cups, calibrated 1oz			X
Dowels			X
Lab notebooks	Class 6		
LED lights, blue	Class 6		
LED lights, green	Class 6		
LED lights, red	Class 8		
LED lights, white	Class 6		
Lids, 1oz		X	
Markers, black	Class 6		
Mirror boards		X	
Newspaper	Kit box		
Paper towels	Kit box		
Pencils	Class 6		
Pipettes			X
Pitcher	Kit box		
Play doh, containers	Class 6		
Powdered milk (bag)			X
Rulers			X
Spoon			X
Sticky tack strip			X
Straw pieces			X
Tape, Scotch rolls	Class 6		
Water			X
Worksheets			
Circuit Permission Slip		x	

GRAND TOTAL OF WHAT GOES HOME: Kaleidoscope, circuit permission slip.

Remind students to have Guardians sign and return the Circuit Permission Slips! They cannot bring home their finished circuits from Class 7 unless they do so.

CLASS 6: MIRROR MIRROR ON THE WALL

Supplies (in class bags)	#
Cardstock walls from Class 4	8
Cardstock strips	16
Crayons, black	4
Crayons, blue	4
Crayons, box	2
Crayons, red	4
Lab notebooks	16
LED flashlights	4
LED lights, blue	4
LED lights, green	4
LED lights, white	4
Markers, black	2
Mirrors, 2x3in	16
Mirrors, round	16
Paperclips, jumbo	8
Pencils	16
Play doh (containers)	4
Scissors (Site provides)	16
Tape, Scotch rolls	4
Worksheets (in envelope)	#
Paper, white 11x17	4
Periscope pattern	16

PREP STEPS:

- **Act. 3:** If cardstock walls were not prepared for Class 4, please turn to page 39 and follow the instructions to create 8 cardstock walls.

VOCABULARY:

- **Infinite:** Never ending.
- **Periscope:** an instrument for observation over, around, or through an object or obstacle.

ACTIVITY 1: THUMB CHECK-IN (Optional)

TIME: 2 Minutes

GOAL: To encourage community building, provide an opportunity to reflect on the day, and create a safe space for students to feel like they belong.

PROCEDURE:

1. Gather students in a circle.
2. Do a quick “thumb check” to see how everyone is doing (e.g., students silently show how they’re doing by using their thumb as a gauge/meter. Thumb up is rating something highly, thumb down is rating something lowly, and feelings in between are rated as a thumb pointed towards the middle.)
3. First, ask students how they are feeling physically (e.g. thumb up = energized/ready to run a marathon and thumb down = sick/tired/injured.)
4. Next, ask students how they are feeling emotionally (e.g. thumb up = happy/glad/proud/interested and thumb down = sad/mad/bored.)
5. Thank students for sharing!

ACTIVITY 2: ICEBREAKER

TIME: 10 Minutes

GOAL: Icebreakers are a great way to build community and a sense of belonging among your students. Plus, they’re fun!

PROCEDURE:

1. Select an icebreaker from the AKA Science Icebreaker Guide.
2. We recommend **QUESTION OF THE DAY**, but you are welcome to use any of the icebreakers listed in the guide or come up with your own.

ACTIVITY 3: PAIR & SHARE

TIME: 5 Minutes

Supplies	#
Pencils	16
Lab Notebooks	16

GOAL: Gauge students' knowledge of today's subject and invite questions

PROCEDURE:

1. Pass out **a notebook and a pencil** to each scientist.
2. Ask a question that relates to today's subject. Have your scientists think about the question by drawing or writing in their notebooks or simply thinking about it.

Example Questions:

- How do we use mirrors?
- Where do we find mirrors in everyday life?
- How could you use a mirror to light up a dark room?

3. Ask students to discuss their ideas with their neighbor before inviting students to share what they came up with. This is a "challenge by choice" opportunity and no one is required to share with the class if they are not comfortable.

ACTIVITY 4: LIGHT MAZE

TIME: 15 Minutes

SOURCE: Elementary Exploration: Seeing the Light by The NEED Project

Supplies	#
Cardstock walls	8
LED Flashlight (3-bulb)	4
LED Lights (white)	4
Mirrors (2x3in)	16
Pencils	16
Play-Doh (containers)	4
Tape (rolls, Scotch)	4
Worksheets	#
Paper (11inx17in, sheets, white)	4

BACKGROUND:

It's not easy to bounce light where you want it to go, but light reflects off mirrors in a very specific way. The angle from which light hits a mirror is identical to the angle from which it reflects and leaves the mirror!

Have you ever wondered how laser grids like the ones in action movies are made? Some of them use the reflective properties of mirrors, just like the maze you created. A single laser beam can be reflected over and over again to create a laser grid. The last mirror reflects the light to a sensor. When any part of the path of the laser light is broken, the sensor doesn't see the light anymore and sets off the alarm! Just like your maze, the grid uses mirrors to create an unbroken path of light. Unfortunately, in real life, laser alarm systems use infrared lasers, so you wouldn't be able to see the lasers and dodge them! (bit.ly/3KxFP9B)

GOAL: To use knowledge of reflections to position mirrors to see around obstacles.

WHAT GOES HOME: Nothing

PROCEDURE:

1. Put students in groups of 3-4.
2. Give each group **four 2inx3in mirrors, four pencils, one 3-bulb LED flashlight, one single-bulb white LED light, one piece of 11inx17in paper, one container of Play-Doh, and two cardstock walls** (from Class 4).
3. Have students place the 11inx17in paper on the table with one of the short edges closest to them. Set up the two cardstock walls on top of the paper with one about a foot behind the other. The students should use the 11inx17in paper as a guide to line the cardstock walls up in the same direction.
4. Have students set their 3-bulb LED flashlight about six inches in front of the cardstock wall that's closest to them, pointing it at the wall. Tell students their goal is to reflect their light around the closer wall so that it shines on the center of the back wall *without changing the position of the LED light itself*.

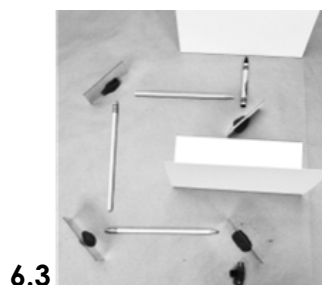
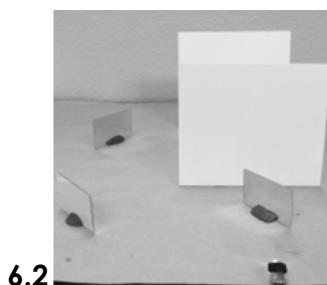
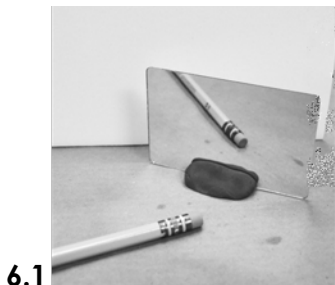
Discussion Prompts:

- *The way light reflects off mirrors depends on the angle and shape of the mirrors. How could we use this information to solve this puzzle?*
5. Prepare students so they have tools for the challenge:
 - a. Have students split their Play-Doh into four equal balls. Each student in a group should take one ball and gently lower the long edge of one mirror into the Play-Doh until it almost touches the table. Students can then push the ball down lightly to create a stable base. The mirror should be able to stand up on its own, completely perpendicular

to the table. Students should also be able to pick up the mirror with the Play-Doh base and rotate or move it as needed (Photo 6.1).

- b. Show students how to predict the path of light by shining one LED light on a mirror and placing a pencil along the line of the beam's reflection. They can use a cardstock wall as a target. If students line up pencils to point in the direction they want the light to go, they'll know where to set up their mirrors (Photo 6.1).
 - c. Show students that when trying to line up a mirror, they can flip their target mirror around to make sure that the reflected beam of light is hitting it. When it's lined up, they can flip the target mirror back and adjust it to hit the next target mirror.
 - d. Tell students that they will only use one LED light to prove that their setup works, but you've given them a second LED light so they can work on multiple parts of their setup at the same time.
6. Reiterate to students that the only rules are they cannot move either the source light or cardstock wall, and the beam of light must hit the back cardstock wall. (Note: one student may need to hold the LED light steady, slightly above the surface of the table, so the beam of light fully hits the mirror.) Encourage students to work cooperatively in teams, honoring the input of all teammates and ensuring that all students have a hand in the solution (Photo 6.2).
 7. Turn off the lights in the room, if possible.
 8. Give students at least 10 minutes to work on the challenge. After 10 minutes, you may want to give hints or help some students overcome obstacles you see.
 9. Allow students the option of sharing their solutions to the challenge. If students need additional help. You can share an example solution, but keep in mind there are lots of ways to solve the puzzle (Photo 6.3).
 10. If a group finishes early, you can increase the challenge difficulty by introducing more obstacles.
 11. Emphasize to students that completing the challenge is great, but even if they couldn't get the light all the way to the back wall, they still learned a lot by working through the challenge as a team!

ACTIVITY PHOTOS:



ACTIVITY 5: MULTIPLE MIRRORS

TIME: 10 Minutes

SOURCE: *Amazing Experiments in Sound and Light* by Michael A. DiSpezio

Supplies	#
Mirrors (2x3in)	16
Paper Clips (jumbo)	8
Tape (rolls, Scotch)	4

BACKGROUND:

When you look in one mirror, you see one reflection. When you look in two mirrors, you see more than two. When you put three mirrors together, you see infinite reflections! How is that possible? Let's remember what reflections are: rays of light bouncing perfectly off a surface and into your eyes. If the reflected rays of light hit another reflection before hitting your eyes, you'll see two images! But, keep in mind that the rays of light from one mirror hit the other, so with two mirrors, you can see four reflections or more by changing the angle of the mirrors. The angle of the mirrors changes how many times the rays of light bounce between the mirrors before reaching your eyes. More bouncing = more reflections!

When you added the third mirror, you trapped all the bouncing light rays in that chamber. All the light bounces between the three mirrors and forms an infinite chamber of reflections! If you've ever stepped into a hall of mirrors, now you know how it makes you look like you're surrounded by yourself. A hall of mirrors is just a trap for rays of light! (bit.ly/447IXQP)

GOAL: To change mirror angles to create an endless reflection of a paper clip.

WHAT GOES HOME: Nothing

PROCEDURE:

1. **Tell scientists:** Almost one thousand years ago, Muslim scientist Al-Hasan Ibn Al-Haytham wrote many books explaining the ways light and sight work together. Some of these books also explained how mirrors can be shaped to change and reflect images and light. Let's examine how mirrors work, like Ibn Al-Haytham did.
2. Give each scientist a **2inx3in mirror** and have them look at themselves in the mirror.
3. Give each student a **small piece of Scotch tape** and have them place the piece of tape on one of their cheeks.

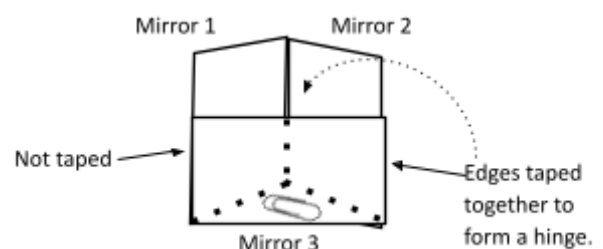
- Have students note which side of their face (right or left) the tape is on. Then have them look in the mirror. In their reflection, each student's tape/ tongue will be on the same side as where they can feel it.

Discussion Prompts:

- *Why do you see yourself when you look in a mirror?*
 - *Do other people see you the same way you see yourself in a mirror? What is the same and what is different?*
 - *How could you use mirrors to see your face the same way other people see it?*
- Pair students. Ask students where they see their partner's tape, on the left or the right? (If the tape is on a student's left cheek, the other student will see that as their right cheek.)
 - Have students take turns holding two mirrors together at an angle (about 45°) so their reflected image bounces between the two mirrors. If they position the mirrors correctly, they will see themselves as others see them, i.e., reversed (Photo 6.4).
 - Explain that mirror images are right/left reversed. So, we actually see ourselves differently in the mirror than how other people see us.
 - Divide students into groups of three and give each group a **jumbo paper clip**. Make Scotch **tape** available to share.
 - Have groups place their paperclips on the table.

Discussion Prompts:

- *Have you ever looked into the mirrors in a dressing room and seen several images of yourself? How do you think it works?*
 - *How could you multiply the number of paper clips you see in the mirror(s)?*
- Have one student in the group hold a mirror facing the paper clip with the short edge on the table (Photo 6.5).
 - Have another group member hold a second mirror next to the first mirror, oriented the same way so that one long edge of each mirror touches the other. The mirrors should be at slightly less than a right angle around the paper clip, i.e., slightly smaller than a right angle.
 - Have the third student place a piece of tape over the line where two mirror edges meet. This should create a hinge that allows students to change the angle of the mirrors while still keeping the mirrors together.
 - Have students count the number of paper clips they see reflected in the two mirrors.
 - Have the third student stand their mirror up differently than the first two, laying the long edge on the table instead of the short edge.



The three mirrors should form a closed triangle around the paper clip.

15. Have another student tape over the edge where the 2nd and 3rd mirrors meet. For the three total mirrors, there should be two pieces of tape and one free space. This will allow students to adjust the size of the triangle and the angles of the mirrors.
16. Have students take turns looking over the top of the third (horizontal) mirror to observe the reflections of the paper clip and discuss what they see (Photo 6.6).
17. Allow groups to experiment with changing the size and angles of the mirror triangle and observe how that affects the number of paper clips and their closeness to each other.

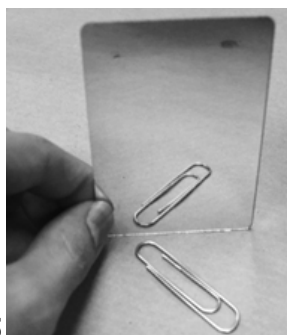
ACTIVITY PHOTOS:



6.4



6.5



6.6

ACTIVITY 6: PERISCOPE

TIME: 20 Minutes

SOURCE: Science Works-65 Experiments that Introduce the Fun and Wonder of Science from the Ontario Science Center

Supplies	#
Cardstock Strips (2inx4.25in)	16
Crayons (box)	2
LED Lights (blue)	4
LED Lights (green)	4
Markers (black, washable)	2
Mirrors (2x3in)	16
Mirrors (round, 1.75in)	16
Scissors (site provides)	16
Tape (rolls, Scotch)	4
Worksheets	#
Periscope Pattern (cardstock)	16

BACKGROUND:

Light travels in a straight line, but as you learned by making your light maze, it can also be reflected. This is very important in submarines. It takes a lot of power to get a submarine up to the surface of the water. But with mirrors, you don't have to raise the whole submarine just to see above the water. A periscope is a tube that runs from the inside of a submarine to above the surface of the water. By placing mirrors in a tube so they are angled towards each other, light is reflected from above the water, down the tube, and into your eye so you can see what's happening above the surface.

What if you're on land and want to see underwater without getting wet? You can use a periscope then, too! You can use the periscope in the same way, but this time you stay above the water and put the periscope beneath the surface of the water. (bit.ly/3qtBQEI)

SURVEY CONNECTION:



This activity is linked to the following survey question:

Q. Select the hypothesis (Circle one):

A. Mirrors reflect objects and bounce light rays.

GOAL: To reinforce the idea that mirrors can be positioned to see around obstacles.

WHAT GOES HOME: Periscope

PROCEDURE:

1. Give each student a **round mirror**. Have students hold the mirror up near their eyes and allow them to explore what they can see around them by changing the angle of the mirror.

Discussion Prompts:

- *How could you use a mirror to look at something in the room behind you without turning your head?*
 - *How could a spy use a mirror to watch a target without being spotted?*
2. Give each student a **Periscope Pattern worksheet and a pair of scissors**. Make **crayons, markers, and tape** available.
 3. If time allows, students can decorate the printed side of their Periscope Pattern with crayons and markers. It's easiest to do the decorating first.
 4. Have students:
 - a. Cut the long, solid black line to remove the title section of the worksheet.

- b. Fold the worksheet on each of the four dashed lines. (It's important to fold slowly and carefully: there are four pre-cut slits in the worksheet, and careful folding will make sure they don't get torn. As you fold, you'll be making a rectangular tube with the printing on the outside.)
 - c. Cut out the two windows. Each window should be cut from the edge of the page, even though the image doesn't go all the way to the edge.
 - d. Bring the two edges of the paper together to form a closed rectangular tube. Tuck the short flap underneath the other edge of the tube and tape it in place. (It helps to tape the top, bottom and middle of the tube.)
5. Give each student a **cardstock strip**.
 6. Have students:
 - a. Carefully slide the cardstock strip through one set of slits.
 - b. Make a loop of tape and stick it on the back of the round mirror.
 - c. Press the back of the round mirror onto the cardstock strip, so that the reflective (shiny) part of the mirror is visible through the window opening (Photo 6.7).
 7. Allow students to experiment with their spy tools. They can point the open end of their tube at an object they want to see, and the object will be visible as a reflection in the mirror. If it's safe to do so, allow students to walk around and explore. Encourage them to rotate their tubes and view different objects.
 8. After students have explored, have them return to their seats.

Discussion Prompts:

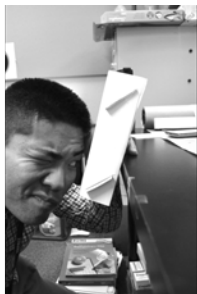
- *How can sailors in submarines see what's on the surface of the water while they are underwater?*
 - *How could we alter our spy tool to solve the problem?*
 - *When might a periscope be useful outside of a submarine?*
9. Give each student a **2inx3in rectangular mirror**. Ask the scientists to hypothesize about how this mirror can be used in the periscope.
 10. Have students slide the mirror *gently* through the other set of slits with the reflective side facing upwards. The reflective side of the mirror should be visible through the top window opening. The spy tool has now become a periscope.
 11. Pair students and give each pair a **green or blue LED light**.
 12. Have one student in each pair hold their periscope vertically with the round mirror at the bottom.
 13. Have that student shine an LED light at the round mirror while the other student holds their hand in front of the rectangular mirror and discuss what happens.

14. Allow time for students to explore. Here are some other fun ways students can test their periscope:
- One student can wiggle their fingers or give hand signals in front of the round mirror while the other student watches in the rectangular mirror.
 - One student can crouch down in front of a desk so that they can only see what's under the desk if they look straight ahead. By holding the periscope vertically in front of them with the top sticking up over the desk, and looking at the round mirror, they should be able to see what's on top of the desk, just like in a submarine! Their partner can act out a scene above the desk, draw them a picture, or write a secret message (Photo 6.8)!
 - Students can hold their periscope sideways and try to see around corners or doorways. If a corner or doorway isn't available, students can use a table or chair as an obstacle to peer around.

ACTIVITY PHOTOS:



6.7



6.8

ACTIVITY 7: DAILY DEBRIEF

TIME: 5 Minutes

GOAL: Reflect on what was explored during the activities and relate to students' own lives.

PROCEDURE:

- Gather students in a circle.
- Ask questions that facilitate a thoughtful reflection of the day's lessons. Questions may be considered in a Pair & Share model.
- If you are short on time, have students think about the questions while they are cleaning up from the activities.

Example questions:

- What happened today?
- How are mirrors useful?

Fun Physics: Color & Light (Grades 6-8)

Class 6: Mirror Mirror On the Wall

- What would we do if we had more time?

CLEAN UP: Implement a fun, daily clean-up routine so that students practice being “truly helpful” to their AKA Science community.

WHAT TO SAVE: Some items will carry over into future classes and others will require proper disposal. We have created a table to help organize your materials by when they will be used again. If an item has a number in the column marked “move to:”, all the items used today should be moved to the new class bag. If marked “send home”, the items are to go home with your scientists. “Save for SUN, recycle, or discard” means the items can be kept for use by your site or discarded as needed.

Supplies	Move to:	Send home	Save for SUN, recycle, or discard
Cardstock walls from Class 4			X
Cardstock strips		X	
Crayons, black	Class 7		
Crayons, blue	Class 7		
Crayons, box	Class 7		
Crayons, red	Class 7		
Lab notebooks	Class 7		
LED flashlights	Class 8		
LED lights, blue	Class 8		
LED lights, green	Class 8		
LED lights, white	Class 8		
Markers, black		X	
Mirrors, 2x3in		X	
Mirrors, round		X	
Paperclips, jumbo			X
Pencils	Class 7		
Play doh (containers)			X
Scissors (Site provides)			X
Tape, Scotch rolls	Class 7		
Worksheets			
Paper, white 11x17			X
Periscope pattern		X	

GRAND TOTAL OF WHAT GOES HOME: Periscope, black marker.

CLASS 7: CURIOUS COLORS

Supplies (in class bags)	#
Beads, UV color changing	32
Binder clips	16
Button batteries	16
Crayons, black	4
Crayons, blue	4
Crayons, box	2
Crayons, red	4
Copper tape rolls	1
Lab notebooks	16
LED bulbs, assorted colors	20
Pencils	16
Pipe cleaners	16
Polarized filters	16
Tape, Scotch rolls	4
Worksheets (in envelope)	#
Electromagnetic Spectrum	1
Greta the Anglerfish circuit worksheet	16
Post Survey Answer Sheet	1
Post Surveys	16

PREP STEPS:

- **Act. 5:** Tear or cut copper tape into sixteen 2.5 inch long strips and sixteen 4 inch long strips - one of each for every scientist.

VOCABULARY:

- **Bioluminescence:** The production and emission of light by living organisms.
- **Electromagnetic spectrum:** Describes all of the kinds of light, including those the human eye cannot see.
- **Polarized film:** An optical filter that lets light waves of a specific polarization pass through while blocking light waves of other polarizations.
- **Ultraviolet:** Light that has a wavelength shorter than that of the violet end of the visible spectrum but longer than that of X-rays. This light generally is responsible for sunburns on skin.

ACTIVITY 1: THUMB CHECK-IN (Optional)

TIME: 2 Minutes

GOAL: To encourage community building, provide an opportunity to reflect on the day, and create a safe space for students to feel like they belong.

PROCEDURE:

1. Gather students in a circle.
2. Do a quick “thumb check” to see how everyone is doing (e.g., students silently show how they’re doing by using their thumb as a gauge/meter. Thumb up is rating something highly, thumb down is rating something lowly, and feelings in between are rated as a thumb pointed towards the middle.)
3. First, ask students how they are feeling physically (e.g. thumb up = energized/ready to run a marathon and thumb down = sick/tired/injured.)
4. Next, ask students how they are feeling emotionally (e.g. thumb up = happy/glad/proud/interested and thumb down = sad/mad/bored.)
5. Thank students for sharing!

ACTIVITY 2: ICEBREAKER

TIME: 10 Minutes

GOAL: Icebreakers are a great way to build community and a sense of belonging among your students. Plus, they’re fun!

PROCEDURE:

1. Select an icebreaker from the AKA Science Icebreaker Guide.
2. We recommend **QUESTION OF THE DAY**, but you are welcome to use any of the icebreakers listed in the guide or come up with your own.

ACTIVITY 3: PAIR & SHARE

TIME: 5 Minutes

Supplies	#
Pencils	16
Lab Notebooks	16

GOAL: Gauge students' knowledge of today's subject and invite questions

PROCEDURE:

1. Pass out **a notebook and a pencil** to each scientist.
2. Ask a question that relates to today's subject. Have your scientists think about the question by drawing or writing in their notebooks or simply thinking about it.

Example Questions:

- *What is your favorite color and why?*
 - *What are the primary colors?*
3. Ask students to discuss their ideas with their neighbor before inviting students to share what they came up with. This is a "challenge by choice" opportunity and no one is required to share with the class if they are not comfortable.

ACTIVITY 4: POLARIZED LENSES

TIME: 10 Minutes

SOURCE: bit.ly/3DU5i9B

Supplies	#
Polarized Filters (1.5inx2.5in)	16
Scissors (site provides)	16
Tape (rolls, Scotch)	4

BACKGROUND:

Polarized lenses are made of a special material that absorbs and emits light. However, there's an important difference between the light it absorbs from one side and releases from the other! A wave of light actually has a shape. That shape is somewhere between straight up and down and side to side. If you think about a wiggly spaghetti suspended in the air, think about all the different ways you could rotate it. Polarized lenses block about half the light passing through them—either they block the up-and-down waves or the side-to-side waves.

When you look through just one polarized lens, it blocks about half of the waves coming through. You can still see the other half of the light. However, if you cross two polarized lenses, you block both up-and-down and side-to-side waves, so nothing reaches your eyes! That's why the filters look black when you cross two of them at a right angle. (bit.ly/3DU5i9B)

SURVEY CONNECTION:



This activity is linked to the following survey question:

Select the hypothesis (Circle one):

A. Mirrors reflect objects and bounce light rays.

GOAL: To learn how polarized filters affect light.

WHAT GOES HOME: Polarized filters (after using in next activity)

PROCEDURE:

1. Give each scientist one **polarized filter**.
2. Have students hold the filters up to their eyes and look around the room. The filters have sharp edges, so warn students not to hold them too close to their eyes. If they need to smooth an edge, they can trim with **scissors** or cover with a small piece of **tape**. Encourage the students to discuss what they see.

Discussion Prompts:

- Does anything look different through the lens?
 - What do you think a polarized lens does?
3. Pair students, and have the pairs face each other.
 4. Have students hold their filter about an inch from one eye. They should hold it horizontally (the long edges should be on the top and bottom and the short edges should be on the sides). Students should be able to see their partner's eyes clearly (Photo 7.1).
 5. Have students close the eye that's not covered by the filter, either by shutting it or covering it with their hand.
 6. Have one student in each pair rotate their filter 90° so that it is vertical, and have students discuss what they see (Photo 7.2).
 7. Have the second scientist rotate their filter so that it is vertical like their partner's and discuss what they see.

Discussion Prompts:

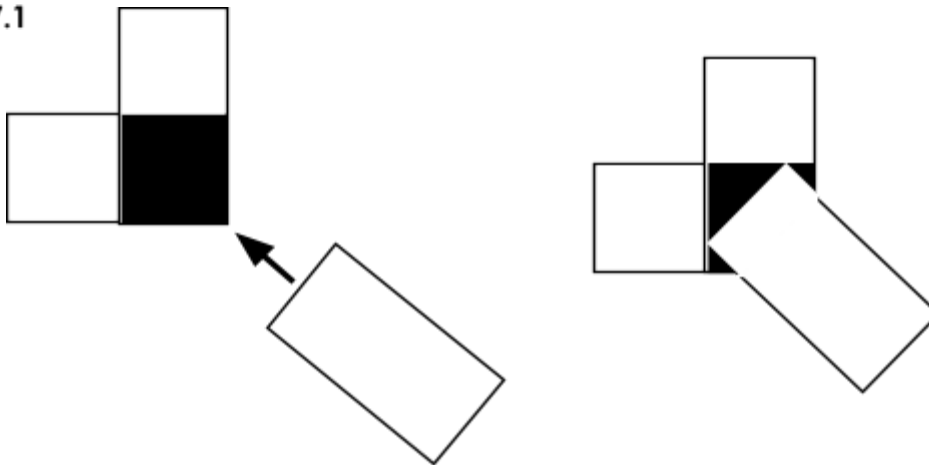
- What do you think would happen if we put something between two perpendicular polarized lenses?
- What do you think you would see with the addition of the third filter? What is your hypothesis?

8. Have students reset their filters to the horizontal first position (long edges on top and bottom) and switch who rotates their filters first, repeating steps 5 and 6.
9. Explain that polarized lenses block out half of all light on their own. The light blocked out is light coming to the lens from a certain direction (either up/down or sideways). When two polarized filters are put together perpendicularly, each filter blocks out one of the two directions of light, thus blocking all light.
10. In pairs, allow students to cross their filters and rotate them into various positions (Photos 7.3).
11. Challenge students to find positions that create black, clear, and in between.
12. Put students in groups of 3.
13. Have two students place their filters at right angles to each other.
14. Have the third student place their filter diagonally *in between* the other two students' filters (Diagram 7.1 and Photo 7.4).

Discussion Prompts:

- *Why did you choose this design?*
- *Were you able to stick to your plan completely? Why or why not?*

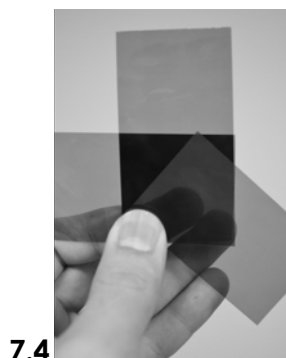
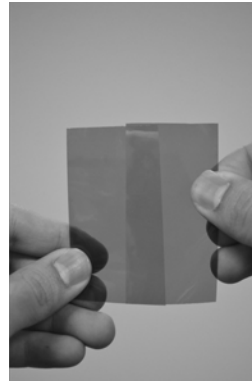
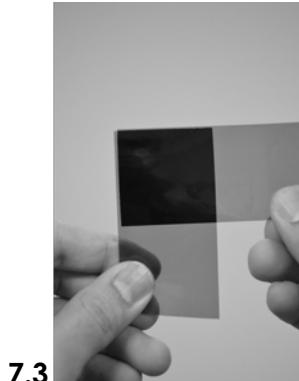
7.1



The figure on the left shows the crossed polarized filters, which create black. The figure on the right shows that when a third polarized filter is added at a diagonal *in between* the crossed filters, the black square becomes somewhat clear.

15. Have everyone hold on to their filters for the next activity.

ACTIVITY PHOTOS:



ACTIVITY 5: COLOR-CHANGING BEADS

TIME: 10 Minutes

SOURCE: stanford.io/3wAzkw1

Supplies	#
Beads (UV, color-changing)	32
Pipe Cleaners	16
Polarized Filters (1.5inx2.5in)	16
Worksheets	#
Electromagnetic Spectrum	1

BACKGROUND:

Visible light is one part of an electromagnetic spectrum, but many wavelengths of light are invisible to the human eye! Along with visible light, invisible light such as infrared, ultraviolet, X-rays, and radio waves are all forms of radiation, which means they carry energy in waves. The length of each wave

and the speed at which it travels determines which form it takes. Ultraviolet radiation is just one of the many types of radiation released by the sun! Most of the other types are absorbed by the atmosphere before they reach us on Earth. Ultraviolet radiation can reach us through the atmosphere, even when it's cloudy! UV radiation can damage your skin. Staying in the sun for too long can give you a sunburn—that's what happens when your skin absorbs too much UV radiation too quickly! Sunscreen helps protect your skin by blocking the UV rays, meaning you can stay in the sun longer without getting a sunburn. (bit.ly/3DXgy5k)

SURVEY CONNECTION:



This activity is linked to the following survey question:

Q. Select the hypothesis (Circle one):

A. Mirrors reflect objects and bounce light rays.

GOAL: To learn about ultraviolet (UV) light.

WHAT GOES HOME: Polarized filters, Pipe cleaner with beads

PROCEDURE:

1. Show students the **Electromagnetic Spectrum worksheet** and discuss different types of light, especially ultraviolet (UV) light.

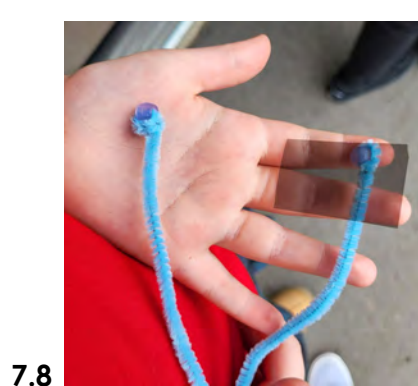
Discussion Prompts:

- *Is all light the same?*
 - *What are some of the different kinds of light?*
 - *Where do we use different types of electromagnetic rays? (radio, microwaves, infrared night goggles!)*
 - *How can we test to see if the sun is releasing something like UV rays if we can't see UV light?*
2. Give each student **two UV color-changing beads and a pipe cleaner**.
 3. Have your scientists thread one bead onto the pipe cleaner and loop the pipe cleaner to lock the bead in place. Then repeat with the second bead on the other side of the pipe cleaner (Photos 7.5 - 7.6).
 4. Take the students outside if possible, however indoors next to a non-tinted window will still work. If it's cloudy outside, that's okay. The activity should still work but might take longer to see the effects.
 5. Have students make a hypothesis about what will happen once we expose the beads to light.
 6. Expose their beads to the sun until the beads change colors (Photo 7.7).

Discussion Prompts:

- *What happened when the beads were exposed to the sun? How is that similar to what happens when people are exposed to too much sun?*
 - *Would this experiment be different on a cloudy day vs sunny day? Why/why not?*
 - *If UV can cause sunburned skin, can it also cause sunburned eyes? (Yes!)*
 - *What effect might polarized lenses have on our beads (and our eyes)?*
7. Discuss what's happening and how UV light affects the beads (and also our skin!) even though we can't see it.
 8. Show students a polarized filter and remind them that it blocks out about half of all light rays passing through it.
 9. Have scientists hold one hand flat with the pipe cleaner/beads laying on their hand.
 10. Each scientist can cover one of the beads with the polarized filter and leave the other one uncovered (Photo 7.8).
 11. Expose the beads to outdoor light at the same time.
 12. After one minute, remove the polarized filter and quickly ask students to compare the brightness of the beads.
 - a. It may work best if you move into the shade before removing the filter.

ACTIVITY PHOTOS:



ACTIVITY 6: LED CIRCUIT

TIME: 15 Minutes

SOURCE: Dr. Carrie Buo and Karley Schlaht, AKA Science; bit.ly/3tGdyrP

Supplies	#
Binder clips	16
Button batteries	16
Crayons, black	4
Crayons, blue	4
Crayons, box	2
Crayons, red	4
Copper tape rolls	1
LED bulbs, assorted colors	20
Worksheets	#
Greta the Anglerfish circuit worksheet	16

BACKGROUND:

This activity is a fun way to learn about simple circuits and how to make a light bulb light up. Electrical circuits are conductive wires that carry electricity in a circular path - when the path is broken the item powered by electricity turns off. The copper tape and LED bulb in the activity make the bulk of the path here with the battery connecting the circuit to turn the bulb on. Copper, like the copper tape used here, is a conductive metal, which means the electricity can flow easily through it to complete the circuit. This is why copper is used in electrical wiring for many homes and other buildings.

We chose a picture of an angler fish for this activity because these fish are bioluminescent - glowing Photobacterium live in their "lures" and naturally emit light. There are many other examples of bioluminescence; fireflies, jellyfish, and certain species of algae all have natural luminescence. In fact, Cannon Beach, OR has experienced glowing waters from bioluminescent algae! Even though the way your circuits light up have nothing to do with how the bioluminescence works, it's a fun use of circuits! (bit.ly/3qOOX3f, bit.ly/3R5AEIH, bit.ly/3qWrDjW)

GOAL: To learn about basic circuits by assembling one that will light up an LED bulb.

WHAT GOES HOME: Completed circuit (if permission slip was returned)

PROCEDURE:

1. **Tell scientists:** Limor "Ladyada" Fried is a pioneer in the open-source engineering market. As the founder of the highly successful online tech company AdaFruit, she was the first woman

engineer to appear on the cover of WIRED Magazine. Let's dive into some tech like Ms. Fried by making some simple circuits.

2. Pass out **one worksheet, one LED bulb, and one copper tape strip of each size** to every scientist.

Discussion Prompts:

- *Have you ever made a circuit before?*
- *Do you know how electricity works?*

3. If the class is interested, they can color their worksheets. This is best done before creating the circuit. Make **crayons** available to everyone.
4. Have your scientists look at the LED bulb and locate the two wires coming out of the bottom of the bulb. The wires are two different lengths - the longer one is positive, the shorter one is negative (Photo 7.9).
5. Bend the wires so they are going in opposite directions of each other, as shown in Photo 7.10.
6. Flip the worksheet over so the circuit pattern is facing up. Place the LED bulb in the hole of the worksheet with the wires on top of the dotted line (Photo 7.11).
9. Using the shorter piece of copper tape, tape down the negative wire of the LED bulb and follow the black line on the paper. It's ok if the copper tape isn't exactly covering the black line but it should be close.
 - a. Tip - peel the backing of the tape off as you apply the copper tape, not all at once. It is easy to tear or tangle the copper tape once the backing is off.
 - b. Extra copper tape is provided in case of mistakes.
10. Follow the other black line with the longer piece of copper tape, taping down the positive end of the LED bulb. To make the corner turn, see Photos 7.12 - 7.14 for the technique. Peel the backing off as you make the turn, not all at once.

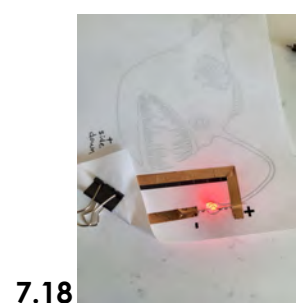
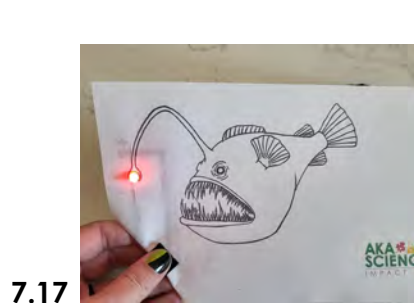
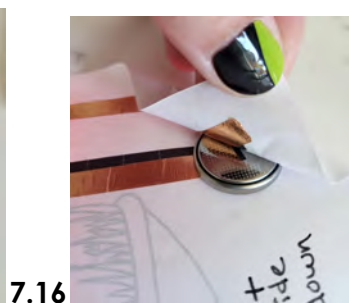
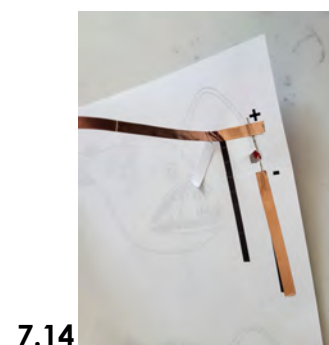
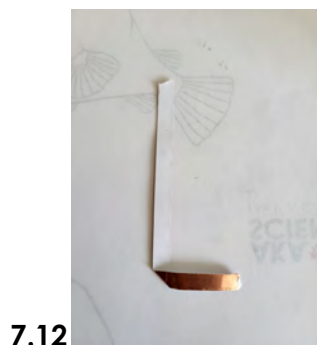
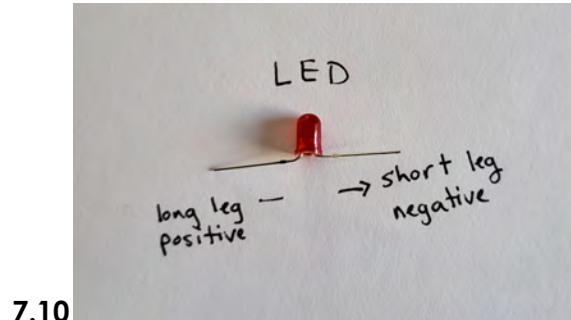
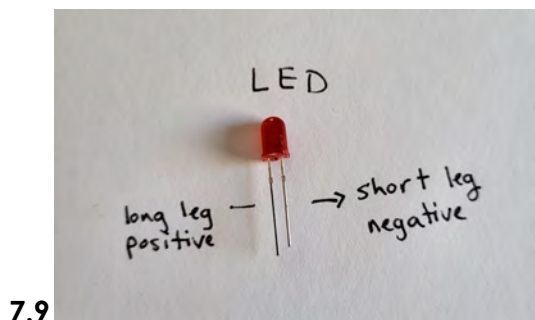
TIP: If your scientists are having a difficult time making the corner turn, the copper tape can be ripped and taped over. This will work but the adhesive makes the circuit less stable. This means the bulb may not stay lit.

11. Pass out **one button battery and one binder clip** to each scientist.
12. Have students place the positive top of the battery on the end of the longer piece of copper tape (Photo 7.15). Then fold the corner of the shorter piece of copper tape over the bottom negative side of the battery (Photo 7.16). When the two ends of the copper tape are pressed to the battery the bulb will light up (Photo 7.17)
13. The binder clip can be used to hold the battery on the paper to keep the bulb lit (Photo 7.18).
14. Flip over the paper and see the angler fish "lure" glowing!

FUN FACTS!

- The angler fish lure is called an “esca”.
- The protein that makes jellyfish glow is called GFP or green fluorescent protein. This protein is used in many scientific experiments!

ACTIVITY PHOTOS:



ACTIVITY 7: SURVEYS & DAILY DEBRIEF

TIME: 10 Minutes

Supplies	#
Pencils	16
Worksheets	#
Survey Answers	1
Surveys	16

GOAL: Reflect on what was explored during the activities and relate to students' own lives and administer surveys to your class.

PROCEDURE:

1. Gather students in a circle.
2. Ask questions that facilitate a thoughtful reflection of the day's lessons. Questions may be considered in a Pair & Share model.
3. If you are short on time, have students think about the questions while they are cleaning up from the activities.

Example questions:

- *What happened today?*
 - *What was a challenge that you overcame?*
 - *Can you think of any animals that glow?*
 - *How does what we learned today apply to your personal life?*
4. Give each student a **Post-Survey worksheet**. Note that the survey is two-sided.
 5. Make **pencils** available.
 6. Read each survey question aloud and have students write or circle their answers on the worksheet.
 7. Assure students that it's okay if they don't know all the answers. Make their best choices.
 8. Afterwards, have students discuss their answers with a neighbor, then invite students to share their answers with the rest of the class.
 9. **PLEASE SAVE STUDENTS' SURVEYS & STORE IN A FOLDER.** You can repurpose one of the worksheet envelopes for this!
 10. At the end of the term, all surveys must be submitted to the Site Manager.

**AKA
SCIENCE**
IMPACT NW

Name (First + Last): _____
School: _____
Date: _____

AKA Science Post-Survey

Attitude questions:

You were part of the AKA Science Fun Physics: Color & Light class!

1. I liked learning about color & light in AKA Science class. (Circle one)

 YES ----- SORT OF ----- NO

2. I liked doing color & light experiments in AKA Science class. (Circle one)



3. I like color & light and science more than I did before. (Circle one)



4. I felt like a scientist when I was in AKA Science class. (Circle one)



5. I want to do AKA Science class again. (Circle one)



**AKA
SCIENCE**
IMPACT NW

Name (First + Last): _____
School: _____
Date: _____

Knowledge questions:

You learned a lot in your AKA Science Fun Physics: Color & Light class!

1. I learned something new about color & light in AKA Science class. (Yes/No) What is something you learned? (Write it/ draw it)

2. White light can be split into a rainbow. (Circle one)
Yes No

3. What happens to light when it passes through things like water or binoculars? (Circle one)
The light disappears The light bends The light accelerates

4. Select the hypothesis (Circle one):
I think mirrors are useful at home.
Mirrors reflect objects and bounce light rays.

5. You are a physicist that is creating a model eye. What materials would you need and what did you learn in this class that would help you do this? (Write it/ draw it)

If any students were absent today, make sure to have them take the Post-Survey during the last class.

Check all surveys for student names! Ensure all names are legible and, if not, please write in their names.

CLEAN UP: Implement a fun, daily clean-up routine so that students practice being "truly helpful" to their AKA Science community.

WHAT TO SAVE: Some items will carry over into future classes and others will require proper disposal. We have created a table to help organize your materials by when they will be used again. If an item has a number in the column marked "move to class bag #", all the items used today should be moved to the new class bag. If marked "send home", the items are to go home with your scientists. "Save for SUN, recycle, or discard" means the items can be kept for use by your site or discarded as needed.

*****See next page for WHAT TO SAVE table and WHAT GOES HOME.*****

Supplies	Move to:	Send home	Save for SUN, recycle, or discard
Beads, UV color changing		X	
Binder clips		X	
Button batteries		X	
Crayons, black		X	
Crayons, blue		X	
Crayons, box		X	
Crayons, red		X	
Copper tape rolls		X	
Lab notebooks	Class 8		
LED bulbs, assorted colors		X	
Pencils	Class 8		
Pipe cleaners		X	
Polarized filters		X	
Tape, Scotch rolls	Class 8		
Worksheets			
Electromagnetic Spectrum			X
Greta the Anglerfish circuit worksheet		X	
Post Survey Answer Sheet			X
Post Surveys	Site Manager		

GRAND TOTAL OF WHAT GOES HOME: Polarized lenses, UV beads on pipe cleaners, completed circuit. Crayons can be saved or sent home.

Circuits can go home if permission slip is returned

Give completed surveys to your manager

CLASS 8: OUTSTANDING OPTICS

Supplies (in class bags)	#
Glow sticks	16
Lab notebooks	16
LED flashlights	4
LED lights, white	4
Pencils	16
Pushpins	4
Scissors (site provides)	16
Tape, Scotch rolls	4
Yarn, 3ft pieces	16
Worksheets (in envelope)	#
Aluminum foil squares, 4x4in	16
Paper, black cardstock	32
Parchment paper squares, 4x4in	16
Post Surveys	Any remaining
Snow Goggles, 1/3 sheets	32

PREP STEPS:

None!

VOCABULARY:

- **Camera Obscura:** A darkened box with a convex lens or aperture for projecting the image of an external object onto a screen inside.
- **Chemiluminescence:** The emission of light during a chemical reaction which does not produce significant quantities of heat.
- **Fluorescence:** The ability of certain chemicals to give off visible light after absorbing radiation which is not normally visible.
- **Phosphorescence:** Light emitted by a substance without combustion or perceptible heat.

ACTIVITY 1: THUMB CHECK-IN (Optional)

TIME: 2 Minutes

GOAL: To encourage community building, provide an opportunity to reflect on the day, and create a safe space for students to feel like they belong.

PROCEDURE:

1. Gather students in a circle.
2. Do a quick "thumb check" to see how everyone is doing (e.g., students silently show how they're doing by using their thumb as a gauge/meter. Thumb up is rating something highly, thumb down is rating something lowly, and feelings in between are rated as a thumb pointed towards the middle.)
3. First, ask students how they are feeling physically (e.g. thumb up = energized/ready to run a marathon and thumb down = sick/tired/injured.)
4. Next, ask students how they are feeling emotionally (e.g. thumb up = happy/glad/proud/interested and thumb down = sad/mad/bored.)
5. Thank students for sharing!

ACTIVITY 2: ICEBREAKER

TIME: 10 Minutes

GOAL: Icebreakers are a great way to build community and a sense of belonging among your students. Plus, they're fun!

PROCEDURE:

1. Select an icebreaker from the AKA Science Icebreaker Guide.
2. We recommend **QUESTION OF THE DAY**, but you are welcome to use any of the icebreakers listed in the guide or come up with your own.

ACTIVITY 3: PAIR & SHARE

TIME: 5 Minutes

Supplies	#
Pencils	16
Lab Notebooks	16
Worksheets	#
Post-Surveys	Any remaining

GOAL: Gauge students' knowledge of today's subject and invite questions

PROCEDURE:

1. Pass out **a notebook and a pencil** to each scientist.

2. Ask a question that relates to today's subject. Have your scientists think about the question by drawing or writing in their notebooks or simply thinking about it.

Example Questions:

- Have you ever used an object with lenses?
 - Can you think of a way to reduce glare from the bright sunlight?
3. Ask students to discuss their ideas with their neighbor before inviting students to share what they came up with. This is a "challenge by choice" opportunity and no one is required to share with the class if they are not comfortable.
 4. **Administer any remaining post-surveys to students if they were absent during Week 7.**

ACTIVITY 4: SNOW GOGGLES

TIME: 10 Minutes

SOURCE: bit.ly/45kqoKg and Dr. Carrie Buco, AKA Science

Supplies	#
Flashlights	4
LED lights, white	4
Scissors (site provides)	16
Yarn, 3ft pieces	16
Worksheets	#
Snow Goggles	32

BACKGROUND:

Most of the time we think of technology as something related to computers or other electronics - something we can plug in and use to make our lives easier. Technology is that and more! An non-electronic example of technology is snow goggles made by Indigenous tribes in and around the Arctic. Snow is made up of millions of tiny crystals that reflect light, which can make it hard to see in bright sunlight. People living in regions that spend much of the year covered in snow needed to find a way to navigate the land in very bright conditions without the sun damaging their eyes. Many of these tribes have created a variation of snow goggles - a piece of bone, wood, or horn that fits over the eyes with a viewing slit in the center. This slit is small enough to see through but blocks most of the light, creating sunglasses without tinted glass! These glasses can even correct mild vision impairments - a technology that many of us today couldn't live without. (bit.ly/3su1No8)

SURVEY CONNECTION:



This activity is linked to the following survey question:

Q. Select the hypothesis (Circle one):

A. Mirrors reflect objects and bounce light rays.

GOAL: To explore how glare from bright light can be reduced using a traditional snow goggle model.

WHAT GOES HOME: Snow Goggles

PROCEDURE:

1. **Tell scientists:** Indigenous people that live in very snowy areas, like the Yup'ik people of Alaska or the Tunumiits of East Greenland, have been making snow goggles out of bone, wood, and whale baleen (teeth) for thousands of years. These goggles protect eyes from the harsh glare of sunlight reflecting off the white snow, like the driftwood pair made by Yup'ik artist Ayap'run Jack Abraham of Alaska that is displayed in the Smithsonian. Today we will make a version of snow goggles out of paper that will work a bit like the ones Mr. Abraham makes.

Discussion Prompts:

- *How do we protect our eyes from bright light?*
 - *Can you think of a way to reduce glare without using sunglasses? (Black under eyes used by athletes)*
2. Pass out a **Snow Goggles Worksheet, a 3-foot piece of yarn, and scissors** to each scientist.
 3. Explain that everyone will be making a pair of snow goggles and then testing to see how they reduce glare from bright lights.
 4. Have your scientists cut out the glasses along the solid outline and cut the slit in the middle. If cutting out the middle is difficult, have your scientists fold the glasses to make cutting easier (Photos 8.1 - 8.2).
 5. Ask everyone to make a hypothesis about whether their glasses will protect their eyes from bright light.
 6. Pair scientists and pass out **one white LED OR one flashlight** to each pair. Explain that because we don't have a snow-covered landscape you have to test if the glasses work in a different way.
 7. Have one scientist in each pair turn on the flashlight or LED and hold it above their partner's head (Photo 8.3). The light holder should move the flashlight until the other student can see the glare of light on the side of their nose. Now have the scientist under the light hold the glasses over their eyes and the glare will disappear (Photo 8.4)!
 8. Scientists can switch roles so each child is able to see the light-blocking effects of the glasses.

Discussion Prompts:

- *Why do you think the goggles reduce glare?*
 - *Is there a way to modify the goggles to make them even more effective?*
9. Optional: Give each scientist a second Snow Goggles Worksheet and have them experiment with the size of the eye opening. Try making the opening larger or smaller and see how it affects the glare reduction as well as ability to see through the goggles.
10. Thread the yarn through the holes in the top of the glasses. Scientists can help each other tie the yarn behind their heads to hold the glasses in place (Photo 8.5).

ACTIVITY PHOTOS:



ACTIVITY 5: GLOW STICKS

TIME: 5 Minutes

SOURCE: Nicole Howe, AKA Science

Supplies	#
Glow sticks	16

BACKGROUND:

A glow stick contains two different chemicals that produce a glow when they're mixed. Because the glow only lasts for as long as the chemical reaction, the glow stick makers have to keep those

chemicals separate until the person who buys them wants them to glow. To keep the chemicals separated, they put one of the chemicals in a thin glass tube. When you bent the glow stick, the cracking sound you heard was the glass tube breaking in the plastic glow stick. After the glass tube cracks, it releases its chemical and it mixes with the surrounding chemical, causing a reaction. This reaction glows as long as there are chemicals left to react. Because this glow results from two chemicals reacting, it's called chemiluminescence. Unlike fluorescence and phosphorescence, the glow stick doesn't need light for energy. Instead, it uses chemicals to fuel the glow that it emits. Did you know that low temperatures slow the rate of the chemical reaction? Because of this, you can put a glow stick in the freezer to make it last longer! (bit.ly/3M36zji)

GOAL: To learn how glow sticks work.

WHAT GOES HOME: Glow sticks

PROCEDURE:

1. Give each student a **glow stick**. DO NOT have them activate it until Step #4.

Discussion Prompts:

- *How is this glow stick activated? Don't show me, tell me.*
 - *Why do we need to be careful with them?*
2. Give students a clue about how the glow sticks work by having them gently shake their glow sticks. They should hear a slight rattling or clicking. If they hold the stick upright (like the letter "i"), the top of the glow stick will have a pocket of air inside it. If students look very closely, they might see an almost invisible tube inside the glow stick (it might help to hold it in front of a light source). Tell them to remember that tube and to think about what might happen to it when they bend the glow stick.
 3. Turn the room lights off.
 4. Have students bend the glow stick until they hear a crack and carefully watch to see what's happening inside (Pictures 8.6 - 8.7).

SAFETY NOTE: Glow sticks can break open if they get mangled, and the liquid inside—while not toxic—is an irritant. Make sure kids are gentle when they bend their glow stick to activate it, and that they hold the stick at arm's length while bending it. If you don't trust your kids to do that, walk around and activate each glow stick yourself. If students get the liquid on their skin, be sure to wash with plenty of soap and water. If they somehow get liquid in their eye, be sure to flush with plenty of water.

Discussion Prompts:

- *What uses do glow sticks have?*
- *What are the downsides of glow sticks?*

ACTIVITY PHOTOS:



ACTIVITY 6: CAMERA OBSCURA

TIME: 25 Minutes

SOURCE: Science Works-65 Experiments that Introduce the Fun and Wonder of Science from the Ontario Science Center

Supplies	#
Pushpins	4
Scissors (site provides)	16
Tape (scotch, rolls)	4
Worksheets	#
Aluminum Foil (squares, 4in)	16
Paper (cardstock, black)	32
Parchment Paper (square, 4in)	16

BACKGROUND:

A camera obscura, or pinhole camera, is a tool used to project images onto a surface. The invention of early photography was based on the model of the camera obscura (using photo-reactive materials, like film, in place of the parchment paper in our model). At its simplest, the camera obscura is a box (which may be room-sized) with a small opening (i.e., pinhole) on one side. Light will pass through the pinhole and strike a specific part of the back wall, forming a projection of the scene outside the box. As the pinhole is made smaller, the image gets sharper, but the light-sensitivity decreases. In this set-up, the image is always upside-down, because light forced through a pinhole crosses over itself. It is possible to project a "right-side-up" image using mirrors. In this activity, we use a tube instead of a box, and parchment paper as a projection surface instead of a wall.

GOAL: To understand how a pinhole can be used to project an image, and to see the world upside-down.

WHAT GOES HOME: Camera Obscura

PROCEDURE:

1. Give each student **two sheets of black cardstock, an aluminum foil square, a parchment paper square, and a pair of scissors**. Make **tape and pushpins** available. Explain that they will be building their own camera obscura.

Discussion Prompts:

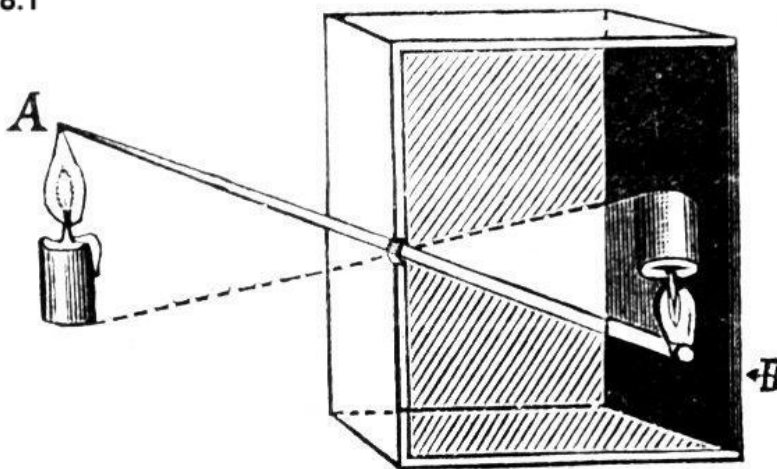
- *Have you ever used or seen a projector before?*
 - *Do you think we could make our own mini projection booth?*
2. Have students roll one of their cardstock sheets into a cylindrical tube 8.5in tall, and approximately 2-3 inches in diameter, and tape it along the loose edge to ensure the tube doesn't unroll. The diameter doesn't need to be exact, but the tube should be thin enough that they can comfortably hold it in one hand.
 3. Have students fold their foil square over one of the tube's open ends, and tape it down securely so that the opening is entirely covered by foil. It may be easier for students to do this in pairs (e.g., one student could hold the foil in place while the other tapes). Be very careful not to rip or puncture the foil during this process. This will be the pinhole tube.
 4. Once the foil is in place, have students use a pushpin to make a small hole in the center of the foil circle now covering one end of the pinhole tube, then have students set their first tubes aside.
 5. Have students roll their second cardstock sheet into another cylindrical tube, also 8.5in tall, but just slightly narrower in diameter than they first, and tape it along the loose edge to ensure the tube doesn't unroll. The second tube should be able to fit snugly inside the first. Test this and adjust the tube size accordingly before moving on to the next step (Photo 8.8).
 6. Have students fold their parchment paper square over one of the second tube's open ends, and tape it down securely so that the tube's opening is entirely covered by the parchment paper. This will be the screen tube. Note that it may be easier for students to do this in pairs.
 7. Have students insert their screen tube into the pinhole tube. The screen tube should be snug enough that it stays in position on its own, but not so tight that it is overly difficult to insert, remove, or move back and forth (Photo 8.9).
 8. Have students look through the uncovered opening in the nested tube set-up, towards a brightly lit area (at a lamp, or out a window from inside works best), and slide the screen tube in and out of the pinhole tube to focus the image that appears on the parchment paper.

SAFETY NOTE: Do not look directly at the sun! This can damage eyes, even through the parchment paper.

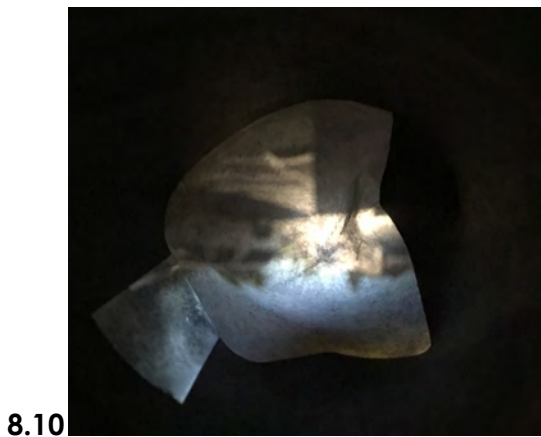
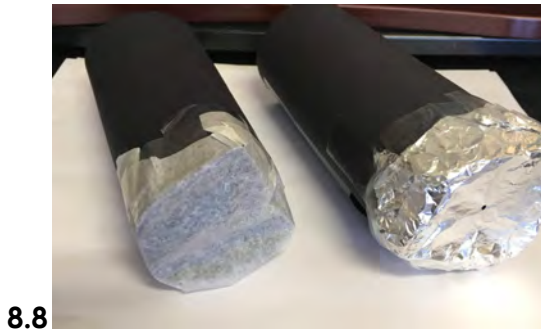
Discussion Prompts:

- *What do you see through your pinhole camera?*
 - *Is it upside down or right-side up? Why do you think that is?*
 - *How could we make this work like a real camera? Where would we put the film?*
9. Have students discuss what they see through their pinhole cameras, or what they notice about the images projected on the parchment paper screen (Photo 8.10).
10. Explain that the reason the images they see appear upside down is because waves of light travel in very straight paths. The light coming through the pinhole from the top of the scene they're looking at must be traveling diagonally to hit the pinhole from a point higher up. It continues on that very straight, diagonal path after traveling through the pinhole, and so is now lower than the pinhole itself. The same thing is happening in reverse for the light coming from the bottom of the scene they're looking at, and so the bottom becomes the top (Diagram 8.1).

8.1



ACTIVITY PHOTOS:



ACTIVITY 7: WRAP UP!

TIME: 5 Minutes

GOAL: Reflect on what was explored during the activities and relate to students' own lives.

PROCEDURE:

1. Gather students in a circle.
2. Ask questions that facilitate a thoughtful reflection of the day's lessons. Questions may be considered in a Pair & Share model.
3. If you are short on time, have students think about the questions while they are cleaning up from the activities.

Example questions:

- *What happened today?*
- *What was a challenge that you overcame?*

- What would we do if we had more time?
- How does what we learned today apply to your personal life?
- What was the best thing you learned in AKA Science class?

CLEAN UP: Implement a fun, daily clean-up routine so that students practice being “truly helpful” to their AKA Science community.

WHAT TO SAVE: Any remaining items can be sent home (at your discretion), saved for use in other programs, or discarded/recycled. Unused items or items such as rulers, lenses, pitchers, plastic bowls, and flashlights can be kept or returned to AKA Science. **Please do not return used plastic cups, spoons, or food items such as milk powder.**

Supplies	Give to Site Manager	Send home	Save for SUN, recycle, or discard
Glow sticks		X	
Lab notebooks		X	
LED flashlights			X
LED lights, blue		X	
LED lights, green		X	
LED lights, red		X	
LED lights, white		X	
Pencils		X	
Pushpins			X
Scissors (site provides)			X
Tape, Scotch rolls			X
Yarn, 3ft pieces		X	
Worksheets			
Aluminum foil squares, 4x4in		X	
Paper, black cardstock		X	
Parchment paper squares, 4x4in		X	
Snow Goggles, 1/3 sheets		X	
Surveys (all)	X		

GRAND TOTAL OF WHAT GOES HOME: Lab notebooks, pencils, snow goggles, glow sticks, camera obscura, one LED light per person.

Make sure all students have completed Post-Surveys. Give completed surveys to your manager.

AKA SCIENCE ICEBREAKER GUIDE



AKA Science is a fun program that is proven to increase students' attitudes about science. Games are a great way to build on that positive association and encourage your budding scientists to have MORE fun while in AKA Science class! We invite you to use this game guide as a tool to get your scientists up and moving, connect with one another, and enrich your AKA Science classroom. By setting aside some time to play games with your students, you'll increase their sense of belonging, support building community within your classroom, and nurture the vital bond between you and your students. This game guide includes a variety of games; from quick silly games that can be done during transitions to longer field games you can play outside. Science is fun, and games make it even better!

ICEBREAKERS (5-15 MINUTES)

Icebreakers accomplish two things: (1) they encourage students to get to know one another and feel more comfortable engaging within the group and (2) they are a fun way to get students up and moving! Similar to QSG, we recommend no more than 3 rounds of any icebreaker so that it keeps things fresh, leaves students wanting more, and provides you with an incentive opportunity for later (e.g. "Once you've completed your projects we can play the icebreaker game you like so much!")

CONVERSATION STARTERS (10 MINUTES)

A conversation starter is designed to encourage students to talk with one other and share interesting ideas or facts about themselves. This can be done in pairs, small groups, or as a whole class and can be short or long (e.g. the starters may naturally lead into fun conversations!)

QUESTION OF THE DAY

- At the beginning of the class, you can choose a Question of the Day (QOTD) to ask the class. Each student can share their answer - either sharing with the whole group or in pairs. This is a great way to encourage conversation and group connections.
 - If you had a superpower what would it be?
 - If you could be an animal for a day what would it be?
 - What's the weirdest thing in your backpack?
 - What's one boring fact about yourself?
 - What's your least favorite animal?
 - If you were a famous TikToker what would you be famous for?
 - If you could invent something that could change the world, what would it be?
 - What is your favorite thing to do while you wait?
 - If you could ask an extraterrestrial one question, what would it be?
 - Which type of habitat best describes you (e.g. beach, mountain, forest, desert?)
 - If you could safely pet any animal in the world, which would it be?
 - What type of weather are you today (e.g. sunny, windy, partly cloudy, etc.?)

- If you had the whole day to yourself with unlimited resources and guaranteed safety, what would you do?

TWO TRUTHS AND A LIE

- Students take turns naming 3 facts about themselves where 2 of the facts are true and 1 is a lie.
- If students are stuck on the "lie" part, remind them that they can choose to make their "lie" obvious (e.g. "I have 5 pet elephants") or tricky (e.g. "I have been skiing 10 times," when the truth is "I have been skiing 2 times.")

NAME GAMES (5-10 MINUTES)

Name Games provide a fun platform for learning each other's names! They are also somewhat physical so they double-perform as energizers. Learning one another's names by the first or second day will encourage interaction among students and will help you remember everyone's names too!

NAME TOSS

- Have students stand in a circle
- Find a small object that is safe to toss between players
- The first player will state their name followed by the name of another player. BEFORE tossing the object the first player will make eye contact with whom they are tossing the object to, then toss the object.
- Each player then repeats the process of stating their name, the name of a player who hasn't played yet, then making eye contact and tossing the object (*note: if it's difficult to keep track of which players have had a turn, create an identifier such as pointing a foot into the circle once they've had a turn)
- Once all players have had a turn, students can have the option to either repeat the same order at a faster pace or reverse the order that they previously did.

NAME + MOVEMENT

- Have the students stand in a circle
- The first student will state their name + a descriptive word that sounds like how their name starts (e.g. "Jumpy Justin.") Justin makes a jumping motion.
- The group repeats it back (along with the movement.)

- Then the next person would say their name (e.g. "Disco Donna") and Donna would do a disco-like movement that the group would repeat back. Next would be "Wiggly William," "Crafty Kathy" And so on.
- Note that the movement just has to start with how the person's name sounds (e.g. "Silly Celia" works even though Silly starts with an s and not a c.)
- Each student will state their name with a descriptive word before it, accompanied by a movement related to that descriptive word (for example: "Wiggly William," and the student wiggles their body)
- Then one student will state their title and perform their movement and then state the title of another student in the circle and perform that students' movement
- Each student will repeat this process until all students have had a chance to participate

ICEBREAKER GAMES (10-15 MINUTES)

Icebreaker games are short, physical games done in a group that encourage students to have fun while getting to know each other and working together towards a common goal. These can be done at any time and are particularly useful if you have a longer class time (e.g. more than 60 minutes) or older students (e.g. middle school.)

HEAD HONCHO

- Standing in a circle, students decide on one person who will be the "detective," and they will turn around to face away from the circle of students
- While the detective is looking away, the rest of the students silently (using only physical gestures) decide on one student to be the "head honcho,"
- The head honcho chooses a body movement (for example: clapping, snapping, wiggling, etc.) and the rest of the students will copy the motion
- Once the motion is decided upon, the students alert the detective that they can rejoin the group
- The detective then stands in the center of the circle and slowly spins around while observing the rest of the group
- At any time, the head honcho can change the motion and the rest of the students follow along with the change—but WATCH OUT! The detective has three guesses to try to pick out which student is the head honcho. If the detective sees the head honcho initiate the change, the detective can pick them!
- If the detective chooses the student who is the head honcho, the detective wins! If the detective doesn't guess correctly in three guesses, the head honcho wins!

POISON DART FROG

- Sitting in a circle, the students all close their eyes or use blindfolds
- The facilitator (or teacher) walks around the outside of the circle and chooses one student to be the poison dart frog by tapping that student lightly on the shoulder (tip: tap the student twice so they know it was not an accidental tap)
- Instruct students to open their eyes. Students may begin to scan around the circle looking at each other but are not allowed to speak during the game
- If the poison dart frog makes eye contact with another student, they may stick their tongue out and point it at them and if they do, the student they pointed at is then "knocked out,"
- When "knocked out," students may make a dramatic display of being "knocked out," for fun if they feel comfortable to do so.

POSITIVE REINFORCEMENT

- Students stand in a large circle except for one student. That one student waits outside of the circle (or classroom if indoors)
- The students who are in the circle decide on a specific action or movement that they would like to see the student who is waiting do (for example: walk like a chicken, jump on one leg, etc.)
- The student who is waiting outside rejoins the group and stands in the center of the circle.
- The goal of the game is for the student in the center to figure out what the action/movement is that the other students decided on.
- No one can give hints or tell the student if they are getting warmer. The only help the student in the middle can receive is if they are doing something that is on track for completing the movement, the rest of the students can say, "YES!"
- Students can only say, "YES!" if they are doing something leading to the desired action/movement (for example if the student walks quickly or hops and they are supposed to skip along students can say, "YES!" to let the student know they are on the right track)
- The player will eventually start paying attention to which movements got YES's and, remarkably, will eventually get the movement correct!

BELONGING & GET-TO-KNOW-YOU (10-15 MINUTES)

Activities focusing on encouraging a sense of belonging or getting to know one another can be implemented similarly to Icebreaker Games, however they have the added benefit of

finding and appreciating commonalities, celebrating differences, and learning about things that are important to one another.

10 THINGS IN COMMON

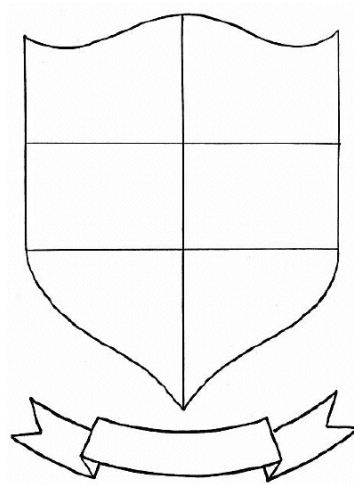
- Put students in groups of up to 5 students and have them discuss and develop a list of 10 things they have in common (example: like pizza, have longer hair, etc.)

COMMON GROUND

- Standing in a circle with one student in the center of the circle
- The student in the center will state their name and something that they like
- Any students who are standing in the circle who also like the same thing will have to step away from their spot and find a new space around the circle; if a student doesn't get to a new spot before they are all filled up, they are the new student in the center
- Make sure there are only enough spots in the circle to have all the students except for one so that there is always one person in the middle
- Students may NOT take the spot right next to them.

FAMILY CREST

- This activity allows students to design their own family crest based on things that are important to them and their family (e.g. plants for gardening, music notes, etc.) or culture (e.g. drawings that represent specific holidays, ceremonies, customs, practices, etc.)



(Example of a blank family crest outline)

FAMILY/CULTURE SHARE

- Stand in a circle so everyone can see/hear each other.
- Students go around the circle taking turns sharing something that is special or important to their families or cultural heritage.
- Once a student has shared, if anyone else in the circle also shares that special/important thing, they raise their hand. Whoever doesn't share that special/important thing, they snap (both hands) repeatedly to celebrate the sharer's special/important thing.
- It is helpful if the facilitator goes first and models the activity. Try to think of something that is important to your family or cultural heritage and share that to break the ice so students feel safer sharing.



Thank you for being a part of AKA Science!
We hope you and your students enjoyed the program.
Thank you for all that you do!