Watching the Game

A Thunder game is filled with things to see: an orange basketball moving across the court, players in bright uniforms, lines that mark where a shot is worth three points, and a scoreboard glowing above the action. But your eyes (or a broadcast camera) cannot see any of those things without light. How does light help thousands of fans in the arena and viewers at home watch every play?

Here's what you'll need:

- **Pencil**
- **Flashlight**
- **Blank paper**
- **Colored pencils**
- **Basketball (or other object)**
- **Basketball Court template (included)**
- **On the Screen card sort (included)**



Warm Up: *We Need Light to See*

When we watch a Thunder game, there is a lot to see, from the basketball bouncing to the players moving around the court. But none of that can be seen without **light**.

In this Warm-Up, students will make observations to describe that objects can be seen **if light is available to illuminate them** or **if the objects give off their own light**. This science disciplinary core idea was originally taught in first grade, so hopefully it's just a review!

Depending on the amount of class time available, this part of the Warm Up can be done two different ways:

For the streamlined option:

- Activate prior knowledge by exploring light as a whole group using familiar objects around your space. Choose an object that does not give off its own light, such as a book, chair, or pair of scissors. Place the object(s) where everyone can see it, and have students describe what they notice. Now adjust the amount of light available to the object by either dimming the lights, moving the object to a darker area, or shining a flashlight directly at the object. After each lighting change, ask the students what became easier and what became more difficult to see. Emphasize that the object didn't change, but the light available to it did.
- Next, show something that gives off its own light, such as a digital screen. If possible, dim the lights again or have the object in a darker space. Ask the students where the light is coming from. Discuss the differences between an object that needs light to be seen and an object that creates its own light.

If you have additional time:

- Extend your explorations by allowing students to view light at different stations and have students make observations. Stations could include: an object inside a shoebox (or other container) with a small viewing hole. Another station could use the corner of the room that uses string lights. A third station could be a space with little to no light at all. Have students write down their observations from each station then share out as a whole group.

Follow-Up Discussion Prompts

- *"If your eyes are open, can you always see?"*
  - Students might initially say "yes," but then identify exceptions. Those answers could include saying they can't see when blindfolded or if something is covering their eyes. Encourage students to consider whether having their eyes open is all we need to see. ("No, because we need light.")
- *"Where is the source(s) of light in this room?"*
  - Answers may vary, but might include the ceiling lights, lamps, windows, screens, etc.
- *"Imagine if we were standing in this room with no windows and no lights on, what would you see?"*
  - Fewer details will be seen. Students may say they can see "nothing" or "it would be too dark."
  - The amount of available light is what changed, not whether their eyes are open or not. Therefore, we need light to see.

Whether you have a little time or a lot of time, at the end of the Warm Up, **students should know that objects can be seen when they are illuminated or give off their own light**.

Teacher Tip: This section is entirely focused on reviewing the core idea that eyes need light to see. Avoid discussing reflection with your students during the Warm Up, as that will be explored in the next section titled "Game Time"! In "Game Time," students will learn about how light has to reach our eyes to see.



Game Time: *Follow the Light*

In the Warm-Up, students learned that an object needs to be illuminated or give off its own light for us to see it. But when you are watching a Thunder player dribble a basketball, we know that the basketball is not producing its own light. So, how do we see it?

For this whole group exploration, we're going to use a flashlight and a basketball (or similar-sized object of any kind). Have one student hold the flashlight as a **light source**, one student hold the **object**, and another student act as the **observer**. If possible, slightly dim the lighting in your space. This can also be done in the dark if the lights can't be dimmed.

Before turning on the flashlight, ask, *"The basketball doesn't make its own light. What has to happen for the **observer** to see it?"* From the Warm Up, students should be able to say that the basketball must be illuminated by a light source to be seen.

Turn on the flashlight. Aim it directly at the object. Now ask, *"Does the light stop traveling when it reaches the basketball?"*

- **Teacher Note:** At this point, student answers could be either "yes" or "no" as long as they state why that is their answer. For example, students may answer "yes, because the basketball has a shadow," or they may say "no" as a guess. Do not reveal the correct answer.

Next, move the observer to a different position while keeping the flashlight and basketball in the same positions. Ask the observer, *"Can you still see the basketball as well as you did when you were standing next to the light source? State why or why not."*

- When the observer moved, their view of the basketball changed. The observer should see fewer details than when they were next to the light source.

Try It:
Divide the students into groups of three or four. Have each group identify an object in their space that does not produce its own **light**. Next, have them identify a light source and a student who will act as the traveling light. Starting at the light source, that student will walk the path the light travels to the identified object, and then to the observer (specifically their eyes).

- Encourage students to notice that the person representing light **changed direction** when it reached the object. This is when the light **reflects** off of the object.
- Emphasize that an observer's eyes are not the "target" of the light reflecting off of an object. This happens no matter what; we just happen to be in the area, so our eyes pick up that reflected light and we can see the object.

Now draw this as a simple model, using arrows to show the direction the light is traveling.

- **Important Note**: While light does travel in a straight line, light travels as waves. While this does not need to be explicitly taught to your students, the teacher model should show light traveling as a wavy line and not straight lines.
- Also, emphasize that the arrows are pointing toward an observer's eyes, reinforcing that our eyes receive light rather than send it outward.

Explain that our eyes do not send out light themselves (like flashlights). Instead, light **has to reach our eyes for us to see**. There is no visual information for our eyeballs to receive without light.

Extension Option: If you have time, try this exploration again using lasers and mirrors.



Analyze the Replay: *Can the Referee See It?*

During a Thunder game, the referees need to be able to see the action clearly, but the players and the basketball are constantly moving around the court. Light travels in a straight line. So, sometimes, a person or an object can block the **line of sight**. The light reflecting the action of the game must have a clear, unblocked path to reach the referee's eyes.

Divide the students into groups of 2 or 3, or they can do this individually. Provide each group or student with the provided **Basketball Court template.**

Let's set up a play on our court. Using squares (Team A), circles (Team B), and triangles (referees), have students draw five players for each team on the Basketball Court, all on one side of the court. Then have them place three triangles (representing the referees) in different locations. Place an "X" with one of the squares or circles to indicate the player with the basketball.

Note: We will need to draw a light source on the court. Technically light is coming from above, but as that is not easily illustrated on paper, the light source can go anywhere on the model.

Tell students, *"Something happened (e.g., a foul) during the game near the basketball hoop! All three referees were watching, but did all three have a clear view?"*

Remind students of what they explored during the Warm Up and Game Time. Light is provided by all of the arena lights (like the flashlight to the basketball from "Game Time"). That light illuminates the players, basketballs, court, and hoop. Light reflects from those objects in many directions. The referees are not "targets" for the light waves; they can only see the action when reflected light reaches their eyes because it has a clear path.

Now have students focus on the action (the player with the basketball) occurring near the **basketball hoop**. Remind students that the arena lights are illuminating everything happening. From the drawn in light source, have students use a colored pencil to draw a line that represents one potential path the light could take to reach each referee's eyes. Some of these lines may be blocked by players, indicating that referee would not have been able to see what happened.

Discuss which referee would have had the best possibility to see what happened at the hoop, and make the call.

Now, direct the students' attention to a different play on the **Basketball Court template**. Tell students, *"The game started again and now the players are on the other side of the court."* Repeat the process by having students create possible paths reflected light could travel to each referee's eyes. Discuss which referee would have had the best possibility to fully see what occurred during this play.

Follow-Up Discussion Prompts

- *"Could each referee see the action at the basketball hoop? "Why or why not?"*
  - No, some referees had a direct line of sight. The other referees' view was blocked by another object or player. This doesn't allow reflected light to reach their eyes.
- *"Was there one referee that could see every play?"*
  - No. As the location of the action changed, so did the view of the referees.
- *"How could having multiple referees from different positions help monitor the game?"*
  - Different positions across the court give different views. If one referee's view is blocked, another referee might have a clear view.
- *"What does this have to do with light?"*
  - Light travels in straight lines. For a referee to see, at least some of the light reflected from the action must have an unblocked path to their eyes.



Overtime: *On the Screen*

Not all Thunder fans are watching each game from the arena! When you're watching a game on a television, you can still see all the players, the basketball, and the court but the light from the arena is not traveling directly to your eyes. How is that possible?

Recenter your students. Ask them to again explain what has to happen inside the arena for the players, fans, and referees to see: light sources in the arena illuminate people and objects, that light reflects off those objects in many different directions, and some of the light enters observers' eyes.

Now ask, *"What if the observer is not a person, but a camera?"*

Explain that cameras also need light to create an image - just like our eyes! Reflected light enters the camera and is turned into **visual information**. That information can then be sent (or **broadcast**) from the arena to televisions like the one in your home.

Divide students into groups and give each group a set of **On the Screen sort cards**. Challenge students to arrange them in the order they believe the game on the court is being transmitted to a fan watching the game on their t.v. at home. Once they have had an opportunity to work out their guess, reveal the correct order:

When discussing, ask:

- *"Do each of those arrows represent light?"*
  - No. Guide students to identify which of the arrows represent light.
- *"Did the same light that reached the camera inside the arena travel all the way to your eyes at home?"*
  - No. The original light source in the arena is not being reflected into your living room.
- *"If the arena lights are not reaching our eyes at home, how are we seeing the game?"*
  - A television (or similar screen) can produce its own light. It takes the information that it was sent from a camera and creates its own lighted image. That new light then travels from the screen to our eyes.
- *"How can we see the light if the TV isn't reflecting any?"*
  - Our eyes just need light to enter them to see something. A basketball does not create its own light, so we provide a light source to see it. The television produces its own light. From there, that light enters our eyes.
- *"Can we watch television or a similar screen in a completely dark room?"*
  - Yes, because it produces its own light. Also, the light it produces could illuminate other objects in the room and reflect off of them, and enter our eyes.



Coach's Corner: *The Science of Seeing*

Light makes vision possible. Some objects are able to produce and emit their own light, such as the Sun or a light bulb. However, most everything around us cannot and instead are illuminated by other sources of light. That light then reflects in many different (but straight) directions. When that reflected light enters our eyes, we are able to see the object. Reflection does not always mean the object has to be a mirror or shiny.

Students will likely enter this activity with common misconceptions about how we see. They may believe that our eyes send something outward, that only shiny things reflect light, and/or we can see in the dark (with absolutely no source of light) once our eyes adjust. It is important to emphasize that **our eyes receive light, and do not produce it.** This activity is also not designed to explore how different colors or types of light can be seen, or the biology of how our eyes work.

This activity is designed to build on students' prior learning from first grade, which is what is reinforced in the Warm Up. This lesson guides students to understand how **light either reflected off of an object or produced by an object** enters the eyes allowing it to be seen, and how to develop a model of this process. There is no need to focus on more advanced concepts such as electromagnetic waves, transmission, frequencies, or even how light relates to thermal properties.

Standards & Skills Alignment

This activity can be used to support students with developing the following skills and/or content.

Content/Skills	Grade 4	Grade 5	Grade 6
Electromagnetic Radiation • An object can be seen when light reflected from its surface enters the eyes.	X		

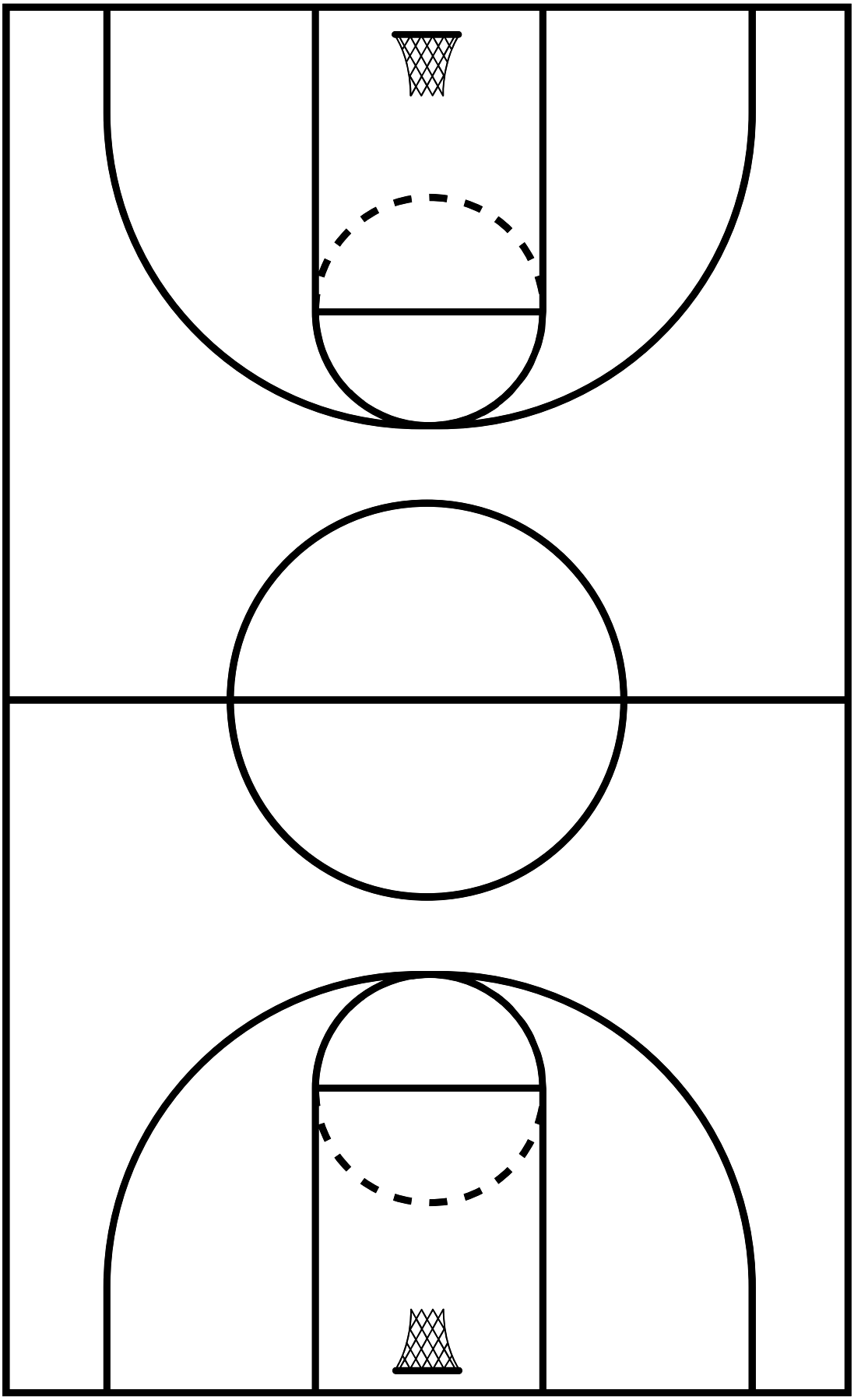
Standards & Skills Alignment (cont.)

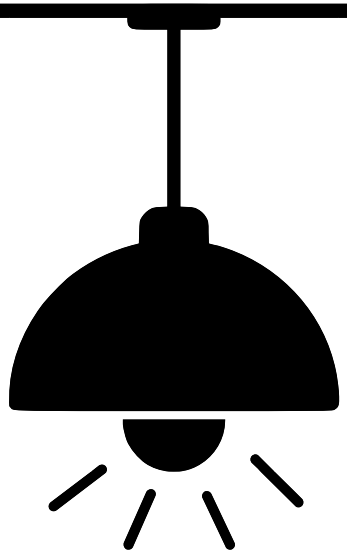
This activity can be used to support students with developing the following skills and/or content.

Content/Skills	Grade 4	Grade 5	Grade 6
Electromagnetic Radiation • When light shines on an object, it is reflected, absorbed, or transmitted through the object. • The path that light can travel can be traced as straight lines.			X
Electromagnetic Radiation • Objects can be seen if light is available to illuminate them or if they give off their own light. • Some materials allow light to pass through them, others allow only some light through, and others block all the light.	**Leveraging K-2 Knowledge**		
Developing and Using Models • Develop and/or use models to describe and/or predict phenomena.	X	X	X
Cause and Effect • Cause and effect relationships are routinely identified, tested, and used to explain change.	X	X	X
Structures and Function • Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.	X	X	X

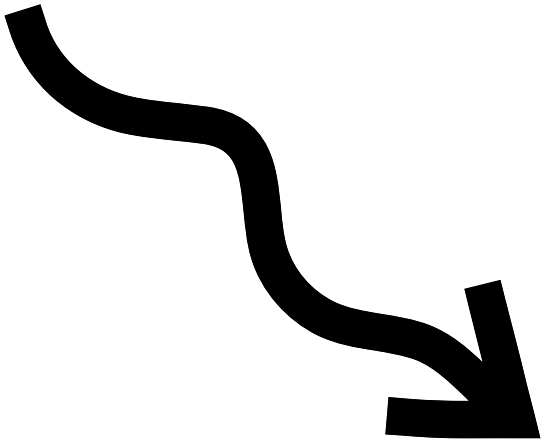
Can the Referee See It?

Name: _____





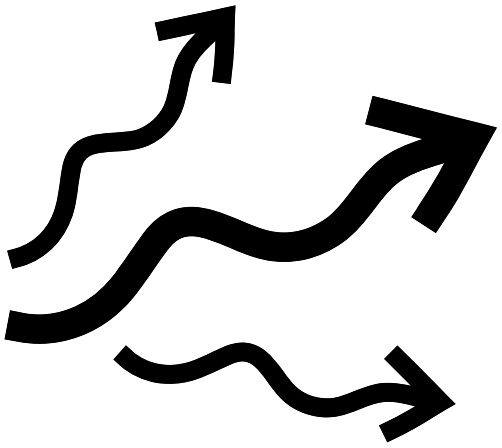
arena light



light



Thunder game



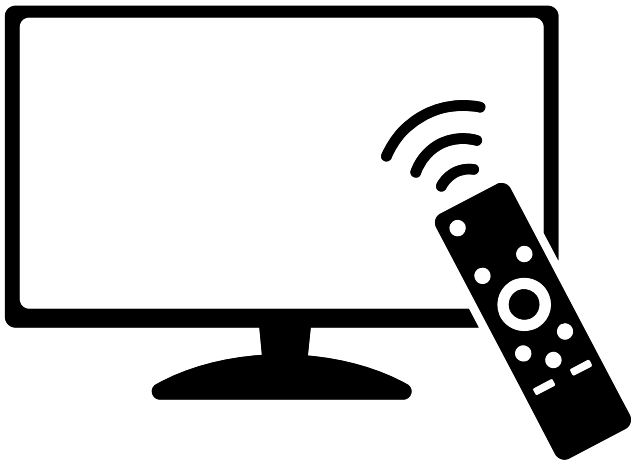
light (reflected)



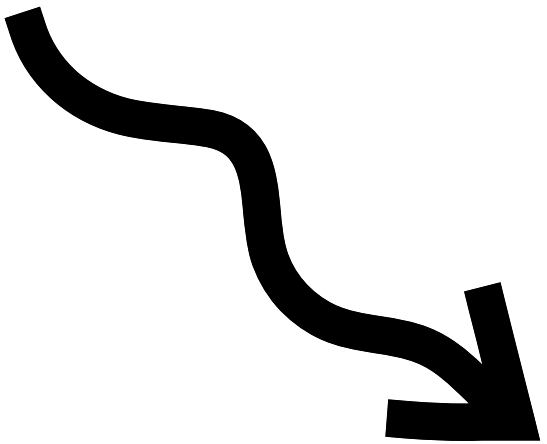
camera



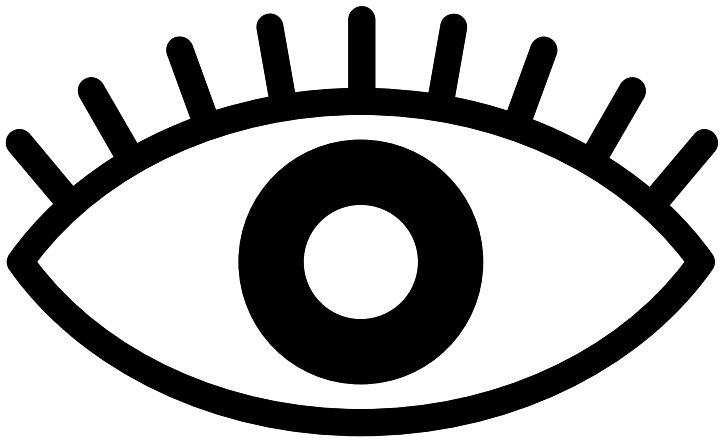
broadcast signal



television screen



light



observer’s eyes