LIGHTS DAY AND NIGHT: THE SCIENCE OF HOW LIGHT WORKS TEACHING GUIDE

ABOUT THE BOOK

A young girl and her cat watch a firefly glow, make shadows in the sun and learn all about how light works in this accessible, kid-friendly introduction to the science of light. In the second book in the delightfully informative Science of How series, award-winning author Susan Hughes's engaging narrative gives young children an age-appropriate overview of the science of light. Ellen Rooney's friendly and inviting illustrations beckon readers to be a part of the characters' fun summertime exploration. Presenting complex topics in a graphic, appealing and easy-to-digest format, this comprehensive one-of-a-kind book strongly supports the Next Generation Science Standards. The manuscript was carefully reviewed by an expert in the field. The book includes a glossary and instructions for a shadow puppet show.

ABOUT THE AUTHOR

Award-winning author Susan Hughes has written over thirty books --- both fiction and nonfiction --- for children of all ages. She is also a freelance editor and writing coach. Susan has always loved writing. When she was growing up she and several friends started a writing club. They would gather with their poems and stories and read them aloud to one another. Susan studied English literature at the University of Toronto. Today, Susan lives in Toronto, Canada, in a house with a big red door. She continues to enjoy freelance editing and commissioned writing, as well as story coaching and critiquing manuscripts. And of course, she loves writing her own stories --- from picture books, middle-grade novels and graphic novels to nonfiction and young adult novels!

Twitter: @childbkauthor
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Facebook: @susan.hughes.9465

ABOUT THE ILLUSTRATOR

Born in New England, Ellen Rooney carries the east coast in her heart while making her home in western Canada. She lives in the Okanagan Valley of British Columbia with her husband and their dog. She loves to visit her big New England family, and the Atlantic

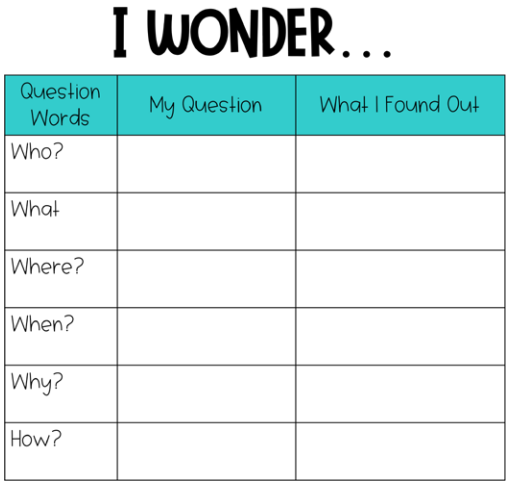
Ocean, whenever she can.

Instagram: @ellenaroo

Pre-reading Activities
Picture Predictions
Starting at the beginning of Lights Day and Night: The Science of How Light Works, flip through the illustrations and show the students each page. Ask and discuss any of the following questions before reading:

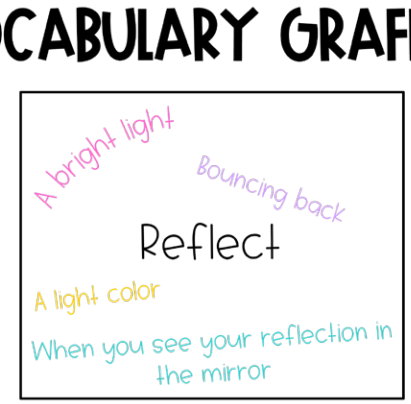
"What do you notice about…"
"What does the illustration tell you about what might be happening?"
"What do you think might happen next? Why?"
"What might this story be about? Why?"

I Wonder Activity
Asking questions is a great way to get students thinking about predictions. First, ask students what the word predict means. Explain that when we predict we make an educated guess about something. For example, before we read a story we can make predictions about what the story may be about. We can do this by answering questions about the text. Students will create a chart in their journals with three columns - 1 column labeled *Question Words*, 1 column labeled my *Questions*, and 1 column labeled *What I Learned* (see sample below). Students will ask themselves a series of wh- questions about the text before reading and record their questions in the table. After reading, students may revisit their table, reflect on their questions, and write what they learned.



Vocabulary Graffiti

In this fun group activity students will be introduced to important vocabulary from the story. First, choose 5 words from the glossary that you anticipate students will not know. Then, post those words around the room (either on small mini whiteboards, copy paper or anchor chart paper). Allow students to travel to each vocabulary word and write or draw what they believe the word to mean. Students may use different colors to write their definitions. When students finish, each word will be surrounded in "graffiti," showing possible definitions for each word (see sample below).



Outline of Activities
Lesson One: Whole Group Literacy | Sequencing the water cycle
Lesson Two: Individual Writing | Comparing & contrasting light using acrostic poems
Lesson Three: Whole Group | Light pollution posters
Lesson Four: Small Group Science | Transparent, translucent, & opaque experiment
Lesson Five: Individual & Small Group Reflection | Putting it all together

The lessons in this guide can be differentiated for students in grades K - 5. They are planned sequentially and work best completed over a series of days. However, they can also be chosen one at a time at random.

Lesson One: Whole Group
Sequencing the water cycle
Target Grade Range: K - 5th Grade

Standards:
CCSS.ELA-LITERACY.RI.K.3
CCSS.ELA-LITERACY.RI.1.3
CCSS.ELA-LITERACY.RI.2.3
CCSS.ELA-LITERACY.RI.3.3
CCSS.ELA-LITERACY.RI.4.3

CCSS.ELA-LITERACY.RI.5.3

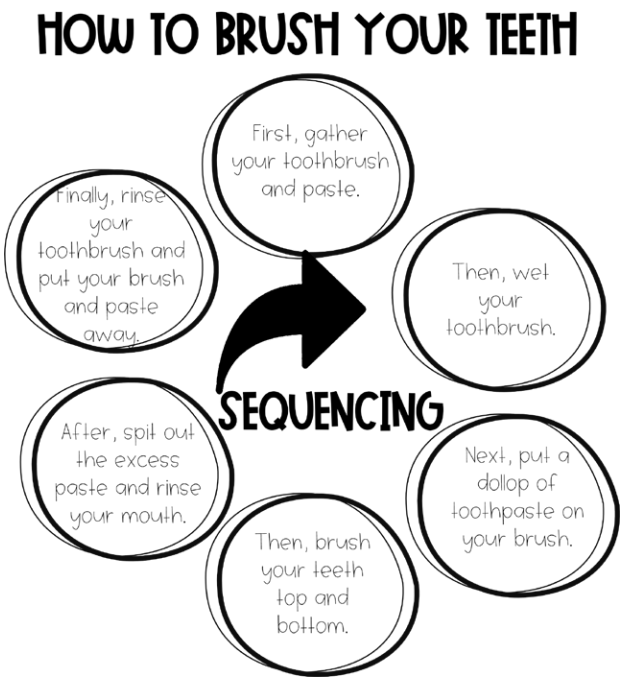
Materials:

- Sticky notes (optional)
- Highlighters
- Pencils
- Student copies of pages 12 - 13 in Lights Day and Night: The Science of How Light Works

Lesson:
Begin the lesson by asking students: "How does light improve our lives?" Depending on the age of students, you can pass out sticky notes and have them record their thoughts and post them around the classroom. Invite students to walk around the classroom and read their classmates' thoughts before having a discussion with the whole group. If students are unable to record their thoughts or read their classmates' recordings of their thinking, you can simply jump right into the whole group discussion and record student thoughts on the white-board.

Explain that today we'll learn all about LIGHT by reading a story called Lights Day and Night: The Science of How Light Works. The author, Susan Hughes, and illustrator, Ellen Rooney, teach us about the different kinds of light and the science behind how light works. Depending on the age of the students, you can approach reading the story in a number of ways. You can read the text aloud, call student volunteers, "popcorn" read, or have students read independently. Consider the grade and skill level of your students when deciding how to read the story.

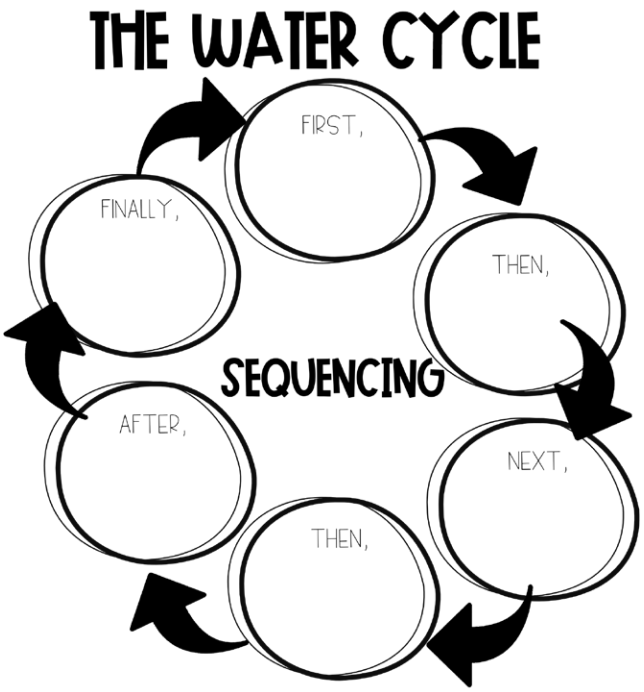
After reading, introduce the non-fiction reading comprehension strategy - sequencing. Explain that when we sequence a body of text, we put the events of something in order from start to finish. Transition words (like first, next, then, finally) help us order events sequentially. Use an example from everyday life to engage students. For example, students can sequence how to brush their teeth and share their thoughts with a nearby partner. Encourage students to use transition words when sharing. Ask students to volunteer their thinking and record the steps of "How to Brush Your Teeth" from start to finish on the white board or anchor chart paper. Organize the steps in a circle, using arrows to indicate what step comes next (see sample below).



Explain that today we'll be looking specifically at sequencing the water cycle on pages 12 - 13. For older students, distribute paper copies of pages 12- 13 for students to read. Re-read pages 12 - 13 with students. While reading, encourage students to use highlighters to find clues from the text that they think might help when sequencing the water cycle from start to finish. Discuss which events of the water cycle happen first, next, then, and last. For younger students, re-read pages 12-13 to students. Highlight important clues from those pages that will lead students to discover what happened first, next, then, and last.

Use anchor chart paper and markers or the white board to draw a large diagram like the one pictured above. Above the diagram label it "The Water Cycle," and ask

students to share the events from start to finish. Inside the arrows using transition words to sequence the events appropriately. Older students can record their thinking independently in their journal. For younger students, simply draw the diagram for students to see. End the lesson by explaining that thinking sequencing helps us better understand how the events of a story or process work together.



Lesson Two: Individual Work
Comparing & contrasting light using acrostic poems
Target Grade Range: K - 5th Grade

Standards:
CCSS.ELA-LITERACY.W.K.4
CCSS.ELA-LITERACY.W.1.4
CCSS.ELA-LITERACY.W.2.4
CCSS.ELA-LITERACY.W.3.4
CCSS.ELA-LITERACY.W.4.4
CCSS.ELA-LITERACY.W.5.4

Materials:

- Whiteboard / anchor chart paper & markers
- Large construction paper (12 x 18)
- White copy paper
- Glue sticks

- Pencils
- Art supplies (crayons or colored pencils)

Lesson:
Begin the lesson by drawing a large Venn Diagram on the whiteboard or anchor chart paper. Explain that a Venn Diagram is a tool we use to help us think about how two topics are both similar and different. Label one side of the Venn Diagram "Natural Light" and label the other side "Artificial Light." Start by asking students to recall what's similar and different about natural and artificial light. Use the Venn Diagram to record student thinking and keep track of the similarities and differences.

Next, reread pages 6 - 11 from Lights Day and Night. Add any similarities or differences students may have missed from the text.

Explain that students will use the similarities and differences written in the Venn Diagram to write two separate acrostic poems - one about natural light and one about artificial - on white copy paper. Depending on the grade and skill level, students may have limited experiences with writing acrostic poems. Explain that an acrostic poem is written about one topic. First, students will write the word vertically. Then, they will write a phrase or sentence using each letter from the word. The first word in each phrase or sentence must start with the next letter in the word (see sample below). Younger students that are unable to write in sentences can simply draw pictures of natural and artificial light on separate pieces of paper.

ACROSTIC POEM

N ot always seen at night.
A lways shining brightly.
T he Northern Lights.
U P! Look UP for natural light.
R equires no electricity.
A ll over the place.
L ightning flashing is an example.

After students complete two separate acrostic poems, they will glue each poem to a larger sheet of 12 x 18 construction paper. They may also draw examples of each type of light around the border of each acrostic poem. End the lesson by allowing students to share with a partner the acrostic poems they wrote.

Lesson Three: Group Work
Light pollution posters

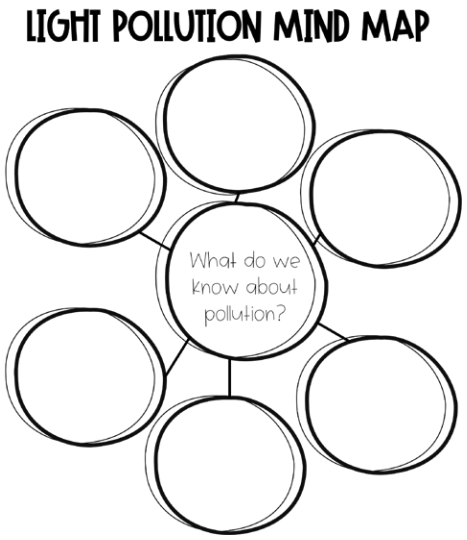
Target Grade Range: K - 5th Grade

Standards:
CCSS.ELA-LITERACY.W.K.7
CCSS.ELA-LITERACY.W.1.7
CCSS.ELA-LITERACY.W.2.7
CCSS.ELA-LITERACY.W.3.7
CCSS.ELA-LITERACY.W.4.7
CCSS.ELA-LITERACY.W.5.7

Materials:

- Poster board
- Access to research tools (Chromebooks, I-pads, non-fiction books, etc.)
- Pencils
- Art supplies (crayons or colored pencils)

Lesson:
Begin the lesson by creating a mind map with students showing what they already know about pollution (see sample below).



Encourage discussion with the following questions and prompts:
"What is pollution?"
"List some examples of pollution…"
"How does pollution negatively affect plants?"
"How does pollution negatively affect animals?"
"How does pollution negatively affect humans?"
"What can humans do to help limit pollution?"

One form of pollution that we don't always think of is called light pollution. In fact, many people don't know what light pollution is. Explain that light pollution is the over-use of artificial light. Major sources of light pollution include: skyscrapers, city / street lights, advertisements, and illuminated sports venues.

The over-use of human-made, artificial lights can have adverse effects on our environment. For example, light pollution in the night sky can disrupt ecosystems, confuse wildlife, result in adverse health effects for humans, and ultimately wastes energy.

In small groups (3 - 4 students per group), encourage students to research negative effects of light pollution and how humans can reduce them. They may choose to use technology like Chromebooks or I-pads, non-fiction books, videos, or information presented from guest speakers. Then, students within each group should work together to create a poster, informing the public of what light pollution is and how we can limit it. For younger students unable to research independently, provide specific examples of negative effects of light pollution and how humans can reduce light pollution (see lists below).

Negative effects of light pollution:

- Artificial light influences the way plants grow (i.e. influences plants that depend on day cycles for growth, photosynthesis can be impacted, confusion between natural sunlight and artificial light).
- Artificial light attracts or confuses some wildlife with adverse effects (i.e. turtle hatchlings following city lights instead of the moon's glow, moths attracted to a light source that kills them, nocturnal animals (such as bats) being confused about the time of day).
- Excessive artificial lights influence human health (i.e. can disrupt sleep cycles leading to fatigue, increased anxiety and stress).

How humans can reduce light pollution:

- Use only the lights you need, especially at night.
- Buildings (small and large) and advertising billboards can limit or turn off their lights at night.
- If you need lights at night, make sure they point down and not up.
- Close window blinds, shades and curtains if you need your lights on in your home or workplace at night.

Then, distribute poster boards to student groups. Allow up to 60 minutes for students to

research and design their posters. They may use crayons or colored pencils to make their visuals appealing and eye-catching. End the lesson by allowing each group to share the poster they created, showing what they learned.

Lesson Four: Small Group Work
Transparent, translucent, & opaque experiment
Target Grade Range: K - 5th Grade

Standards:
NGSS: 1-PS4-2.
NGSS: 1-PS4-3.

Materials:

- Activity materials:
  - Small items from the classroom (erasers, paintbrush, pencil, chalk, sticky notes, etc.)
  - Bag
  - Blindfold
- Experiment materials for each group:
  - Flashlight
  - Variety of items including examples of opaque, translucent, transparent materials (black paper, white paper, paper towels, wax paper, tissue paper, books, magnifying glasses, plastic bags, aluminum foil, etc.)
  - Recording sheet
  - Pencils

Lesson:
Begin the lesson by completing the hands-on activity described on page 9. First, gather several small items from around your classroom and place them in a bag. Provide a blindfold to student volunteers. Call students one at a time to the front of the room to blindly reach in the bag and try to guess what they're touching. Use the experience to reiterate the importance of light and how it affects our everyday lives.

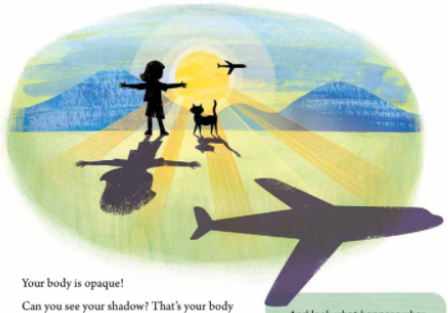
Next, refer back to and reread pages 18 - 23. Explain that we'll study how different objects respond to light using what we've learned with a fun science experiment. Split students into small groups of 3 - 4.

... it hits something!

What happens when light hits a solid object, like a cement wall, a book or a metal door?

These objects are **opaque**. They block light from traveling all the way through them.

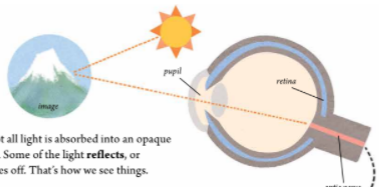
Many opaque objects **absorb**, or take in, light.



Your body is opaque!

Can you see your shadow? That's your body absorbing light and blocking its path.

And look what happens when an airplane flies over a field. An airplane is also opaque.



But not all light is absorbed into an opaque object. Some of the light **reflects**, or bounces off. That's how we see things.

The reflected light travels through a hole in your eye, the **pupil**, and onto the **retina**, a thin layer of tissue at the back of your eye. This tissue turns the light energy into signals, and the optic nerve carries those signals to your brain.

So, we can see objects that give off their own light. We can also see objects that reflect light into our eyes.

Now, shine a light through a piece of tissue paper. Why does it look blurry? Tissue paper is **translucent**. It reflects or absorbs much of the light. Only a little light passes through.

When light travels through a window, a little of it reflects off the glass — but most of it passes right through. The glass is **transparent**, or see-through.

Students will complete the following steps to conduct the experiment:

Note: The teacher will prepare the materials for the experiment prior to the lesson. In small groups of 3 - 4, students will test each object provided using the flashlight. The teacher may choose to conduct the experiment as a whole group with younger students or if supplies are limited. Use your discretion.

Step 1: Give out the materials to each group.
Step 2: Students will make an educated guess about whether each object will let a lot of light through, some light through, or no light through.
Step 3: Students will place a check mark in each column on the recording sheet, indicating their guess.
Step 4: Students will test each object by shining the light from the flashlight at the object.
Step 5: Students will reflect on their guesses. They will write "yes" in the final column if their guess was correct and "no" if it was incorrect.
Step 6: Encourage students to discuss and use the science words at the bottom of the recording sheet to describe each object.

Name: _____

FLASHLIGHT SCIENCE

Before testing each object, check the box with your guess whether the object will let a lot of light, some light, or no light through. After testing all objects, write "yes" in the final column if your guess was correct or "no" if it was incorrect.

OBJECT	A LOT OF LIGHT = TRANSPARENT	SOME LIGHT = TRANSLUCENT	NO LIGHT = OPAQUE	WERE YOU RIGHT?
Black paper				
Tissue paper				
Plastic bag				

VOCABULARY

Transparent – lets most of the light pass through
Translucent – lets some, but not all, light pass through
Opaque – does not let light to pass through

This science experiment reminds us that objects respond to light differently. Remind students that opaque objects are objects that block light from traveling all the way through them, translucent objects are objects that let some light through them, and transparent objects are objects that let a lot of light pass through them. Use what students learned about light above to reflect on the objects tested during the

experiment. End the lesson by allowing students an opportunity to reflect and share what they noticed, liked, or would change about the experiment.

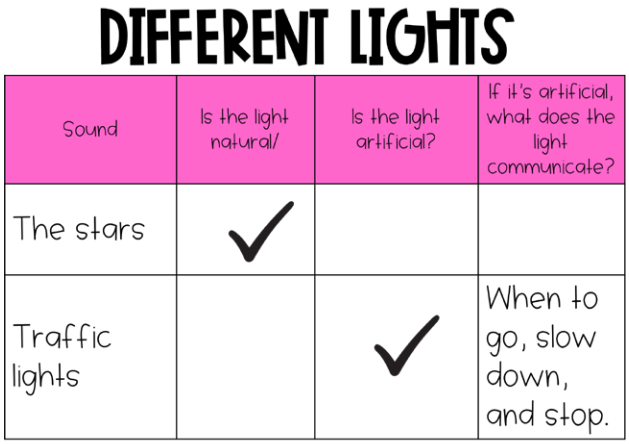
Lesson Five: Group & Individual Work
Putting it all together
Target Grade Range: K - 5th Grade

Standards:
CCSS.ELA-LITERACY.RI.K.10
CCSS.ELA-LITERACY.RI.1.10
CCSS.ELA-LITERACY.RI.2.10
CCSS.ELA-LITERACY.RI.3.10
CCSS.ELA-LITERACY.RI.4.10
CCSS.ELA-LITERACY.RI.5.10

Materials:

- Copies of Spin a Fact game boards
- Pencils
- Paperclips
- Copies of Exit Tickets

Lesson:
We've learned so much about the science of light! Brainstorm with students examples of different types of light(s) and consider whether they happen naturally or not, whether they communicate something, and, if so, what they might communicate. Draw a t-chart table on the board to record the student responses (see sample below).



During this lesson we'll review what we've learned about the science behind light in a

fun way! Choose the Spin a Fact gameboard that works best for the grade level and skill sets of your students (see samples below). Explain that students will need a partner to play Spin a Fact. Distribute copies of the game boards. Explain that partners will use the gameboard, pencils, and paper clips to take turns spinning the spinner and review what they've learned about light. Students can replay the game as many times as time allows.

At the very end of the lesson, distribute Exit Tickets (see sample below). Ask students to write or draw three new things they learned about light, two ideas about light they want to know more about, and one question they still have about light.

Name: _____

3, 2, 1 EXIT TICKET

3	What are THREE new things you learned about light?
2	What are TWO things about light that you want to know more about?
1	What is ONE question you still have about light?

Optional Extensions

Social Studies - Introduce students to Thomas Edison, the inventor of the light bulb. Students will research the history of how he discovered electric power which led to the creation of the lightbulb and indoor light sources on which we depend today. Students can create a timeline of his life, or write a short biography of his accomplishments.

STEAM - Create shadow puppets like the ones described in the back of the book. Use the supplies listed on page 30 to design a shadow puppet show.

Writing - Encourage students to write a persuasive letter to a local government leader explaining light pollution and some of its adverse effects. Students will need to use both reasons and evidence to support their thinking. Their letter should communicate what light pollution is, why light pollution should be reduced, and possible solutions for limiting it in their community.

Art - Discuss transparent, translucent, and opaque objects. Ask students if tissue paper and wax paper are transparent, translucent, or opaque. Have them create "stained glass" decorations and find out! (You may wish to show students photos of actual stained-glass decorations or windows.) Students glue colored tissue paper directly on

wax paper. Then, wax-paper-side up, they use a black sharpie to draw the outline of a specific object of their choice (a heart, a star, a rainbow, etc) directly on the wax paper. Using scissors, students will cut along the line. When the "stained glass" decoration is put up to a window, the sun shines through the colorful tissue paper, making a one-of-a-kind creation!

Math - Find your two favorite pages in Lights All Around. Count the different lights you see illustrated on these pages. Depending on the grade and skill level, students can count the lights pictured in different illustrations on 3 or more pages to find a total number of lights.

Lights Day and Night
Written by Susan Hughes
Illustrated by Ellen Rooney

Name: _____

FLASHLIGHT SCIENCE

Before testing each object, check the box with your guess whether the object will let a lot of light, some light, or no light through. After testing all objects, write "yes" in the final column if your guess was correct or "no" if it was incorrect.

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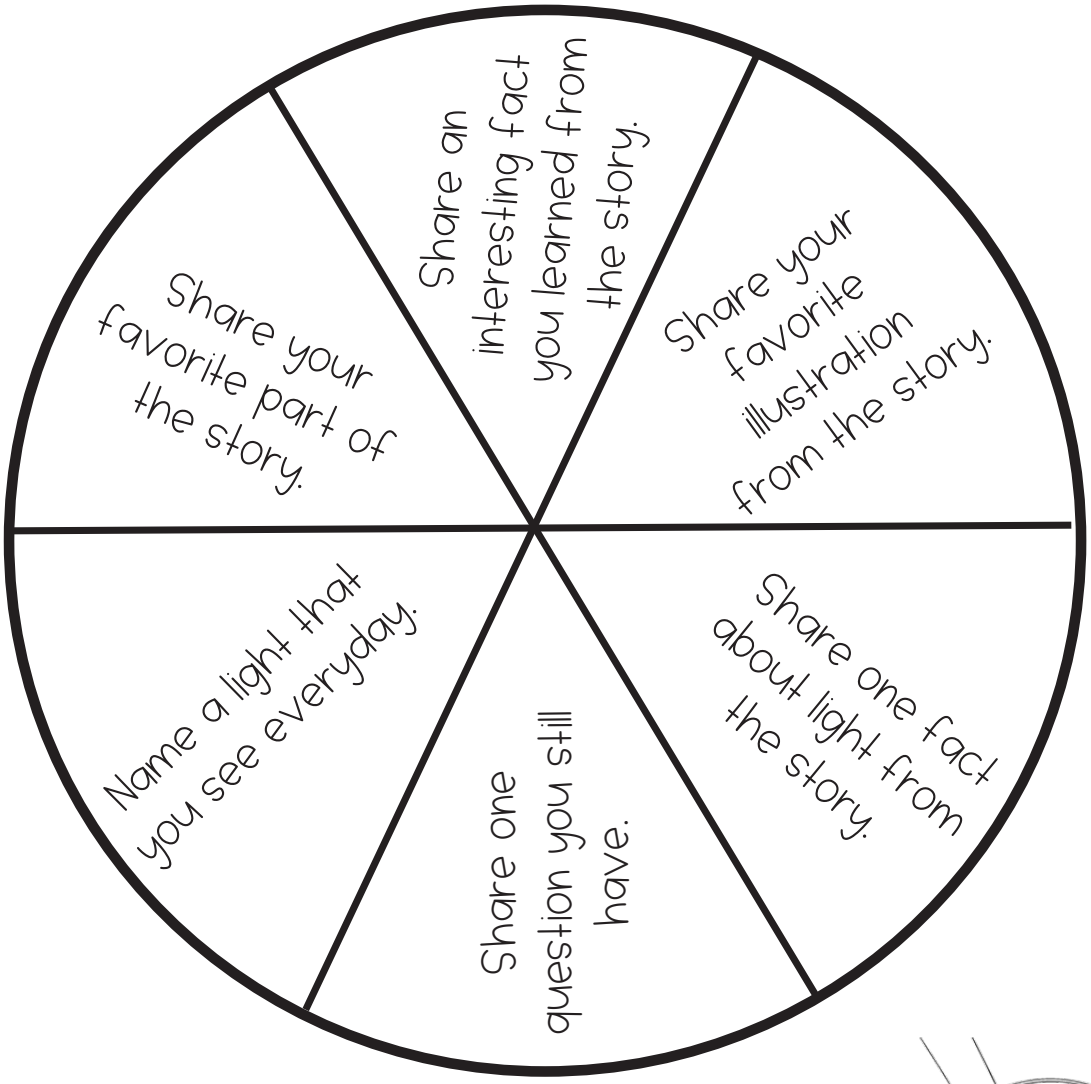
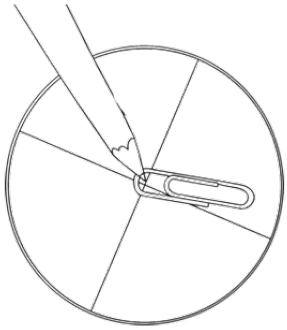
SPIN A FACT GAME

Think about what you've learned about light. With your partner, take turns spinning the the spinner and answer the question you land on.



You will need:

- A pencil
- A paperclip
- A partner



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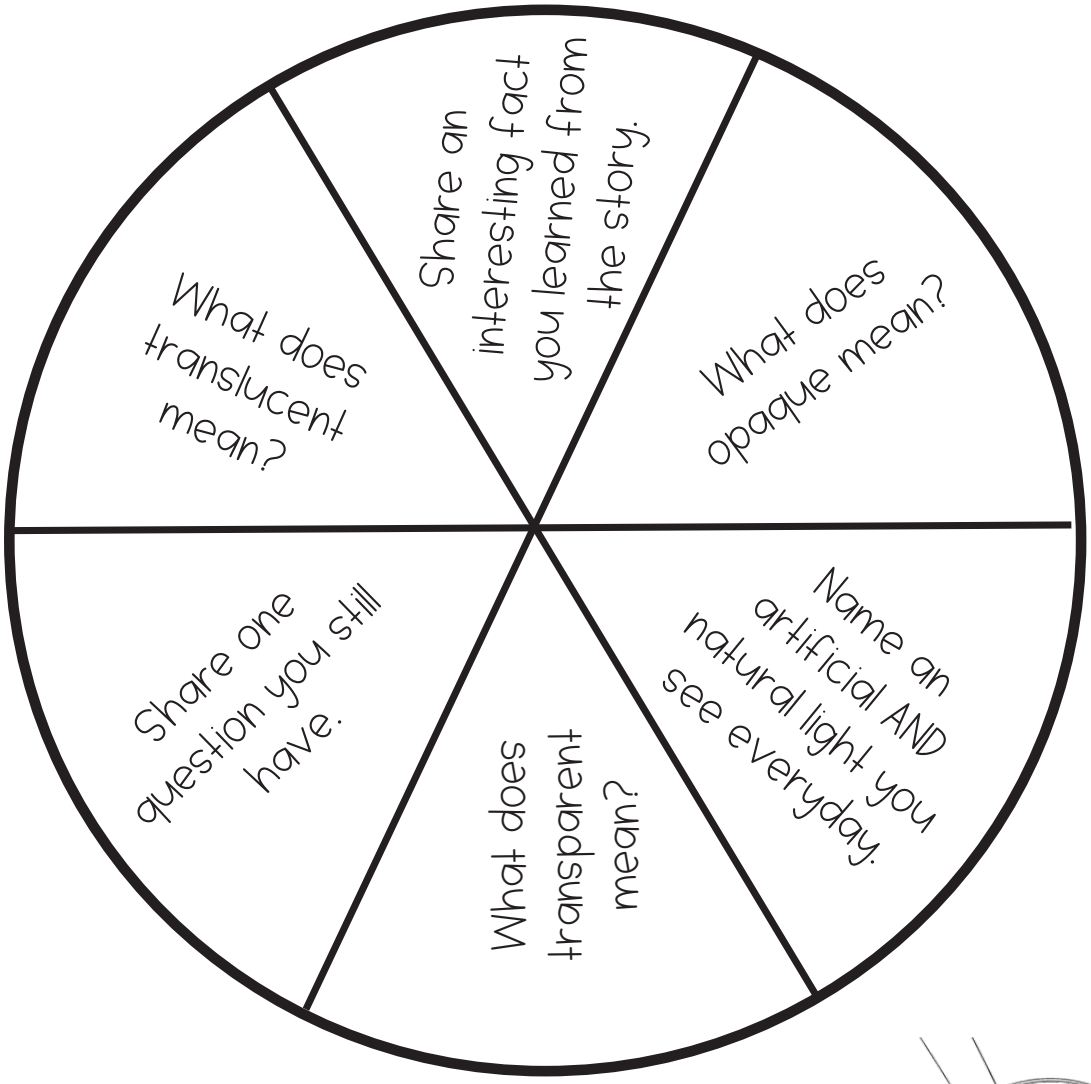
Name: _____

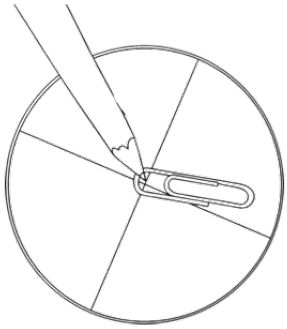
SPIN A FACT GAME

Think about what you've learned about light. With your partner, take turns spinning the the spinner and answer the question you land on.



You will need:

- A pencil
- A paperclip
- A partner



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Name: _____

3, 2, 1 EXIT TICKET

3	What are **THREE** new things you learned about light?
2	What are **TWO** things about light that you want to know more about?
1	What is **ONE** question you still have about light?

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