Rainbow Refraction

Physical Science | Lesson Guide

2nd Grade

Photo Description

This image shows a beautiful rainbow stretching across a rainy sky after a storm. You can see wet roads, green grass, trees, and a few cars on the highway. The rainbow appears when sunlight shines through water droplets in the air, creating the colorful arc we see in the sky.

Scientific Phenomena

Anchoring Phenomenon: Light Refraction and Dispersion Creating a Rainbow

When sunlight passes through millions of tiny water droplets floating in the air (from rain or mist), the light bends and bounces inside each droplet. White sunlight is actually made up of many different colors mixed together. When light bends inside water droplets, the colors separate from each other—red, orange, yellow, green, blue, indigo, and violet spread out into a visible arc. This separation of colors is called dispersion, and the bending of light is called refraction. This happens because each color of light bends at a slightly different angle when it passes through water.

Core Science Concepts

- Light travels and can be bent: When light passes through water droplets, it doesn't go straight—it bends and changes direction. This helps us see rainbows.

- White light contains many colors: Sunlight looks white, but it is actually made of red, orange, yellow, green, blue, indigo, and violet colors all mixed together. Water droplets separate these colors so we can see them.

- Water droplets act like tiny mirrors and prisms: Each raindrop reflects and refracts light, splitting it into separate colors. When millions of droplets do this together, we see a rainbow.

- Rainbows appear when conditions are just right: You need three things to see a rainbow: sunlight, water droplets in the air, and the sun behind you while you look at the rain in front of you.

Pedagogical Tip:

When teaching about rainbows, avoid the misconception that rainbows are "made of" the water itself. Instead, emphasize that water droplets help us see the colors that are already in sunlight. Use the analogy of a prism or a clear glass ball to help students understand that water is transparent but can bend light.

UDL Suggestions:

To support multiple means of representation: Use physical demonstrations with a clear glass of water and a flashlight to show how light bends. Provide images of rainbows at different angles. For engagement, allow students to create their own "rainbows" using spray bottles on sunny days. For expression, let students draw, paint, or arrange colored tissue paper to show the order of rainbow colors rather than only answering verbal questions.

Zoom In / Zoom Out

Zoom In: Inside a Water Droplet
When we zoom in very close—much closer than we can see with our eyes—we'd see that a single raindrop is made of billions and billions of tiny water molecules all stuck together. When sunlight enters a water droplet, it bounces around inside like a ball in a box, hitting the curved walls of the droplet. As the light bounces and bends, the different colors separate from each other because they bend at slightly different angles. Each color travels a different path through the droplet before exiting, which is why we see them as separate stripes in the rainbow. If we could zoom in even more, we'd see the individual light waves themselves, each with a different length—red light waves are longer and bend less, while violet light waves are shorter and bend more.

Zoom Out: Earth's Water Cycle and Atmosphere
When we zoom out to see the big picture, rainbows are part of Earth's water cycle. Water evaporates from oceans, lakes, and rivers, rises into the atmosphere, forms clouds, and falls as rain. A rainbow appears during or just after a rainstorm when sunlight and falling water droplets meet at just the right angle. Rainbows connect to weather patterns, seasons, and how water moves around our planet. They only appear in certain places on Earth where you have both sunlight and rain at the same time, and they depend on your position as an observer. In some parts of the world, rainbows are more common than in others because of different rainfall and weather patterns. Rainbows also help scientists understand how light behaves in our atmosphere and how water droplets scatter and refract light in our skies.

Discussion Questions

1. What do you think is happening inside those water droplets that makes the different colors appear? (Bloom's: Analyze | DOK: 2)

2. Why do you think you can only see a rainbow when the sun is behind you and the rain is in front of you? (Bloom's: Evaluate | DOK: 3)

3. If rainbows are made of separated colors from sunlight, what color do you think appears on the outside edge of the rainbow, and why? (Bloom's: Analyze | DOK: 2)

4. Have you ever seen a rainbow? Can you describe where the sun and rain were when you saw it? (Bloom's: Remember | DOK: 1)

Potential Student Misconceptions

Misconception 1: "Rainbows are made of water."
Scientific Clarification: Rainbows are not made of water itself. Water droplets are transparent (you can see through them), but they bend the light that passes through them. The rainbow we see is actually the separated colors of sunlight—the water droplets are just helping us see those colors. Think of it like this: a prism is made of clear glass, but it makes a rainbow. The rainbow isn't made of glass; it's made of light that the glass has bent and separated into colors.

Misconception 2: "You can walk to the end of a rainbow and find a pot of gold."
Scientific Clarification: Rainbows appear at a specific angle (about 42 degrees) from the sun. As you move toward where a rainbow seems to end, the rainbow moves with you! You can never actually reach a rainbow because it's not a physical object in one location—it's a result of light bending through water droplets as seen from your specific position. If you move, the rainbow appears to move too.

Misconception 3: "Rainbows only appear in the sky after rain."

Scientific Clarification: While rainbows are most common after rain, they can appear anytime there are water droplets in the air and sunlight at the right angle. You can make a rainbow on a sunny day by spraying water with a garden hose or spray bottle. Rainbows can also appear near waterfalls or fountains. The three conditions needed are sunlight, water droplets, and the sun positioned behind you—not just after a rainstorm.

Extension Activities

Activity 1: Make Your Own Rainbow (Water Prism Exploration)
On a sunny day, give each student a clear glass of water. Have them hold the glass up to sunlight and look for a rainbow created by the water inside. Students can also try spraying water with a spray bottle on a sunny day to see rainbows form in the mist. Ask them to draw or paint what they observe.

Activity 2: Rainbow Order Memory Game
Create cards with each color of the rainbow. Have students arrange them in the correct order (ROYGBIV). Make it a matching game where they match color words to color cards. This reinforces that rainbows always appear in the same order.

Activity 3: Rainbow in a Jar (Layered Density Activity)
Using glasses of water with different amounts of food coloring (progressing from light to dark), layer the glasses to create a "rainbow stack." While this isn't a true rainbow by refraction, it helps students see color progression and can lead to discussions about why rainbows have colors in a specific order.

Cross-Curricular Ideas

Math Connection: Rainbow Angles and Measurement
Have students measure and compare rainbows using angle tools or protractors (simplified for second grade). Ask: "If a rainbow always appears at about the same angle from the sun, why do rainbows look different sizes?" Students can also practice sequencing by ordering the rainbow colors (ROYGBIV) and counting how many colors are in a rainbow. Create a simple graph showing how many students have seen rainbows in different seasons.

ELA Connection: Rainbow Stories and Poetry
Students can write descriptive sentences about rainbows using sensory words: "The rainbow looks like...", "If I could touch a rainbow, it would feel..." Introduce poetry by having students create acrostic poems using the word RAINBOW. Read aloud picture books about rainbows and have students retell the story in their own words. Students can also interview family members about rainbows they've seen and share those stories with the class.

Art Connection: Color Mixing and Rainbow Creation
Students can create their own rainbows using watercolor paints, colored pencils, or tissue paper collage. Explore color mixing by blending paints to see how new colors are created. Have students paint or draw what they see in the photo, focusing on the colors of the rainbow and the landscape. Create a classroom "rainbow wall" where each student contributes a rainbow artwork, displaying the colors in the correct order.

Social Studies Connection: Rainbows Across Cultures
Different cultures have stories and meanings associated with rainbows. Share simple rainbow stories or legends from various cultures around the world (Native American, Hawaiian, Asian, African, etc.). Discuss how people in different parts of the world see rainbows and what rainbows might mean to them. Have students learn that rainbows are a natural phenomenon that all people on Earth can observe, connecting us through science.

STEM Career Connection

Meteorologist (Weather Scientist)
Meteorologists study weather and the atmosphere, including when and where rainbows form. They use tools to measure rain, temperature, and wind to predict weather. A meteorologist might observe rainbows to understand atmospheric conditions and explain to people what kind of weather is happening. These scientists help keep us safe by warning about storms. They work at weather stations, airports, and on TV news. Average Annual Salary: $97,000 USD

Optometrist/Optical Physicist
These scientists study how light works and how it travels through materials like water, glass, and the human eye. They understand refraction and how light bends, which is exactly what happens in a rainbow. They might design glasses, contact lenses, or tools that use light. Some work to make better instruments that use light to help people see better or to explore space. Average Annual Salary: $119,000 USD (Optometrist); $104,000 USD (Physicist)

Environmental Scientist
Environmental scientists study Earth's atmosphere, weather, water, and how all living things interact with their environment. They observe rainbows and other weather phenomena to understand climate patterns and water cycles. They help protect our planet by studying how weather and water move around Earth and how to keep our environment healthy. Average Annual Salary: $71,000 USD

NGSS Connections

Performance Expectation: 1-PS4-1 Plan and conduct investigations to provide evidence that vibrations make sound and that light can be detected and can travel in a straight line until it strikes an object.

Disciplinary Core Ideas:
- 1-PS4.A - Sound can make matter vibrate, and vibrating matter can make sound. Light travels and can be detected.
- 2-PS4.B - Different materials have different light-related properties (some materials allow light to pass through, some scatter light, some allow only some light through).

Crosscutting Concepts:
- Patterns - Rainbows follow a predictable pattern of colors in the same order every time.
- Cause and Effect - When sunlight interacts with water droplets, rainbows form as a result.

Science Vocabulary

* Rainbow: An arc of colors in the sky that appears when sunlight shines through water droplets in the air.

* Refraction: The bending of light when it passes through water or other clear materials.

* Light: Energy that we can see; it travels in straight lines until it hits something.

* Water droplet: A tiny drop of water, like rain or mist floating in the air.

* Sunlight: Light that comes from the sun; it looks white but contains all the colors mixed together.

* Dispersion: The separation of white light into its different colors.

External Resources

Children's Books:

- Rainbows Are Made by Ruth Heller (Illustrates the science of rainbows with beautiful pictures)
- Rain by Manya Stojic (A story about rain and what comes after—includes rainbows)
- Come Look With Me: Rainbows by Gladys S. Blakely (Interactive exploration of rainbows in art)

Final Note for Teachers: This lesson connects wonderfully to weather units and can be taught after students learn about rain and storms. Encourage students to observe rainbows in nature and share their observations with the class!