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.

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)

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.

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)

YouTube Videos:
- "What is a Rainbow?" by National Geographic Kids
  A short, animated explanation of how rainbows form, appropriate for early elementary.
  https://www.youtube.com/results?search_query=national+geographic+kids+what+is+a+rainbow

- "Rainbow Science for Kids" by Crash Course Kids
  A hands-on demonstration showing how light bends through water and creates rainbows.
  https://www.youtube.com/results?search_query=crash+course+kids+rainbow

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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!