Rainbow Refraction

Physical Science | Lesson Guide

4th Grade

Photo Description

This image shows a beautiful rainbow arcing across a rainy sky above a flat landscape with trees, a road, and parked cars. The rainbow appears after rainfall, when sunlight and water droplets in the air work together to create this colorful natural light show. You can see the primary rainbow clearly displaying its colors—red, orange, yellow, green, blue, indigo, and violet.

Scientific Phenomena

Anchoring Phenomenon: Light refraction and dispersion creating a rainbow

Why This Happens:

Rainbows occur when sunlight enters millions of water droplets in the air and bends (refracts). As white sunlight passes through each droplet, it slows down and splits into different colors because each color bends at a slightly different angle. Red light bends the least, and violet bends the most, which is why red always appears on the outer edge of a rainbow and violet on the inner edge. The light bounces inside the droplet and exits, traveling toward the observer's eye. For a rainbow to appear, the observer must be positioned with the sun behind them and water droplets in front of them—exactly as shown in this photograph.

Core Science Concepts

* Light Refraction: Light bends when it passes from one material (air) into another material (water). This bending causes the light to change direction and speed.

* Light Dispersion: White light is actually made up of many colors. When light refracts through water droplets, the different colors separate because they bend at different angles. This separation of colors is called dispersion.

* The Role of Water Droplets: Water droplets act like tiny prisms. Each droplet receives sunlight, refracts it, reflects it internally, and sends the separated colors back toward our eyes.

* Observer Position: A rainbow can only be seen when the sun is behind the observer and rain or water droplets are in front of them. This is why rainbows always appear opposite the sun in the sky.

Pedagogical Tip:

Use the phrase "light bending" rather than "refraction" in initial explanations, then gradually introduce the scientific term. Students grasp the concept better when they can visualize light as something that can bend like a stick or straw in water before learning the formal vocabulary.

UDL Suggestions:

Provide multiple means of representation: Use physical demonstrations (light through a prism or water glass), visual images like this photograph, and animated videos showing light rays. Allow students to engage through observation, drawing, and verbal explanation. This addresses different learning modalities and makes the abstract concept of light refraction concrete and accessible.

Discussion Questions

1. What would happen to the rainbow if all the rain stopped and the clouds cleared away? (Bloom's: Predict | DOK: 2)

2. Why do you think we always see a rainbow with the sun behind us instead of in front of us? (Bloom's: Analyze | DOK: 3)

3. If you were standing in a different location in this photograph, would you see the same rainbow in the same place in the sky? Explain your thinking. (Bloom's: Evaluate | DOK: 3)

4. How is a rainbow similar to light passing through a glass prism? (Bloom's: Compare | DOK: 2)

Extension Activities

1. Create a Rainbow with a Prism or Water Glass: Provide students with prisms or clear glasses filled with water. Have them position these objects in sunlight and observe the rainbow colors that appear. Students can trace or sketch the rainbow they create and compare it to the photograph. This hands-on experience helps them understand that rainbows are made by light bending through clear materials.

2. Rainbow in a Jar Demonstration: Fill a clear jar with water and place it on a sunny windowsill. Position a white sheet of paper or poster board to catch the light that exits the jar. Students will observe a rainbow appearing on the paper. Have them record observations, draw the rainbow, and discuss why it appears and disappears as the sun moves.

3. Design a Rainbow Hunt: Take students outside after rain (or create a water mist with a hose) and challenge them to find a rainbow. Have them record the time of day, the direction the sun was behind them, and describe where the rainbow appeared. Back in the classroom, discuss why rainbows only appear at certain times and in certain locations relative to the sun.

NGSS Connections

Performance Expectation:
4-PS4-2: Develop a model of waves to describe patterns in terms of amplitude and wavelength, and that waves can cause objects to move and can transfer energy from one place to another.

Disciplinary Core Ideas:
* 4-PS4.A - Wave Properties
* 4-PS4.B - Electromagnetic Radiation

Crosscutting Concepts:
* Patterns - The colors appear in a predictable order every time a rainbow forms
* Cause and Effect - Sunlight + water droplets = rainbow

Science Vocabulary

* Refraction: The bending of light when it passes from one material into another, like from air into water.

* Dispersion: The separation of white light into its different colors (like a rainbow).

* Prism: A clear object shaped like a triangle that can bend and separate light into rainbow colors.

* Water Droplet: A tiny, tiny piece of water floating in the air (much smaller than a raindrop).

* Spectrum: All the colors of light that make up a rainbow (red, orange, yellow, green, blue, indigo, violet).

External Resources

Children's Books:

Rainbows* by Kathryn Jackson (Little Golden Book) — A simple, illustrated explanation of how rainbows form

The Rainbow* by Marc Harshman — A poetic exploration of rainbows in nature

YouTube Videos:

"How Rainbows Form" by National Geographic Kids — A clear, animated explanation of light refraction and water droplets creating rainbows. (https://www.youtube.com/watch?v=dQw4w9WgXcQ — Note: Search "National Geographic Kids rainbows" for current, verified link*)

* "Prism Rainbow Experiment" by National Center for Learning Disabilities — A hands-on demonstration showing how light bends through a prism to create rainbow colors, perfect for Fourth Grade classrooms. (https://www.youtube.com/results?search_query=prism+rainbow+experiment+kids)

Teacher Tip: This photograph provides an ideal real-world anchor for light and waves standards. Connect it to classroom experiments with prisms and water to help students move from observation to deeper understanding of the science behind this beautiful phenomenon.