Fountain

Physical Science | Lesson Guide

4th Grade

Photo Description

This fountain has water flowing down from the top tier to the bottom in a steady stream. The water has frozen into long, white icicles hanging from each level of the fountain. Even though it's cold enough to freeze, the water keeps moving and flowing from one level to the next.

Scientific Phenomena

The Anchoring Phenomenon is the coexistence of flowing liquid water and solid ice in the same fountain system. This occurs because moving water has a harder time freezing than still water due to its kinetic energy, and the continuous flow prevents complete solidification. However, when the flowing water splashes and clings to the fountain's edges, it loses energy and freezes into icicles. The temperature is at or near the freezing point (32°F/0°C), creating perfect conditions for this liquid-solid water demonstration.

Core Science Concepts

1. States of Matter - Water exists simultaneously as a liquid (flowing) and solid (ice) in the same system, demonstrating how temperature and energy affect matter's state.

2. Heat Transfer - Moving water transfers thermal energy more effectively than still water, which is why the flowing portions remain liquid while stationary droplets freeze.

3. Freezing Point - Water changes from liquid to solid at 32°F (0°C), but this process can be affected by movement, impurities, and energy transfer.

4. Energy and Motion - The kinetic energy of flowing water helps prevent freezing, while water that loses this energy (dripping, clinging) more readily solidifies.

Pedagogical Tip:

Use this image to help students understand that scientific phenomena often show multiple concepts simultaneously. Encourage them to look for "both/and" rather than "either/or" situations in nature.

UDL Suggestions:

Provide multiple ways for students to explore this concept: tactile experiences with ice cubes and warm water, visual diagrams of molecular movement, and kinesthetic activities where students model fast-moving vs. slow-moving water molecules.

Zoom In / Zoom Out

1. Zoom In: At the molecular level, water molecules in the flowing stream are moving rapidly and have more kinetic energy, making it harder for them to form the organized crystal structure needed for ice. When water droplets cling to surfaces, the molecules slow down and arrange into rigid ice crystals.

2. Zoom Out: This fountain demonstrates the larger water cycle system where water constantly changes states - evaporating, condensing, freezing, and melting. The same processes happening here occur in rivers, lakes, and streams during winter weather patterns across entire watersheds.

Discussion Questions

1. Why do you think the water keeps flowing even though there are icicles forming? (Bloom's: Analyze | DOK: 2)

2. What would happen to this fountain if the temperature dropped much lower or if the pump stopped working? (Bloom's: Evaluate | DOK: 3)

3. Where else have you seen water in two different states at the same time? (Bloom's: Apply | DOK: 2)

4. How could we design an experiment to test what makes water freeze faster - moving water or still water? (Bloom's: Create | DOK: 4)

Potential Student Misconceptions

1. Misconception: "All water freezes at exactly the same time when it gets cold."
Clarification: Moving water requires colder temperatures to freeze than still water because motion creates energy that resists the freezing process.

2. Misconception: "Ice and liquid water can't exist together naturally."
Clarification: Water can exist in multiple states simultaneously when conditions are right, such as at the freezing point with varying energy levels.

3. Misconception: "The fountain should be completely frozen if it's cold enough to make icicles."
Clarification: The pump keeps water moving, and moving water transfers heat energy, preventing complete freezing even in below-freezing temperatures.

Cross-Curricular Ideas

1. Math - Measurement & Data: Have students measure the length of icicles at different times of day and record the data on a chart. They can practice measuring in inches or centimeters, create bar graphs comparing icicle lengths, and make predictions about which icicles will grow longest based on their starting measurements.

2. ELA - Descriptive Writing: Ask students to write a detailed description of the frozen fountain using sensory words (what they see, hear, and imagine feeling). They could also write a fictional story from the perspective of a water droplet's journey from flowing liquid to frozen icicle, using sequence words like "first," "next," and "finally."

3. Art - Observational Sketching: Have students create detailed drawings of the fountain, paying close attention to the texture and patterns of the ice formations. They could use white paint, markers, or pencils on colored paper to replicate the contrast between the frozen and flowing water, exploring how artists show movement and stillness in their work.

4. Social Studies - Weather & Community: Connect this image to how winter weather affects the community. Students could research how cities prepare for freezing temperatures, interview community members about winter safety, or investigate how frozen fountains impact public spaces and tourism in different regions.

STEM Career Connection

1. Water Systems Engineer: These scientists and engineers design and maintain systems that move water through cities and buildings, like the pump system in this fountain. They make sure water flows safely and figure out how to keep water systems working in cold weather. Water systems engineers earn about $85,000-$95,000 per year.

2. Climate and Weather Scientist (Meteorologist): Meteorologists study temperature, weather patterns, and how cold affects water in nature. They predict when it will freeze and help communities prepare for winter weather. Understanding why water freezes in fountains is part of their work! Meteorologists earn about $60,000-$75,000 per year.

3. Materials Scientist: These scientists study how different materials like ice, metal, and stone behave in cold temperatures. They might design fountain materials that don't crack when water freezes inside them, or develop special coatings to protect structures during winter. Materials scientists earn about $80,000-$100,000 per year.

NGSS Connections

- Performance Expectation: 2-PS1-1 - Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties
- Disciplinary Core Ideas: 2-PS1.A - Different kinds of matter exist and many of them can be either solid or liquid
- Crosscutting Concepts: Patterns - Patterns in the natural world can be observed and used as evidence
- Science and Engineering Practices: Planning and carrying out investigations to answer questions about the natural world

Science Vocabulary

* Kinetic energy: The energy something has when it is moving
* Freezing point: The temperature at which a liquid turns into a solid
* States of matter: The different forms matter can take, like solid, liquid, or gas
* Thermal energy: Heat energy that can move from one object to another
* Crystallization: When molecules arrange themselves in an organized pattern to form crystals
* Phase change: When matter changes from one state to another, like liquid to solid

External Resources

Children's Books:
- Water Is Water: A Book About the Water Cycle by Miranda Paul
- The Magic School Bus at the Waterworks by Joanna Cole
- Ice Is Nice!: All About the North and South Poles by Bonnie Worth