# Force

Physical Science | Lesson Guide

4th Grade

## Photo Description


Large waves crash against dark rocks near the shore, creating white foam and spray. The powerful water hits the rocks and splashes high into the air. You can see how the ocean's energy moves the water against the solid rocks on the beach.

## Scientific Phenomena

This image shows the Anchoring Phenomenon of wave energy transfer and collision forces. When ocean waves move toward shore, they carry energy from wind across the water. As waves hit the rocks, the water's kinetic energy transfers into the rocks and changes direction, creating the dramatic splash and spray. The force of moving water demonstrates how energy can be transferred from one object to another through collisions.

## Core Science Concepts

1. Energy Transfer: Moving water carries energy that transfers to rocks when they collide
2. Forces and Motion: Waves demonstrate how forces can change the direction and speed of moving objects
3. Cause and Effect: Wind energy creates waves, which then create splashing when they hit barriers
4. Properties of Water: Water can exist as liquid droplets in spray and foam during wave action

**Pedagogical Tip:**

Use slow-motion videos of waves crashing to help students observe the energy transfer that happens too quickly to see in real time. This helps make the invisible phenomenon of energy transfer visible.

**UDL Suggestions:**

Provide multiple ways for students to demonstrate wave energy: kinetic learners can create waves in water tables, visual learners can draw energy transfer diagrams, and auditory learners can describe the sounds of crashing waves.

## Zoom In / Zoom Out

1. Zoom In: At the molecular level, water molecules are constantly moving and bouncing off each other. When waves crash, millions of water molecules suddenly change direction and speed, creating the kinetic energy we see as splashing.

2. Zoom Out: This wave action is part of Earth's water cycle system. Ocean waves help move water into the atmosphere through evaporation from spray, transport energy across ocean basins, and gradually shape coastlines through erosion over thousands of years.

## Discussion Questions

1. What do you think would happen if these waves hit sand instead of rocks? (Bloom's: Analyze | DOK: 2)
2. Where do you think the energy in these waves originally came from? (Bloom's: Evaluate | DOK: 3)
3. How might the size of the splash change if the waves were moving faster or slower? (Bloom's: Apply | DOK: 2)
4. What evidence can you see in the photo that shows energy is being transferred? (Bloom's: Analyze | DOK: 2)

## Potential Student Misconceptions

1. Misconception: "The water in waves moves forward toward the shore."
   Reality: Water molecules mostly move up and down in circles; it's the energy that moves forward through the water.

2. Misconception: "Bigger rocks always stop waves completely."
   Reality: Wave energy can go around, over, and through rock barriers, though rocks do absorb and redirect much of the energy.

3. Misconception: "Waves only happen in oceans."
   Reality: Any moving liquid can create waves when energy is added, including lakes, rivers, and even water in bathtubs.

## Cross-Curricular Ideas

1. Math - Measurement and Data: Have students measure the height of wave splashes in photos or videos using a ruler or grid overlay. Create a bar graph comparing splash heights from waves of different sizes. Students can predict and then measure how high splashes might go based on wave speed.

2. ELA - Descriptive Writing: Ask students to write vivid descriptions of the wave crashing scene using sensory words (what they see, hear, feel). Create an acrostic poem using the word "WAVES" or "ENERGY." Students can also research and write informative paragraphs about different types of ocean waves.

3. Social Studies - Coastal Communities: Explore how people who live near the ocean use wave energy and how waves affect their communities. Students can research lighthouses, harbors, or sea walls built to protect coastal towns from wave damage. Discuss how understanding wave energy helps us build safer communities.

4. Art - Dynamic Movement: Have students create paintings or drawings that show movement and energy using splashing water as inspiration. Use watercolor techniques to create the effect of waves and spray. Students can also design their own "wave barriers" using art materials and test them in a water table to see which designs work best.

## STEM Career Connection

1. Oceanographer - An oceanographer is a scientist who studies the ocean, including how waves form, move, and affect sea life and coastlines. They use special equipment to measure waves and understand ocean energy. Oceanographers help us learn how to protect our oceans and predict dangerous storms. Average Salary: $63,000-$75,000 per year

2. Coastal Engineer - A coastal engineer designs and builds structures like sea walls, jetties, and breakwaters to protect beaches and towns from wave damage. They use their knowledge of wave energy and forces to create structures that are strong enough to withstand crashing waves. Average Salary: $68,000-$85,000 per year

3. Renewable Energy Technician - A renewable energy technician works with wave energy devices that capture the power of ocean waves and convert it into electricity for homes and businesses. These professionals help develop clean energy solutions using the same wave energy you see in this photo. Average Salary: $55,000-$70,000 per year

## NGSS Connections

- Performance Expectation: 4-PS3-1 - Use evidence to construct an explanation relating the speed of an object to the energy of that object
- Disciplinary Core Ideas: PS3.A Energy and Matter, PS3.B Conservation of Energy and Energy Transfer
- Crosscutting Concepts: Energy and Matter, Cause and Effect
- Science and Engineering Practice: Constructing Explanations and Designing Solutions

## Science Vocabulary

* Energy: The ability to cause motion or change in matter
* Transfer: When energy moves from one object to another object
* Kinetic energy: The energy that moving objects have
* Force: A push or pull that can change how objects move
* Collision: When two objects hit each other and energy moves between them

## External Resources

Children's Books:
- Waves by Patricia J. Murphy
- The Magic School Bus Ups and Downs: A Book About Floating and Sinking by Joanna Cole
- National Geographic Readers: Waves by Anne Schreiber