ARM

CLIMATE RESEARCH FACILITY

Education and Outreach Lesson Plan

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Grade levels K–2

Moving Water and Waves

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Approximate Time

One hour

Objective

The objective of this activity is to enable students to understand how **wind** causes water to move to generate waves and how these waves in turn create water pressure that forces water to move from higher to lower pressure when rushing onto shore.

Background Information

- Every day we see water on the move. Although there may be very little observable movements on the ocean surface on a very fine day, in fact, the ocean water is always moving. There are many ways that you can make waves in water. Most waves are created by winds.
- The narrow strips where the land meets the seas, coastlines, are among the most dynamic environments on Earth. Relentless attack by waves gnaws away at even the hardest of rocky coasts, reshaping the shore with each passing wave. Even the gentlest waves change the shape of the shoreline each day in imperceptible ways.
- It takes lots of energy to make the waves crashing against a shoreline. Where does this energy come from? The single most important wave-building energy source is wind.
- Wind-generated waves may originate thousands of kilometers out at sea. Out in the deep open ocean, waves usually start out small and choppy. If the wind is strong and lasts long enough, the wave pattern becomes more organized.
- Storm-driven waves often travel towards the distant shore as low, rounded swells.

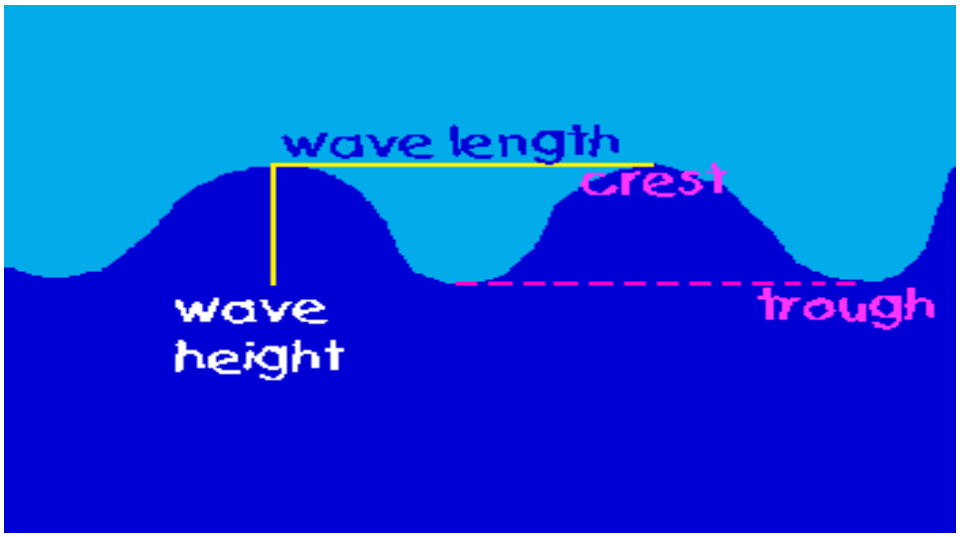


Figure 1: Waves have a wave height, a wave length, a crest, and a trough.

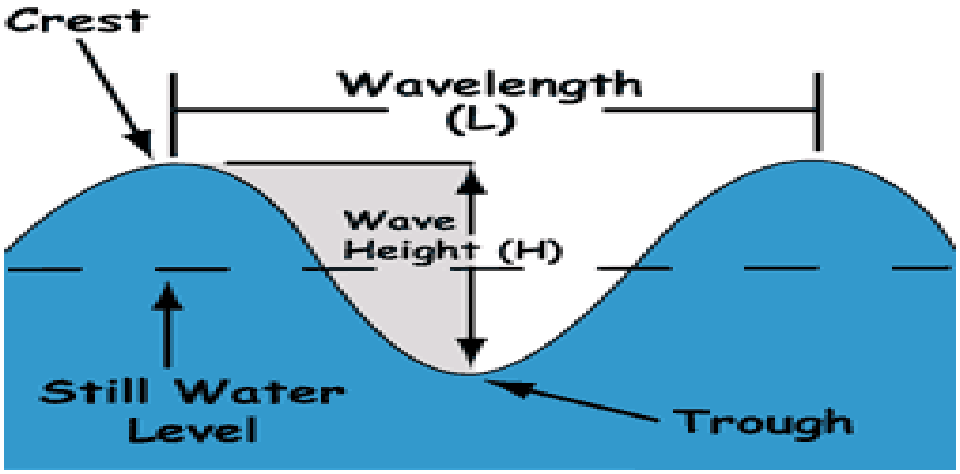


Figure 2: Shows how to measure wave height and the length of a wave.

- As swells approach the shallow coastline they begin to touch bottom. Water drags against the sea bottom, slowing its forward movement. While the wave slows, water piles up, building higher and higher waves as the bottom shallows (Figure 3).

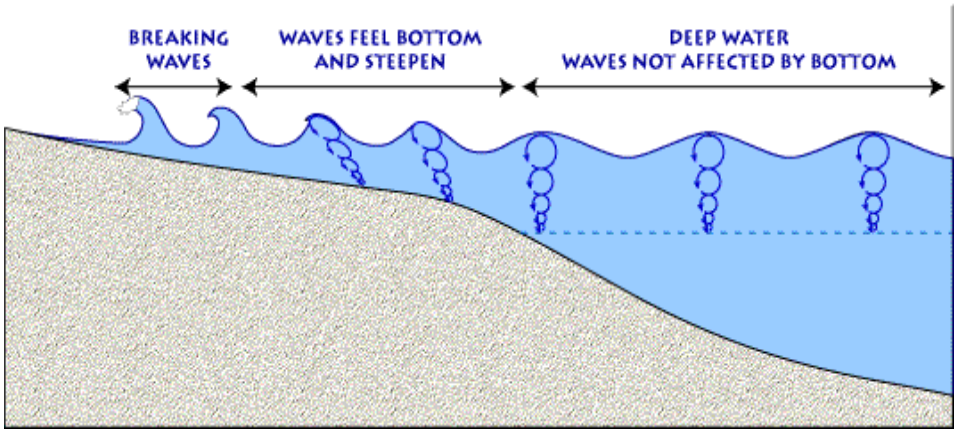


Figure 3: Eventually the wave reaches a critical point when the steep advancing edge collapses. Breaking waves disintegrate into turbulent sheets of water called swash that carry sand and gravel up onto the beach.

- A **tsunami** (plural: **tsunamis** or **tsunami**; from Japanese: 津波) literally means "harbor wave".

Key Vocabulary

- **Coastline:** The narrow strips where the land meets the sea.
- **Crest:** The point on a wave with the maximum value or upward displacement of water.
- **Energy:** The capacity of a physical system to perform work. Energy exists in several forms such as heat, kinetic or mechanical energy, light, potential energy, electrical, or other forms such as wind or wave energy.
- **Swell:** The slow up and down movement of a long, smooth wave or series of waves in the sea; a long wave on water that moves continuously without breaking.
- **Swell height:** This is the height of the swell/wave as it travels in deep water towards our coasts. This is not the same thing as the height of the wave on the beach.
- **Trough:** The lowest part of the wave between crests.
- **Tsunami:** A tsunami is a series of ocean waves generated by sudden displacements in the sea floor (seaquake), landslides, or volcanic activity. In the deep ocean, the tsunami wave may only be a few inches high. The tsunami wave may come gently ashore or may increase in height to become a fast moving wall of turbulent water several meters high.
- **Waves:** A disturbance on the surface of a liquid body, as the sea or a lake, in the form of a moving ridge or swell.
- **Wave height:** The vertical distance between the trough of a wave and the following crest.
- **Wind:** The perceptible natural movement of the air, esp. in the form of a current of air blowing from a particular direction: "an easterly wind".

Materials

Each student or group of students will need the following:

- A rectangular metal or glass container (a cake pan works well)
- Water
- Approximately 2 kilograms (4−5 pounds) of sand (optional)
- Electric fan or a hair dryer
- Stopwatch or watch with a second hand (many iPhones have a stopwatch feature in the clock app)
- Butcher paper to record student responses

Preparation

Since this is a demonstration for a primary class, you may want to start the lesson with a large sheet of butcher paper and list where students have noticed water during the daily activities of life and when they are outside in a natural setting like the beach, forest or park.

After the demonstration, use another sheet of butcher paper to record student responses to the related questions (see below for questions).

SAFETY NOTE:

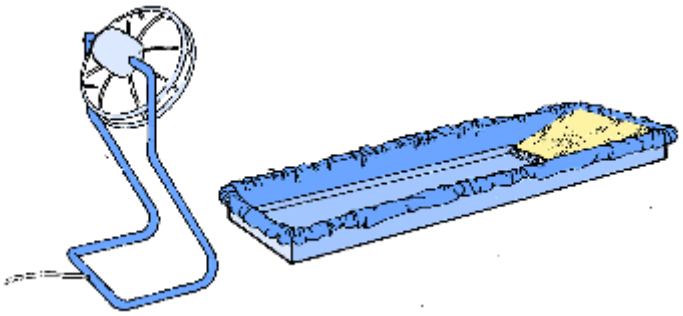
DO NOT let students use the hair dryer or fan at all! Electrical appliances and water do NOT mix, especially with children. Do not put your students or yourself a risk by allowing a student to conduct this demonstration!

Management Tip

Students may need to fill in Student Record Sheets as directed by the teacher, depending upon student needs. The Student Record Sheet can be modeled under a document camera or can be enlarged to poster size to be completed as a whole-class activity.

Procedure

1. With sand, construct a beach at one end of the tank.
2. Fill the container with water to a depth of about 5 centimeters (approx. 2 inches).
3. Place the fan or hair dryer on one side of the container so that the fan can blow onto the surface of the water. It should be aimed down the container along the surface of the water at about a 45-degree angle.



4. Switch on the fan (or hair dryer) at a lower speed then at a higher speed. Allow 2 minutes for each trial. Let the students observe the different results.
5. Ask the class the questions related to the demonstration under "Closure/Evaluation."

Closure and Evaluation Questions

Ask students:

1. What happened when the fan (or hair dryer) was switched on?
2. What happened to the waves when the fan (or hair dryer) was changed to a higher speed?
3. What happened to the size of the waves as time progressed?

   Note to teacher: you may want to draw a picture on the butcher paper of the size of waves generated related to various fan speeds (wind speed).
4. Did you notice any differences in the waves from one end of the tank to the other? If so, what were they?
5. While the fan was running which side of the water tank had the higher pressure of water?
6. What happened when the fan was switched off?
7. From all your observations, what characteristics of winds are important in determining the height of a wave?

   (Alternate wording for Kindergarten or primary children: From what you noticed about the waves, what is important about the wind to cause the waves to be different heights?)

Suggested Follow-Up Activities

- Introduce the term **tsunami** and suitable information to enable students to understand the dynamics and causes of tsunamis. A graphic input chart on butcher paper with tsunami information and suitable pictures of a tsunami in action and its aftermath, may be used.
- Help students to find suitable websites to view tsunami videos, images, and information, depending upon maturity level of students. The teacher may opt to show these from a class computer via document camera or projector. One such site is http://www.tsunami.noaa.gov/. It has a wealth of scientific information as well as a video clip called "Tsunami Teacher".
- Wave art: draw waves of varying sizes showing normal waves, waves generate by an ocean storm, and a tsunami. Use a picture of a person or a car cut out from a magazine as a way to show scale.

- Images of tsunami:




Sources

http://geomaps.wr.usgs.gov/parks/sea/gwave.html

http://www.arm.gov/about/glossary

http://www.tsunami.noaa.gov/

http://environment.nationalgeographic.com/environment/natural-disasters/tsunami-profile/

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