12A Waves

How do ocean waves shape landforms?

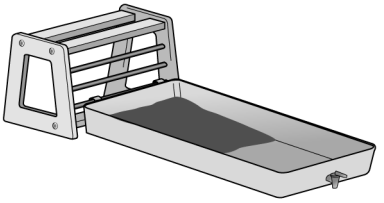
Waves are the primary force of erosion along coastlines. Along the Pacific coast, waves can contain a lot of energy and come ashore with great force. The beautiful cliffs along the Pacific coast are formed by this strong wave action.

Waves form as energy is transferred from wind blowing across the water's surface. Large waves are often caused by powerful storms far from shore. In this investigation you will model how waves can shape coastal areas.

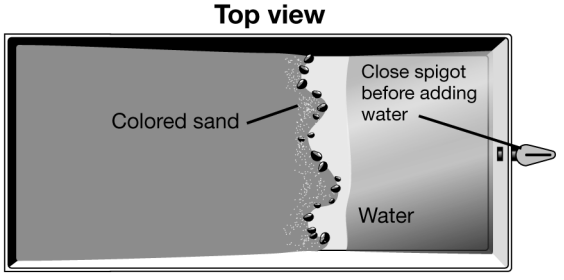
Materials

- Stream table setup (includes stage, two buckets, the table and grit)
- Small block of wood to be used as a "wave maker" (about 4 cm shorter than the width of the stream table
- Small rocks and pebbles
- Beaker
- Small amount of colored sand

1 Setting up



1. Set up your stream table so that the slope is at the lowest setting.
2. Fill the top half of your stream table with tightly packed grit. The grit should be five to seven centimeters thick. It should gradually slope down towards the middle of the stream table.
3. Create a shoreline in your sand bank. Be creative. Shorelines are rarely straight. Add small rocks and pebbles to your shoreline.
4. Sprinkle the colored sand along the shoreline of your model. Make sure the spigot at the end of the stream table is closed.
5. Fill the empty half of your stream table with water until the water level begins to reach your shoreline.
6. Sketch your shoreline before completing the next step.
7. Place the piece of wood at the end of the table in the "ocean." Push it back and forth gently to create equal sized waves.



8. Create waves in your stream table for a full minute. Take note of what happens to the colored sand and the shape of your shoreline.

Shoreline before waves	Shoreline after waves

2 Stop and think

a. What happened to the colored sand as you created waves in your model?

b. Describe the changes that the waves made to your shoreline.

c. Describe the rate of erosion along areas of shoreline that "stuck out" into the ocean. How was erosion different here than areas (such as a bay) that were farther inland?

3 Doing the experiment

1. Now form a new shoreline. Again, be creative! You can shape bays, inlets, peninsulas, and areas of different thicknesses of sand.
2. Sprinkle colored sand along your shoreline as you did in the first trial.
3. Use the wood block to make larger waves than the first trial. Note what happens to the shape of your coastline and the colored sand. Create waves for one full minute.
4. Repeat steps 1 through 3. This time create waves from different angles and observe how this affects the erosion of your shoreline.

4 Thinking about what you observed

a. How did the rate of erosion change as you created more powerful waves? Why?

b. Which areas of your coastline eroded the fastest? Why do you think this is so?

c. Which areas of your coastline eroded the slowest? Explain your answer.

d. How did changing the angle of the waves affect the erosion of your shoreline?

e. As waves move ashore, they pick up sediment such as sand and pebbles. How do you think the sand and pebbles affect the erosion of coastal areas?

f. In this investigation you created different sized waves using a piece of wood. How are different-sized waves formed in nature?

5 Exploring on your own

1. Look up the definitions and find pictures of the following coastal features: sea caves, wave-cut cliffs, sea arch, and sea stacks. Once you have researched each of these features, try to model their formation in your stream table setup.
2. Use the Internet to research the nearest coastal area to your school. Find pictures. Summarize the shape of this coastline and predict how the coastline will change as waves erode the region.
3. Look at a map or a satellite picture of the eastern coast of the United States and the Gulf Coast. Focus your attention on the barrier islands along these coasts. How permanent do you think these islands are? Is it a wise decision to build on these islands? Why or why not?

12B Wave Speed

What is the relationship between water depth and wave speed?

In the ocean, most waves are driven by the wind. As long as the wave is in deep water, the water depth does not influence the wave very much. When a wave approaches the shore, however, the speed of the wave changes.

In this investigation, you will collect data to observe how water depth affects waves speed.

Materials

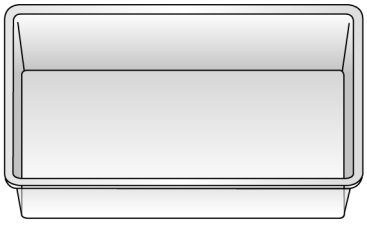
- GeoBox
- 1,000-mL beaker
- Masking tape
- Timer
- Ruler or measuring tape
- Graph paper
- Wooden block

1 Setting up

1. Gather your materials including the GeoBox. Fill the 1,000-mL beaker with water.

2 Stop and think

- Predict the relationship between wave speed and water depth. Does the wave speed increase or decrease as the water depth increases? Why?



GeoBox

3 Doing the experiment

1. Place water in the tray to a depth of one centimeter.
2. Place the wooden block under one end of the tray. One student will be the "timer," and the other student will watch the waves.
3. First practice the following, then measure when you are ready. Pull the wooden block out. This will create a wave as the tray falls to the table. The water will "slosh" lengthwise in the tray.
4. As soon as you begin to move the block, start the timer. The person watching the wave will watch it make four round trips. That means back and forth four times. As soon as it finished making the four round trips, stop the timer. Record your data (time) in the table. Repeat the same depth for two more trials.
5. Once you have made three time measurements for the one-centimeter depth, add water up to the two-centimeter mark.
6. Follow the same procedure and continue increasing water depth until you get as high as you can go (probably around six centimeters).

7. Find the average time for each depth. Then calculate wave speed using the formula below.

$$\text{wave speed} = \frac{\text{total distance traveled}}{\text{average time}}$$

Hint: Be careful when you measure for the total distance traveled —think about how many times the wave goes back and forth.

Table 1: Wave speed at different depths

Depth (cm)	Trial 1 (seconds)	Trial 2 (seconds)	Trial 3 (seconds)	Average (seconds)	Wave speed (cm/sec)
1					
2					
3					
4					
5					
6					

8. Make a graph with depth on the *x*-axis and wave speed on the *y*-axis.

4 Thinking about what you observed

a. Describe the pattern of the graph.

b. Why should there be any change in wave speed?

5 Exploring on your own

a. What happens when waves reach the shoreline?

b. What is the difference between swells and whitecaps?

c. Would waves approach the shore in the same manner if the shoreline was gradual or very steep? Explain.