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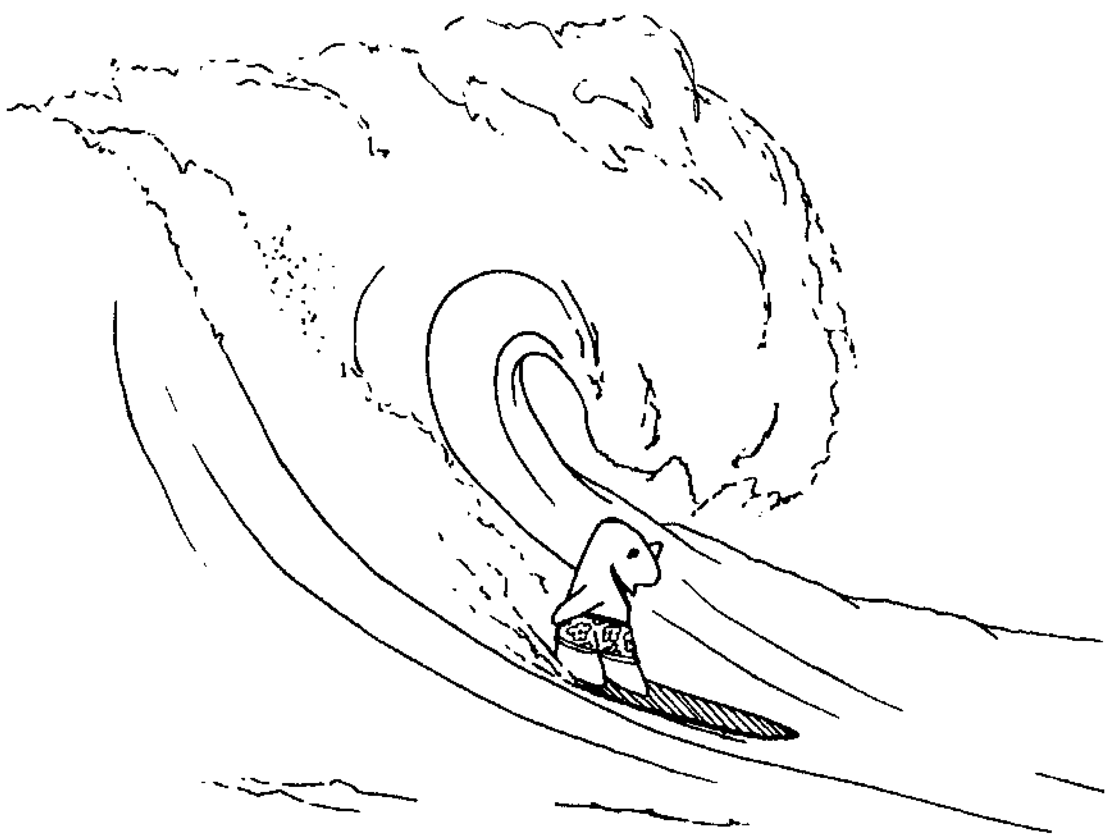
Ohio Sea Grant

WAVES ON THE GREAT LAKES

by
John Keir, Westerville (OH) City Schools
and
Victor J. Mayer, The Ohio State University



TEACHER GUIDE

OEAGLS-Oceanic Education Activities for Great Lakes Schools

OEAGLS Investigation #27

Completed June 1987

This instructional activity was prepared with the support of the National Oceanic and Atmospheric Administration, Sea Grant College Program Office, U. S. Department of Commerce, under Ohio Sea Grant Project #718716. Funding support was also provided by The Ohio State University's School of Natural Resources and College of Education. Any opinions, findings, conclusions or recommendations expressed herein are those of the authors, and do not necessarily reflect the views of NOAA or the University.

TEACHER GUIDE

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TEACHER GUIDE
WAVES ON THE GREAT LAKES

by
John Keir, Westerville (OH) City School
and
Victor J. Mayer, The Ohio State University
Ohio Sea Grant Education Program

OVERVIEW

This investigation includes three activities which lead students to an understanding of how waves are formed and how they move in water.

Activity A introduces students to the parts of a wave. A demonstration using a stream table leads them to discover different factors which determine the size of a wave.

Activity B introduces wave motion. Students observe how waves move in a rope and in water.

Activity C explains how breakers are formed and the effects they may have on the shoreline. Students use the stream table and various building materials to devise structures for protecting a harbor from the action of waves.

The film "Waves on Water" is recommended as a general introduction to these activities. This 16 minute film is available from Encyclopedia Britannica Films, 425 N. Michigan Ave., Chicago, IL 60611; 1-800-558-6968.

In addition, the film "Moods of Surfing" is recommended as an introduction to Activity C. This 16 minute color film is available from Pyramid Films & Videos, Box 1058, Santa Monica, CA 90406; 1-800-523-0118.

PREREQUISITE STUDENT BACKGROUND

Ability to multiply and divide by 3, 4 and 7.

MATERIALS

Activity A:

Stream table, water, electric fan, two popsicle sticks or tongue depressors, blocks of wood, clay, and screening.

Activity B:

Length of rope (about 3 meters).
Optional: video camera, tape and monitor.

Activity C:

Stream table, fan, blocks of wood, clay, screening.

OBJECTIVES

When students have completed these activities, they will be able to:

1. Describe how waves form on water.
2. Label a drawing of waves showing the crest, trough, wavelength and wave height.
3. Describe the three factors that determine wave height.
4. Describe how whitecaps form.
5. Describe the motion of water in and below a wave.
6. Describe how breakers form.
7. Describe the difference between spilling and plunging breakers.
8. Describe the effects breakers have on the shoreline.

Waves on Lake Erie

by
John Keir, Westerville (OH) City Schools
and
Victor J. Mayer, The Ohio State University
Ohio Sea Grant Education Program

INTRODUCTION

You may have seen water waves sometime in your life. You might have seen them in your bathtub, in a lake or pond near your home, or maybe on a visit to one of the Great Lakes. Have you ever sat on a beach and watched the waves? You might have noticed that they come in different sizes. Some days the waves are perfect to swim in or surf on. Other days the waves are so big that they could hurt you or even damage docks and buildings along the shore. There are some places on Lake Erie and Lake Michigan where houses have been destroyed by waves that were produced during severe storms.

Did you ever wonder where waves come from, or why some are big and others small? This activity will help you answer these and other questions about waves.

ACTIVITY A: WHAT CAUSES WAVES ON WATER?

KEYWORDS: Crest, trough, wavelength, wave height, period, fetch, whitecaps.

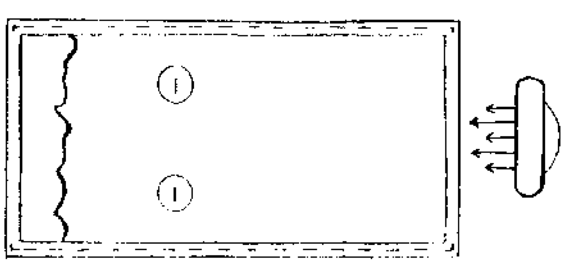
MATERIALS

Stream table filled with water, electric fan.

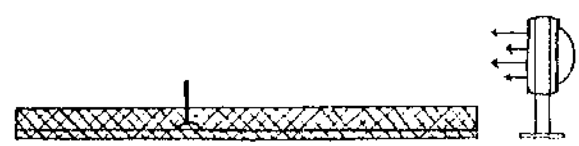
PROCEDURE

Try this activity yourself before using it in the classroom.

Set up the apparatus as shown in the diagrams below. Line the sides of the stream table with screening to absorb waves. Position the two popsicle sticks upright in the water as shown by using the clay as a base.



TOP VIEW



SIDE VIEW

Record all answers on your answer sheet. Answer the first two questions based on your personal observations. Then watch the demonstration of how waves form on water and what influences the size of waves.

Discuss the answers to these questions with your students. Make sure they understand that wind is the most common cause of waves on water.

1. Name some things you have seen that cause waves to form.

T1. Any disturbance of the water by wind, boats, etc. will cause waves.

2. Which of these causes do you think is most common?

T2. Wind is the most common cause of waves on water.

Your teacher will turn the fan on at a low to medium speed. Answer the following questions based on your observation of the demonstration.

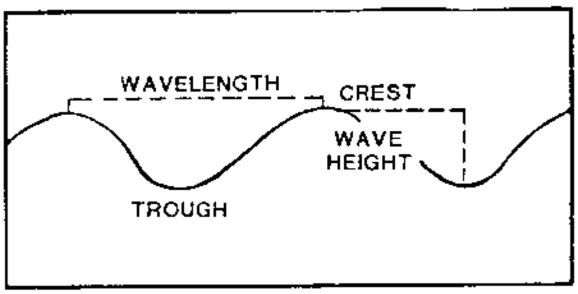
Have the students gather around the stream table and turn the fan on at a low to medium speed.

3. What happened to the surface of the water when the wind from the fan started to blow over it?

T3. The surface was disturbed and waves were formed. As the air moves over the water, there is friction between them. This disturbs the water surface and forms small ripples. As the air moves over the ripples, the friction makes the waves bigger. Energy is transferred from the wind to the water.

4. Draw a picture of several waves in the space provided on your answer sheet.

T4-8. Students' drawings should be similar to this example.



5. The high point of a wave is called the **crest**. Label the crest of a wave on your drawing.

6. The low point of a wave is called the **trough**. Label the trough of a wave on your drawing.

7. The distance from one wave crest to the next is called the **wavelength**. Label the wavelength on your drawing. Look at the stream table and compare the wavelengths at a point close to the fan and at a point farther away.

8. The vertical (up and down) distance between a crest and a trough is called the **wave height**. Label the wave height on your drawing. Compare the wave heights at a point close to the fan and at a point farther away.

9. The time it takes for two wave crests in a row to pass a fixed point is called the **period** of the wave. Is the wave period longer at a point close to the fan or at a point farther away?

T9. The wave period is largest at the point farthest away from the fan because the waves are bigger there and have spread apart. Turn up the fan to a high speed. Have students observe what happens.

10. What happened after the fan was turned up to the higher speed?

T10. The size of the waves increased. Now move the fan so that it is blowing across the width of the stream table, instead of along the length of it. Have students answer the following questions based on their observations.

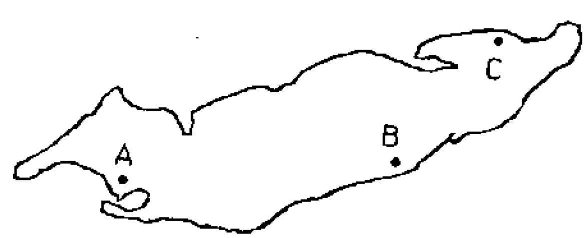
11. After the fan was moved, were the waves as big as before? Why?

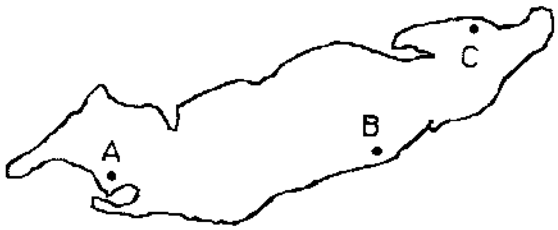
T11. No, the waves were not as big. They did not have the room or the time to grow bigger.

12. Steady winds blowing over water for a long time help to produce large waves. From your observations, what are two other factors that influence wave height?

T12. In addition to the length of time that the wind has been blowing, the wind speed and the distance wind blows across open water are two factors that influence wave height.

The size of the wave is partly a result of the distance the wind has been blowing across the surface of the water. This distance is called the **fetch** of the wave. As the fetch gets longer, the wave height increases.





13. Examine the map of Lake Erie above. If the wind was coming from the northeast, which point on the map would have the highest waves? Why?

T13. Point A would have the highest waves, because the fetch is longest there when the wind is blowing from the northeast.

14. If the wind was coming from the west, which point would have the highest waves? Why?

T14. Point C would have the highest waves, because the fetch is longest there when the wind is blowing from the west.

Because of the fetch of winds coming from the northeast, Marblehead Peninsula can have differences in water level as much as 9 feet above average lake level.

Use the following information to answer the next two questions.

As you observed earlier, when wave height increases, the wavelength also increases. The maximum height for a stable wave is 1/7 of its wavelength. With a wavelength of 7 feet, a stable wave could be as high as one foot. A wave having a wavelength of 14 feet could be 2 feet high and still be stable, and so on. A wave over 100 feet high was once seen on the Pacific Ocean.

15. What wavelength would support a stable wave 100 feet high?

T15. The wavelength would be 7 X 100 = 700 feet.

If winds are blowing so hard that the wave height increases faster than the wavelength, the crest of the wave will become unstable. This means that the crest will fall over because the wave is too steep. Foam on the crest and whitecaps are created. See the diagram below.

16. What do you think the foam on whitecaps is made of?

T16. The foam is made of bubbles.

The Wave (Albert Bierstadt, 1887)

ACTIVITY B: HOW DO WAVES MOVE ON WATER?

MATERIALS: Length of rope (about 3 meters); optional: video camera, tape and monitor

PROCEDURE

> Tie one end of the rope to a door handle. Shake the free end of the rope up and down to produce waves. Allow your students time to make observations. Have them identify crests, troughs, wavelengths and wave heights. Vary the speed with which you shake the rope to make bigger and smaller waves.

Your teacher will demonstrate how waves travel along a rope. Waves move on a rope much like they move on water. As your teacher produces waves on the rope, look for crests and troughs. Look for wavelength and wave height.

With colored tape or a wide marker, make a mark near the middle of the rope. As waves are demonstrated, note how the mark moves.

1. Which moves forward, the rope or the wave?

> T1. The wave moves forward.

2. Water waves are similar in that the wave moves forward, but not the water. How is the rope moving when a wave passes?

> T2. The rope moves up and down when a wave passes through it.

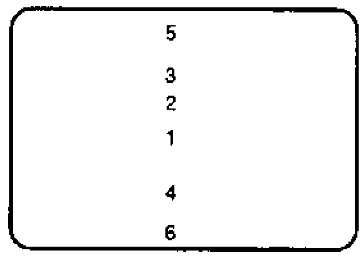
If the equipment is available, make a short videotape of the waves made with the marked rope. Tape several different periods and heights of waves, keeping each type going for about a minute. As you play back the tape, pause the player at intervals so that you can measure the wave heights, wavelengths and periods of waves and record data on your answer sheet. Can you confirm that there is a relationship between wavelength and wave height?

> It should be possible to confirm that with larger wave heights there are also longer wavelengths.

In the space marked on your answer sheet, diagram the movement of the mark on the rope. Stop the tape at any point and measure the distance to the mark from the top of the screen and from the left side. Put a 1 on your answer sheet in the spot that matches these coordinates.

Play a few more frames of the tape and pause again. Remeasure to the mark and put a 2 in the new position on the answer sheet. Continue numbering new positions until you have tracked the mark through a complete wave cycle (crest to trough to crest).

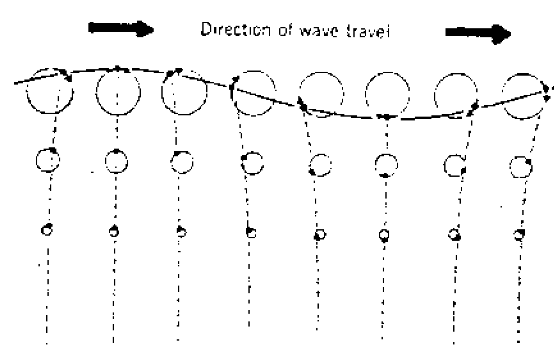
> The numbers may be very close together if wave height is small. Best results are had with large wave heights. A possible example would be:



3. Does your diagram reflect what you answered in #2?

> T3. The diagram should show vertical movement of the mark.

Water moves in a different way than the rope does when a wave passes. Water in a wave moves in a nearly circular motion. It ends up near the point where it started after the wave passes by. See the diagram. Notice that water waves extend below the surface. The bigger the wave, the farther down its motion extends.



Actual movement of water in a wave

ACTIVITY C: WHY DO BREAKERS FORM?

KEYWORDS: **Spilling breakers, plunging breakers**

MATERIALS: Stream table, fan, blocks of wood, clay, screening.

PROCEDURE

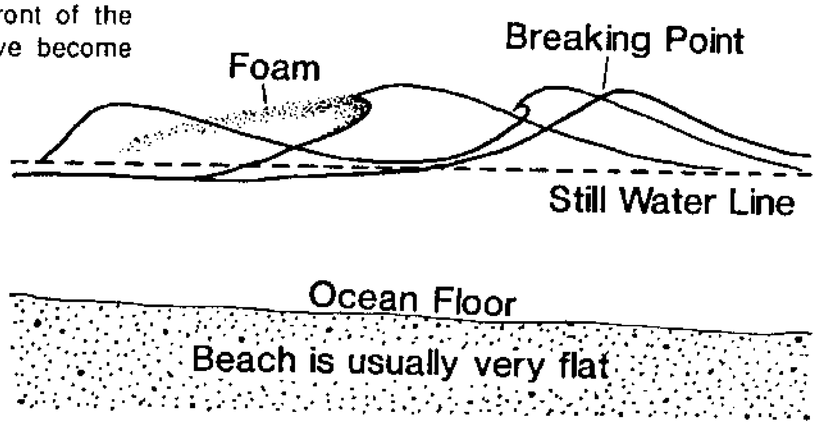
You may want to show the film "Moods of Surfing" (1[illegible] minutes) as an introduction to this activity.

Have you seen people surfing? Have you watched waves breaking along a beach? As waves move into shallow water near shore, they "feel bottom" as the water depth decreases. This slows the wave and increases the wave height, making the wave unstable. When the water depth is about 4/3 of the wave height, the top of the wave falls over, or breaks. Water then rolls down the front of the wave and crashes. These waves have become **breakers**.

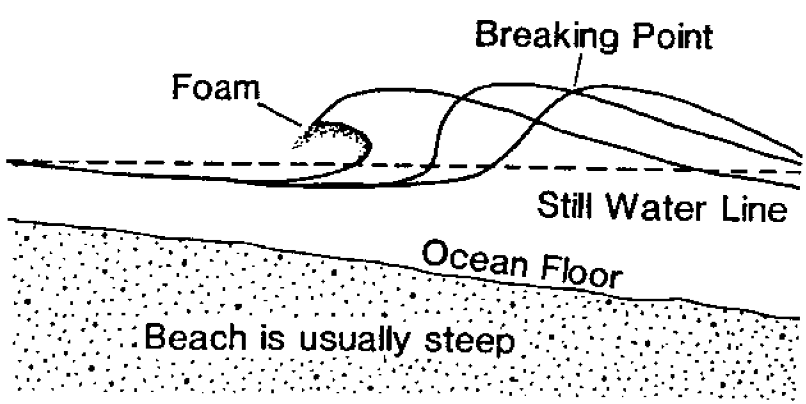
1. If six-foot waves were approaching shore, how deep would the water be where they became breakers?

T1. The water is 4/3 X 6 = 8 feet deep.

Along a shore with a gentle slope, the waves will break far from shore. These are called **spilling breakers**. They are the kind of waves that surfers look for. See the diagram below.



Along a shore where the bottom rises very steeply, the waves break close to shore and crash violently against the shore. These are called **plunging breakers**. See the diagram below.



2. Why do you think surfers do not try to ride these kinds of waves?

T2. It would be a very short, violent ride. The surfer could get hurt or killed.

3. Would you expect to find large breakers on a small lake or pond? Why or why not?

T3. No. Since small lakes or ponds do not have a long enough fetch for large waves to form, so large breakers could not be produced.

4. Would you expect to find large breakers on a large body of water such as Lake Erie or the ocean? Why or why not?

T4. Yes. Large bodies of water have a long enough fetch and strong, steady winds blowing over them to produce large waves.

Breakers release a lot of energy when they crash against the shore. This energy does work. The waves loosen rocks and sediments along the shore and then move them. If too much material is moved, there is an erosion problem along the shoreline. There are severe erosion effects along Lake Erie's shoreline. Most of the problems have been caused by storms.

5. Why would storms on the lake create an erosion problem?

T5. Storms cause large waves, which produce large breakers. These move more sediment than is normally moved.

Waves can also cause serious problems in harbors by smashing boats against docks or the shore and making it difficult to steer boats.

Your teacher will provide a stream table with water and a fan to create waves. A variety of construction materials will also be available.

6. At one end of the stream table, make some structures that would reduce the problem of waves in a harbor. Draw a diagram of the structures you created.

T6. Structures will vary. Discuss the reasons for using different structures with your students.

7. How effective were your structures in reducing the waves entering your harbor?

T7. Answers will vary based on student observations. Discuss the results with your students.

Researchers working for Ohio Sea Grant have investigated the use of old tires in protecting harbors from waves. When first installed, they seemed to be quite effective.

8. Can you think of any reasons why a floating tire breakwall might lose its effectiveness against waves?

T8. Answers will vary. The floating tire breakwall could break away from its moorings.

You have seen that waves have a great deal of energy. They can erode cliffs, destroy docks, and ruin boats. Couldn't this energy be harnessed in some way to help solve world energy problems? The North Sea is very rough because of almost constant high winds. Scientists in Great Britain believe that it would be possible to harness this energy to produce electricity.

9. How do you think this could be done?

T9. Answers will vary. The countries that have explored this possibility have mainly been concerned with using the up and down motion of waves in deep water to operate a generator.

In these activities, you have learned how waves are formed and how they move. You have seen how the energy in waves affects the shoreline and experimented with ways to protect harbors. Waves can benefit people by providing fun for surfers or a possible source of electricity. Waves can also cause harm by damaging property or eroding shorelines if their energy is not controlled. By studying about waves, people can learn to use the energy in waves and to minimize their harmful effects.

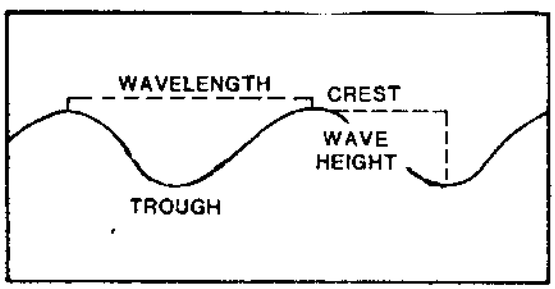
REVIEW QUESTIONS

1. What is the most common cause of waves on water?

R1. Wind is the most common cause of waves on water.

2. Label the crest, trough, wavelength and wave height on the diagram below.

R2.



3. What are the three factors that determine wave height?

R3. The three factors that determine wave height are the length of time the wind has been blowing, the fetch (the distance wind blows over open water), and the wind speed.

4. When do whitecaps form?

R4. Whitecaps form when the wave height increases faster than the wavelength.

5. What type of motion does water in a wave have?

R5. Water in a wave has a circular motion.

6. Where do spilling breakers form?

R6. Spilling breakers form where the bottom slopes gently to the shore.

7. Where do plunging breakers form?

R7. Plunging breakers form where the bottom rises very steeply to the shore.

8. What effects do breakers have on the shoreline?

R8. Breakers move sediments along the shoreline. Large breakers can cause serious erosion problems.

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Carter, Charles, William Neal, William Haras, and Orrin H. Pilkey, Jr. Living with the Lake Erie Shore. Duke University Press, 1987. 263 pp.

Eichenlaub, Val. Weather and Climate of the Great Lakes Region. University of Notre Dame Press, 1979. 335 pp.

EVALUATION ITEMS

1. What is the most common cause of waves on water?
   a. earth movements
   b. boats on the water
   • c. wind on the water
   d. fish jumping out of the water

2. The distance from one wave crest to the next is called the
   a. trough
   • b. wavelenghth
   c. period
   d. fetch

3. Factors that influence wave height are:
   a. the length of time the wind has been blowing
   b. the speed of the wind
   c. the distance the wind blows across open water
   • d. all of the above
   e. none of the above.

4. The water in a wave moves
   a. up and down when the wave passes.
   b. back and forth when the wave passes.
   • c. in a nearly circular motion when the wave passes.
   d. forward with the wave as it passes, until it hits land.

5. When the bottom rises steeply, waves break violently close to shore. These waves are called
   a. bottom breakers.
   • b. plunging breakers.
   c. spilling breakers.
   d. the surf.

6. The waves surfers like to ride are called
   a. bottom breakers.
   b. plunging breakers.
   c. the surf.
   • d. spilling breakers.

7. The maximum height for a stable wave is
   • a. 1/7 of its wavelength.
   b. 4/3 of its wavelength.
   c. 3/4 of its wavelength.
   d. 1/2 of its wavelength.

8. What happens when the wave height increases faster than the wavelength?
   a. The crest of the wave increases.
   b. The wave crest becomes unstable.
   c. Whitecaps are formed.
   d. a and b
   • e. b and c

9. The highest waves would form when
   a. the fetch of the wave is shorter.
   • b. the fetch of the wave is longer.
   c. the trough of the wave is deeper.
   d. the trough of the wave is shallower.

Other titles of Oceanic Education Activities for Great Lakes Schools

for middle schools:

The Effect of the Great Lakes on Temperature
The Effect of the Great Lakes on Climate
Ancient Lake Shores
How to Protect a River
Changing Lake Levels on the Great Lakes
Erosion Along the Great Lakes
Coastal Processes and Erosion
Pollution in Lake Erie: An Introduction
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Getting to Know Your Local Fish
Shipping: The World Connection
We Have Met the Enemy
It's Everyone's Sea: Or Is It?
PCBs in Fish: A Problem?
A Great Lake Vacation
Storm Surge
River Trek

for primary grades:

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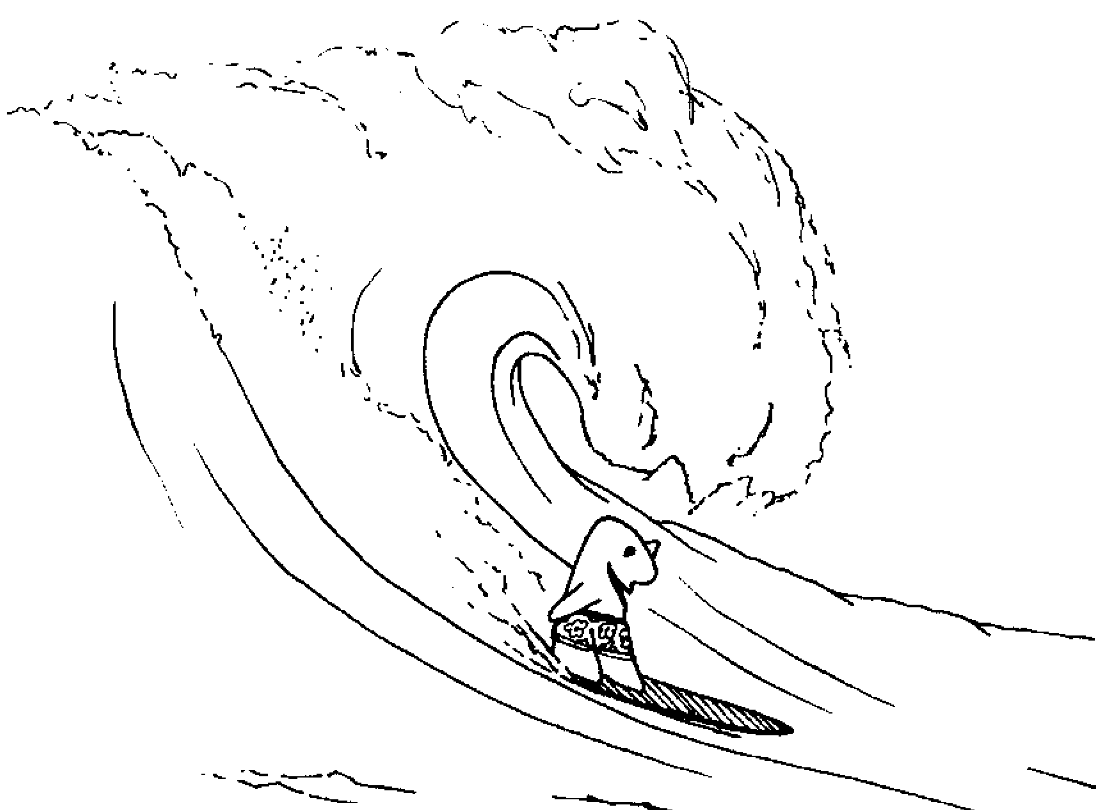

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INTRODUCTION

You may have seen water waves sometime in your life. You might have seen them in your bathtub, in a lake or pond near your home, or maybe on a visit to one of the Great Lakes. Have you ever sat on a beach and watched the waves? You might have noticed that they come in different sizes. Some days the waves are perfect to swim in or surf on. Other days the waves are so big that they could hurt you or even damage docks and buildings along the shore. There are some places on Lake Erie and Lake Michigan where houses have been destroyed by waves that were produced during severe storms.

Did you ever wonder where waves come from, or why some are big and others small? This activity will help you answer these and other questions about waves.

OBJECTIVES

When you have completed these activities, you will be able to:

1. Describe how waves form on water.

2. Label a drawing of waves showing the crest, trough, wavelength, and wave height.

3. Describe the three factors that determine wave height.

4. Describe how whitecaps form.

5. Describe the motion of water in and below a wave.

6. Describe how breakers form.

7. Describe the difference between spilling and plunging breakers.

8. Describe the effects breakers have on the shoreline.

ACTIVITY A: WHAT CAUSES WAVES ON WATER?

MATERIALS: Stream table filled with water, electric fan.

PROCEDURE

Record all answers on your answer sheet. Answer the first two questions based on your personal observations. Then watch the demonstration of how waves form on water and what influences the size of waves.

1. Name some things you have seen that cause waves to form.
2. Which of these causes do you think is most common?

Your teacher will turn the fan on at a low to medium speed. Answer the following questions based on your observation of the demonstration.

3. What happened to the surface of the water when the wind from the fan started to blow over it?
4. Draw a picture of several waves in the space provided on your answer sheet.
5. The high point of a wave is called the **crest**. Label the crest of a wave on your drawing.
6. The low point of a wave is called the **trough**. Label the trough of a wave on your drawing.
7. The distance from one wave crest to the next is called the **wavelength**. Label the wavelength on your drawing. Look at the stream table and compare the wavelengths at a point close to the fan and at a point farther away.
8. The vertical (up and down) distance between a crest and a trough is called the **wave height**. Label the wave height on your drawing. Compare the wave heights at a point close to the fan and at a point farther away.
9. The time it takes for two wave crests in a row to pass a fixed point is called the **period** of the wave. Is the wave period longer at a point close to the fan or at a point farther away?

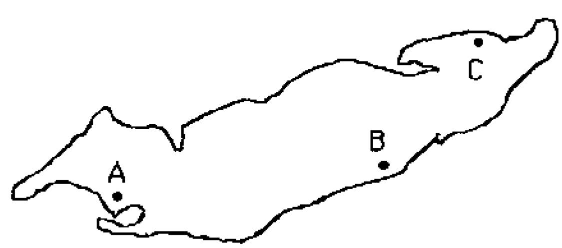
Your teacher will now turn up the fan to a high speed. Observe what happens.

10. What happened after the fan was turned up to the higher speed?

Your teacher will now move the fan so that it is blowing across the width of the stream table, instead of along the length of it. Answer the following questions based on your observations.

11. After the fan was moved, were the waves as big as before? Why?
12. Steady winds blowing over water for a long time help to produce large waves. From your observations, what are two other factors that influence wave height?

The size of the wave is partly a result of the distance the wind has been blowing across the surface of the water. This distance is called the **fetch** of the wave. As the fetch gets longer, the wave height increases.



13. Examine the map of Lake Erie above. If the wind was coming from the northeast, which point on the map would have the highest waves? Why?
14. If the wind was coming from the west, which point would have the highest waves? Why?

Because of the fetch of winds coming from the northeast, Marblehead Peninsula can have differences in water level as much as 9 feet above average lake level.

Use the following information to answer the next two questions.

As you observed earlier, when wave height increases, the wavelength also increases. The maximum height for a stable wave is 1/7 of its wavelength. With a wavelength of 7 feet, a stable wave could be as high as one foot. A wave having a wavelength of 14 feet could be 2 feet high and still be stable, and so on. A wave over 100 feet high was once seen on the Pacific Ocean.

15. What wavelength would support a stable wave 100 feet high?

If winds are blowing so hard that the wave height increases faster than the wavelength, the crest of the wave will become unstable. This means that the crest will fall over because the wave is too steep. Foam on the crest and **whitecaps** are created. See the diagram below.

16. What do you think the foam on whitecaps is made of?

The Wave (Albert Bierstadt, 1887)

ACTIVITY B: HOW DO WAVES MOVE ON WATER?

MATERIALS: Length of rope (about 3 meters); optional: video camera, tape and monitor

PROCEDURE

Your teacher will demonstrate how waves travel along a rope. Waves move on a rope much like they move on water. As your teacher produces waves on the rope, look for crests and troughs. Look for wavelength and wave height.

With colored tape or a wide marker, make a mark near the middle of the rope. As waves are demonstrated, note how the mark moves.

1. Which moves forward, the rope or the wave?

2. Water waves are similar in that the wave moves forward, but not the water. How is the rope moving when a wave passes?

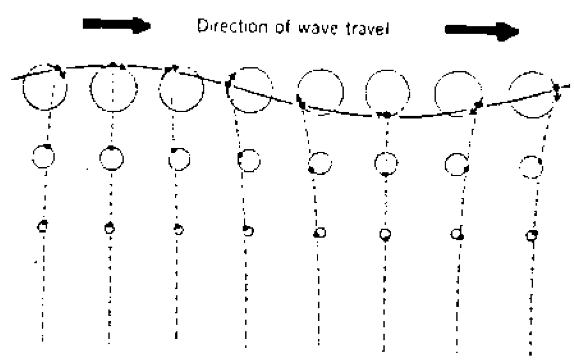
If the equipment is available, make a short videotape of the waves made with the marked rope. Tape several different periods and heights of waves, keeping each type going for about a minute. As you play back the tape, pause the player at intervals so that you can measure the wave heights, wavelengths and periods of waves and record data on your answer sheet. Can you confirm that there is a relationship between wavelength and wave height?

In the space marked on your answer sheet, diagram the movement of the mark on the rope. Stop the tape at any point and measure the distance to the mark from the top of the screen and from the left side. Put a 1 on your answer sheet in the spot that matches these coordinates.

Play a few more frames of the tape and pause again. Remeasure to the mark and put a 2 in the new position on the answer sheet. Continue numbering new positions until you have tracked the mark through a complete wave cycle (crest to trough to crest).

3. Does your diagram reflect what you answered in #2?

Water moves in a different way than the rope does when a wave passes. Water in a wave moves in a nearly circular motion. It ends up near the point where it started after the wave passes by. See the diagram. Notice that water waves extend below the surface. The bigger the wave, the farther down its motion extends.



Actual movement of water in a wave

ACTIVITY C: WHY DO BREAKERS FORM?

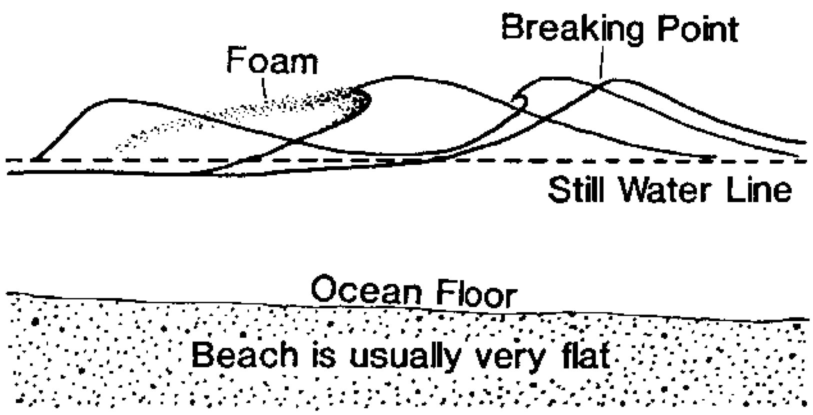
MATERIALS: Stream table, fan, blocks of wood, clay, screening.

PROCEDURE

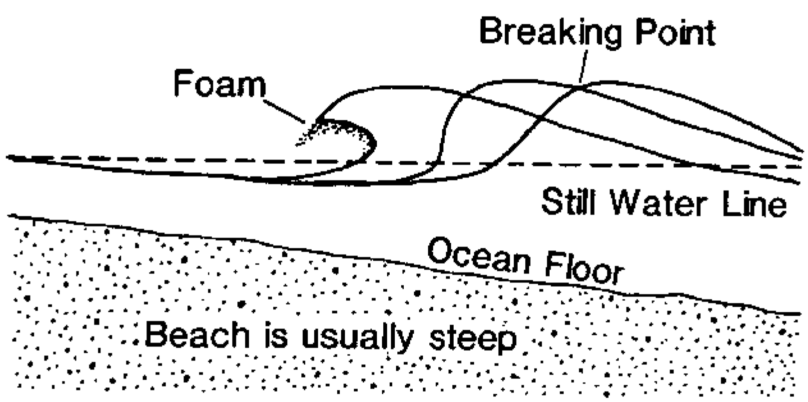
Have you seen people surfing? Have you watched waves breaking along a beach? As waves move into shallow water near shore, they "feel bottom" as the water depth decreases. This slows the wave and increases the wave height, making the wave unstable. When the water depth is about 4/3 of the wave height, the top of the wave falls over, or breaks. Water then rolls down the front of the wave and crashes. These waves have become **breakers**.

1. If six-foot waves were approaching shore, how deep would the water be where they became breakers?

Along a shore with a gentle slope, the waves will break far from shore. These are called **spilling breakers**. They are the kind of waves that surfers look for. See the diagram below.



Along a shore where the bottom rises very steeply, the waves break close to shore and crash violently against the shore. These are called **plunging breakers.** See the diagram below.



2. Why do you think surfers do not try to ride these kinds of waves?

3. Would you expect to find large breakers on a small lake or pond? Why or why not?

4. Would you expect to find large breakers on a large body of water such as Lake Erie or the ocean? Why or why not?

Breakers release a lot of energy when they crash against the shore. This energy does work. The waves loosen rocks and sediments along the shore and then move them. If too much material is moved, there is an erosion problem along the shoreline. There are severe erosion effects along Lake Erie's shoreline. Most of the problems have been caused by storms.

5. Why would storms on the lake create an erosion problem?

Waves can also cause serious problems in harbors by smashing boats against docks or the shore and making it difficult to steer boats.

Your teacher will provide a stream table with water and a fan to create waves. A variety of construction materials will also be available.

6. At one end of the stream table, make some structures that would reduce the problem of waves in a harbor. Draw a diagram of the structures you created.

7. How effective were your structures in reducing the waves entering your harbor?

Researchers working for Ohio Sea Grant have investigated the use of old tires in protecting harbors from waves. When first installed, they seemed to be quite effective.

8. Can you think of any reasons why a floating tire breakwall might lose its effectiveness against waves?

You have seen that waves have a great deal of energy. They can erode cliffs, destroy docks, and ruin boats. Couldn't this energy be harnessed in some way to help solve world energy problems? The North Sea is very rough because of almost constant high winds. Scientists in Great Britain believe that it would be possible to harness this energy to produce electricity.

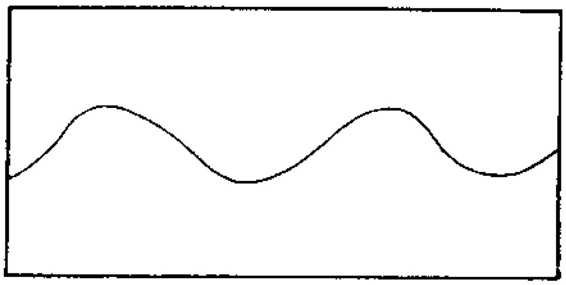
9. How do you think this could be done?

In these activities, you have learned how waves are formed and how they move. You have seen how the energy in waves affects the shoreline and experimented with ways to protect harbors. Waves can benefit people by providing fun for surfers or a possible source of electricity for Great Britain. Waves can also cause harm by damaging property or eroding shorelines if their energy is not controlled. By studying about waves, people can learn to use the energy in waves and to minimize their harmful effects.

REVIEW QUESTIONS

1. What is the most common cause of waves on water?

2. Label the crest, trough, wavelength and wave height on the diagram below.



3. What are the three factors that determine wave height?

4. When do whitecaps form?

5. What type of motion does water in a wave have?

6. How do spilling breakers form?

7. How do plunging breakers form?

8. What effects do breakers have on the shoreline?

NAME: ______________________________

WAVES ON LAKE ERIE
ANSWER SHEET

ACTIVITY A: What causes waves on water?

1. Name some things you have seen that cause waves to form. ______________________________

2. Which of these causes do think is most common? ______________________________

3. What happened to the surface of the water when the wind from the fan started to blow over it? ________

____

4. Draw a picture of several waves in the space below.

5. Label the crest of the wave on your drawing.

6. Label the trough of the wave on your drawing.

7. Label the wavelength on your drawing.

8. Label the wave height on your drawing.

9. Is the wave period longer at a point close to the fan or at a point farther away? ______________

____

10. What happened after the fan was turned up to the higher speed? ______________________

____

11. After the fan was moved, were the waves as big as before? _______ Why? ______________

____

12. From your observations, what are two factors that influence wave height? ______________

____

13. If the wind was coming from the northeast, which point would have the highest waves? ____________

Why? ____

14. If the wind was coming from the west, which point would have the highest waves? ____________

Why? ____

15. What wavelength would support a stable wave 100 feet high? Show your work. ____________

16. What do you think the foam on whitecaps is made of? ________________________

ACTIVITY B: How do waves move on water?

1. Which moves forward, the rope or the wave? ________________________

2. How is the rope moving when a wave passes? ________________________

Period	Wave Height$_1$	Wave-Length$_1$	Wave Height$_2$	Wave-Length$_2$	Wave Height$_3$	Wave-Length$_3$	Average Height	Average Length

As you measure the position of the mark on the screen, record that position in the diagram below.

3. Does your diagram reflect what you answered in #2? ___________

ACTIVITY C: Why do breakers form?

1. If six-foot waves were approaching shore, how deep would the water be where they became breakers?
   Show your work. ____________________

2. Why do you think surfers do not try to ride plunging breakers? ____________________
   ____

3. Would you expect to find large breakers on a small lake or pond? _______ Why? ____________
   ____

4. Would you expect to find large breakers on a large body of water such as Lake Erie or the ocean? _____
   Why? ____

5. Why would storms on the lake create an erosion problem? ____________________
   ____

6. Draw a diagram of the structures you created in the space below.

7. How effective were your structures in reducing the waves that came into the harbor? ___________
   ____

8. Can you think of any reasons why a floating tire breakwall might lose its effectiveness?

____

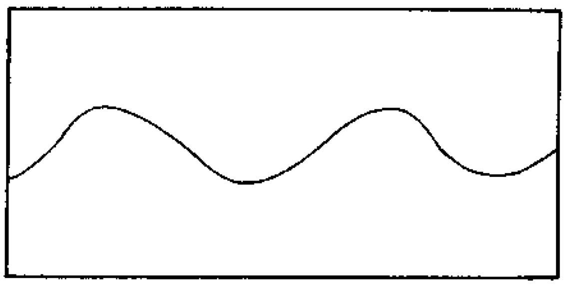
9. How do you think people could use wave energy to produce electricity? ______________

____

Review Questions

1. What is the most common cause of waves on water? ______________

2. Label the crest, trough, wavelength and wave height on the diagram below.



3. What are the three factors that determine wave height? ______________

____

4. When do whitecaps form? ______________

5. What type of motion does water in a wave have? ______________

6. How do spilling breakers form? ______________

7. How do plunging breakers form? ______________

8. What effects do breakers have on the shoreline? ______________

____