OREGON MARINE SCIENTIST AND EDUCATOR ALLIANCE

Waves Lab Worksheet

Tides, Waves, and Floods

Part 1. Ocean Wave Characteristics

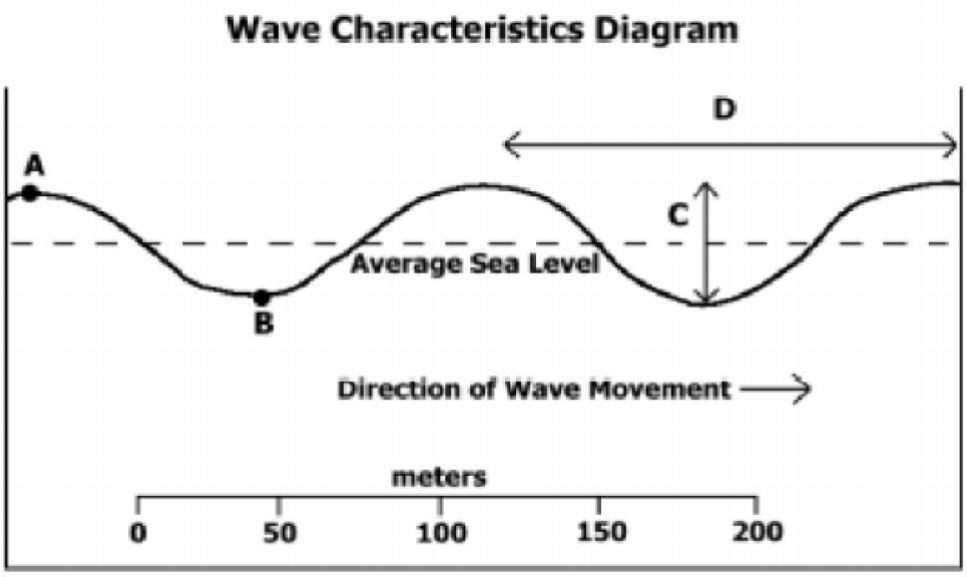


Figure 1. Wave Characteristics diagram. Credit: NASA

Let's start by describing a wave. Ocean waves have characteristics that we can measure to describe them.

1. Indicate the correct wave characteristic for each letter in the figure above.
   You can choose from: wavelength, wave height, wave crest, and wave trough.

   A.

   B.

   C.

   D.

Part 2. Wind waves

Waves traveling in water deeper than one-half their wavelength are called **deep water waves**. Waves traveling in water shallower than one-twentieth of their wavelength are called **shallow-water waves**. Shallow-water waves interact with the ocean floor. As waves enter shallow water their speed and wavelength decrease, but their height increases.

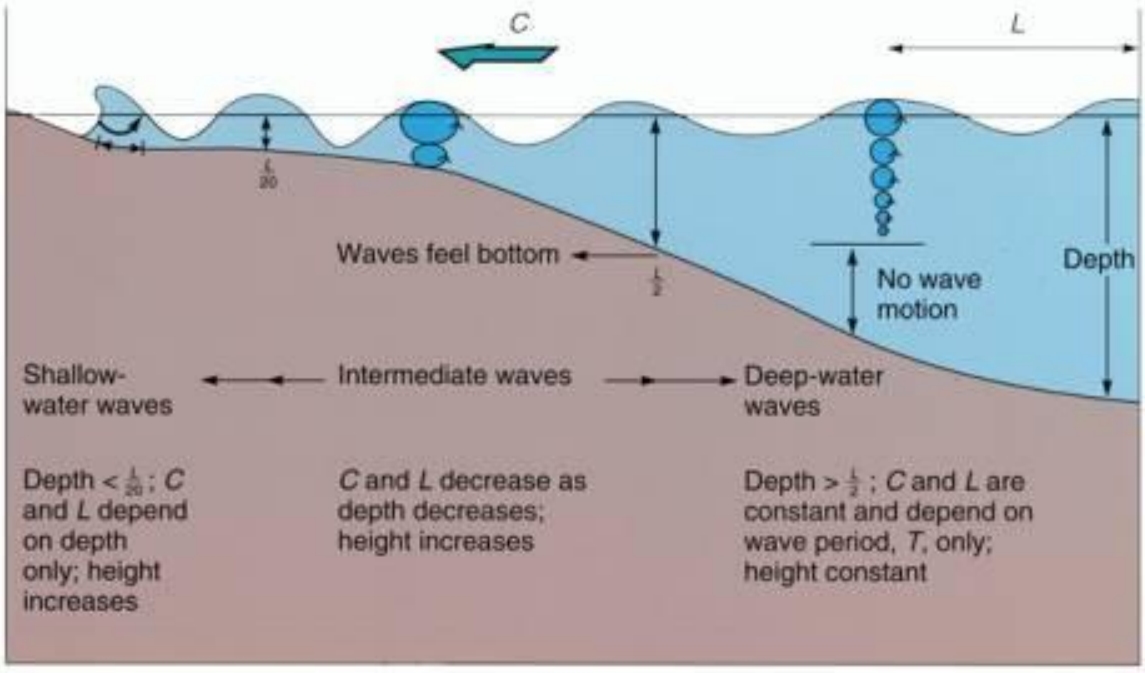


Figure 2. Shallow- and deep-water wave characteristics. Credit: marine.maine.edu

Waves are generated by a disturbing force. Let's consider a wave produced by wind (a disturbing force).

1. Using the scale at the bottom of Figure 1, measure the wavelength of the wind-generated wave in Figure 1 and record it below.

   Wavelength = _____ meters

2. Ocean waves are also characterized by wave period. This is the time it takes for two successive crests (or one wavelength) to pass a fixed point. On the ocean it is usually easier and more accurate to record how long it takes ten waves to pass and then divide by ten to obtain the average period. If it takes 130 seconds for 10 of the above wind-generated waves to pass, determine the period and record it below.

   Period = _____ seconds

3. Ocean waves are also characterized by their speed. This can be summarized in the following equation:

   Where C = speed (celerity)
   L = wavelength (meters)
   T = period (in seconds)

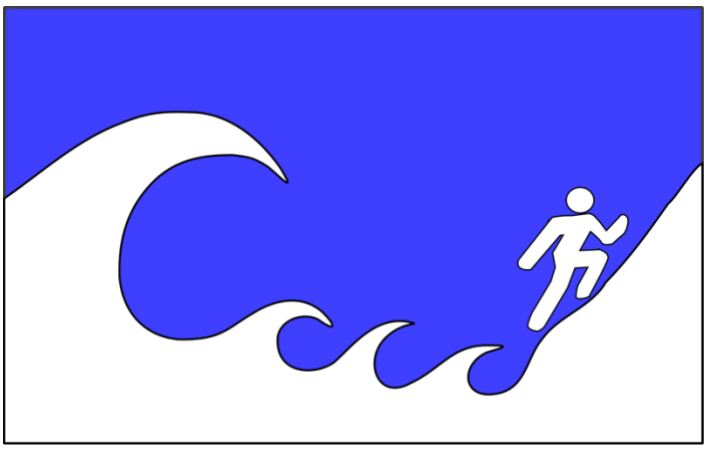
   Record the wave speed of this hypothetical wind wave below and show your work for credit.
   Show work here:

   Speed = _____ (m/s)

4. The average depth of the world's ocean basins is about 4300 m. Is this wind wave a shallow-water wave or a deep-water wave? Your answer should include a calculation to support your answer.

Part 3. Tsunamis, Tides, and speeds of shallow-water waves

Giant waves can be caused by storm surges. One type of giant wave mistakenly referred to as a tidal wave is created by seismic activity under or near the ocean. These waves actually have nothing to do with tides. Scientists use the Japanese word, tsunami (the "t" is pronounced the same as the "ts" in "lets"), for these large waves caused by underwater earthquakes and volcanoes. Tsunamis contain a tremendous amount of energy. As they approach the shore (shallow water), they grow in height (sometimes 30m) causing great destruction and loss of life.



1. Tsunami waves typically have wavelengths up to 200 km (125 miles). Tsunami waves are considered shallow-water waves. Why are tsunami considered shallow-water waves? (HINT: the deepest oceanic trenches are 11 km deep). Use a calculation to support your answer.

2. How are tsunamis different from other waves?

3. How are tsunamis generated? List as many possible mechanisms as you can.

On December 26, 2004, scientists at the Pacific Tsunami Warning Center learned of the speed of the Indonesian tsunami and tracked it as it moved across the Indian Ocean. They were able to notify East African officials of the impending disaster. In this activity, you will calculate the approximate speed of a tsunami and create a time travel map and chart that shows their arrival at specific geographic locations.

<u>Procedure</u>

a. Below you are given a hypothetical tsunami situation. Begin by reading through the scenario.
b. Apply formulas to determine the approximate speed of the tsunami and the time it takes to reach each location. TO RECEIVE CREDIT, NEATLY SHOW ALL OF YOUR WORK ON ANOTHER SHEET OF PAPER, AND ATTACH IT TO YOUR LAB BEFORE TURNING IT IN.
c. For each scenario, write down the order in which the tsunami will strike each location.

Wave Speed Formula

Because a tsunami is considered a shallow-water wave, the equation to calculate its speed is a little different than a deep-water wave.

g (acceleration due to gravity) = 9.81 m/s^2
d = water depth in meters

Your speed calculation initially will be in meters/second. Convert meters/second to kilometers/hour using the following formulas:

1 hour = 60 minutes = 3,600 seconds

1 kilometer = 1,000 meters

Round your final answer to the nearest whole number.

Travel Times Calculation

Calculate travel times by dividing distance by tsunami speed. Remember to convert the decimal part of the number to minutes by multiplying the decimal part by 60. For example, one point four (1.4) hours equals 1 hour and 24 minutes.

The Scenario

Seismologists have just registered an earthquake in Seward, Alaska, that is big enough to produce a tsunami. The ocean depth is 4,000 meters. Use the wave speed formula to approximate the tsunami's speed and calculate the travel time to each location.

* Kodiak, Alaska	279	km from Seward
* Kauai Island, Hawaii	4,325	km from Seward
* Kwajalein, Marshall Islands	6, 712	km from Seward

Part 4. Tides

Considering only the lunar tide, make a diagram in the space below that indicates the moon and the Earth and indicate the two tidal bulges that will be formed on the Earth from the gravitational pull of the moon and the inertial force caused by the Earth and moon rotation.

1. The Earth has a circumference of 40, 075 km at the equator.
   What is the wavelength for the wave that is being produced by the lunar influence? Explain.

   Draw a diagram of the wave and show how someone at point A on Earth would see the crests of the wave pass by during one day.

2. What is the period of this wave? Explain.

3. Are tides considered shallow water or deep water waves? Explain.

4. If the average depth of the ocean is 4300 m, how fast should this wave be traveling using our speed calculation for shallow water waves? Show calculations.

5. Is this the correct speed of this wave? Why or why not? Show calculations and explanations on a separate sheet.

6. If this is not the correct speed of the tidal wave, calculate the actual speed of a tidal wave. (Show your calculations)