

Surfing the Waves Activity Sheet

Name: Teacher Guide

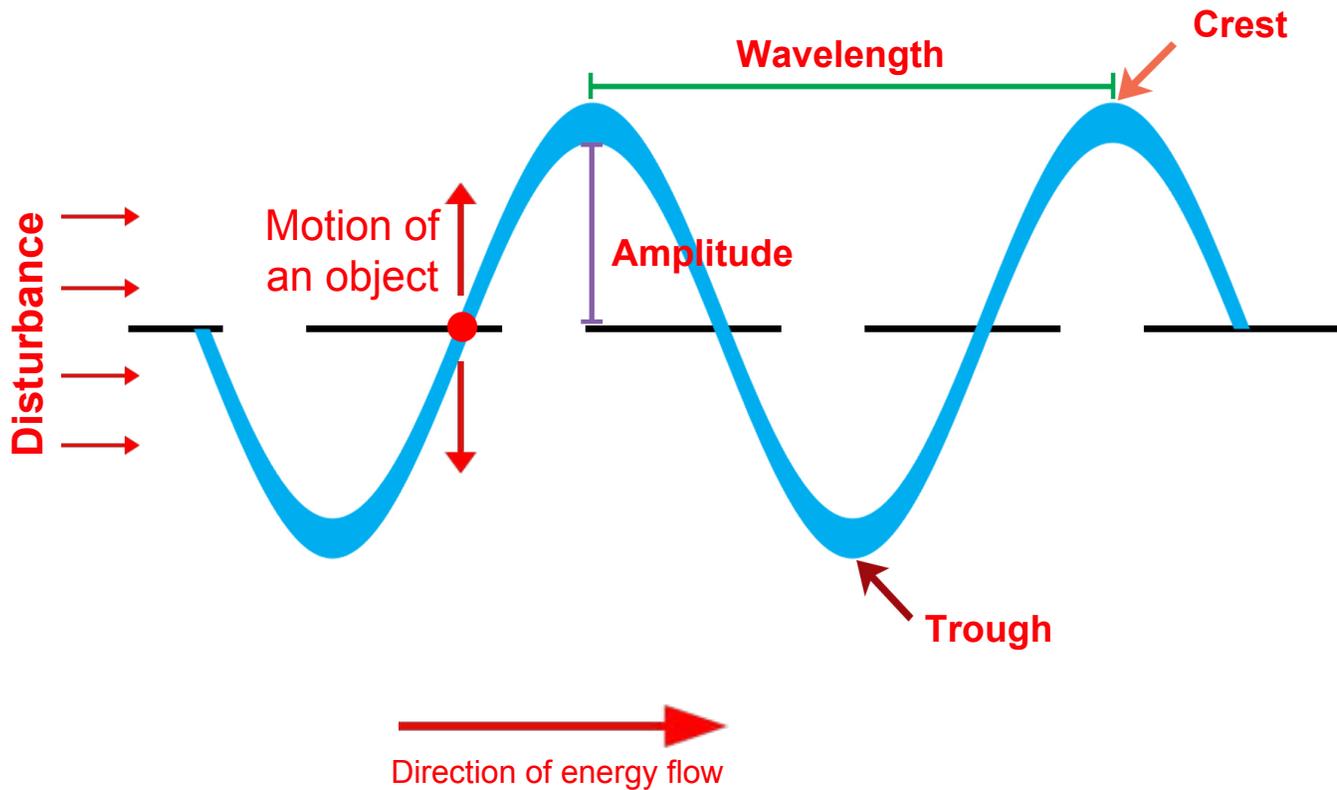
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Part A: Make Rope Waves

1. Gather your materials to make rope waves!
 - a. Tape, long rope or extension cord (about 12 feet of each).
2. Tape a long straight line on the floor to represent the rope without movement. This tape line should be about the same length as your wave model rope (about 12 feet).
(Note: You can tape it as a dotted line to conserve tape.)
3. Line up your rope or extension cord on the taped line and have one person sit at each end.
4. Place a piece of tape around the rope (at about the half-way mark). The tape represents a single particle.
5. Have one person hold their end still, while the other person moves their hand side to side, **against the ground**, to make waves.
6. Practice making waves:
 - a. Take turns making waves from either side!
 - b. Try moving the rope faster. Then, try moving the rope slower.
 - c. Try moving your arm in wider strokes on the ground. Then, try moving the rope in narrower strokes on the ground.
7. Use your best practice technique to make a wave with your rope. Stop the motion so that the rope stays in its wave shape.
8. Describe the shape of the wave. Write or draw your observations.

Students should be able to describe the S-shape of the rope/cord. Some might draw the shape of it or report that the wave kind of looks like a snake slithering along the ground!
9. Label your wave diagram on page 2.



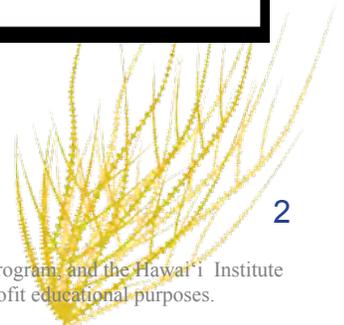


Label your wave diagram with the vocabulary below:

- Crest:** the top of the wave
- Trough:** the bottom of the wave
- Amplitude:** The distance from crest of the wave to the still-water level. Some people refer to amplitude as "from crest to rest."
- Wavelength:** the distance from one wave crest to the next.

Draw your own arrows to represent:

- Where the **disturbance** occurred to make waves (i.e. which side of your rope did you move).
- The direction of **energy flow** from that disturbance.
- The **direction of the motion of an object** (represented by the red dot).



Part B. Make Water Waves

Answers will vary. Suggested ideas to look for are presented here.



1. Before building your wave tank model to explore ocean waves, think about the last time you were at the beach (or watch waves from an internet beach camera) and answer these questions:
 - a. What did the waves look like? Describe. I watched waves on the South shore. There were waves rolling like small hills toward the beach. Some of the waves would break farther out than others. Some would not break until they reached the shore. I also saw waves going sideways to the beach. Some of these made small whitecaps as they passed by.
 - b. How big were the waves?

The waves were about waist high to head high when the surfers caught and rode them. Based on the size of a person, I estimate this as 2-4 feet, from crest to trough, because the surfers were mostly shorter than 6 feet and they did not stand straight up.

 - i. What is the term that scientists use to describe wave height? Scientists use amplitude to describe wave height. Amplitude is the distance from crest to still water level. Since the surfers I watched stood up at the trough of the wave, the waves I observed had an amplitude of about 1-2 feet.
 - c. Were the waves close together or were they far apart?

The waves headed toward shore were fairly far apart—maybe like 20 to 30 feet or more. But, the small waves heading past the beach, in the deeper windier water, were closer together—more like 5-15 feet apart.

 - i. What is the term that scientists use to describe the distance between waves? Scientists use wavelength to describe the distance between waves. Wavelength is the distance from the crest of one wave to the crest of the next wave.
2. Now practice making waves in your wave tank!
3. Fill your wave tank about halfway with water. Make sure there isn't too much water that will spill over the sides!
4. Conduct your trials.

Trial #1: Blowing

- a. Using a straw, blow across the water. If you don't have a straw, you can use your breath.
- b. Describe what you see.

As I blow with my straw, I see wave sets forming and moving across the water.
- c. Play with making different waves by blowing in different directions or with varying strength.

As I blow harder, I see larger waves (higher height) and farther apart. The movement of the waves changes with the direction that I blow. The waves move away from where I am blowing—just like the wave energy moved away from the end of the rope as I moved my end up and down.



Trial #2: Tilting



- a. Gently lift one side of the bucket up a few inches and lower it back down to the table.
- b. Describe what you see.
As the bucket dropped back down the water sort of lagged behind, and then as it dropped, the water made a wave that moved across the bucket.
- c. Did your wave have a large or small amplitude compared to trial #1?
The wave was much higher, with a larger amplitude, compared to the wind-generated waves I made with my straw in trial #1.
- d. Did your wave have a long or short wavelength compared to trial #1?
The wave also had a longer wavelength. The wavelength stretched almost all the way across the bucket.
- e. Play around with making different waves and see if you can create repeating patterns in the wave energy. (*Hint: lift the bucket a little higher, or lift it twice in a row. Be careful not to spill water out of the bucket!*)

Trial #3: Add an object

- a. Add your floating object on one side of the bucket.
 - b. Make waves by blowing as you did in trial #1. Be sure not to blow directly on the object, but instead keep it directed at the water!
 - c. What happened to your object? How did it move?
It moved! It actually traveled across the bucket—in the direction of the energy flow!
 - d. Make waves by tilting, as you did in trial #2.
 - e. What happened to your object? How did it move?
This time, my object moved up and down, like the red mark on my rope wave. The object did not move a much in a forward direction.
 - f. See if you can get your object to move to the other side of the container.
Teacher tip: You might consider having students race their objects for fun!
5. Can you see the similarities in the waves you made with the rope with the waves in your wave tank?



Answers will. In our trials, the wind/straw waves and the bucket-drop waves seem to have the same type of S-shape as the rope waves, but the bucket-drop wave is easier to compare to the rope wave. This is because the crest and trough can be more clearly seen, since the wave is so big. Also, in the bucket-drop wave, there are really only one or two crests at a time in the bucket, and the large amplitude makes it easier to see the floating object going up and down (whereas in the wind waves, the object goes up and down but also travels more visibly across the bucket).





Activity Questions

Name: _____

1. Describe the general motion of the waves you created.
The waves moved up and down in an S, or snake-like way. They also moved away from their disturbance source (student hand, wind/straw, and dropping bucket).
2. How did the waves change in amplitude and wavelength when you:
 - a. Blew harder?
Stronger wind mean a larger disturbance. So, stronger wind tends to create larger waves, which are higher in amplitude and longer in wavelength.
 - b. Tilted the bucket higher?
The higher the bucket drop, the more energy in the disturbance, so there is a corresponding increase in wave height (amplitude) and wavelength.
3. What would be different if you had a longer tank?
A longer tank would prevent the wave energy from bouncing back so quickly. This would allow us to better see the wave crests and troughs of the larger waves created by dropping the bucket.
4. How were your waves similar to ocean waves breaking on the shore? How were they different?
Our waves were similar because they had the same general shape and they were made of water. Also, most waves that break on the shore, and that people surf, are caused by wind disturbance, like ours. The waves we made were different than waves because the waves in our bucket did not really break. That was partly because the bottom of our bucket is the same depth all the way across. Most waves break on the shore because the bottom gets shallower and starts interfering with the wave.
5. What happened to the floating object when you made waves?
The floating object moved up and down and also moved forward in the same direction as the wave energy.
6. Did your object catch and move forward on every wave you made? If not, in what directions did the object move on the waves it did not ride?
The floating object did not catch every wave. It had a harder time catching the big waves when we dropped the bucket. When it did not catch the wave, the object moved up and down.
7. How is the motion of your floating object similar and different from a surfer waiting to catch a wave in real life?
Our object was actually pretty similar to a surfer waiting to catch a wave. Sometimes a wave can catch a surfer that is not paddling (or a piece of wood, trash, or even a lost board), but most of the time, a surfer needs to paddle to get speed to catch a wave. If they do not paddle, the surfer will usually go up and down with the waves as the waves roll by. Also, we noticed that the object caught the smaller waves more easily than the large bucket-drop waves. This is also similar to surfers; generally, surfers need larger boards and more speed to catch bigger, faster moving waves.

