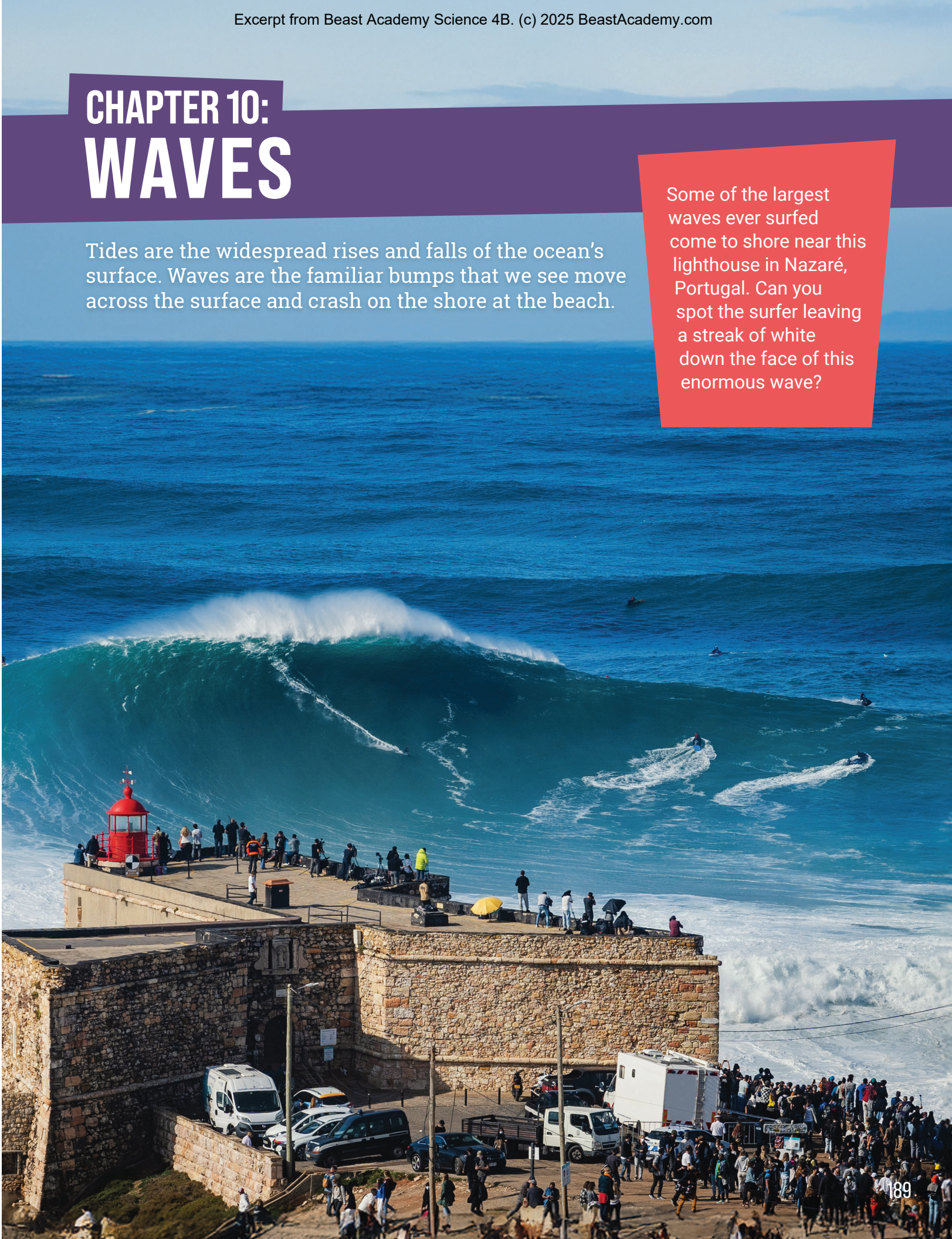
CHAPTER 10: WAVES

Tides are the widespread rises and falls of the ocean's surface. Waves are the familiar bumps that we see move across the surface and crash on the shore at the beach.

Some of the largest waves ever surfed come to shore near this lighthouse in Nazaré, Portugal. Can you spot the surfer leaving a streak of white down the face of this enormous wave?

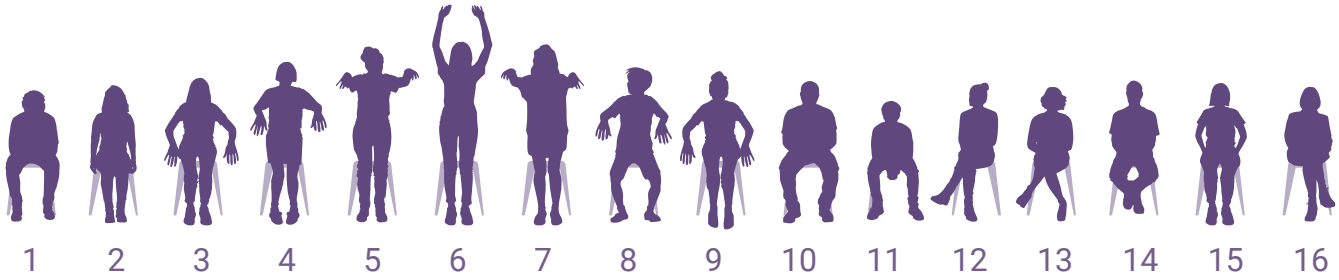


WAVES

If you have ever been to a beach, you probably had the chance to watch waves crash into the shore. To understand how waves work in the ocean, we'll examine some other waves you may have seen, starting with a human wave.

Fans at sporting events can create a human wave that moves around the stadium. When the wave reaches a section of seats, the fans stand and throw their arms in the air, then quickly sit as the fans in the next section stand to continue the wave.

With the right timing, even a small row of people can create a wave that travels from one end to the other.



1 In the wave created by the people above, person 9 is about to stand as the wave reaches them, person 6 is standing with their arms high in the middle of the wave, and person 3 is about to sit all the way down. Which way is the ***wave*** traveling?

- ○ Left to right ➡
- ○ Right to left ⬅
- ○ Up and down ↕

2 In the wave created by the people above, which way do the ***people*** move?

- ○ Left to right ➡
- ○ Right to left ⬅
- ○ Up and down ↕

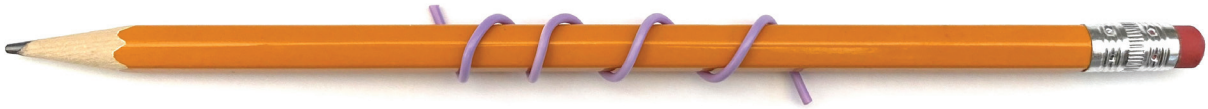
3 After the wave above has passed from one end to the other, where do all of the people end up compared to where they started?

- ○ In the same place
- ○ Farther to the right
- ○ Farther to the left

WAVE MOTION

There are lots of ways that waves and the materials they travel through can move, but the way material moves in a wave is not always as it appears.

Straighten out a paper clip then coil it around a pencil as shown below. Answer the questions that follow to help you see how a wave can travel one way while the material in the wave is actually doing something completely different.



4 Hold your pencil so that it looks like the one above. Slowly rotate it in the direction shown by the arrow on the right so that the paperclip also rotates. Which way do the diagonal lines of the paperclip appear to move?

○ Left to right ➡ ○ Right to left ⬅ ○ Neither

5 Hold your pencil so that it looks like the one above and slowly rotate it the opposite way. Which way do the diagonal lines of the paperclip appear to move?

○ Left to right ○ Right to left ○ Neither

6 Use a marker to draw a dot somewhere in the middle of the paperclip. How does the dot move as you rotate the pencil? In a straight line? Back and forth? Up and down? Around in circles? Describe the motion of the dot.

DISCUSSION:

7 Does the actual motion of the metal in the paperclip match how you see the diagonal line "waves" move as you rotate the pencil? Explain.

ROPE WAVES

We can demonstrate how different types of waves work using a rope.

MATERIALS

You will need:

- A rope that is at least one-eighth inch thick and 8 feet long
- Something to tie it to like the back of a sturdy chair or a doorknob

SETUP

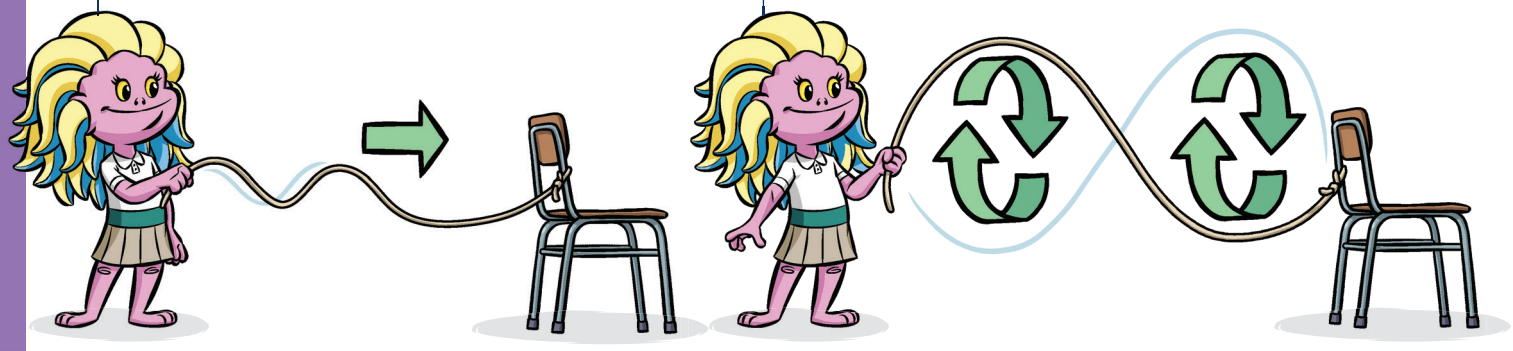
To perform the wave demonstrations on this page, you will need a clear space that is a few feet longer than your rope, preferably outdoors. Tie one end of a rope to something sturdy like a pole, doorknob, or the back of a heavy chair. Or, have a partner hold it while you hold the other end of the rope. Remove anything nearby that the rope could hit as you flick and swing it as described below.

TRAVELING WAVES

Flick the rope quickly and watch as a wave travels along the rope from your hand to the other end. This is called a traveling wave. Try lots of different flicks and watch how the wave travels along the rope.

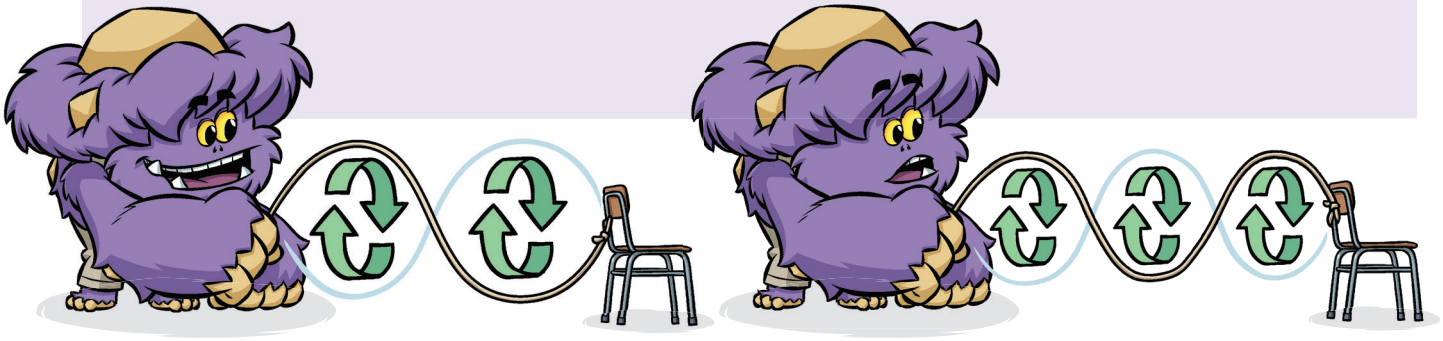
STANDING WAVES

Swing the rope in a circular motion like a jump rope, but faster. If you swing the rope at just the right speed, it will form two spinning halves as shown below. This is called a standing wave.



CHALLENGE:

8 If you swing the rope in a circular motion at just the right speed, you can create a standing wave like the one shown on the left. The point at the center of the rope that hardly moves is called a node. Try swinging the rope faster to create another node as shown on the right. Can you create even more nodes? How many can you get?

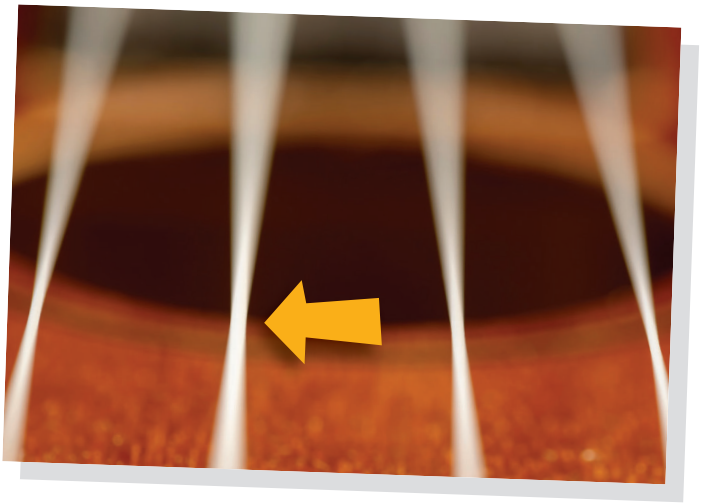


9 Put a piece of tape around the rope and watch how it moves as you move your hand up and down to send **traveling waves** along the rope. How does the tape move?

- Side to side
- Up and down
- Away from you

10 You can make traveling waves with the rope dangling loose, or with the rope pulled tighter so that the rope is nearly flat. How does the tightness of the rope affect the speed of the waves that travel along it?

11 This photo of vibrating guitar strings shows that parts of the strings are barely moving. Do these guitar strings have standing waves or traveling waves?



- Standing
- Traveling
- Both

We'll learn why different strings make different sounds in Chapter 12.