WAVES IN A BOTTLE

There aren't many places that are nicer to visit than the ocean. It's fun to play in the sand and splash in the water. Watching the waves roll in is calming and soothing. Have you ever wondered what processes are responsible for the movement of those ocean waves?

Waves are disturbances of the water surface that you can see in any water basin -- rivers, lakes, seas, and oceans. Waves are caused by **kinetic energy** (the energy an object has due to its motion) passing through the water, forcing the water to move in a circular motion. The water in those ocean waves really doesn't travel much at all since the only thing waves transmit across the ocean (or river or lake) is energy.

Playing in waves breaking on the beach

Surfers riding an ocean wave

There are different types of ocean waves created by different energy sources. **Surface waves** are the most common, caused by wind. As the wind blows, it transfers energy through **friction**, a force between two surfaces sliding across one another. The faster the wind and the longer it blows, or the farther it can blow uninterrupted, then the bigger the waves will be. Surface waves occur constantly all over the world, and those are the waves you see at the beach under normal conditions.

Severe weather or natural events like earthquakes and landslides produce larger and potentially dangerous types of waves. Powerful storms moving inland can create a **storm surge**, a long wave caused by high winds and low atmospheric air pressure. Underwater earthquakes and landslides can move large amounts of water very quickly. This creates a series of very long waves called **tsunamis**. Storm surges and tsunamis force sea levels to rise to great heights when they reach the shore, which can be extremely destructive to coastal areas.

Storm surge in Key West, Florida

Tsunami at a resort on the North Sea

As a wave passes through water, the surface water and a column of water below it follow the same movements. When the wave bottom reaches a shallow area, like the **surf zone** where wave water comes onto the beach, the lower section of the wave slows down and **compresses** (flattens or squeezes) forcing the wave's **crest** (top) higher into the air. Eventually this causes the wave to reach a breaking point, and the crest comes crashing down as wave energy is **dissipated** (scattered in different directions) into the surf zone.

We can't actually put an ocean into a bottle, but we can make a substitute using oil and water that will let you observe patterns similar to what you might see in ocean waves. You will have to use some energy, plus a little oil and water, to create your own waves!

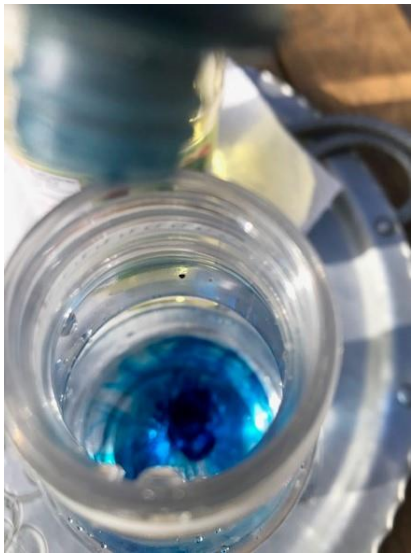
ACTIVITY: Combine oil and water together to make waves in a bottle

Materials

- water
- cooking oil (we used canola but any vegetable oil, or clear mineral oil, also works)
- blue food coloring
- An empty clear, plastic bottle plus cap, labels removed (soda or water bottle, shampoo bottle, mouthwash bottle, etc.)

1. Fill the bottle about half full with water.
2. Add a few drops of food coloring to the water inside the bottle.

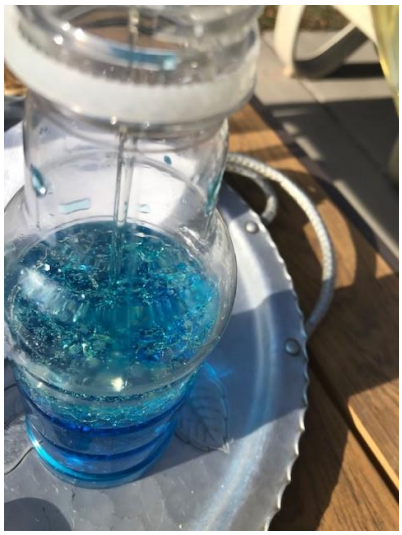
Step 1



Step 2

Step 2

3. Fill the rest of the bottle with oil. Fill it as full as possible, reducing the amount of airspace that will be left after you put the cap back on.



Step 3

Step 3

4. Screw the cap back on the bottle and shake it. The more you **agitate** (shake) the bottle, the more the bubbly the mixture becomes. Tilt it back and forth, and watch the waves crash into one another.
5. Set your bottle down occasionally to let the bubbles settle, and then start all over again.

Step 4

Step 5

What happened? The oil and water in your bottle didn't mix. Instead, they formed blobs and bubbles of liquid while you were shaking the bottle. Once you stopped shaking, the liquids settled into two separate layers. Oil floats on top of the ocean after a spill from an oil tanker. Motor oil leaks from a car and is visible as a colorful sheen on puddles in the street. Olive oil separates from and rests on top of your salad dressing at dinnertime. Even if you shake the bottle of dressing, the oil immediately separates as soon as it settles.

Why didn't the oil and water mix? Oil and water are **immiscible**, meaning they are incapable of being mixed or blended together. Oil molecules are attracted to other oil molecules so they stick together. The same goes for water molecules. They just can't mix. Oil always floats on top of water because oil is less **dense** (light in weight and its molecules aren't packed tightly together) than water.

ADDITIONAL RESOURCES

Materials from the Washoe County Library System:

Biomes: Coastlines and Seas [DVD videorecording] Discovery Channel School

The Blue Planet : [Blu-ray] Seas of Life BBC/Discovery Channel

How Many Fish in the Sea?: A Book About Oceans by Linda Tagliaferro

Liquids by Ben Morgan

My Life With the Wave by Octavio Paz; as retold for children by Catherine Cowan

The Next Wave: The Quest to Harness the Power of the Oceans by Elizabeth Rusch

Ocean [DVD videorecording] DK Publishing, Inc.

Ocean: A Visual Encyclopedia by John Woodward

Scholastic Atlas of Oceans by Scholastic Reference

Seymour Simon's Extreme Oceans by Seymour Simon

The Science of Energy by Mason Crest

Wave by Suzy Lee

Waves: From Surfing to Tsunami by Drew Kampion

Videos:

BBC Earth Lab, "Where Do Waves Come From? Earth Lab" https://youtu.be/Fkwkn7vXpWI

TED-Ed, "How Tsunamis Work - Alex Gendler" https://youtu.be/Wx9vPv-T51I

University of New South Wales, "How Do Waves Break?" https://youtu.be/aXuQC1qRuE

Websites:

National Geographic Kids, Ocean Habitat https://kids.nationalgeographic.com/explore/nature/habitats/ocean/

National Oceanic and Atmospheric Administration (NOAA), Ocean Exploration and Research, Ocean Exploration Facts https://oceanexplorer.noaa.gov/facts/facts.html

Smithsonian Institution, Ocean Initiative, Ocean: Find Your Blue, Currents, Waves, and Tides https://ocean.si.edu/planet-ocean/tides-currents/currents-waves-and-tides