Accelerometer Proximity

Water Oscillations

Overview

Waves are disturbances that transfer energy through a medium. In this lesson, you will explore how waves behave in water and how you can measure their properties such as height and frequency using databot.

Grades: Middle School
Time: 45 Minutes
Subject: Physical Science
Topics: Wave, Wave Frequency, Height, and Amplitude

Background

Water waves are a fascinating way to explore how energy moves through liquids. Waves are created when energy is transferred through water, causing it to move in a pattern. In water, waves are typically generated by wind, earthquakes, or other forces acting on the surface. They are characterized by several key properties:

- Wave Height: The vertical distance between the crest (highest point) and trough (lowest point) of the wave.
- Wavelength: The horizontal distance between two consecutive crests or troughs.
- Frequency: The number of waves that pass a given point in a specific time period.
- Period: The time it takes for one complete wave to pass a point.
- Amplitude: The maximum vertical displacement of the wave from its resting position, which reflects the wave's energy.

When waves travel across the surface of the water, the particles of water move in circular motions, creating a rolling effect. The size and behavior of waves depend on factors such as wind speed, the distance the wind travels over the water (fetch),the depth of the water, and even obstacles the water encounters along the way.

Understanding these properties helps scientists and engineers predict wave behavior, design structures to withstand wave forces, and study natural phenomena like tsunamis and tides.

What You Will Need/Prep

- Databot
- IOS/Android Smart Device
- Container with water
- Small weight for databot
- Paper sheet for measurement
- Install Vizeey™ on your Smart device.

- Test your databot™ connection.
- You will be prompted to select and connect to databot™ each time you launch an experiment.
- If there are two or more databot™'s listed, the one closest to your device will be highlighted.
- Study the background information and terms and prepare to explore!

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This hands-on experiment demonstrates fundamental principles of wave motion and how sensors can capture and analyze physical phenomena.

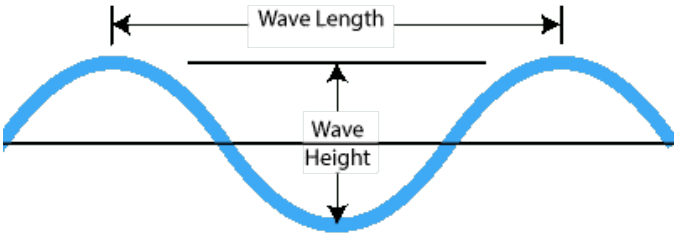
Learning Objectives

In this investigation you will master the following knowledge and skills:

- Use databot's sensors to measure and analyze wave motion.
- Observe and measure wave height and frequency.
- Compare data from different wave generation methods.
- Understand the relationship between wave height and energy.

Important Terms

- **Wave:** A disturbance that transfers energy through space or a medium.
- **Frequency:** The number of waves that pass a point in a given time.
- **Wave Height:** The vertical distance between the trough and crest of a wave.
- **Amplitude:** The maximum displacement of a wave from its equilibrium position.



Interesting Facts About Waves

Waves come in different types, including surface waves, internal waves (within the water body), and even rogue waves, which are unexpectedly large and dangerous.

Surfing relies on ocean waves, which are created by wind energy transferring to the water. The larger the wind and fetch, the bigger the waves for surfers to ride.

Tsunamis, often caused by undersea earthquakes, can travel at speeds of up to 500 miles per hour across the ocean.

Waves also play a role in renewable energy, with wave energy converters harnessing their motion to generate electricity.

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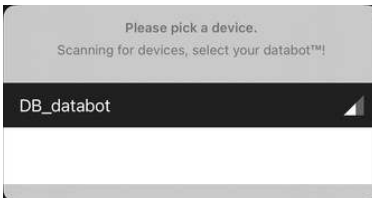
Using Vizeey

In order to work with the experiment you need to launch the Vizeey application and click on + in the upper right corner.

Then select “Add experiment from QR code” and scan the QR code prepared for this experiment. Your experiment will appear in the list.

Once in the Experiment

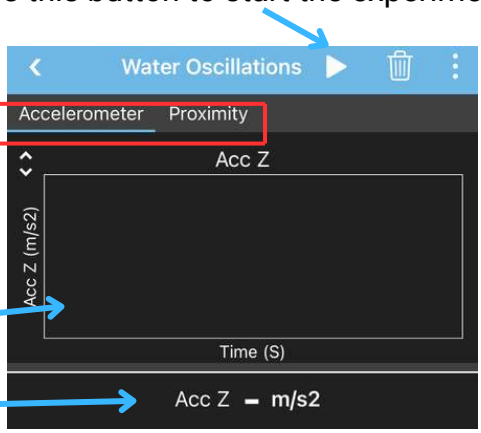
When you start the experiment active databots show up in your connection list. Select the one with the strongest signal (blue). Make sure your databot is turned on.



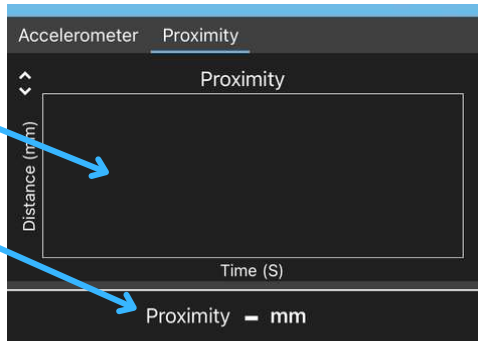
In this lab you will use two sensors: accelerometer and proximity sensor (10 cm)

The lesson is divided into two parts. In the first part, you will use a proximity sensor, and in the second part, you will use an accelerometer. You can select them from the tab here.

Press this button to start the experiment.



- databot acceleration graph
- Current acceleration
- databot proximity graph
- Current proximity

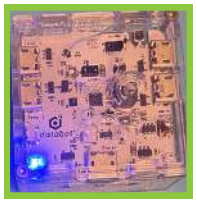


Databot has two operating modes:

- **Vizeey Mode** (for use with the Vizeey app).
- **Web Server Mode**

To activate Vizeey Mode:

- Position the Databot with its sensors facing upward and turn it on.
- If the databot’s LED glows green, it’s in Web Server Mode. If this happens, turn it off, adjust the orientation, and try again.



Good

Bad

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Part 1: Initial Observations and Questions

What happens to the water when a disturbance occurs?

How do the waves change as they move farther from the source of the disturbance?

Are the waves uniform, or do they vary in height and speed?

Part 2: Hypothesis

How do you think the wave height will change if the force applied to the water increases?

Do you think waves occurring closer to databot will show different readings compared to waves occurring farther away? Why or why not?

What do you think happens to the wave height if you change the water level in the container?

Part 3: Experiment Procedure

Investigating Water Oscillations

You'll study the characteristics of water oscillations using databot and analyze wave motion data.

Materials Needed:

- A container with water (e.g., a transparent plastic container or a glass bowl).
- Databot
- A stick or dropper to create water oscillations.

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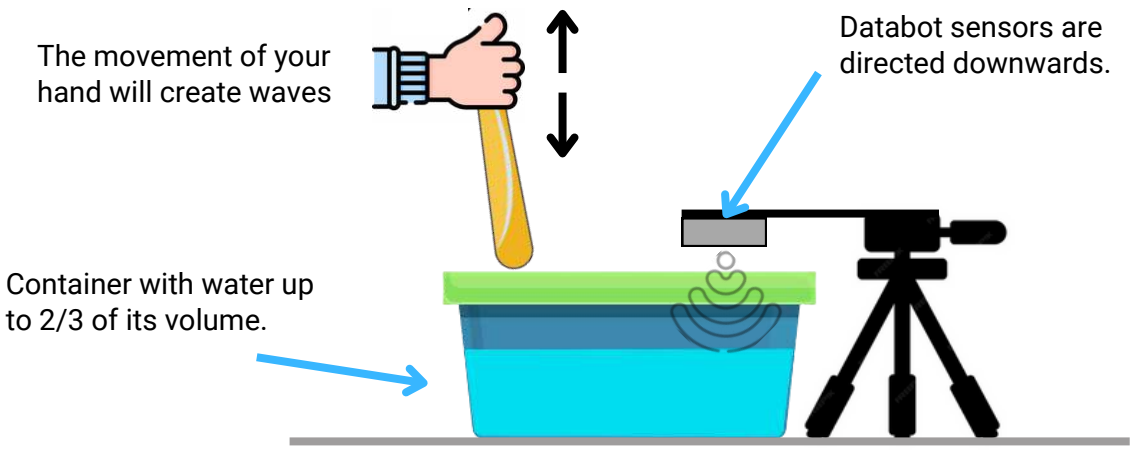
Experiment Steps:

- Select a container that can hold water and is stable on a flat surface.
- Fill the container with water up to 2/3 of its volume.
- Turn on databot.
- Position databot so that its distance sensor is directed at the water's surface, or place it securely on a platform next to the container. The Databot's sensor will measure the distance from the sensor to the water surface.



- Tap on "**Water Oscillations**" in Vizeey to load the experiment.
- You will be prompted to connect to databot.
  - Hint- if there is more than one databot in use, the one closest to you will be in blue!
  - A solid blue light on databot means you are connected.
- Start your experiment using: ▶
- Use these icons ▶ ⏸ at the top of the screen in Vizeey to start and to pause the experiment.
- Select the tab *"Proximity"* for this part of the experiment.
- Use the stick or dropper to lightly tap the surface of the water, creating small waves.
- Observe how the waves are detected and displayed as oscillations on the graph within the Vizeey app.

Analysis Question:

Analyze the graph displayed in the Vizeey app. Why do you think the data points on the graph are not stable?

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Water Oscillations and Their Modeling

You'll investigate the properties of water oscillations.

Materials Needed:

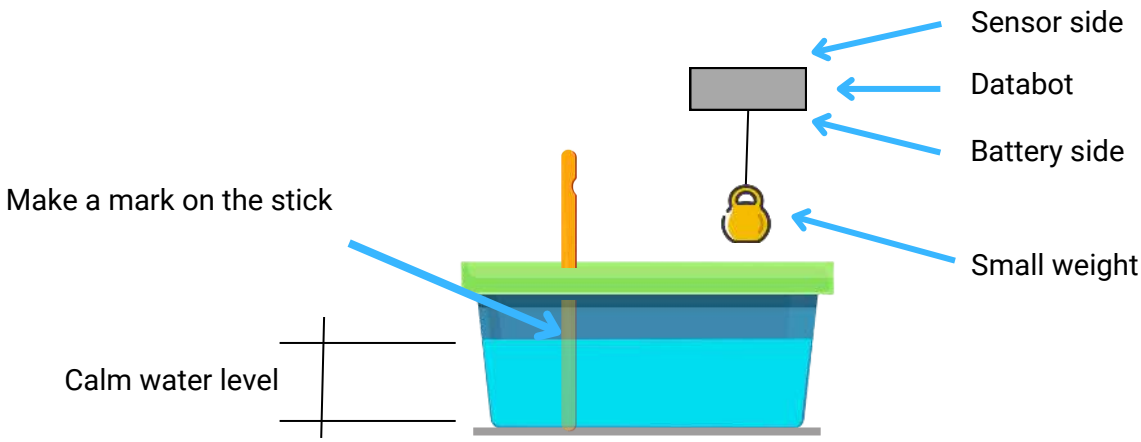
- Transparent container (bowl or water bathtub).
- Databot
- A small weight
- Rubber band or string.

Experiment Steps:

- Fill the container with water up to 2/3 of its volume.
- Measure and record the depth of the water using a wooden stick or a thin sheet of heavy cardboard. _____

Do not use a thin sheet of paper, it can quickly get wet and will not show the correct results.

- Secure a small weight (e.g., a coin or ball) to databot using a string or rubber band. Attach one end of the string to databot and the other to the weight. The weight should hang beneath databot, with the sensors facing upward.



- Turn on databot
- Tap on **"Water Oscillations"** in Vizeey to load the experiment.
- You will be prompted to connect to databot.
  - Hint- if there is more than one databot in use, the one closest to you will be in blue!
  - A solid blue light on databot means you are connected.
- Start your experiment using: ▶
- Use these icons ▶ ⏸ at the top of the screen in Vizeey to start and to pause the experiment.
- Use the tab *"Acceleration"* for this part of the experiment.

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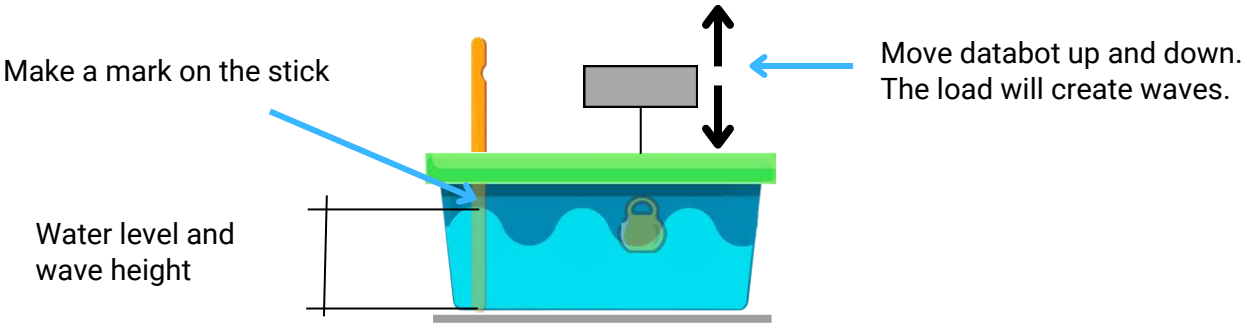
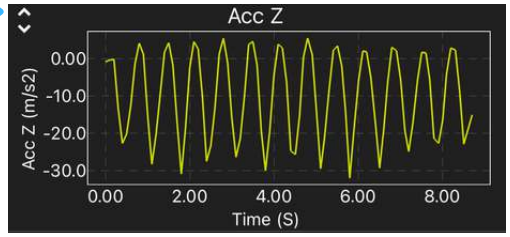
- Submerge a new dry stick or thin sheet of cardboard into the container all the way to the bottom.
- Using databot with a weight attached, move it up and down in the water for 5 seconds to create oscillations.



- Remove the stick or cardboard and measure the length of the wet part
- Stop the experiment.

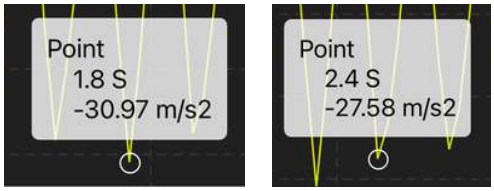
Part 4: Data Analysis

To analyze the chart, click on the 2 arrows



To see the values at any point of the graph, you first need to use the "Pick data" button.

Click on any point on the chart to see the values.

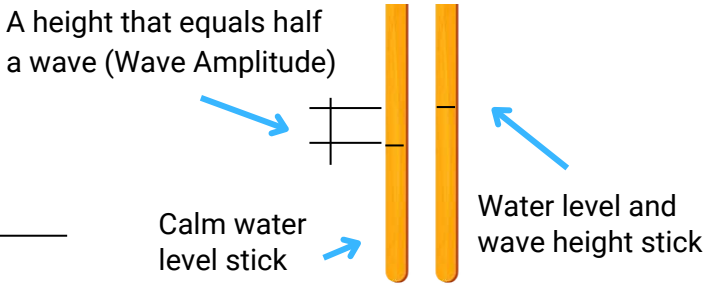


Knowing the time of several peaks you can subtract the time of the oscillations you created.

T= 2.4 - 1.8 = 0.6 c

Let's calculate the height of the wave.

By analyzing the data from the sticks, calculate the height of the wave



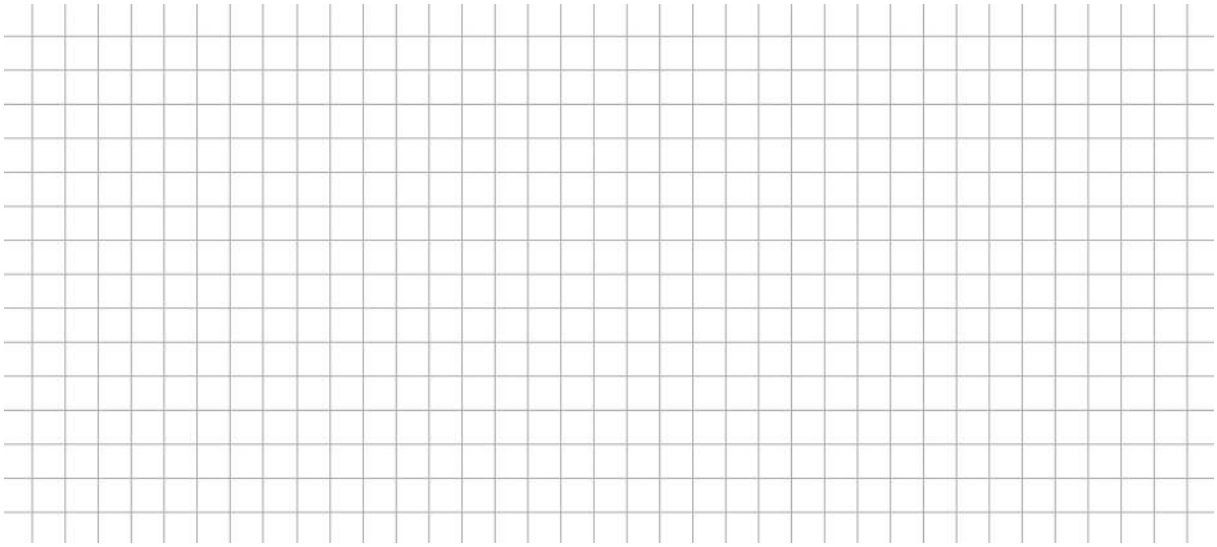
Knowing the time of oscillation that you created and the height of the wave, you can calculate the **wave frequency**

$$f = \frac{1}{T} \qquad f = \frac{1}{0.6} \approx 1.67\,\text{Hz}$$

The wave frequency is 1.67 Hz

Make your calculations here.

Draw your wave here and note any characteristics you have learned about it



Part 5: Concept Questions

What patterns can you observe in the graph when waves were generated?

How does the weight attached to databot influence the amplitude of the waves?

Part 6: Reflection

How changes in the water level or weight would alter the graph's results. Test your predictions if time permits.