

Lab 5: Modeling the Movement of Ocean Waves

Part I. Wave Machine

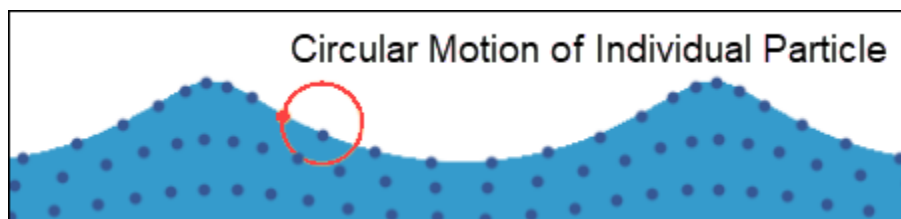
The wave machine used in Part I of this lab consists of a series of disks on a shaft that can be rotated by a crank handle. A dozen blue dots are at the top of rods that rest on top of the disks.

Rotate the handle of the wave machine and observe the result:

1. Describe pattern that is created as the handle is rotated.
2. Focus on the left-most dot. Describe the motion of this dot as the handle is turned.



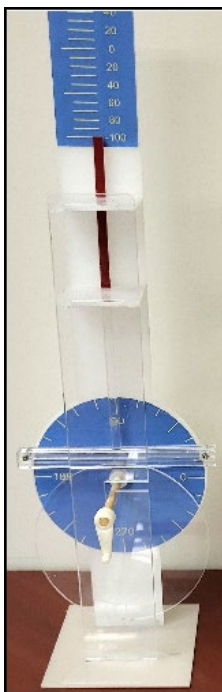
This simulation models the motion of an individual particle of water in the deep ocean. Each particle travels in a circle that ends near the starting position after a rotation. The vertical motion of the individual particles created by this circular motion results in a horizontal wave.



In shallow waters when the depth of the water is less than that one-half the wavelength of the wave, reflections from the bottom create more complicated patterns. Wind and tides can also cause movement of waves near the shoreline.

Part II. Investigating Movement of an Individual Particle

The movement of an individual particle can be explored in more detail by focusing on a single disk and rod representing one segment of the wave machine. The height of the top of the rod can be measured on a scale that ranges from plus one hundred (+ 100) at the maximum height to minus one hundred (- 100) at its minimum height, with zero (0) at the midpoint of the scale.



Use the handle to turn the disk of this wave particle explorer. Record the height of the rod for each of the following positions of the handle of the disk with one of the following three choices:

(a) *Max* for “Maximum Height, (b) *Mid* for “Midpoint,” or (c) *Min* for “Minimum Height”

Position of Disk Handle	Height of Rod
Pointing Right (90 degrees)	_____
Pointing Straight Up (0 degrees)	_____
Pointing Left (270 degrees)	_____
Pointing Straight Down (180 degrees)	_____

How is the position of the disk related to the height of the rod?

Part III. Digital Simulation

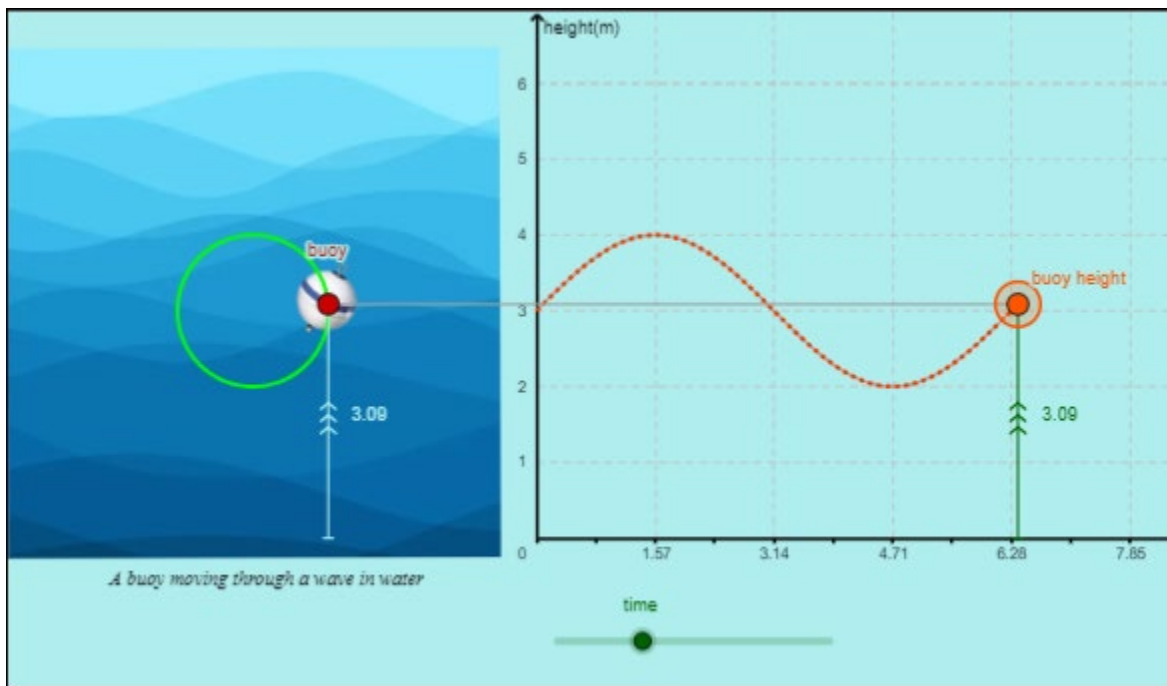
Steven Greenstein, a professor of mathematics at Montclair State University, created a digital simulation to accompany this lab. The simulation provides a slider that can be adjusted to depict the circular motion of an ocean buoy with an accompanying graph of buoy height over time. Access the simulation through the link below:

<https://www.geogebra.org/m/r9e8s69k>

Run the simulation by moving the slider labeled “Time”.

Then label the graph shown below to indicate the following positions of the buoy on the graph:

- Top of the circle formed by the path of the buoy
- Left of the circle formed by the path of the buoy
- Right of the circle formed by the path of the buoy
- Bottom of the circle formed by the path of the buoy



What similarities are found in the digital and physical models?

What component in the mechanical wave machine is analogous to the buoy in the digital model?

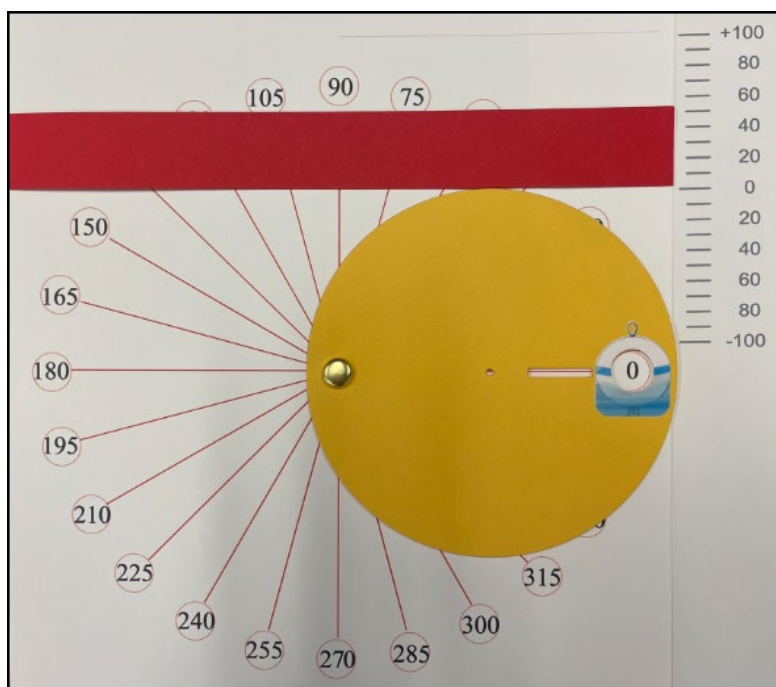
Part IV. Physical Recreation of the Digital Simulation in Part III

In this lab, you will create a graph of the height of the top of the buoy tracker as the buoy rotates.

Recording the Data

The red straight edge can be used to locate the vertical position of the top of the disk. The position of the top of the disk is recorded by placing a dot on a strip of paper with a scale representing height (from a maximum height of +100 to a minimum height of -100). This measurement should be recorded for each 15-degree interval as the disk is rotated through a circle.

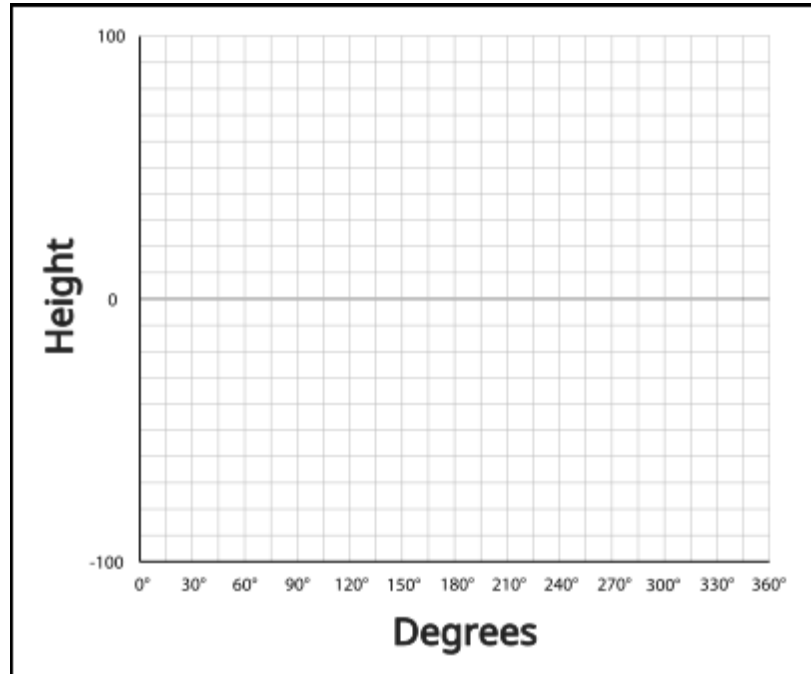
1. Rotate the yellow disk until the buoy (blue & white circle) is positioned at 0 degrees.
2. Place the vertical strip of a paper (with a scale from +100 to -100) beside the disk in the manner shown in the image below. (You may want to watch the accompanying video to see how this is done.)



3. Record the height of the top of the disk by placing the red straightedge on the top of the circle.
4. Place a dot on the vertical strip at the point that aligns with the bottom of the straightedge.
5. Record the height of the top of the disk at 15-degree intervals as the disk is rotated through a complete circle.

A. Graphing the Data

1. Transfer each of the heights recorded to the corresponding position on the graph paper provided.



2. What pattern emerged when the heights recorded were graphed?
3. How does this pattern correspond to the pattern created by the wave machine in Part I of the lab?
4. How is this pattern related to an ocean wave?