



**Wave Progression**  
**2024 NHERI O. H. Hinsdale Wave Research Laboratory**  
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**Summary-**

During this activity, students will explore wave progression by placing Lego structures of their own construction in a mini flume and testing which structures knock over and which hold up against the wave by the mini flume.

**Engineering Connection-**

This lesson will connect to the principles of engineering as students must design and construct and implement a Lego structure to test against a wave.

**Audience-**

Middle School (6-8th grade)

**Lesson Objectives-**

Students will be taught the development of waves as they come to shore while also testing how some structure shapes are more resilient than others. The first component will focus on how waves shoal, plunge, and break, and some of the basic reasons why this happens. The second component will have students assemble a lego structure that will withstand waves and see whose structure fails first.

**Educational Standards-**

The main standard being focused will be the Oregon Science Standards for K-12, adopted on June 16, 2022. Specifically used is the 2022 Science Standards and Guidance for [Middle School Science](#). Page 13 will be used to model Engineering content and pages 17-19 will be used to explain the physical science aspects.



### **Material List-**

- Model flume (ideally use model flume in HWRL)
- Lego bricks
- Clipboards
- Pencils
- Lab reports with questions and write-up portions that cover the lesson being taught
- Laminated images of different wave shapes
  - Normal wave
  - Shoaling
  - Plunging
  - Breaking

### **Introduction-**

With a greater need for coastal engineers, the best way to address this demand is to encourage students from a younger age. One of the best target groups for this are middle school students, as they have the capacity to understand more physical science concepts and their basic applications to engineering. With this, it makes it far easier to not only demonstrate these concepts, but also to explain them. Ideally, this would at least get the students to be interested in the topic and consider it as they move on in their academic journey.

### **Procedure-**

Background knowledge needed by instructor

- Progression of wave propagation
- Fundamental understanding that as wave shoals, gains energy, and trips, has most energy in break, loses energy as bores

### **Before the activity**

- Place ramp/slope in model wave flume
- Arrange lego platform on model wave flume
- Fill model wave flume with water
- Print enough copies of lab reports
- Prepare laminated wave images
- Handout materials (pencils, lab reports, and clipboards)

### **During the activity**

- Discuss the relevance of waves to everyday life. During this process, students should be taking notes on their lab reports.
  - Ask students when the last time they went to the beach was and if they surf/body surf
  - Ask students if they know how waves look like
  - Explain to them what the different states of waves are (show laminated images)



- Explain to them how the water particles move in a circular pattern and not in the direction of the wave propagation
- Explain that we need to understand waves in order to prepare for them and how they can harm homes and properties (like tsunamis)
- Transition over to model wave flume
  - Demonstrate a few waves and show the different processes
  - Explain why waves shoal and why they start to break
- Begin Lego demonstration
  - Place sample Lego structure and launch wave, demonstrating the impacts of the wave on the structure
  - Task students in groups of 3 to build a structure with a limited number of bricks to withstand the wave, structure must also be able to fit a single Lego person inside
  - Test each groups structures and ask reasons why they built it a certain way, whether or not it would be functional, and why the structure succeeded or failed

#### **After the activity**

- Ask students what they learned about waves
  - What are the different stages of a wave?
  - What is important to know about waves and why?
  - etc.
- Ask students to return materials
- Explain to students that there many different jobs that look at how waves act
- Encourage them to pursue STEM in general

#### **Assessment-**

Students will write a lab report, concluding the flume activity, which will evaluate the performance of their structure, and how they would alter their structure's composition in the future to improve performance against the wave.

#### **Wrap-up-**

The lesson will conclude with a thoughtful discussion after the lab write up is turned in and completed. It will include questions concerning which Lego build was the most effective against the wave (remained least altered). Discuss questions on lab report such as,

- 'How would a larger wave affect your Legos? What about a longer wave? A faster wave?'
- 'What changes would you make to your Lego build in the future to help it withstand the waves better?'
- 'Know that you understand more about how a wave works, how would you reposition the location of you build to accommodate the waves?'

Wrap up by reinforcing importance of thinking ahead while engineering, as well as the importance of pivoting when new information is introduced.