Wave Experiments

Level

5-6

Key question

How do we use a stream tray to model waves?

Key outcome

Describe and monitor wave action.

Three wave experiments using a stream tray

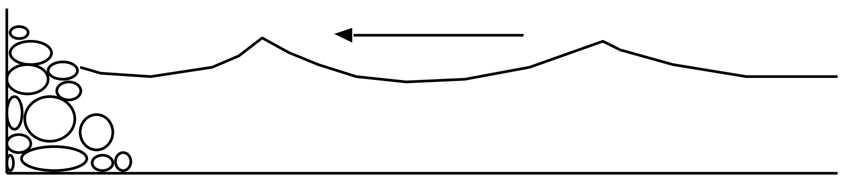
What you need

A small group is preferable so that all participants can do the experiments; otherwise, the leader/teacher would use the experiments to demonstrate, with the students gathered around the tray.

Stream tray
Bucket of sand
Bucket of stones
Two different lengths of wood
Electric fan

Key questions accompany each of the three experiments.

Figure 1. Set-up with stones



Key question

How do different surfaces reflect waves.

Investigating the Effect of Beach Materials on the Reflecting Waves

What you do

1. Fill the stream tray to a depth of 4 cm.
2. Place a board (on a slight angle) at the end of the tray
3. Create a wave that will be reflected off the board and count how many times the wave moves back and forth across the tank before it disappears.
4. Replace the reflecting board with stones. Place a pile of stones at one end of the tray. These stones should be piled up to a level just below the top of the tray. Ensure that there is a seaward slope with the pile of stones and it is even across the width of the tank (Figure 1).
5. Create a wave that will be reflected off the stones and count how many times the wave moves back and forth across the tank before it disappears.

by Dr Bill MacIntyre, Massey University, New Zealand.

6. Replace the stones with a pile of sand. Ensure that the sand is higher than the water level and that there is a seaward slope on the sand.

7. Create a wave that will be reflected off the sand and count how many times the wave moves back and forth across the tank before it disappears.

If there are differences, can you explain them? What would happen if there was island in the centre of the stream tray?

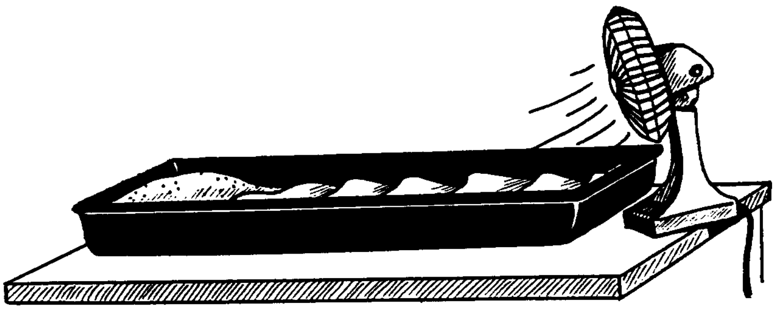


Figure 2. Set-up with fan

Investigating The Relationship Between Wind And Wave Size

Key question

How does wind effect waves?

Construct a "beach' at one end of the tank/stream tray with sand or pebbles. Slowly fill the stream tray with water to a depth of 3 cm. Position a fan (or hair dryer) at one end of the stream tray -opposite to the sand end. Aim the fan so that the air will hit the water at a 45• angle as shown in Figure 2. Never let the fan or hair dryer touch the water or electric shock could occur.

Before you begin, read the steps below and make a table to record your observations and predictions.

1. Using the 'low' speed on the fan, turn it on for 3 minutes. Record your observations of the water in the form of a table (see next page). Allow the water to become calm.

2. Using the 'high' speed on the fan, turn it on for 3 minutes. Record your observations of the water on the table. Allow the water to become calm.

3. Write a prediction that describes what you think will happen to the water when you turn the fan on for 5 seconds at 'high' speed. Turn it on for 5 seconds and record your observations next to the prediction.

4. Now that you have your prediction and observation recorded in the table, predict what will happen to the water when the fan stays on for 10 seconds at 'high' speed.

Wave Experiments

Using your observations what can you say about the link between wave size and wind. What would happen to the water:

- if the stream tray was longer
- if the angle of the fan was different.

Lost At Sea: Investigating the Relationship between Wave Speed and Water Depth

Key question

How does water depth effect wave speed?

1. Fill the stream tray to a depth of 1 cm. Use the longer piece of wood to act as a reflector at one end of the tank.
2. Practice making a wave pulse by 'dropping' or 'pushing' the shorter piece of wood into the water at one end. Don't make a wave too big or you will have problems with the depth. Time how fast the wave travels the distance of the tray.
3. Record the distance and time taken in the table below.
4. Repeat this for depths of 2 cm, 3 cm, 4 cm, and 5 cm.
   - Do you see any patterns or trends?
   - What will happen if there is sand on the bottom?

<u>Extension</u>

1 Additional activities using stream trays:

- Use Condy's Crystals in the water and observe the currents.
- Join stream trays together to show catchment ecology.
- Sprinkle green KOOL-AID cordial crystals on land, water, and let it percolate it through the water table.
- Made a sand cliff with igneous bits (including pumice) inside it and show wave cut.

2. Consider all three experiments: what implications do the results have for the real life situation along our coastlines?
3. Repeat appropriate experiments in the sea (refer to other activity units).

Example of recording table for investigating relationship between wave speed and water depth

Depth (cm)	Distance (m)	Time (sec)	Velocity (m/sec)
1 cm		(i) (i) (ii) average	
2 cm		(i) (ii) (iii) average	
3 cm		(i) (ii) (iii) average	
4 cm		(i) (ii) (iii) average	
5 cm		(i) (ii) (iii) average	

Wave Observations

Level

7-8+

Key question

How can wave action be measured?

Key outcome

Describe and monitor waves.

Adapted from field notes prepared by Rochedale High School, and St. Aidan's School in Brisbane.

What you need

- Pencil, paper or field sheets
- Clipboard
- Stopwatch
- Ruler/tape measure
- Float (apple rather than foam is suggested)

What you do

Assemble in small groups and do the experiments. One student should record data accurately for use by the group later.

Wave Period

Record the time in seconds for eleven wave "crests" to pass a stationary point. Eleven "crests" must include ten complete waves (crests and troughs). Crest one is zero time, crest eleven is end of time period.

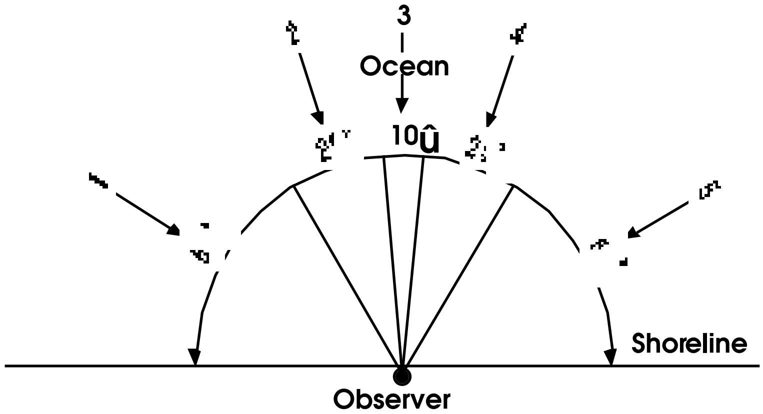
Wave Height

This observation relies solely on your judgement. Record the breaking wave height to the nearest one-fifth of a metre (i.e. 20 cm). If the wave height is less than 20 cm, then record "0". If no waves exist , record "0" for both wave period and wave height.

Wave Angle at Breaker

Record the code (1 to 5) which best describes the direction of the approaching waves according to Figure 1 below. If no waves exist record "0".

Figure 1. Wave direction code



Wave Observations

Surf Zone Width

Estimate the distance, to the nearest whole metre, from the water line, at the time of observation, to the line of the most seaward row of breakers.

To determine if the waves are constructive or destructive build a sand castle where the waves are washing up the beach. If the wash is stronger than the backwash, the waves are constructive. Write up your findings.

How will the speed of the backwash vary between a steep beach face and a flat beach face?

To determine if beach drifting is occurring, place a plank or heavy branch at right angles to the wash of the waves. Notice the effect of this mini-breakwall on deposition. What do you notice? What would be the effect of these breakwalls on a coastline?

The slope of the ocean bed affects the shape of the waves (wave profile). Look at the wave profile and indicate the probable sea floor at this beach.

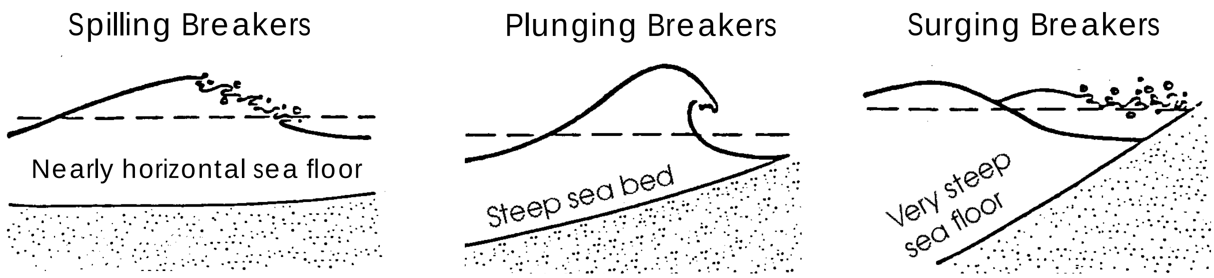


Figure 2.
Three types of breakers

Wave Type

Record the code (0-4) which best describes the type of breaking wave.

0 Calm: No waves exist.

1 Spilling: Spilling occurs when the wave crest becomes unstable at the top and the crest flows down the front face of the wave producing an irregular foamy whit surface. This wave is sometimes referred to as a ‘roller’.

2 Plunging: Plunging occurs when the wave crest curls over the front face of the wave and falls into the base of the wave, producing a high splash and much foam. This wave is sometimes referred to as a ‘dumper’.

3 Surging: Surging occurs when the wave crest remains unbroken while the base of the front of the wave advances up the beach.

4 Plunging/Spilling: This is a combination of spilling and plunging waves.

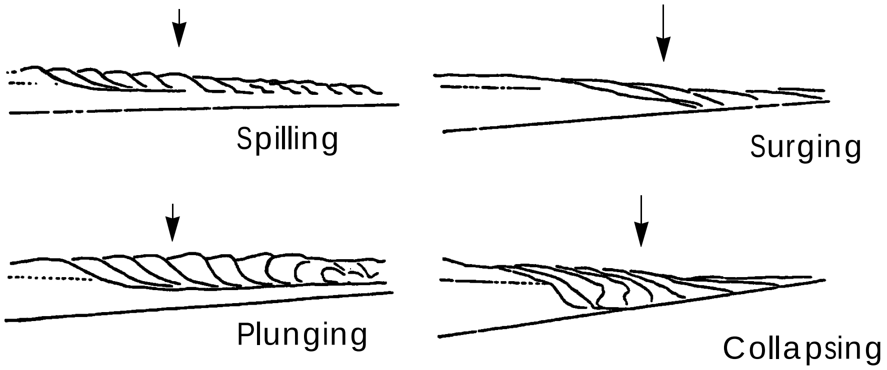


Figure 3. Wave types

Offshore Bar

1 = yes, if there is a distinct gutter between the initial breakpoint and the beach allowing the wave to re-form.

2 = no, if the wave continues in a broken state from the initial breakpoint to the beach.

Longshore Drift

Drop a piece of buoyant material (e.g. foam) at the water's edge and time how long it takes to move a measured distance. Note that the foam must be recovered, which may be difficult. An apple may be used as an alternative. Summarise your conclusions below.

To show the ways different shaped loads are transported by water, place small flat and uneven stones where the waves can move them. Comment on the ways or ease with which they move.

Field sheet for beach measurements

Carry out the following measurements and/or observations.

Phenomena	Site
1. Sand composition at mid tidal zone: • clear particles – mica or quartz • black rutile – mica or quartz • blue-black – basalt • red-brown – sandstone • grey – pumice • old coral, shells, sponge	
2. Sand texture at LWM to base of dune: • coarse, rough, smooth, angular, size	
3. Distance: • LWM to HWM • HWM to Berm • Berm to Dune Base	
4. Dune Height	
5. Berm Height	
6. Beach Angle: • LWM to HWM • HWM to Berm Base • Top of Berm to Dune Base	
7. Evidence of efforts to protect/stabilise sand dunes	
8. Rough cross section and vegetation transect	