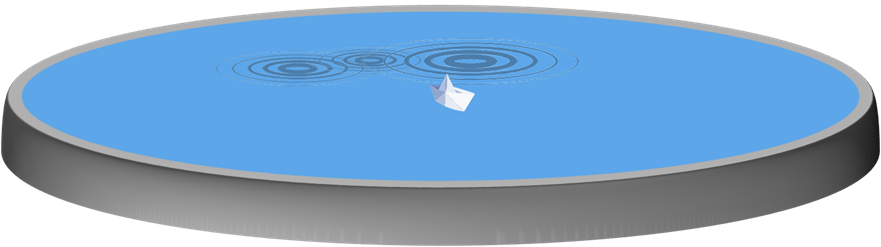
**Ripples on a pond**

Some children have made a paper boat.

It has got stuck in the middle of a pond.



The children want to get their boat back.

They are discussing what will happen if they throw stones into the water.

**Jenna:** Bigger stones make bigger waves.

**Keisha:** Bigger waves transfer more energy to the boat.

**Mark:** The stone pushes water against the boat.

**Luca:** The waves speed up as they spread out.

**Nadia:** Waves won’t push the boat forward.

**To answer:**

1. Who is right about what happens?
   * *Explain your answer*
2. Who is wrong about what happens?
   * *What would you say to help them understand?*

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| Cards for  **Ripples on a pond** | **Jenna:** Bigger stones make bigger waves. |
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*Physics > Big idea PSL: Sound, light and waves > Topic PSL4: Waves > Key concept PSL4.1: Waves on water and ropes*

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| **Response activity** |
| **Ripples on a pond** |

**Overview**

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| Learning focus: | A transverse wave travelling across the surface of water (or along a rope) transfers energy, as particles of water (or rope) are successively made to vibrate at right angles to the direction in which the wave travels. |
| Observable learning outcome: | Describe the movement of each ‘particle’ of a transverse wave as the wave moves forward.  Explain how movement of each ‘particle’ of a transverse wave causes a perturbation to move forward.  Compare the speed of transverse waves that have different amplitudes or frequencies to each other and are moving through a common medium.  Compare the amount of energy transferred by transverse waves that have different amplitudes or frequencies to each other and are moving through a common medium. |
| Activity type: | Talking heads |
| Key words: | Wave, transverse wave, amplitude |

This activity can help develop students’ understanding by addressing the sticking-points revealed by the following diagnostic questions:

* Diagnostic question: Part of a moving wave
* Diagnostic question: Rope wave
* Diagnostic question: Faster waves
* Diagnostic question: Energy from a wave

**What does the research say?**

When waves move through a medium students often describe the movement of some entity (perhaps mass, matter or force) through the medium. The scientific explanation involves no such movement. A wave moves forwards when a perturbation passes through a medium, and after it has passed the material of the medium returns to its original position. This is what distinguishes the motion of a wave from the motion of an object. (Fazio et al., 2008)

The motion of waves is hard for students to understand because waves form from large numbers of small scale events, such as the up and down movement of water particles in a water wave that are quite different to the form and motion of the wave (Caleon and Subramaniam, 2010).

In a study of students enrolled onto a university physics course (Wittmann, Steinberg and Redish, 1999) some students explained that waves that had a bigger amplitude moved faster because they had been given more energy or more force when they were set going. It should be noticed that in a string any sideways force that produces the wave is not pushing along the direction of the wave and so does not accelerate the wave in the forwards direction. Any extra energy is observed by the greater side-to-side movement of the string as the wave progresses.

In the same study, Wittmann, Steinberg and Redish (1999) found that a few students had the misunderstanding that waves with smaller amplitudes travelled faster. The reason being that the smaller pulses could slip more easily through a medium. This is an example of students thinking of the wave as a moving ‘object’, rather than as a perturbation moving through a medium.

**Ways to use this activity**

This task is intended for discussion in pairs or small groups. It can be done as a pencil and paper exercise or projected onto a screen.

Students should read the statements and follow the instructions on either the worksheet or the PowerPoint. Listening in to the conversations of each group will often give you insights into how your students are thinking. Each member of a group should be able to report back to the class.

Feedback from each group can be used, with careful teacher questioning, to bring out a clear description or explanation of the science.

*Differentiation*

The quality of the discussions can be improved with a careful selection of groups; or by allocating specific roles to students in the each group. For example, you may choose to select a student with strong prior knowledge as the scribe, and forbid them from contributing any of their own answers. They may question the others and only write down what they have been told. This strategy encourages contributions from more members of each group.

NB in any class, small group discussions typically improve over time and a persistence with this strategy is often very successful in the medium to long term.

**Expected answers**

Jenna, Keisha and Nadia are right.

Bigger stones ‘push’ *down* on the water with more force and produce waves with bigger amplitudes. The wave transfers more energy to the boat, making it move up and down further more. The movement of water in a wave is up and down and not forward, so waves do not push the boat forward.

Luca and Mark are wrong.

All the waves travel at the same speed away from where the stone dropped in, so long as the depth of the water stays the same. The stone makes water move up and down, so it does not push water against the boat. Rather it lifts the boat up and down vertically.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG), paper boat: <https://pixabay.com/vectors/paper-toy-boat-kids-folding-float-40021/>.

**References**

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