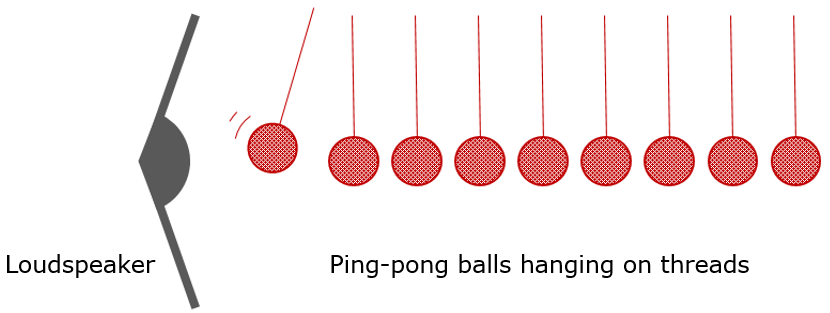
**Model sound wave**

A group of students make a model to show how a sound wave moves through the air.



**To answer**

1. What do the ping-pong balls represent?
2. What happens to the ping-pong balls when the loudspeaker vibrates?
3. How is this model ***similar*** to how a sound wave moves?
4. How is this model ***different*** to how a sound wave moves?

*Physics > Big idea PSL: Sound, light and waves > Topic PSL4: Waves > Key concept PSL4.2: A wave model of sound*

|  |
| --- |
| **Response activity** |
| **Model sound wave** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | As a sound wave (longitudinal wave) travels it transfers energy, as particles of the medium through which it travels are successively made to vibrate forwards and backwards along the direction in which the wave travels. |
| Observable learning outcome: | Recognise that as a sound wave travels forward, the medium it travels through does not.  Describe the movement of each ‘particle’ of a longitudinal (sound) wave as the wave moves forward.  Explain how movement of each ‘particle’ of a longitudinal wave causes a perturbation to move forward. |
| Activity type: | Critiquing a representation |
| Key words: | Sound wave, vibrate, vibration, longitudinal wave |

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

* Diagnostic question: Moving sound
* Diagnostic question: Flame in a sound wave
* Diagnostic question: Longitudinal wave

**What does the research say?**

The transmission of sound is difficult to understand. It is common for students to think of sound as a material substance that moves from one place to another (Barman, Barman and Miller, 1996). Even at degree level Linder (1992) found that some students thought of sound as a ‘lump’ of material travelling through a passive medium, similar to a surfer on a water wave. In a study of 15- to 16-year-old science students (n=243) Caleon and Subramaniam (2010) found that over 60% thought that as sound moves through a medium, it carries or pushes the particles of the medium forward. The most common misunderstanding was that sound is an entity, passed or carried from particle to particle in a collision-like process.

Finding out exactly what students are thinking about sound can be difficult, as they often label ideas of ‘sound particles’ with scientific terms: sound waves, disturbances, or vibrations. Superficially it can appear that students have a scientific understanding when they do not (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 backwards and forwards movement of air particles in a sound wave. These small scale events are quite different to the form and motion of the wave (Caleon and Subramaniam, 2010). This can be seen clearly when spectators at a sports event stand up and sit down in sequence to produce a *Mexican wave,* which moves around the stadium. A model longitudinal wave can be set up similarly, with students who are standing in a line stepping forwards and backwards in sequence. This process transfers energy through a medium, but without the transfer of any bulk substance.

**Ways to use this activity**

Students should complete this activity in pairs or small groups, and the focus should be on the discussions. It is through the discussions that students can check their understanding and rehearse their explanations.

Philosophically science can be said to be a description of the ‘best model’ we have for the world. In this activity students should identify ways in which this particular model is a good representation of the real world, and ways in which it is not.

Students should work together to answer the questions on either the worksheet or the PowerPoint. Giving each group one worksheet to complete between them is helpful for encouraging discussion, but each member should be able to report back to the class. Listening in to the conversations of each group will often give you insights into how your students are thinking.

Ending with the students completing the worksheet or questions from the PowerPoint individually, might help them to consolidate their learning.

*Differentiation*

You may choose to use simplified worksheets for some students, for example with gaps to fill in so they can focus on the science. In some situations it may be more appropriate for a teaching assistant to read and/or scribe for one or two students.

**Expected answers**

1. The ping-pong balls represent particles of air.
2. The loudspeaker bumps into the first ping-pong ball and knocks it to one side. The ping-pong ball bumps into the next one and so on until the last one is knocked. The sound (vibration) can be felt at the last ping-pong ball. Meanwhile the first ping-pong ball bounces back the other way and moves forwards and backwards about a mean position repeating the above over and over …
3. The movement of ping-pong balls spreading along the line is similar to the movement of air particles spreading forward in a sound wave. Each ping-pong balls move forwards and backwards about its original position. The ping-pong balls change direction only when they are hit by, or when they hit another particle. Compressions will repeatedly move along the line of ping-pong balls.
4. Air particles are free to move around and are not held in place. There are many, many times more air particles than there are ping-pong balls (in the order of 10 000 000 000 000 000 000 000 times as many). Air particles are too small to see. Air particles whizz around in random directions at very high speeds.

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG), from the BEST response activity ‘Sound model’ in topic PSL1: Sound and light.

Images: Peter Fairhurst (UYSEG).

**References**

Barman, C. R., Barman, N. S. and Miller, J. A. (1996). Two teaching methods and students' understanding of sound. *School Science and Mathematics,* 96(2)**,** 63-67.

Caleon, I. and Subramaniam, R. (2010). Development and Application of a Three-Tier Diagnostic Test to Assess Secondary Students' Understanding of Waves. *International Journal of Science Education,* 32:7**,** 939-961.

Fazio, C., et al. (2008). Modelling Mechanical Wave Propogation: Guidelines and experimentation of a teaching-learning sequence. *International Journal of Science Education,* 30:11**,** 1491-1530.

Linder, C. J. (1992). Understanding sound:so what is the problem? *Physics Education,* 27**,** 258-264.