Objectives

P4.6 Recall and use both the equations below for all waves:

wave speed (metre/second, m/s) = frequency (hertz, Hz) × wavelength (metre, m)

$v = f \times \lambda$

wave speed (metre/second, m/s) = distance (metre, m) ÷ time (second, s)

$v = x/t$

P4.7 Describe how to measure the velocity of sound in air and ripples on water surfaces.

P4.17 *Investigate the suitability of equipment to measure the speed/frequency/wavelength of a wave in a solid and a fluid.*

Maths requirements

1a Recognise and use expressions in decimal form.

1b Recognise and use expressions in standard form.

2a Use an appropriate number of significant figures.

2b Find arithmetic means.

3a Understand and use the symbols: =, <, <<, >>, >, ∝, ~.

3b Change the subject of an equation.

3c Substitute numerical values into algebraic equations using appropriate units for physical quantities.

3d Solve simple algebraic equations.

Learning outcomes

6th **SP4.6** Recall the equation relating wave speed, frequency and wavelength

8th **SP4.6** Use the equation relating wave speed, frequency and wavelength.

6th **SP4.6** Recall the equation relating wave speed, distance and time.

8th **SP4.6** Use the equation relating wave speed, distance and time.

7th **SP4.7** Describe how to measure the velocity of sound in air.

7th **SP4.7** Describe how to measure the velocity of waves on the surface of water.

Exploring

1. Measuring waves in liquids and solids – Core practical

This practical forms part of the Core Practical requirement of the specification. It is supported by the information on *Students' sheet CP1(Investigating speed, frequency, wavelength of a wave in a solid and a liquid)* and in the Student Book. This practical is described in two parts on *Students' sheet CP1(Investigating speed, frequency, wavelength of a wave in a solid and a liquid)*.

Speed of waves on water: Each group needs a ripple tank. Students are asked to estimate the speed of a wave by measuring how far it travels in a certain time, and also to calculate it from measurements of frequency and wavelength. Note that the speed of a wave in water depends on the wavelength and the depth, so the results students obtain will depend on both the depth of water in their tank and the frequency they set. They should use digital cameras, if available, to help them with the measurements.

Measuring waves in a solid: The method uses the fact that a standing wave in a cylindrical object has a wavelength twice the length of the object, but students are not expected to recall this fact. The rod is suspended using rubber bands and hit on one end with a hammer. Use a smartphone frequency app to detect the highest frequency.

Support: Students may need help setting up the ripple tank.

Stretch: If different lengths of rod are available, students could repeat the measurements in a solid and compare their results for various lengths (there should be no difference), and/or look up the speed of sound in the materials used and compare their results with published data.

Expected results

To compare the appropriateness of the apparatus used for measuring waves in different materials.

Course resources

Phys Students' sheet CP2

Equipment

Speed of waves on water: ripple tank (ideally with beaches to prevent reflections), stopwatch, ruler, digital camera

Speed of sound in solid: 2 clamps and stands, 2 rubber bands, long metal rod (up to 1 m long), metre rule, hammer, smartphone with frequency app