

**teacher guide**

**Mechanical waves 2: Wave properties**

# Components

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|  | NAME | TYPE | AUDIENCE |
|  | *Wave properties*  teacher guide | This provides teachers with suggestions on how to use the learning object in this resource. | teachers |
|  | *Wave properties explorer*  learning object | Students interact with a variety of waves to understand their properties. | teachers students |
|  | *Waves*  worksheet | This worksheet contains questions that involve concepts of wave type, amplitude, frequency and interference. | students |

Purpose

To **Explain** characteristics and properties of mechanical waves.

# Activity summary

Outcomes

Students:

* describe movement of particles in transverse and longitudinal waves;
* explain the meaning of amplitude, wavelength, frequency, speed and period of mechanical waves;
* describe relationships between speed, wavelength and frequency, and between frequency and period of waves; and
* explain interference caused by interacting waves.



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| ACTIVITY | POSSIBLE STRATEGY |
| Students explore the interactive program, *Wave properties explorer*, guided by the worksheet, *Waves*. | individually or pairs |
| Discussion of worksheet questions and additional questions such as:   * Is a ‘Mexican’ wave really a wave? * In what ways has a wave been represented? (visual, descriptive, graphical) | teacher-led whole group |

# Technical requirements

The learning object requires Adobe Flash Player version 8 or later (this is a free download from [www.](http://www/) adobe.com). It can be placed on a web or file-server and run either locally or remotely in a web browser.

The teacher guide and worksheet require Adobe Reader (version 5 or later), which is a free download from [www.adobe.com.](http://www.adobe.com/) The worksheet is also provided in Microsoft Word format.



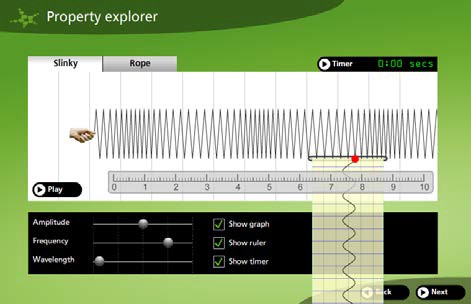
move in a circular pattern, however the motion is retrograde (anti-clockwise in the animation) whereas motion in water waves is prograde (clockwise in

the animation). Motion in a Rayleigh wave changes direction at depth, from retrograde to prograde.

Rayleigh waves are the slowest of earthquake waves, however they are amongst the most destructive.

Because they propagate in two dimensions (across the surface) rather than three dimensions (through the volume of the Earth in the case of P- and

S-waves) they dissipate much more slowly so they can carry a greater amount of energy further.



### Property explorer screen

Students use the second screen in the animation to make a detailed investigation of three properties of mechanical waves: amplitude, frequency and wavelength.

Each can be varied for two principal wave types: a slinky spring (longitudinal wave); and a rope wave (transverse wave). The speed of the wave is constant, so varying frequency affects wavelength and vice versa according to the equation v = f # m

(speed = frequency multiplied by wavelength).

Controls are included to display a graph of particle motion, a moveable ruler and a timer. Using these tools, students may determine other properties such as motion period and wave speed.

**Amplitude**

Adjusting the **amplitude slider** changes the amount the hand generating the waves moves. Rope wave amplitude can be easily determined on screen by measuring the distance between top and bottom of wave crests. Measure the slinky wave amplitude by selecting the **Show graph** checkbox. Changing amplitude has no effect on wavelength, period, frequency or speed of a wave. Large amplitude waves carry more energy (eg a big water wave or a loud sound).

## Frequency

Moving the **frequency slider** changes the rate the hand moves up and down or back and forth. Use the **Timer** to determine frequency by counting how many waves pass a fixed point in a unit of time. Frequency can be varied between 0.25 Hz and 1.25 Hz (slinky wave) and 0.5 Hz and 2.5 Hz (rope wave). Wavelength automatically adjusts as frequency is changed in order to keep speed constant.

## Wavelength

Moving the **wavelength slider** changes the wavelength. The **Ruler** can be used to determine wavelength, which varies between 8 and 1.6 units (slinky wave) and 2 and 0.4 units (rope wave).

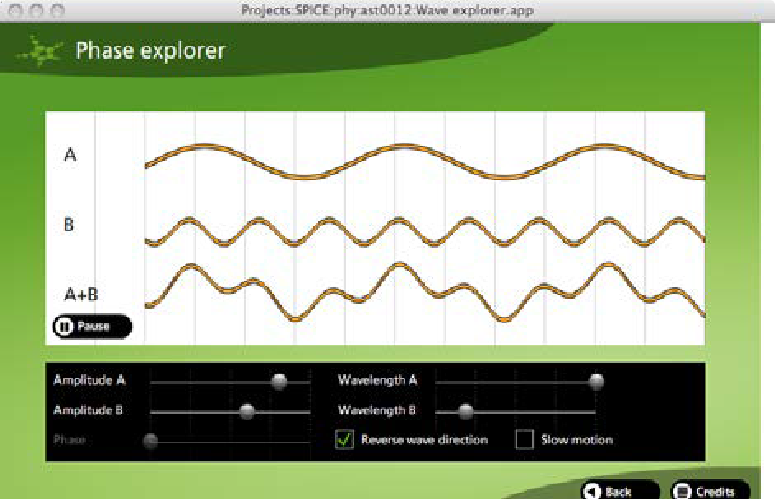
Frequency automatically varies as wavelength is adjusted in order to keep speed constant.

## Speed

Speed may be calculated using the **Ruler** and **Timer**. For the slinky spring it should be 2 units s-1 and for the rope wave 1 unit s-1.

## Period

Period of the wave may be measured using the **Timer**. It’s the time taken for one complete wave to pass any given reference point. The period is calculated as 1/*f* (reciprocal of the frequency).



### Phase explorer screen

The third simulation screen may be used to investigate how waves combine. Two transverse waves (**A** and **B**) are shown, together with the result of adding the waves together (**A** + **B**).

Amplitude and wavelength of the two source waves may be independently varied using sliders for each. Phase difference between waves may also be adjusted so that waves are in phase or out of phase.

Select **Reverse wave direction** to reverse the direction of one wave. With this setting standing waves can be generated.

# Associated SPICE resources

*Mechanical waves 2: Wave properties* may be used in conjunction with related SPICE resources to address the broader topic of mechanical waves.

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| DESCRIPTION | LEARNING PURPOSE |
| *Mechanical waves*  This learning pathway shows how a number of SPICE resources may be combined to teach the topic of mechanical waves. |  |
| *Mechanical waves 1: The physics of tsunamis*  Video and a fact sheet compare surface waves with tsunami waves. | Engage |
| The sequence overview in *Mechanical waves* contains suggested **Explore** activities suitable for use at this point. | Explore |
| *Mechanical waves 2: Wave properties*  This resource includes a learning object (in which students interact with a variety of waves to understand their properties), and associated student worksheets. | Explain |
| *Mechanical waves 3: Graphing waves*  These student worksheets describe experiments with longitudinal waves. | Elaborate |
| *Mechanical waves 4: Tsunami problems*  These student worksheets cover a range of problems concerning the physics of tsunamis and other waves. | Elaborate |
| The sequence overview in *Mechanical waves* contains suggested **Explore/Explain**  activities suitable for use at this point. | Explore/Explain |
| *Mechanical waves 5: The physics of whale stranding*  An interview with physicist Dr Ralph James illustrates how his research into microwaves led him to develop and test a theory to explain whale beaching. | Elaborate |

# Acknowledgements

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