Name ..... Class ..... Date .....

The properties of waves (wavelength, frequency, and velocity)

Specification reference:

- P6.1.2 Properties of waves

Aims

In this exercise you will apply your knowledge of waves to answer questions about wave properties; including wavelength, frequency, and velocity (or wave speed).

Learning outcomes

After completing this activity, you should be able to:

- state what a wave is
- label diagrams to show the properties of a wave
- describe the properties of waves; including wave speed, frequency, and wavelength
- describe how to calculate the speed of sound in air
- determine the depth of the sea bed by using the equation: distance = speed × time
- use the wave equation: wave speed (m/s) = frequency (Hz) × wavelength (m) to calculate wave speed, frequency, or wavelength.

Questions

1 Draw lines to match each word to its definition. (*4 marks*)

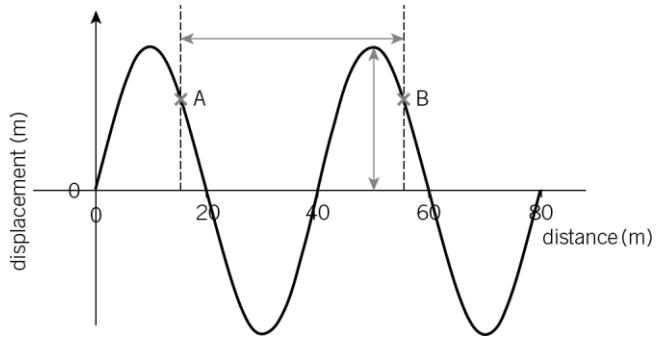
Amplitude	The number of waves or oscillations per second, measured in hertz, Hz.
Wavelength	The time for one wave to pass a given point or the time for one complete oscillation, in seconds, s.
Time period	Distance from the rest position to the top of the wave, measured in metres, m.
Frequency	Distance from one point on the wave to the identical point on the next wave, measured in metres, m.

Name ..... Class ..... Date .....

2 Label the following two diagrams with the correct words from the box. Each word only needs to be used once.

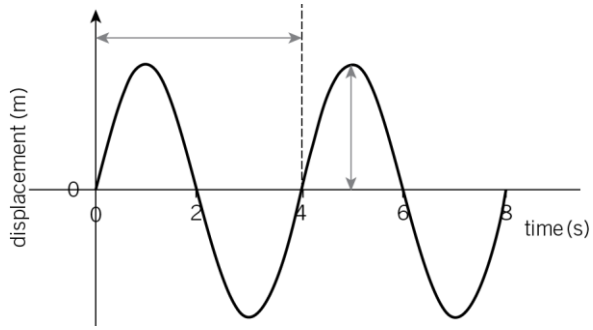
time in s	amplitude	displacement in m	wavelength	time period

a



(*2 marks*)

b



(*3 marks*)

3 A water wave passes a boat. An observer on the boat notices that 120 water waves pass the boat in a time of 1 minute. The boat is at anchor (it is not moving).

a Calculate the frequency of the water waves in hertz, Hz.

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..... (*2 marks*)

b The water waves have a wavelength of 1.8 m. Calculate the wave speed of the water waves.

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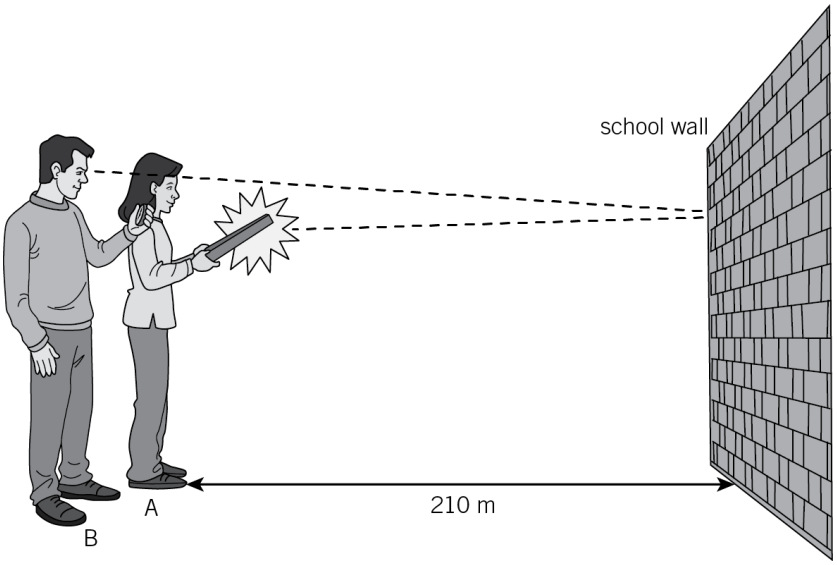
..... (*3 marks*)

Name ..... Class ..... Date .....

4 A sound wave is generated by clapping two wooden sticks together. The students record hearing the echo 1.2 seconds later. The students are standing 210 m from the wall.



a Use this information and the diagram to determine a value for the speed of sound in air.

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..... (*4 marks*)

b Explain how the investigation could be changed so that the value for the speed of sound obtained would be more accurate.

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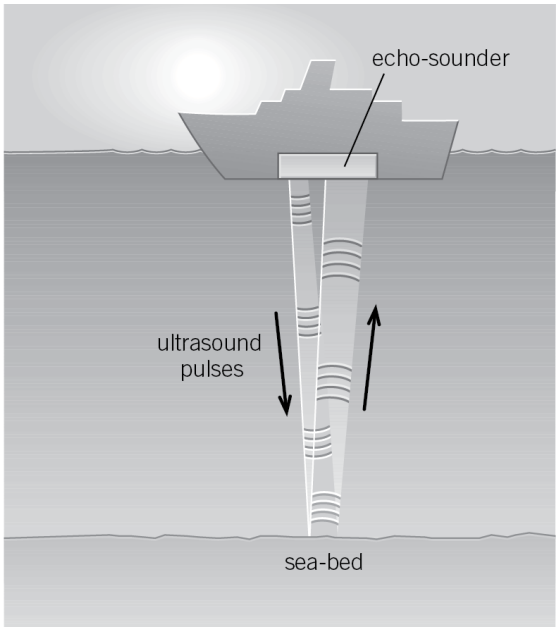
..... (*2 marks*)

Name ..... Class ..... Date .....

5 An ultrasound signal is sent out by a ship to detect how far beneath the surface the sea bed is. The process is called 'echo-ranging'. The ultrasound signal has a frequency of 24 000 Hz and a wavelength of 0.63 m. The time between sending the signal and detecting the reflected wave is 0.42 s.



a Explain why the process is called echo-ranging.

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..... (*2 marks*)

b Explain why the equation used to find the distance of the sea bed beneath the surface can be written as $d = \frac{1}{2}(v \times t)$

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..... (*2 marks*)

c Calculate the distance from the surface of the water to the sea bed.

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..... (*4 marks*)

Name ..... Class ..... Date .....

6 The table below shows values for wavelength, frequency, time period, and wave speed. Fill in the missing values in the table and identify what the wave might be. (*11 marks*)

Wavelength in m	Frequency in Hz	Time period in s	Wave speed in m/s	Type of wave
5.0	2.0			water wave
6.0×10^{-7}			3.0×10^{8}	
	26 000		1570	
		3.3×10^{-7}		radio wave