



Physics. *You work it out.*

Travelling vs. Standing

A Level

P

P

P

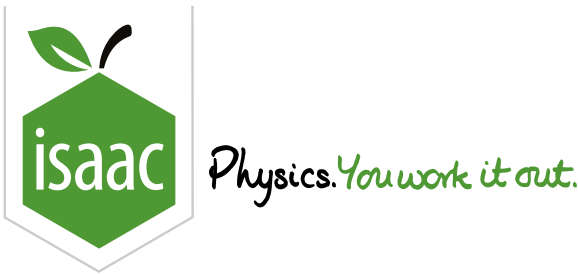
Which of the following correctly compares the characteristics of travelling and stationary plane waves?

| | <i>Travelling wave</i> | <i>Stationary wave</i> |
|----------|--|--|
| <i>A</i> | no medium required | requires a material medium |
| <i>B</i> | separation between two adjacent points of corresponding phase is one wavelength | separation between a node and the adjacent antinode is half a wavelength |
| <i>C</i> | amplitude of vibration varies with position | the amplitude of vibration is the same at all points |
| <i>D</i> | energy at any point is always kinetic | energy at any point changes between kinetic to potential and back again |
| <i>E</i> | energy is transported at a speed given by the frequency multiplied by the wavelength | no net transport of energy |

- ☐ *A*
- ☐ *B*
- ☐ *C*
- ☐ *D*
- ☐ *E*

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Standing Waves 1

Essential Pre-Uni Physics D5.1

A Level

P

P

P

Consider a particle that is at a particular antinode of a standing wave, which we'll call point A. Fill in the table below to state how the motion of certain other particles will compare to this one. [For amplitude, state whether it will be smaller/larger/the same; for phase, state the phase difference in degrees.]

| Position of Particle | Amplitude | Difference in Phase |
|---|-----------|---------------------|
| At the next antinode along from point A | (a) | (b) |

Part A Amplitude

a) Amplitude compared to point A?

- ☐ Same
- ☐ Zero
- ☐ Twice as large

Part B Phase

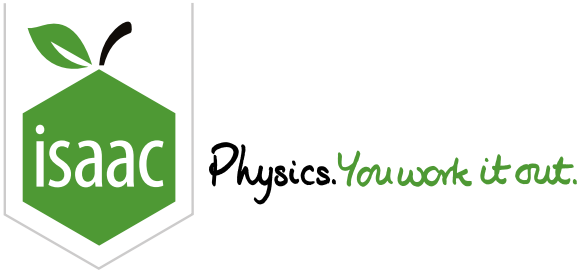
b) Phase relative to point A?

- ☐ 90°
- ☐ 180°
- ☐ 360°

Gameboard:

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Standing Waves 2

Essential Pre-Uni Physics D5.2



Consider a particle that is at a particular antinode of a standing wave, which we'll call point A. Fill in the table below to state how the motion of certain other particles will compare to this one. [For amplitude, state whether it will be smaller/larger/the same; for phase, state the phase difference in degrees.]

| Position of Particle | Amplitude | Difference in Phase |
|---|-----------|---------------------|
| Between point A and the next node along | (a) | (b) |

Part A Amplitude

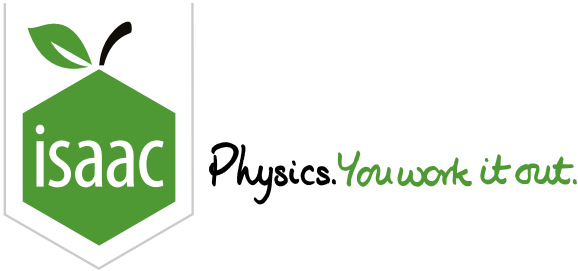
a) Amplitude compared to point A?

- ☐ The same
- ☐ Larger
- ☐ Smaller

Part B Phase

b) Phase relative to point A?

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Standing Waves 3

Essential Pre-Uni Physics D5.3



Consider a particle that is at a particular antinode of a standing wave, which we'll call point A. Fill in the table below to state how the motion of certain other particles will compare to this one. [For amplitude, state whether it will be smaller/larger/the same; for phase, state the phase difference in degrees.]

| Position of Particle | Amplitude | Difference in Phase |
|--|-----------|---------------------|
| Beyond the next node along from point A, but before the next antinode to point A | (a) | (b) |

Part A Amplitude

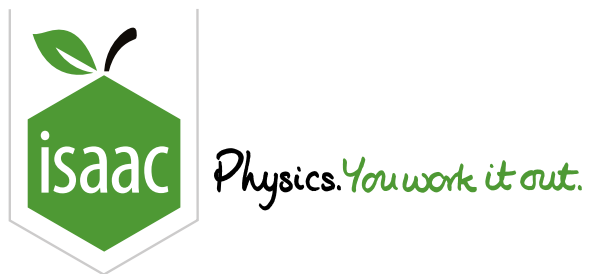
a) Amplitude compared to point A?

- ☐ Smaller
- ☐ Larger
- ☐ The same

Part B Phase

b) Phase relative to point A?

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Standing Waves 4

Essential Pre-Uni Physics D5.4

A Level



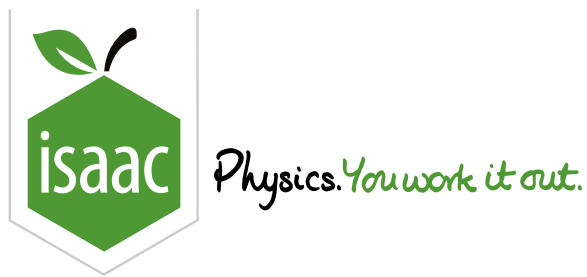
What is the difference between the 'amplitude' and the 'displacement' of a particle at an antinode?

- ☐ The amplitude is the distance from the equilibrium position.
- ☐ The amplitude is the distance between successive peaks or troughs in the wave.
- ☐ The amplitude is the maximum magnitude of displacement of a particle from its equilibrium position.

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Standing Waves 5

Essential Pre-Uni Physics D5.5

A Level



You must give a unit in all of your numeric answers in order to obtain the mark.

Part A Distance from nodes to antinodes

Two waves of amplitude 4.0 cm and frequency 14 Hz are moving in opposite directions at 5.6 m s^{-1} along a stretched string. If a standing wave were formed, how far apart would you expect the antinodes to be from the nodes on either side of them?

Part B Minimum length of the string

If the string had two fixed ends, what is the minimum length it must be in order for a standing wave to be possible?

Part C A string of length 0.70 m

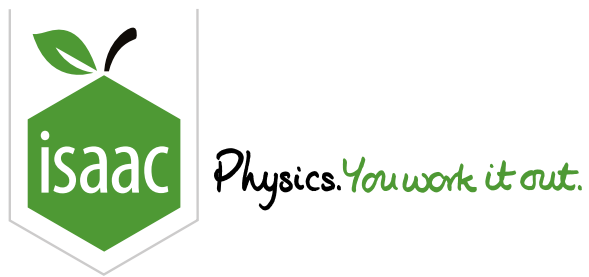
If the string had two fixed ends and was 0.70 m long, why would no standing wave be formed?

- ☐ If the string was 0.70 m long then both ends would be antinodes, which is not possible if both ends are fixed.
- ☐ The wavelength of the standing wave is greater than 0.70 m .
- ☐ Both ends cannot be nodes as the internodal distance is 0.20 m , so no standing wave can form.

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Standing Waves 6

Essential Pre-Uni Physics D5.6

A Level



You must give a unit in all of your numeric answers in order to obtain the mark. The speed of sound in air is 330 m s^{-1} .

Part A Lowest frequency

A wind instrument is 60 cm long, and can be modelled as a tube with one closed end and one open end. What is the lowest frequency that can be played on this instrument?

Part B Second-lowest frequency

If a note of the second-lowest possible frequency were played on the instrument, state the positions of the nodes (measured as distances from the closed end of the tube).

- ☐ One 20 cm from the closed end, another 40 cm from the closed end.
- ☐ One at the closed end, another 20 cm from the closed end and another 40 cm from the closed end.
- ☐ One at the closed end, another 40 cm from the closed end.

Part C Third-lowest frequency

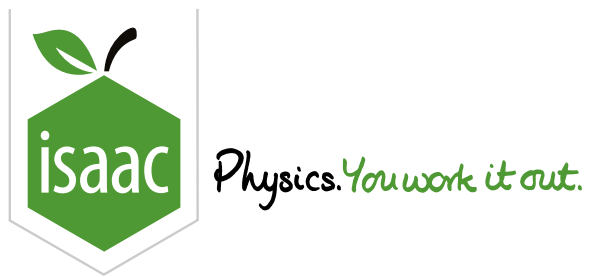
State the positions of the nodes if a note of the third-lowest possible frequency were played.

- ☐ One at 30 cm from the closed end.
 - ☐ One at closed end, another 24 cm from the closed end and the last 48 cm from the closed end.
 - ☐ One at closed end, another 20 cm from the closed end and the last 40 cm from the closed end.
-

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Standing Waves 7

Essential Pre-Uni Physics D5.7

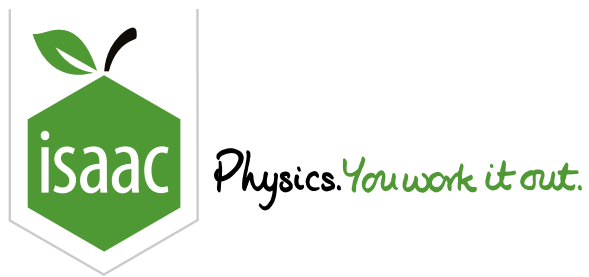


Two microwave emitters are placed facing each other about a metre apart and coherently emit microwaves of the same frequency. A detector moved back and forth between them detects regions of maximum intensity spaced 4.0 cm apart. Calculate the frequency of the microwaves.

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Standing Waves 8

Essential Pre-Uni Physics D5.8

A Level



You must give a unit in all of your numeric answers in order to obtain the mark. The speed of sound in air is 330 m s^{-1} .

Part A Water in a tube

A musical note of several frequencies is sounded at the mouth of a 1.0 m long vertical tube that has some water in the bottom. Give the depth of water in the tube if the fundamental frequency heard is 125 Hz.

Part B Matching amplitudes

When the lowest frequency above the fundamental is played, at what height will the particles' displacement be out of phase and have the same amplitude as that of the particles 8.0 cm above the surface of the water? Give your answer as a distance above the surface of the water.

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Speed Camera

A Level



This problem involves beats and can be solved using the Doppler effect. These topics are not covered in some Physics A Levels. For more information please check with your teacher.

A car is travelling past a speed camera on a motorway. The camera uses a radio signal of wavelength 3.2 cm which is then reflected back to the camera from the rear of the car as it travels past. The camera is at the same height as the rear of the car and is close enough to the car's path that the velocity of the car can be considered to be along the path of the radio signal.

From the point of view of the car, the signal incident on the reflective surface will be Doppler shifted. This signal is now reflected back to the speed camera from a moving source. This signal, when it is received back by the camera, is therefore twice Doppler shifted.

The superposition of the transmitted and reflected signals gives beats with a frequency of 2200 Hz .

Given that the speed limit is 100 km h^{-1} , how much faster than the speed limit is the car travelling? Give your answer in km h^{-1} .

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