

Standing waves on strings and in pipes

Physics grades 11-12 (A Level · IB · Class 11-12) · Test

Name: _____ Date: _____ Class: _____ Mark: ____ / 20

This test lasts 45 minutes and is worth 20 marks. Use $v = 343 \text{ m/s}$ for sound in air, show all your working and give answers with units. Draw clear sketches where they help you.

Level: Physics grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** IB C.4

Time: 45 minutes · 8 questions · Total: 20 marks · Calculator allowed

Question 1 Violin string (3 marks)

A string of length 0.90 m is fixed at both ends and carries waves of speed 180 m/s.

- Calculate the wavelength of the fundamental. (1 mark)
- Calculate the fundamental frequency. (1 mark)
- State the frequency of the third harmonic and the number of antinodes it has. (1 mark)

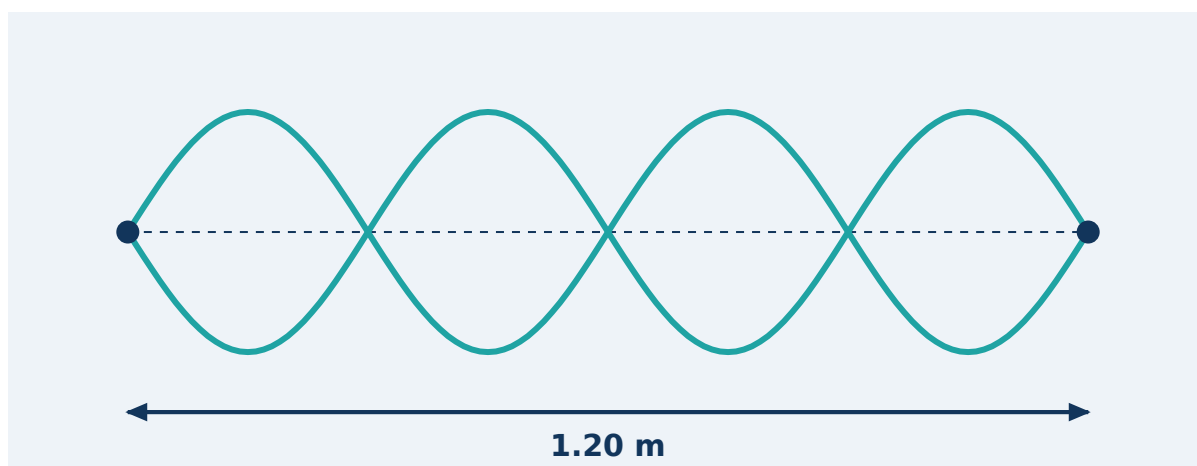
Question 2 Closed pipe resonances (3 marks)

A pipe closed at one end has length 0.40 m ($v = 343 \text{ m/s}$).

- Calculate the fundamental frequency. (1 mark)
- Calculate the next two resonant frequencies. (2 marks)

Question 3 Reading the loops (3 marks)

The diagram shows a stationary wave on a string driven at 200 Hz.



Stationary wave with four loops on a string of length 1.20 m.

- a. State the harmonic number. (1 mark)
- b. Calculate the wavelength. (1 mark)
- c. Calculate the wave speed. (1 mark)

Question 4 Two kinds of wave (3 marks)

State three differences between a stationary wave and a progressive wave.

Question 5 Odd harmonics (2 marks)

Explain why a pipe closed at one end produces only odd harmonics.

Question 6 Doubling the tension (2 marks)

A string has a fundamental of 220 Hz. Calculate the new fundamental if the tension is doubled with length and mass per unit length unchanged.

Question 7 Fretting a string (2 marks)

An open guitar string of length 0.64 m has a fundamental of 110 Hz. A finger presses the string so its vibrating length is 0.48 m. Calculate the new fundamental frequency.

Question 8 End correction idea (2 marks)

Explain what is meant by the end correction of a pipe and how it affects the calculated frequency if ignored.