Grade 12 Physics, Explained

Unit 8 · Waves in Pipes and Strings

HARDER PRACTICE QUESTIONS

Full marks 27

Write your answers on separate paper. Show your working. Ignore end corrections unless a question gives one.

1 Spot the error [3]

Find the mistake in the working and correct it.

A pipe 0.50 m long is open at both ends; sound travels at 340 m/s. Rajan finds its fundamental: "$f_1 = \frac{v}{4l} = \frac{340}{4 \times 0.50} = \mathbf{170\ Hz}$."

2 Read the data [3]

Answer from the data.

A pipe is found to resonate at 375 Hz and at 525 Hz, and at no frequency in between. Is it open or closed? Find its fundamental frequency.

3 Predict, then explain [3]

Write your prediction first, then explain it.

A flute (an open pipe) is tuned at 15 °C, then played in a hall at 35 °C. Predict whether its note goes up or down, and find by what percentage. Would the note of a sitar string change for the same reason?

4 A real setting [4]

The numbers are made up, but of the right size.

A sitar string vibrates over a length of 0.86 m and is tuned to a fundamental of 240 Hz. Its mass per unit length is 0.40 g/m.

i. Find the speed of the waves on it.
ii. Find its tension.
iii. A fret shortens the vibrating length to two thirds. What note does the string then play?

5 Show that [3]

Show that the fundamental frequency of a wire of diameter d and density ρ is $f = \frac{1}{ld}\sqrt{\frac{T}{\pi\rho}}$. Then find how much more tension a wire of twice the diameter needs to play the same note at the same length.

6 What if? [3]

A pipe closed at one end has a fundamental of 160 Hz. What if its closed end is opened? Give its new fundamental and its first two overtones, and its first two overtones before.

7 Check the readings [3]

One reading doesn't fit. Find it.

Deepa finds the length of sonometer wire that resonates with each tuning fork, the tension kept the same:

Frequency (Hz)	256	320	384	512
Length (m)	0.60	0.48	0.40	0.32

Use the law of length to find the reading that doesn't fit, and the length it should be.

8 Correct the misconceptions [3]

The paragraph has three mistakes. Write each mistake and correct it.

Bimala wrote: "The open end of an organ pipe is a node, because the air there is open to the room. The first overtone of a closed pipe is its second harmonic. And tightening a guitar string makes its waves slower, which raises its note."

9 Make your own [2]

Design a closed pipe whose fundamental is 425 Hz when sound travels at 340 m/s. What is the next note it can play?