Standing Waves

PreLab submission with a pass grade is required to begin the lab.
Must be submitted no later than right before the start of the lab.

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Section: H4
Date: 11/20/2024

Readings

You can review the concepts using these links or your favorite textbook,
Standing waves, Relationship between the speed of a wave on a string and string's tension, Standing waves in tubes

Dialog:

1. Vibrating String

A string of mass 3.0 grams is 2.0 m long, fixed at both ends, and set into transverse vibration at a frequency of 100 Hz.

a) For what tension, T0, of the string will standing waves be set up so that there are no nodes other than those at the ends of the string ? Show your calculation.

m = 0.003 kg
l = 2.0 m
⇒ μ = m/l = 0.0015 kg/m
f = 100 Hz

For nodes at the end, λ = 2L = 4.0 m
v = fλ = 100 * 4 = 400 m/s
but v = Sqrt(T/μ) ⇒ T0 = μv^2 = **240 N = T0**

b) For what tension, T1, will the string vibrate with one node at the exact center (ends are always nodes)?

For T1, $\lambda = L = 2.0$ m
$v = f\lambda = 200$ m/s
T1 = 60 N

2. Standing waves in tubes

Hint: Here is a great video which explains the phenomena and shows you how to solve this problem.
A small speaker is placed at one end of a clear plastic tube. The length of the air column in the tube can be changed by a plunger which has a microphone attached to it. The speaker sets the air molecules into longitudinal vibration at one end, and the microphone measures the amplitude of the wave at the other end of the tube.
When the speaker is producing waves with a frequency of 400 Hz, we start from a very small length and gradually pull the plunger away to increase the air tube Length. At L=25 cm the microphone measures the biggest amplitude.

Find the velocity of sound in the air tube. Show your calculation.

If L is the biggest Amplitude, and you observed this for the first time, we saw the first resonance, i.e. $\lambda = 4L$ at that point. $\Rightarrow \lambda = 100$ cm = 1.0 m
$v = f\lambda = 400$ m/s

Results

Record your results in the table below.

In[1]:=
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Grid[{{Text["Standing Waves"], SpanFromLeft},
  {"T0, N", "T1, N", "Vsound, m/s"}, {240 , 60 , 400 }}, Frame → All]
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Out[1]=

Standing Waves		
T0, N	T1, N	Vsound, m/s
240	60	400

Rutgers 275 Classical Physics Lab
"Standing Waves"
Contributed by Maryam Taherinejad and Girsh Blumberg ©2014, revised by V. Podzorov 2023.