Physics 200 (Stapleton) Name: B 5/6 (add d=rt)

Notes: Waves and Sound, Part 2 (odds and ends)

Frequency vs Period:

Frequency = # of waves/time

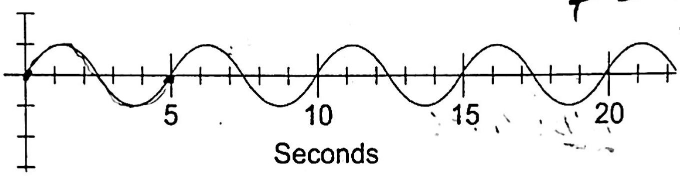
Period (T) = time/# of waves = time for one wavelength to pass

$f=1/T$ $T = 1/f$

Find f and T for the wave below.

$T = 5s$

$f = \frac{1}{5s} = 0.2Hz$



Transverse and Longitudinal Waves

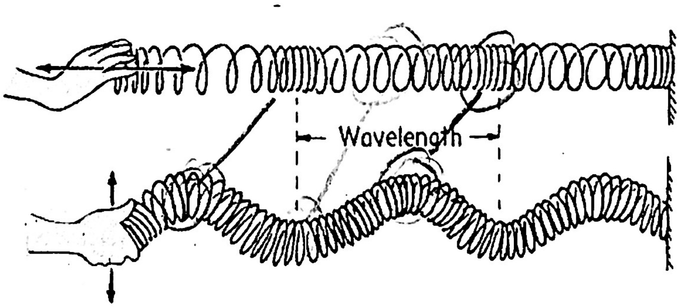
A. A transverse wave (a.k.a. shear wave, sinusoidal wave) is a disturbance perpendicular to the direction of propagation.

B. A longitudinal wave (or compressional wave) is a disturbance parallel to the direction of propagation.

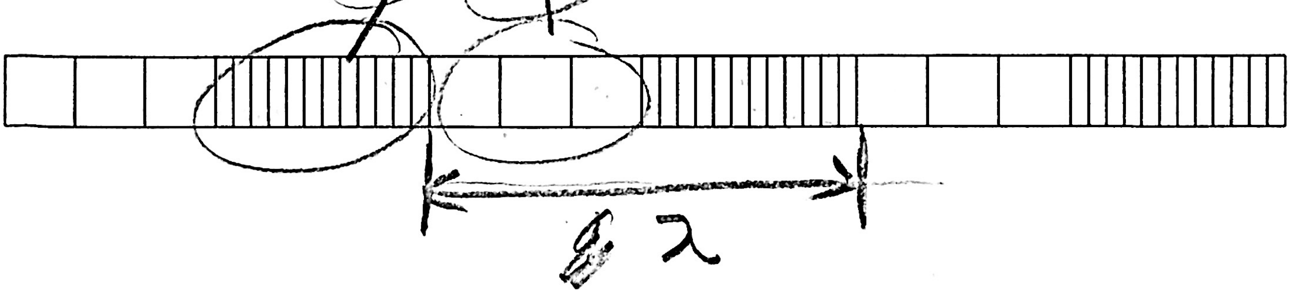
Longitudinal (a)

Identify the two different types of waves on the right.

Transverse (b)

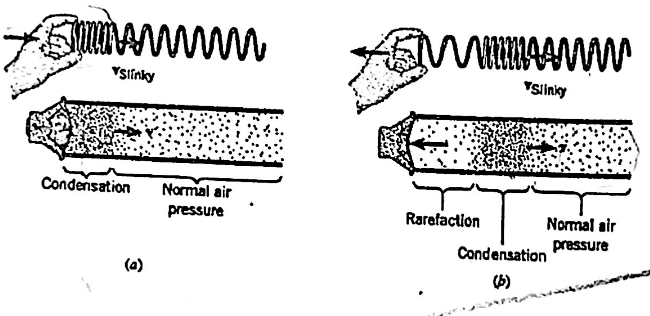


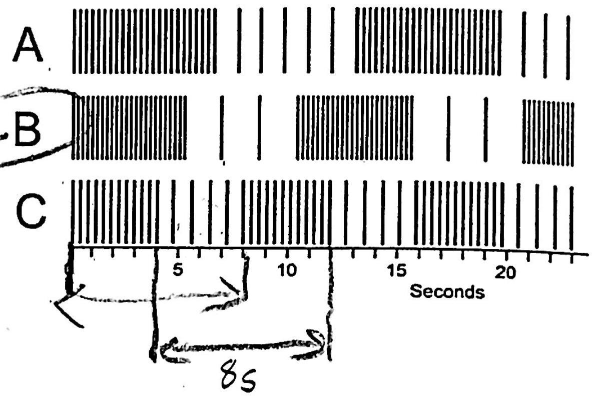
Parts of a longitudinal wave: compression, rarefaction, wavelength



λ

Formation of a sound wave (longitudinal wave, a.k.a. compression wave)





Which of the series of waves on the upper right shows the greatest amplitude? B

Which is the quietest? C

Find the period and frequency of wave C. T = 8s

f = 1/8 Hz = 0.125 Hz

Sound waves are longitudinal, but they can be represented as transverse waves.

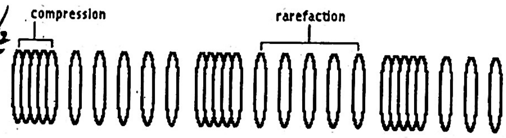


Figure 1: Longitudinal Wave

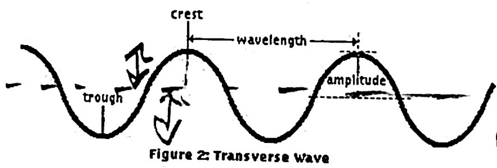


Figure 2: Transverse Wave

Speed of Sound, In Air:

The speed of sound in air depends, primarily, on temperature.

You can use either of the equations below to approximate the speed of sound in air, in m/s, where T = air temperature in degrees Celsius.

$V = 331.3 + 0.606\,T$ or $v = 331.3\sqrt{1 + \frac{T}{273.15}}$

T = 23.9°C

Estimate the temperature in this room and calculate the approximate speed of sound:

V = 331.3 + 0.606(23.9)

V = 345.8 m/s

Check For Understanding:

T = 1/f V = fλ

Answer Choices: Speed, Loudness, Period, Wavelength, Density of Compressions, Density of rarefactions

1. Sound Wave A and Sound Wave B are produced in the air of the same room at the same time. If they have the same frequency but different amplitudes, which of the characteristics above may differ for the two waves?

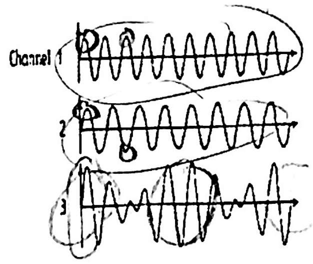
   Loudness, Density of Comp, + Rar.

2. Which of these characteristics (if any) change(s) as the observer moves farther away from the source? In other words, if you hear the same wave at a closer distance vs a farther distance, what changes?

   Same things

Wave Interference and Beats:

Wave Interference can cause **"beats"**. When two waves have slightly different frequencies, their interference alternates between constructive and destructive. The diagram below shows transverse representations of two sound waves (channels 1 and 2) and their resultant sound (channel 3).



- In the diagram, label the channel with the highest frequency (1 or 2).
- Then label regions of constructive and destructive interference. Channel 3 is the "sum" of channels 1 and 2.
- Label the "beats" that will be heard

Beat frequency =difference in frequencies of two notes that are played together
Example: What is the beat frequency when 220Hz and 216Hz are played at the same time? 4Hz

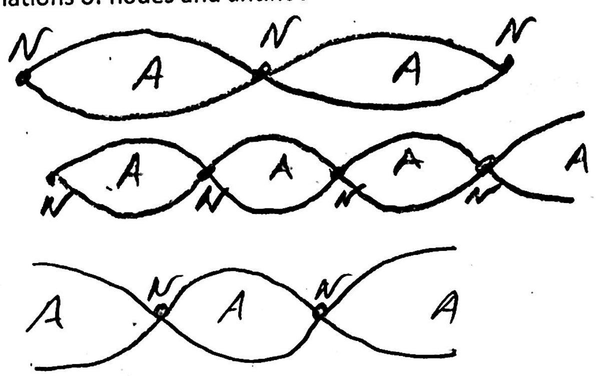
Standing Waves Revisited:

What are the rules for drawing standing waves?

1. Antinodes + nodes alternate
2. If an end is free to move, it is a(n) antinode. If an end is fixed, it is a(n) node.

Draw a vibrating string with the combinations of nodes and antinodes below. Take note of free and fixed ends.

- 3 nodes, 2 antinodes
- 4 nodes, 4 antinodes
- 2 nodes, 3 antinodes



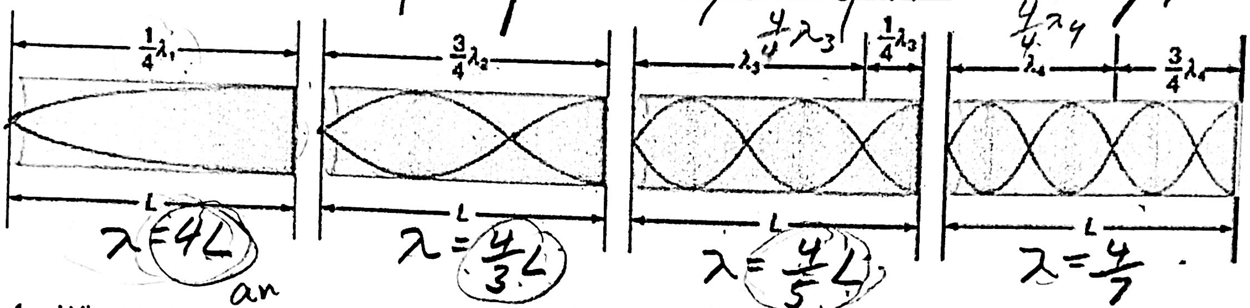
Harmonic Nomenclature:

- The "Fundamental" (a.k.a. 1st harmonic) is the standing wave pattern with the longest possible wavelength
- The 2nd harmonic (if there is one – sometimes there isn't) has a frequency that is 2x the fundamental frequency, and a wavelength that is 1/2 the wavelength of the fundamental. The nth harmonic has a frequency of n times the fundamental frequency and a wavelength equal to 1/n times the wavelength of the fundamental.
- FYI, "Overtones" are all of the harmonics, beginning with the second, numbered without gaps.

1st overtone / 3rd Harmonic — 2nd overtone / 5th Harmonic — 3rd overtone / 7th Harmonic

Standing Sound Waves in a Tube

Wavelengths and Harmonics in a tube open at one end (e.g. an organ pipe)



1. What is ~~the most~~ an important difference between standing sound waves in a pipe and standing waves on a string?

   transverse — longitudinal

2. The diagram above represents the organ pipe waves as transverse waves. In reality, they are longitudinal. What is really happening to air molecules at the antinodes?

   Moving left and right

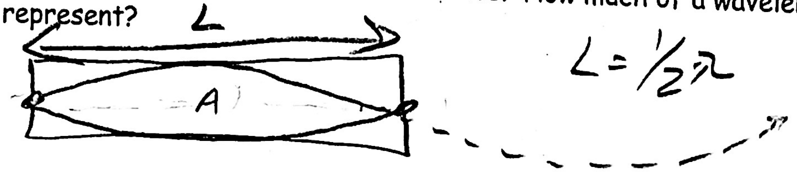
3. At the nodes, what are the air molecules doing?

   Not moving

4. For the fundamental, explain why there is a node at the left end and an antinode at the right?

   Air can move in and out — Pipe is closed (Air can't move)

5. Draw the fundamental for a pipe that is closed at both ends. How much of a wavelength does the pipe length represent?



   $L = \frac{1}{2}\lambda$

6. On the diagram above, write an equation for wavelength in terms of tube length, for each standing wave pattern.

7. On the diagram, label the standing wave patterns with their harmonic names.

8. If you're interested, label the standing waves using the term "overtone," rather than the term harmonic.