Resonance & Volume

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I. Wave-Interference Simultaion

Watch the simulation linked in the readings column.
(Here’s the link again, just in case: www.walter-fendt.de/html5/phen/standingwavereflection_en.htm)

The simulation shows a wave pulse bouncing off a barrier and interacting with itself.

To start the simulation, just click "start." No need to change any settings.

Then wait for the waves to travel across the "string" and begin to bounce off the barrier on the right. This will take a minute, so be patient.

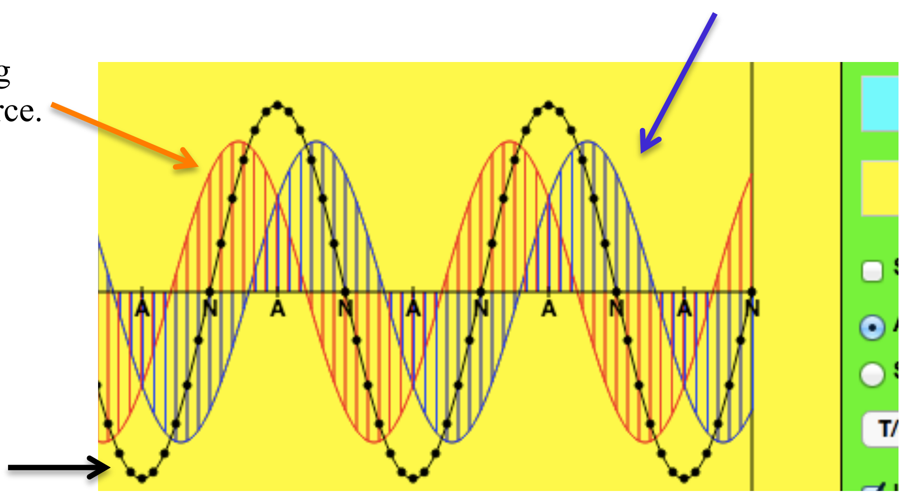
Once the waves start to bounce, the waves coming back to the left (blue) will start to interact with the waves traveling to the right (red).

The resulting interference pattern is shown in black. (See image below.)

Keep watching as the bouncing waves travel back all the way across the "string." You now have a fully formed standing wave.

Left-moving
reflected off barrier.

Right-moving
waves fr source.



Resulting
interference
pattern.

Watch this standing wave for a while. Notice how the reflecting (blue) waves go in and out of phase with the original (red) waves.

Answer the following questions:

A. What does the resulting interference-pattern look like when the red & blue waves are exactly out of phase?
B. What the interference-pattern look like when the when the red & blue waves are perfectly in-phase?
C. What do you notice about the nodes?
D. What do you notice about the anti-notes?

II. Standing Waves & Harmonics

A. 1-D: A string 30 cm long with a linear mass density of .65 g/m (6.5×10^{-4} kg/m) and subjected to 45 Newtons of tension.

1. Find the *fundamental frequency* for the string.
2. Find the *3rd harmonic* for the same string.

B. 2-D: Two speakers are placed 5 m apart. Both play an identical 440 hz tone at the same volume, in phase with each other. Assume that the speed of sound in air is 340 m/s.

Find the two points (locations) closest to the mid-point between the speakers at which a tiny microphone could be placed and perpetually pick up (detect, measure) nothing but silence.

i.e.: Find the *nodal* locations nearest to the *central antinode*.

III. Sound Volume & Speed

A. The master volume knob at a P-Funk concert is turned up: as a result, the intensity of sound waves, measured in Watts/m^2, increases by a factor of 10,000.

By how many decibels does the sound increase?

B. The sound volume at the center of a thunderstorm is measured at 120 dB.

Consider a spherical shell of radius 200 meters surrounding the storm center.

How much (kinetic) energy is accumulated in a typical minute by all the wave motion incident on this shell (captured by this shell)?

C. You see one lightning bolt and then, a short time later, hear the associated thunder.

You then hear thunder again -- with no intervening lightning. You realize that you're hearing the 'same' thunder, echoing off a nearby mountain range.

Explain how you could use this echo to make your own measurement for the speed of sound. What other data would you need?

D. Explain how counting the seconds between seeing a lightning bolt and hearing the thunder could allow you to measure (roughly) how far away the storm is.