ENGR 101 Tutorial Week 1: The Science and Technology of Sound

In this tutorial we will explore the physics of sound, learn a bit about the human ear, and how our sound technology is designed to work with the human ear.

You will need to make some sketches for this tutorial. The easiest way to do this is to sketch on paper, take a photo, upload the photo and insert into this document.

Two Kinds of Waves

When a wave passes through a medium, the medium wiggles. We will discuss two kinds of waves. Make sketches to show what happens in the medium in each case.

Transverse waves

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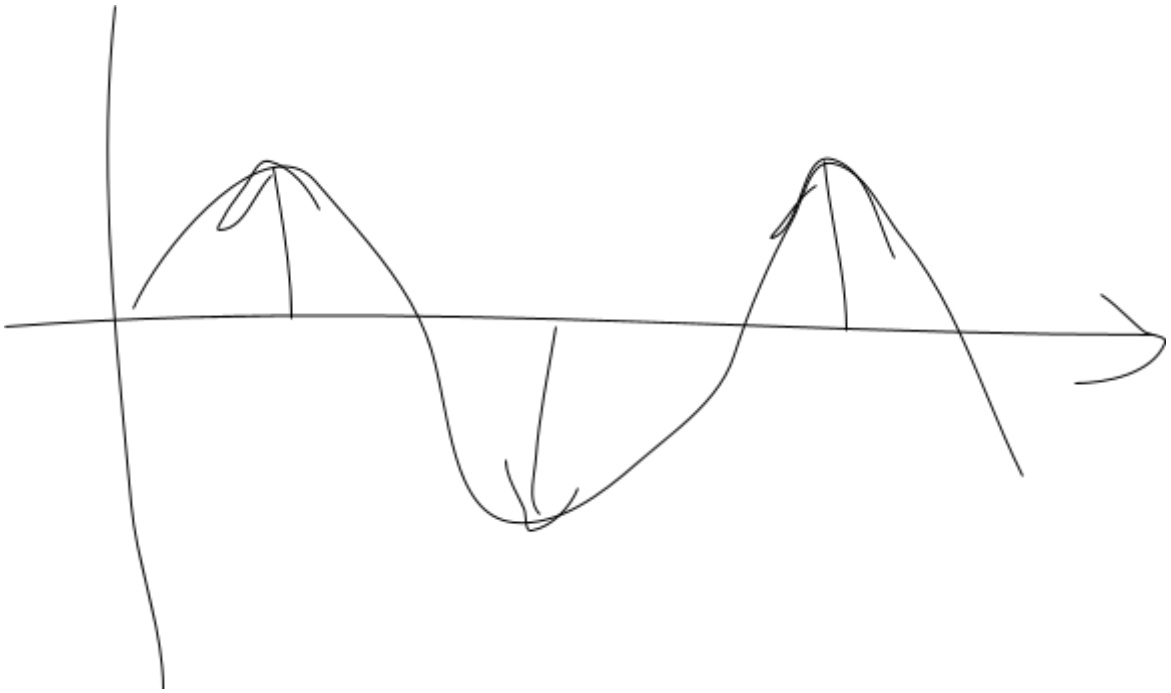

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Longitudinal or compressional waves

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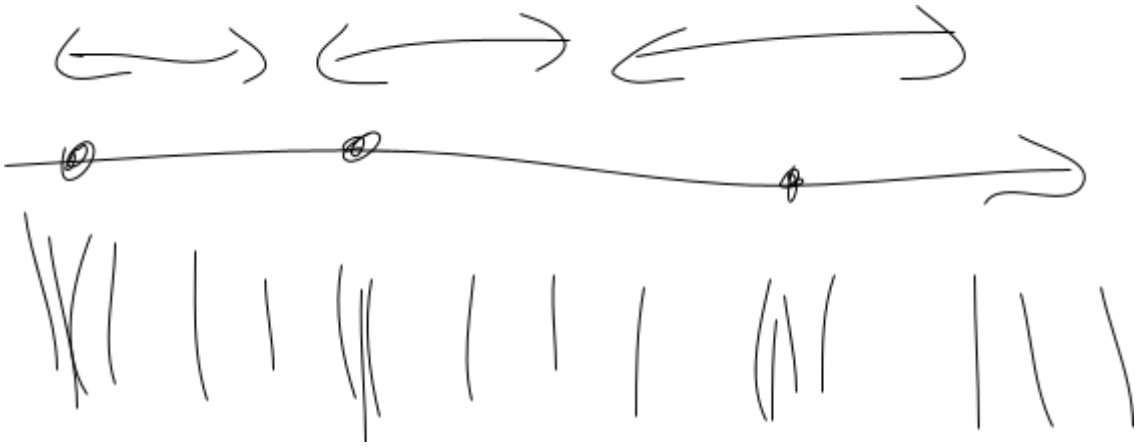

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Sound is a wave. What kind of wave is it?

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Sound is a longitudinal wave.

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Make a sketch connecting the mathematical sine wave to what is actually happening in the air.

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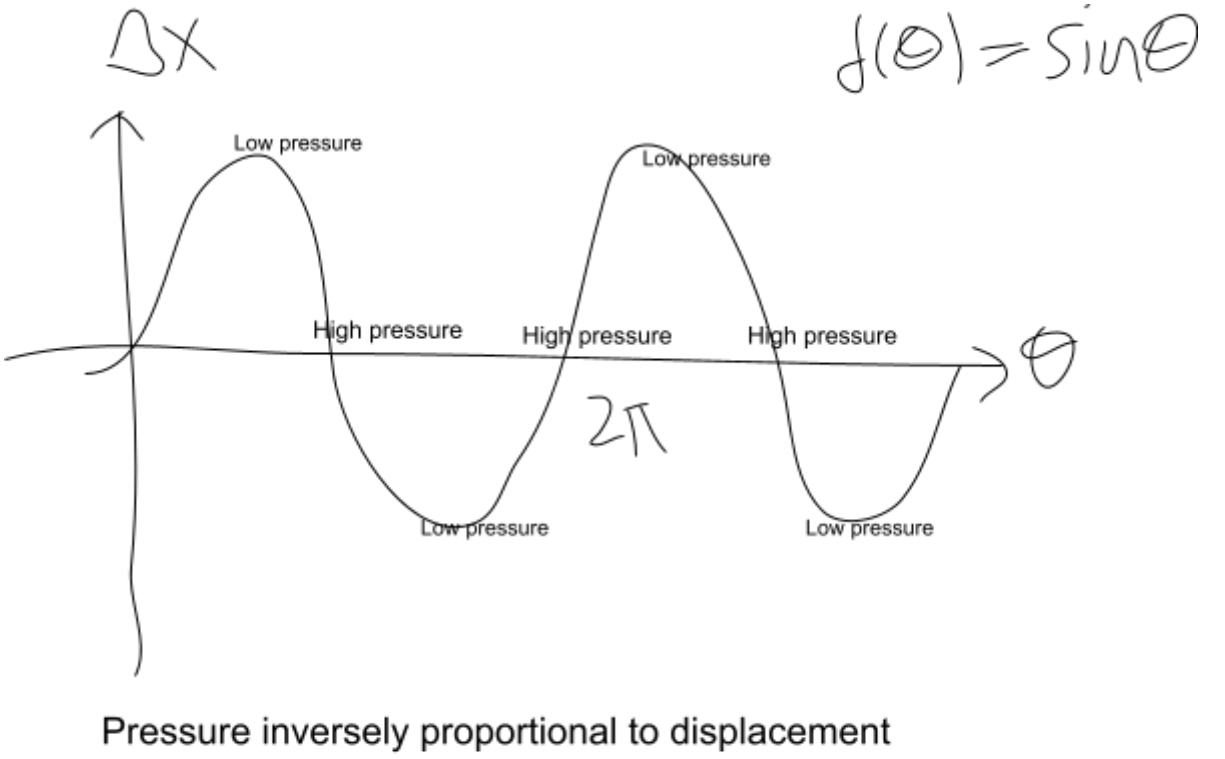

Pressure inversely proportional to displacement

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We will do a demonstration showing that the air is wiggling longitudinally when sound is present. Describe the demonstration very briefly.

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Grab a sheet of paper, hold it gently perpendicular to the ground, and speak in a low frequency into the paper at a close distance. This will result in vibrations in the paper.

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Explain briefly how a speaker works.

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AC current of frequency f → there is alternating direction of magnet, which repels and attracts a diaphragm and causes vibrations of frequency f → sound of frequency f (longitudinal waves)

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How can we show sound moves through air and does not carry air with it?

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Inhale inwards and then speak. You hear it, but the air is going inwards. Fart across the room. They hear it but don't smell it.
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Wave parameters
As seen on the Wave Demonstrator, describe what each of the wave parameters means and how they affect the sound. Sketches will be helpful. You should include wavelength, frequency, period, and amplitude. Also write a formula for the speed of a wave in terms of the other parameters. Note the speed formula works for all waves, not just sound.
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Wavelength = distance between two adjacent crests in the geography graph of the wave.
Frequency = how many waves pass through a given position per second.
Period = time it takes for the wave to move one cycle
Amplitude = maximum displacement of the wave from the equilibrium positions

V = f * wavelength (proven with v = d/t)
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Human hearing
What is the frequency range for human hearing (nominally)?
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20Hz → 20kHz
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Describe two technologies that make use of the usual decline of high frequency hearing with age.
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Teenager repellent and the mosquito ringtone
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Superposition
When two sound waves are present at the same time, what happens?
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The wave amplitudes add together (depending on the sign of the amplitude, either constructive/destructive superposition) occur and produce a new wave.

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Challenge
Give a mathematical description of a wave.
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Simple harmonic motion of a medium →

y(t) = Amplitude * sin((2pi * t) / period + phase shift)

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Find the amplitude, frequency, period, wavelength, and speed and direction of the following wave.

$y = 7sin(0.1x - 0.5t)$

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A=7
T = 4pi
Direction = negative
Wavelength = 20pi

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