## Physics of Everyday Life

Why do you take really short steps when you walk on ice? Why are hybrid cars more efficient for in-town driving? Why does a standard electric outlet have three holes, but many devices only use two of them? Why is the sky blue, and why are sunsets red? Why are new light bulbs so much more efficient than the old incandescent bulbs? These are examples of the questions that we'll work out in this class. Each class, we'll start with some hands-on experimentation to help us understand basic principles of motion, of electricity, of light, of sound of magnetism and other topics. And then we'll discuss how what we've learned applies to everyday life. Come prepared to be active, to be social, and to be amazed! You don't need any background in science—just a bit of curiosity and a willingness to engage and explore!

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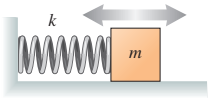
Week 1: Everything Is Electric
Week 2: Is It Magic, or Is It Magnets?
Week 3: On Your Wavelength: Electromagnetic Waves
Week 4: Physics of Sound & Music
Week 5: Energy, Thermodynamics & The Arrow of Time
Week 6: Push and Pull: Force & Motion
Week 7: Go With the Flow: Physics of Fluids
Week 8: A Warm Planet in a Cold Universe: How the Earth Stays Warm, and Why It's Getting Warmer

## Oscillations and Resonance

## Making Sound

#1: Need an oscillation

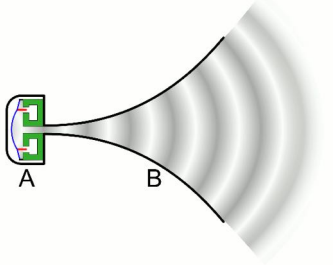
Mass on Spring




**When you push it to the side, something pushes it back.**

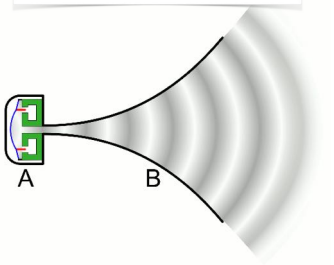
## Making Sound

#2: Need to create a wave in air

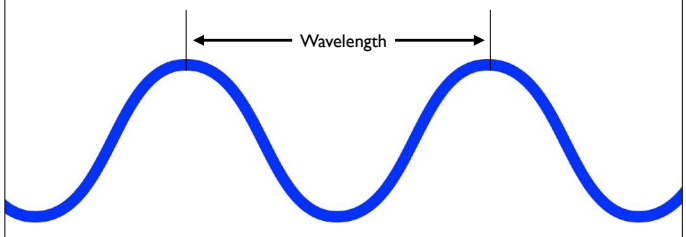



## Wave Property

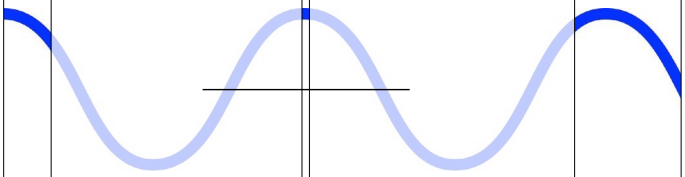
The air doesn't travel….The wave does!




## Frequency and Wavelength



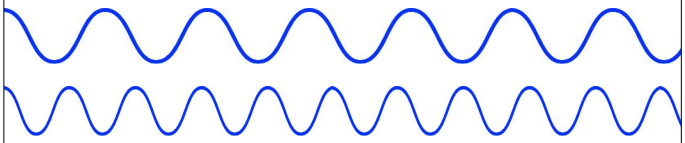

## Frequency and Wavelength



Frequency is how many waves per second hit one point.

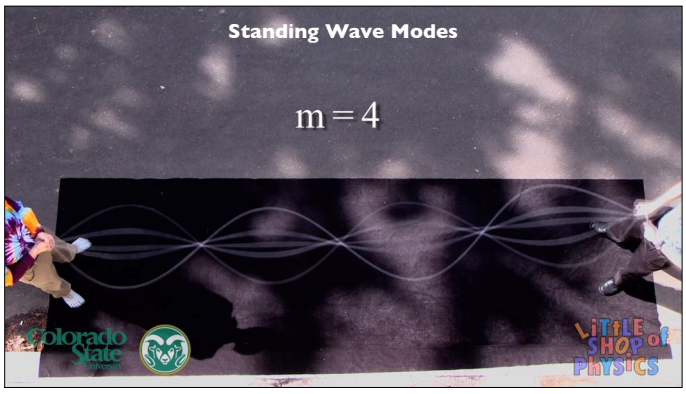
1 cycle per second = 1 hertz (1 Hz)

## Shorter wavelength means higher frequency.



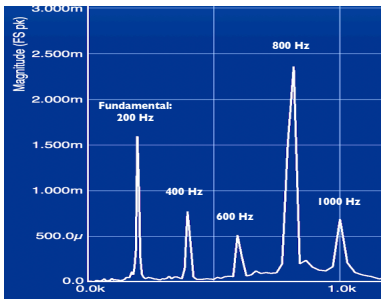
## Higher Frequency Means Higher Pitch

| | | | | |
|---|---|---|---|---|
| C | 4 | 261.626 | 1.301m | Middle C |
| C# / Db | 4 | 277.183 | 1.228m | |
| D | 4 | 293.665 | 1.159m | |
| D# / Eb | 4 | 311.127 | 1.094m | |
| E | 4 | 329.628 | 1.032m | |
| F | 4 | 349.228 | 0.974m | |
| F# / Gb | 4 | 369.994 | 0.92m | |
| G | 4 | 391.995 | 0.868m | |
| G# / Ab | 4 | 415.305 | 0.819m | |
| A | 4 | 440 | 0.773m | Tuning reference note |
| A# / Bb | 4 | 466.164 | 0.73m | |
| B | 4 | 493.883 | 0.689m | |

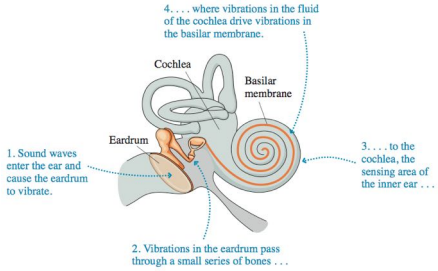



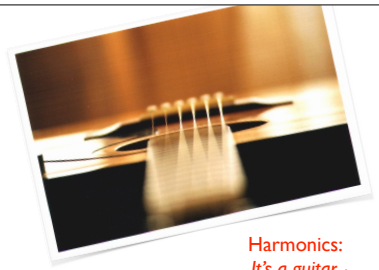

## Harmonic Series

Note sung at 200 Hz




## A Typical Sound is a Mix of Different Frequencies. Your Brain Decodes the Mix In Amazing Ways.



## Fundamental and Harmonics

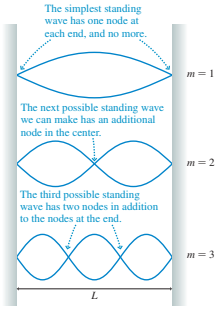
Fundamental: *It's a low A.*

110 Hz

Harmonics: *It's a guitar.*

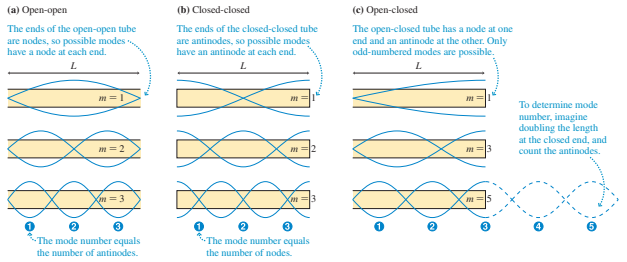
220 Hz
330 Hz
440 Hz
⋮

## Modes and Nodes



## Standing Sound Waves

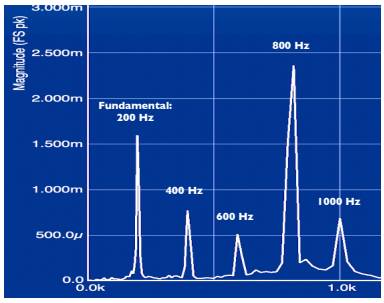
*Only certain conditions work.*




## Longer Tubes Mean Lower Pitches

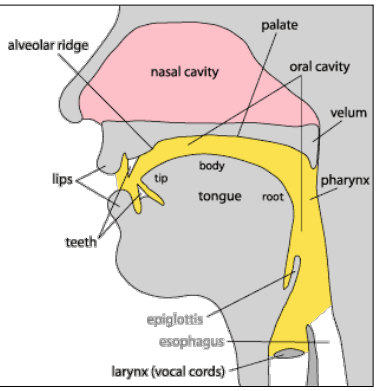
## Harmonic Series

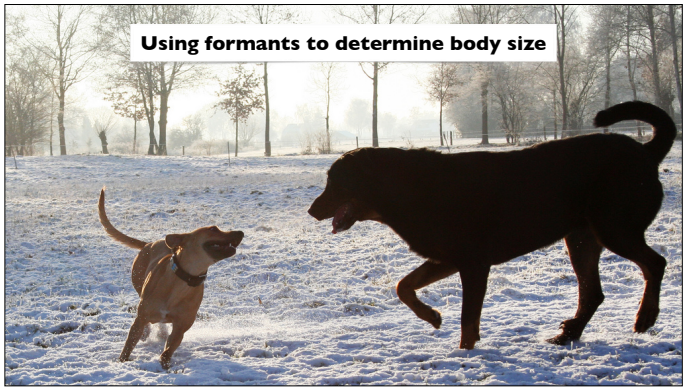
Note sung at 200 Hz




## Formants

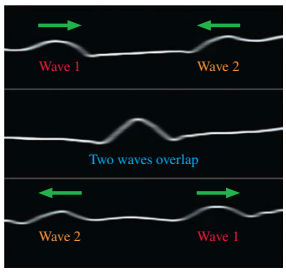
Resonances of Vocal Tract Source-Filter Model



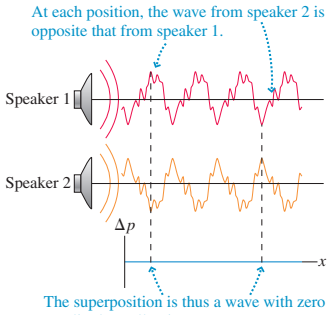




## Superposition

Where two waves meet, the displacement is the sum of the displacements of the two waves.



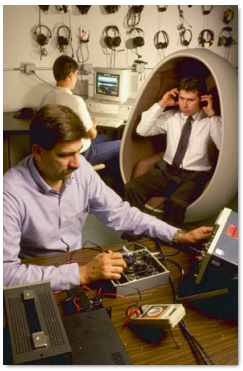

## Add a wave and its opposite

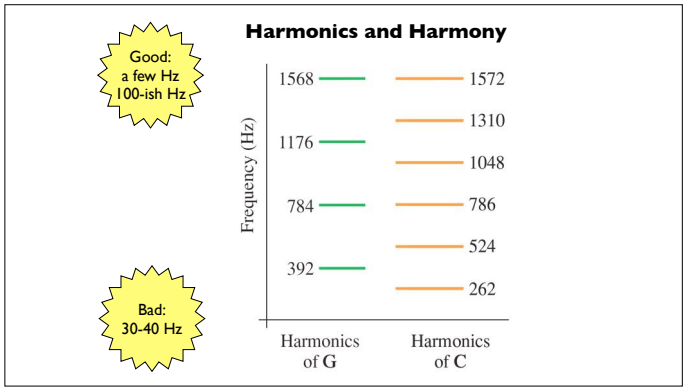


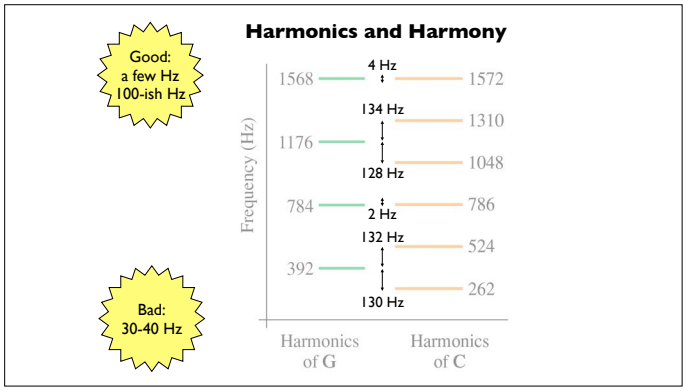

## Sound Canceling Headphones

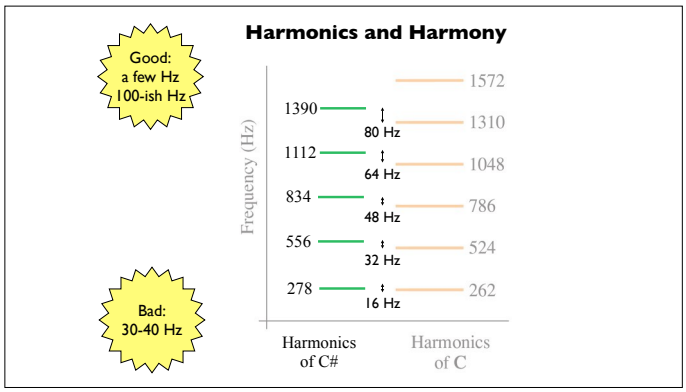
How can *adding* sound *reduce* the overall sound intensity level inside the headphones?

What is the point of the microphone outside the headphones?




Harmonics and Harmony
Good:
a few Hz
100-ish Hz
Bad:
30-40 Hz
Frequency (Hz)
1568
1176
784
392
1572
1310
1048
786
524
262
Harmonics
of G
Harmonics
of C


Harmonics and Harmony
Good:
a few Hz
100-ish Hz
Bad:
30-40 Hz
Frequency (Hz)
1568
1176
784
392
4 Hz
134 Hz
128 Hz
2 Hz
132 Hz
130 Hz
1572
1310
1048
786
524
262
Harmonics
of G
Harmonics
of C


Harmonics and Harmony
Good:
a few Hz
100-ish Hz
Bad:
30-40 Hz
Frequency (Hz)
1390
1112
834
556
278
80 Hz
64 Hz
48 Hz
32 Hz
16 Hz
1572
1310
1048
786
524
262
Harmonics
of C#
Harmonics
of C