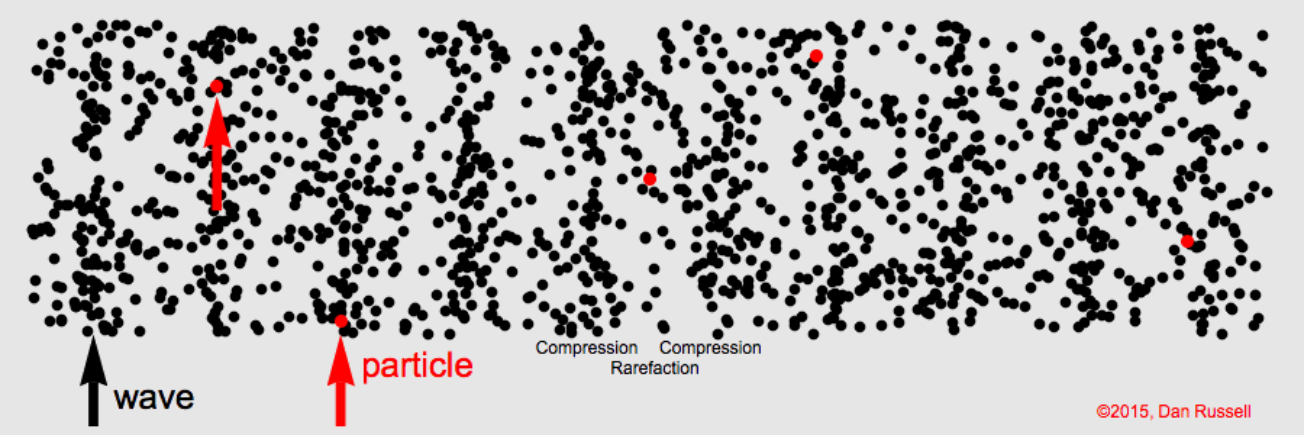
C.2

Sound

IB PHYSICS | WAVE RESONANCE

Sound Waves start as Vibrations

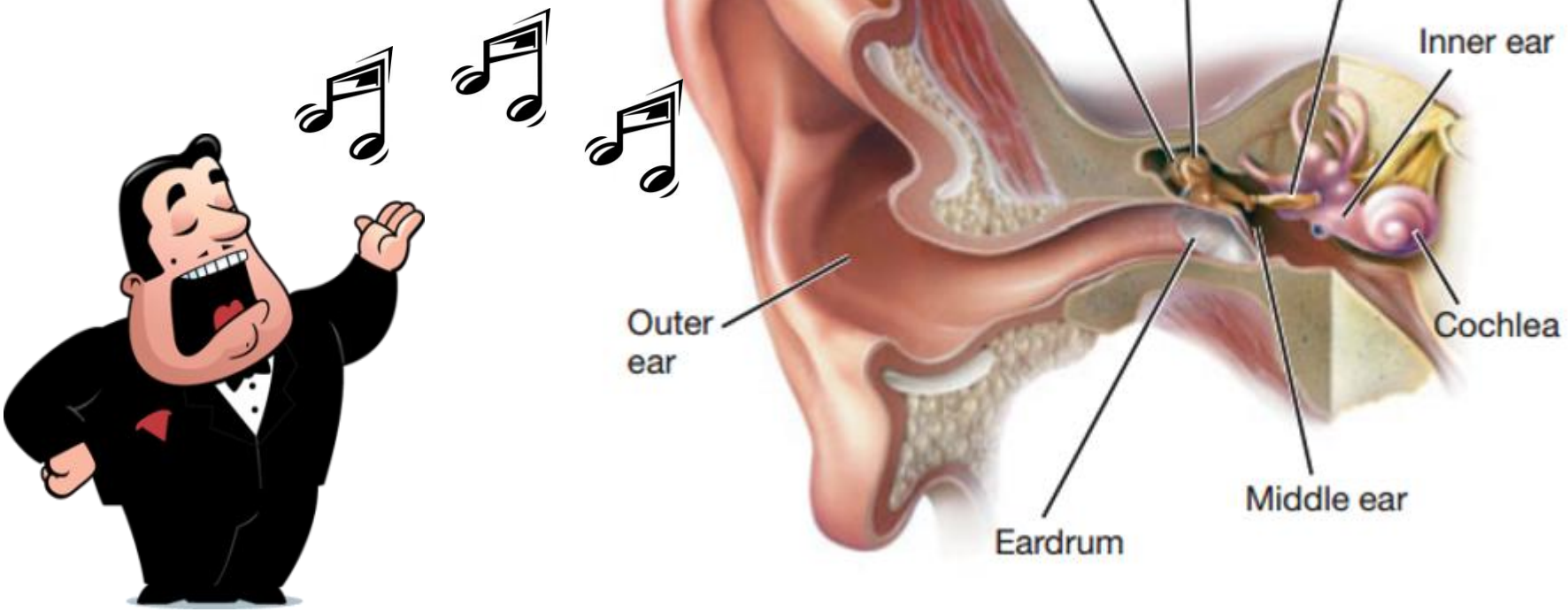


What kind of wave is sound?

Longitudinal

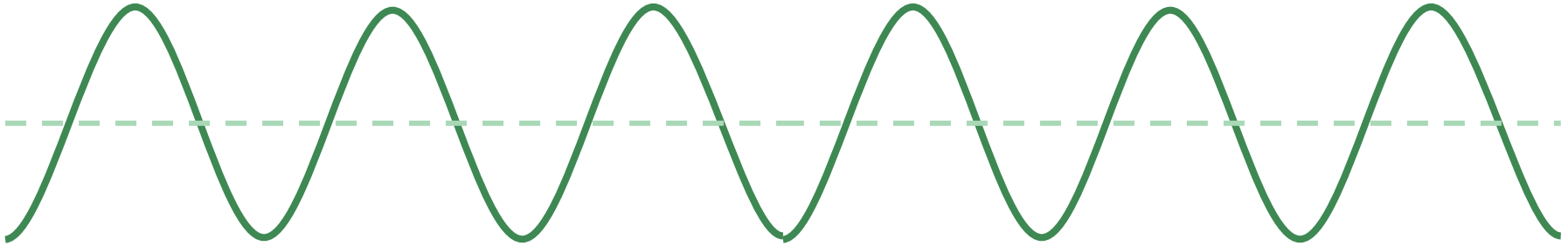
Sound is Pressure

Vibrations pressurize the air molecules and those pressure waves cause our ears to vibrate too!

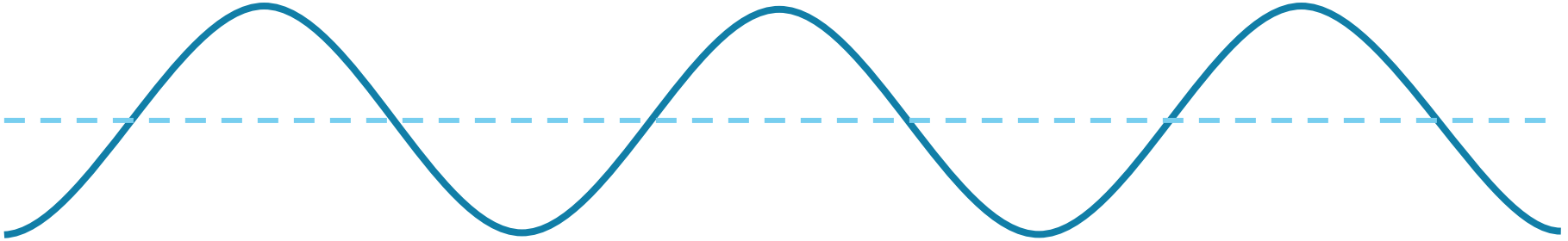


Pitch is Related to Frequency

High pitched sounds have **high** frequencies



Low pitched sounds have **low** frequencies



Speed of Sound Depends on Medium

Medium	Speed of sound (m/s)	Medium	Speed of sound (m/s)
Gases		**Liquids at 25 °C**	
Air (0 °C)	331	Water	1,490
Air (25 °C)	346	Sea water	1,530
Air (100 °C)	386	**Solids**	
Helium (0 °C)	972	Copper	3,813
Hydrogen (0 °C)	1,290	Iron	5,000
Oxygen (0 °C)	317	Rubber	54

Air (25 °C)

760 mph

0.21 miles/sec

Speed of Sound for Air (at any temp)

$$v = 331 \text{ m s}^{-1} + 0.6 \times (\text{Temp in °C})$$

Speed of Sound Depends on Medium

Why does Medium Affect Speed?

molecule spacing

Medium	Speed of sound (m/s)	Medium	Speed of sound (m/s)
Gases		**Liquids at 25 °C**	
Air (0 °C)	331	Water	1,490
Air (25 °C)	346	Sea water	1,530
Air (100 °C)	386	**Solids**	
Helium (0 °C)	972	Copper	3,813
Hydrogen (0 °C)	1,290	Iron	5,000
Oxygen (0 °C)	317	Rubber	54

Do other factors increase speed?

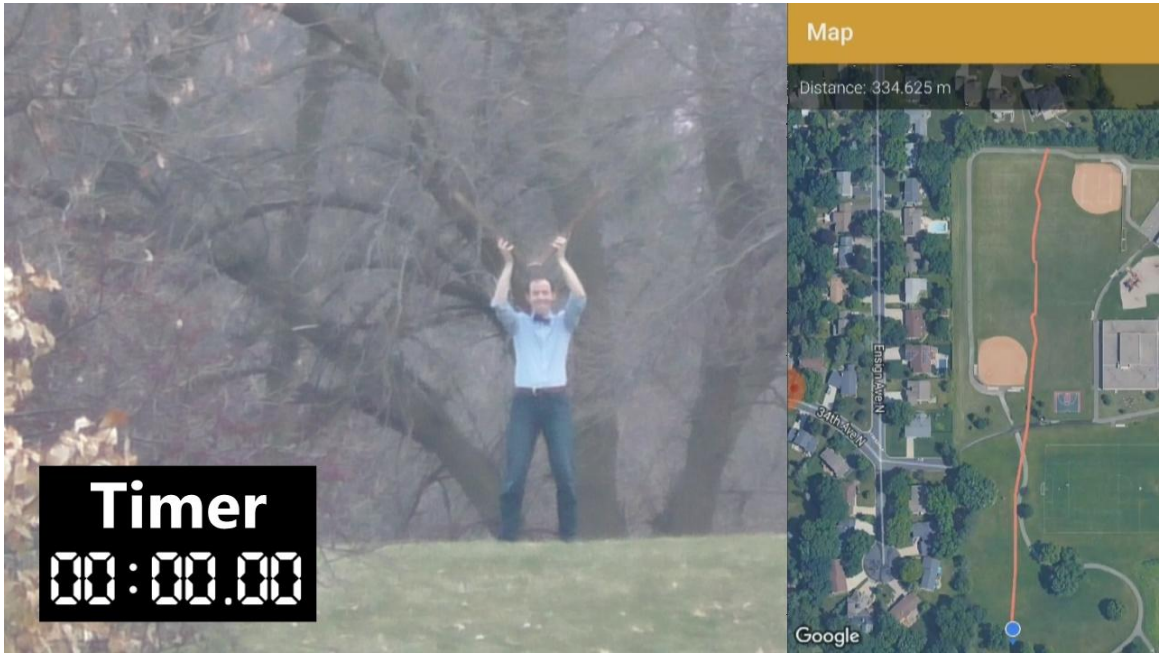
Frequency? No

$$v = f \times \lambda \qquad v = \not{f} \times \not{\lambda}$$

Amplitude? No

*Independent from all other wave properties

Sound is fast, but not THAT fast…



$$d = 335\ \text{m}$$

$$t = 0.935\ \text{s}$$

$$v = \frac{d}{t} = \frac{335\ \text{m}}{0.935\ \text{s}} = \mathbf{358\ m\ s^{-1}}$$

Using the Speed of Sound

You see lightning strike and immediately start counting, once you get to 7 seconds, you hear the boom of thunder. How far away is the storm?

Air (25 °C)

346 m/s

760 mph

0.21 miles/sec

$$d = vt = (0.21)(7)$$

$$= \mathbf{1.47\ miles}$$

Shortcut for Clocking a Storm

As soon as you see lightning strike, start counting…

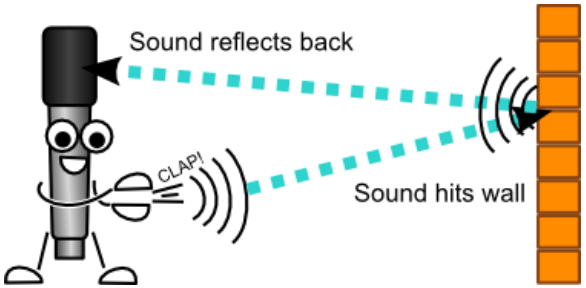
One one thousand, Two one thousand…

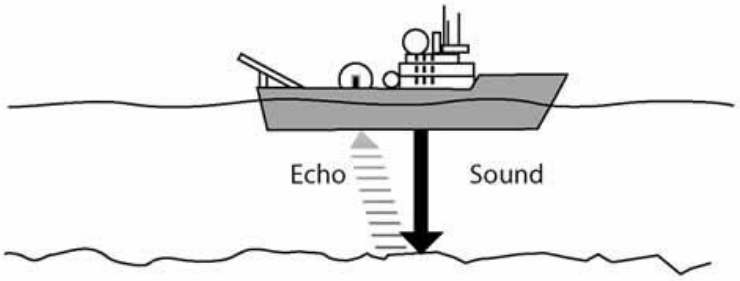
Stop counting as soon as you hear the thunder from that bolt of lightning

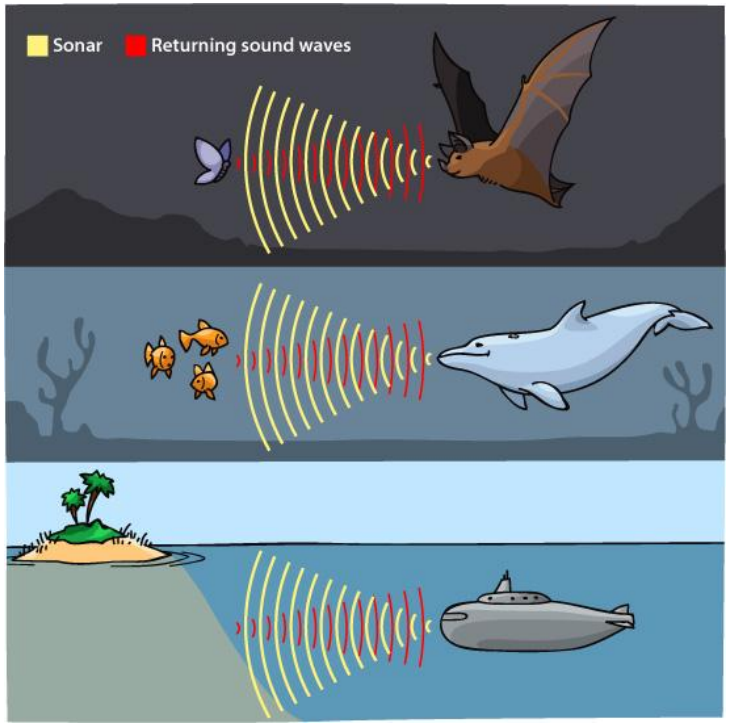
Distance in Miles = Time / 5

ECHO…. Echo…. Echo….

When you hear an echo, you are hearing the sound after it has reflected off of an object and returned to your ear







Calculating Distance from an Echo

A saxophonist plays a duet with himself using the echo of the sound in a long pipe. If the speed of sound is 340 m/s and echo returns 1.3 seconds after the original sound, how long is the pipe?

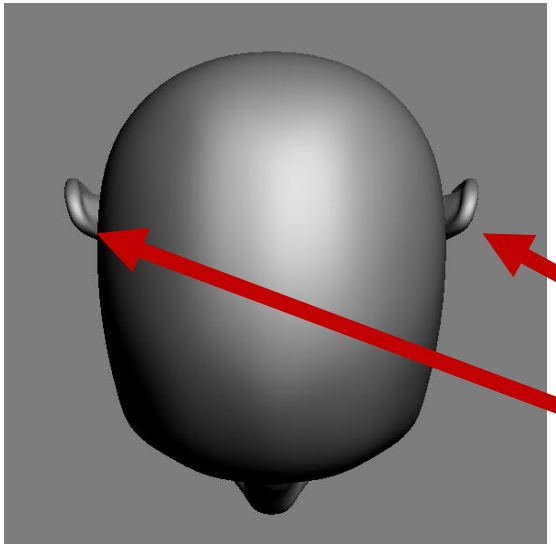
$$v = \frac{d}{t}$$

Only half the time to go one way

$$d = vt = (340)(0.65) = \mathbf{221\ m}$$

How do we locate sounds?

Sound reaches one ear before the other. It also sounds different from different locations due to the shape of our ears.



Lesson Takeaways

- ❑ I can relate the pitch of a sound to the frequency of the sound wave
- ❑ I can describe why sound travels at different speeds in different media
- ❑ I can calculate how far a distant object is by timing an echo