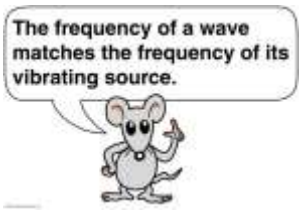
Ch. 12 Sound

AP Physics B

11.1~11.3 What's a Wave?



- What's a wave?

  Propagation of energy!

  Think of a wave moving across a field of wheat. What goes from one end of the field to the other?

  What happens to the wheat when the wave gets to it?

  Does the wheat itself go very far?

What causes waves?

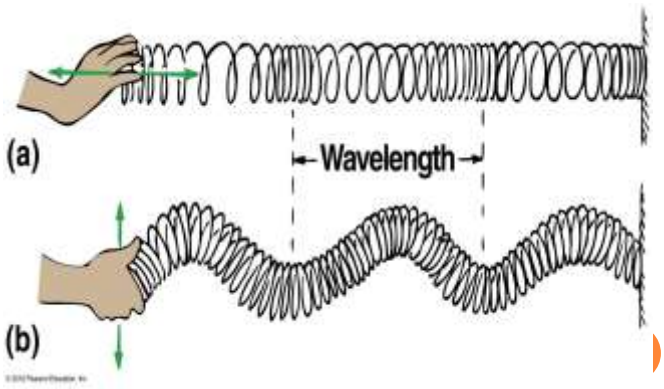
What causes waves?

- Vibrations

11.1~11.3 What's a Wave?

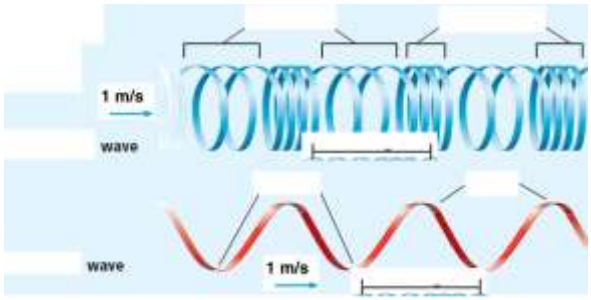
- Types of waves: http://en.wikipedia.org/wiki/Sound_speed
- Demo: CISE 11.6

- Longitudinal (Sound)
- Transverse (Light)



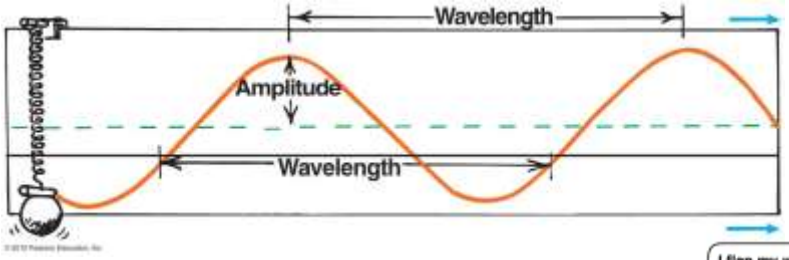
Pop Quiz

1. A wave carries _____
2. Waves that require a medium are called _____ waves
3. Waves that do not require a medium are called _____ waves.
4. Waves produced by a combination of longitudinal and transverse waves are called _____ waves.
5. What kind of a wave is each?
6. Label the parts of the waves.



- 2 types of waves
  - Needs to move through a medium (**MECHANICAL**)
  - Can move through vacuum **(ELECTROMAGNETIC)**

11.1~11.3 What's a Wave?

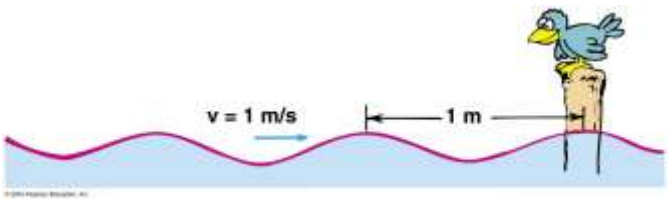


- Frequency *f* (Hertz = Hz) = cycles/seconds
  = how fast something oscillates
- Period *T* (seconds) = How long it takes to complete 1 cycle
  = 1/*f* = time/cycles
- Wave speed = how fast the *wave* travels

- What is the difference between the "how fast" in wave speed and the "how fast" in frequency?
  - Wave speed involves distance and time
  - Frequency only involves time

Parts of a Wave

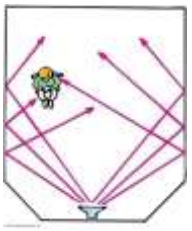
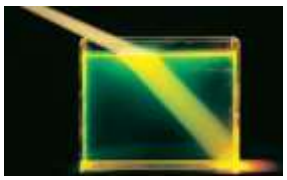
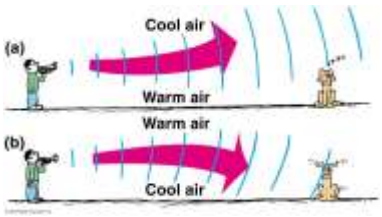
WAVE PART	CONTROLLED BY	RELATION
Amplitude	Source	A ↑ → energy ↑
Frequency	Source's shaking	f ↑ → energy ↑, λ ↓
Wave speed	Medium	
Wavelength	v = λ f	λ ↑→ energy ↓, f ↓



Wave Interactions

- Reflection
- Refraction
- Diffraction
- Interference

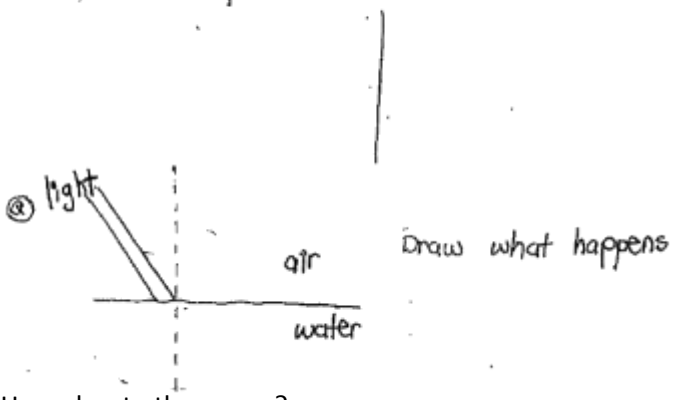


20.3 Refraction

- Refraction =

Draw 2 examples

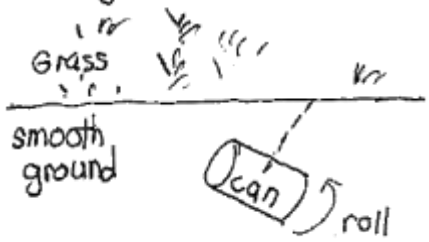


Draw what happens

- How about other cases?
  - Perpendicular incidence?
  - Slow to fast?

20.3 Refraction

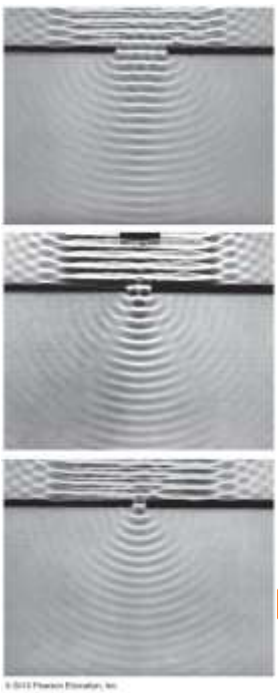
@ Why is a refracted light wave bent?



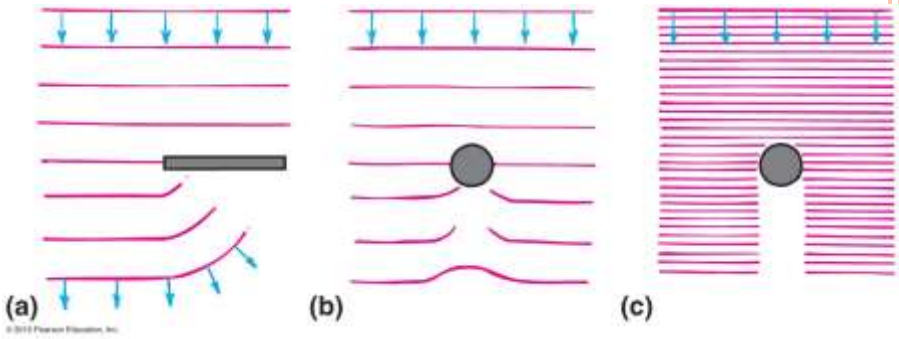
- Draw what happens. Why?

13.3 Diffraction

- See Pg. 247



13.3 Diffraction

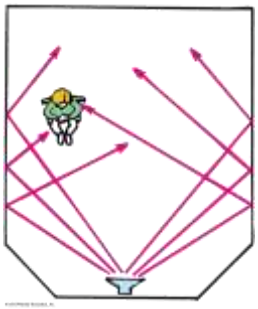


13.3 Diffraction

- Fuzzy shadows
  Use laser (monochromatic)
  1 wavelength
  Interference for fringes

11.6 Sound Can be Reflected

- Echo = reflected sound wave.
- Refection, transmission, absorption.
- Law of reflection: incident and reflected waves have the same angle.
- Reverberations: multiple reflections of sound.
- Interesting fact: ellipse



11.6 Sound Can be Reflected

- Echo = reflected sound wave.
- More sound energy reflects from rigid smooth surface than a soft surface (less absorption)

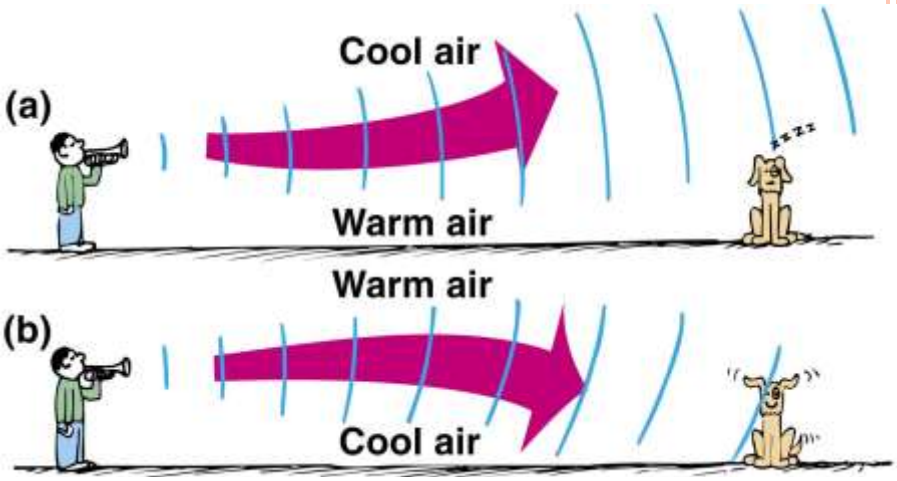
- If you can see it, you can hear it.

11.7 Sound can be Refracted

- Reflection: when a wave bounces back
- Refraction: when a wave bends due to difference in medium
- Diffraction: when a wave bends around a corner.

11.7 Sound can be Refracted

- Sound waves bend when they go through different materials.



11.7 Sound can be Refracted

- Differences in water temperature → blind spots for submarines (undetectable by ultrasonic waves)

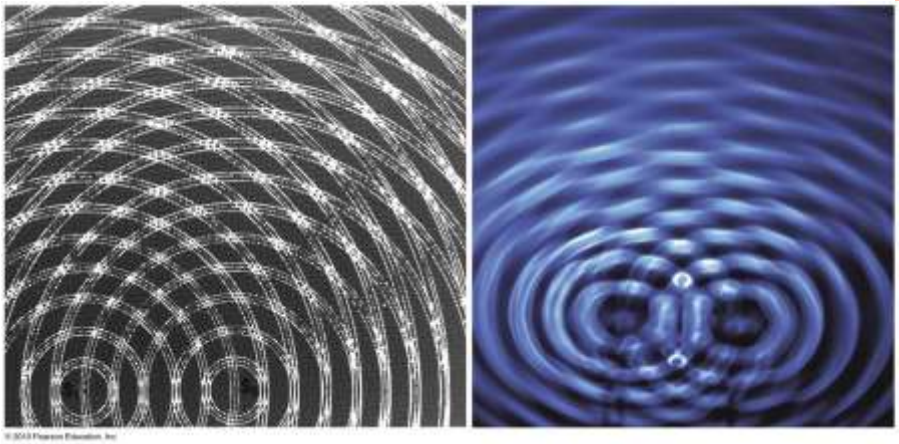
Echolocation

- Dolphins emit ultrasonic waves and their echoes' time delay to know location of object.
- They can replicate the echo for others.

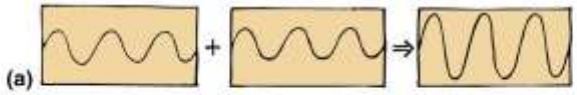
11.10 Interference

- Interference: when waves add or substract.
- Constructive: the new wave is bigger.
- Destructive: the new wave is smaller.
- See link

11.10 Interference



11.10 Interference

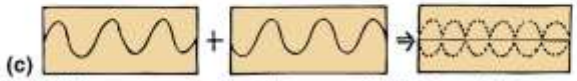


(a)

The superposition of two identical transverse waves in phase produces a wave of increased amplitude.

(b)

The superposition of two identical longitudinal waves in phase produces a wave of increased intensity.



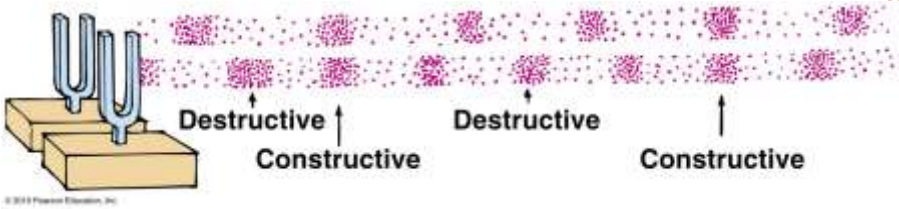
(c)

Two identical transverse waves that are out of phase destroy each other when they are superimposed.

(d)

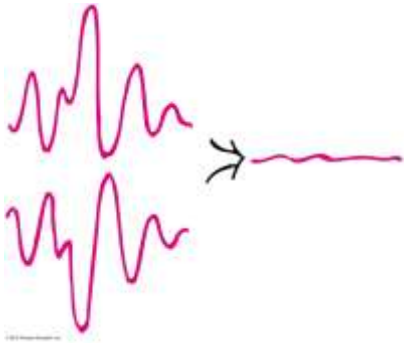
Two identical longitudinal waves that are out of phase destroy each other when they are superimposed.

11.10 Interference



11.10 Interference

- Anti-noise headphones



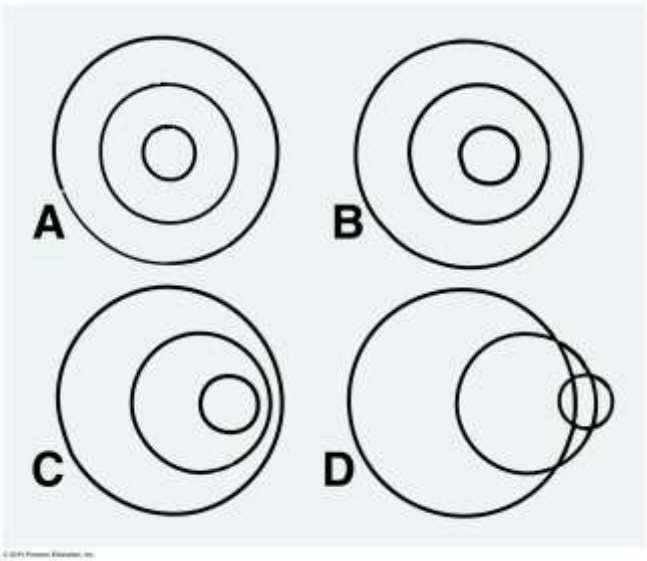
11.10 Beats

- Beat = pulse due to interference
- http://en.wikipedia.org/wiki/Beat_frequency
- http://www-math.mit.edu/daimp/Beats.html

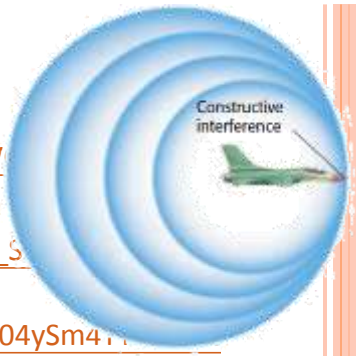
11.10 Interference

- Discover (Pg. 209)

Doppler Effect, Shock Wave, Sonic Boom



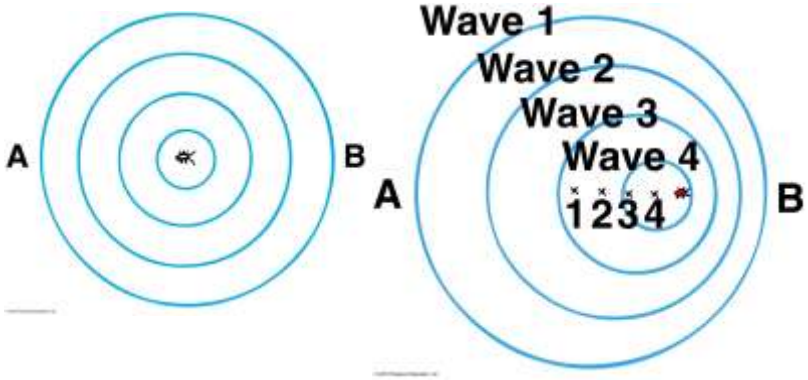
Sonic Boom!!!!



- http://www.youtube.com/watch?v=gW
- http://www.youtube.com/watch?v=_0_S
  ure=fvst
- http://www.youtube.com/watch?v=QX04ySm4
  ure=related

Figure 7 *When a jet travels at supersonic speeds, the sound waves it creates spread out behind it in a three-dimensional cone shape.*

11.11 Doppler Effect



11.11 Doppler Effect

Ch. 11 Resonance

AP Physics B

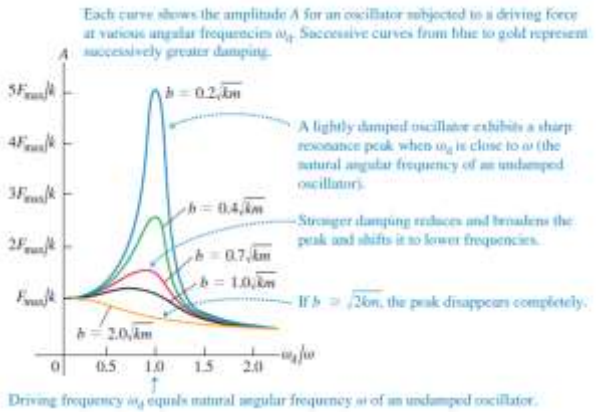
11.8 Natural Frequency

- Forced vibration: when you make something vibrate "unnaturally"

- Natural Frequency: every elastic object will vibrate at its own special frequency.

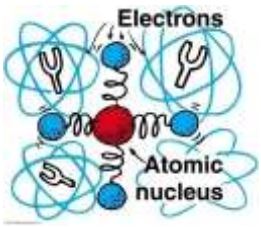
  Drop an eraser, a pencil… the sounds are different. They vibrate at their own special frequencies.

  Tuning fork has its own natural frequency.



12.2 Transparent? Opaque?

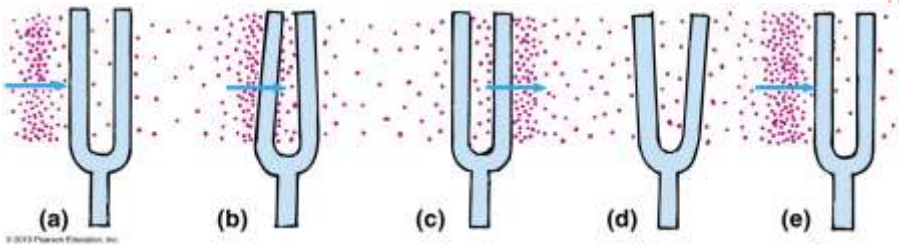
- Resonance: when an elastic object is pushed at its special frequency → amplitude increases a lot



11.9 Resonance

- Natural or resonant frequency: special frequency at which an object vibrates when disturbed.
- Resonance: when you push the object at its natural frequency, the vibration increases a lot.
- Child on a swing.

11.9 Resonance



11.9 Resonance

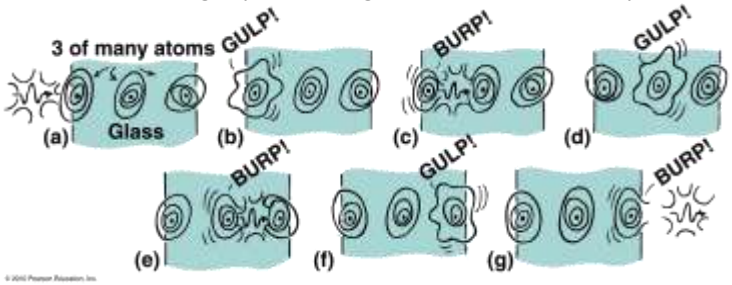
- Break Step

- More examples?

12.2 Transparent? Opaque?

- Transparent: Light can pass through.

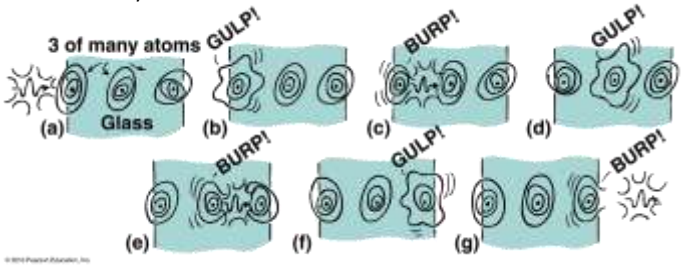
  Clear glass
  - Lets all visible light pass through. There is a time delay.



  - Absorbs ultraviolet waves. (resonance of electrons)
  - Absorbs infrared waves (too long, molecules resonate)

12.2 Transparent? Opaque?

- Speed of light:
  - $c = 3 \times 10^8$ m/s in vacuum

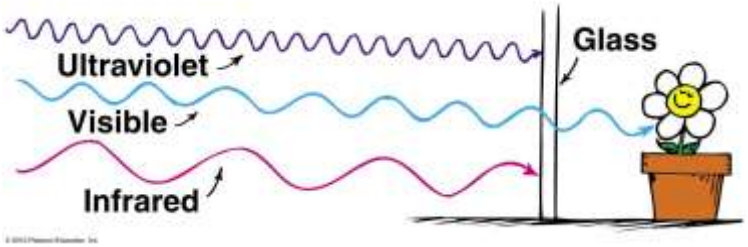


- Speed of light in material:
  - Photons still travel at c between atoms.
  - Photons overall travel slower based on how long the atoms gulp them.
  - Water: 0.75 c
  - Glass: 0.67 c
  - Diamond: 0.41 c

12.2 Transparent? Opaque?

- Pg. 219 Check Your Thinking

1. Why is glass not transparent to ultraviolet light?
2. Why is glass transparent to visible light?
3. Why is glass not transparent to infrared light?
4. Pretend that while you walk across a room you make several short stops to greet people. How is this similar to visible light traveling through glass?
5. In what is it not similar?

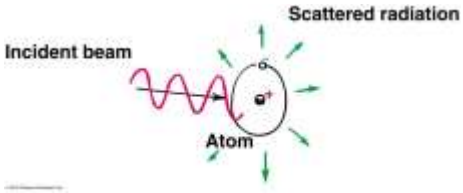


12.3 Color Science

- Why the Sky is blue

  Scattering: tiny tiny particles (~wavelength of light) re-emit light at high frequencies in all directions.

- Violet is scattered most. Then blue, green, yellow, orange, red.
- We don't see violet well, so we see most of the blue scattered light.



12.3 Color Science

- Why is the sky blue?

  Small particles (clear, dry day) scatter blue most.

  Bigger particles (humid day) scatter lower frequencies too → whitish

  Big big particles (pollution) scatter low-frequency light or absorb instead of scatter → brownish haze

12.3 Color Science

- Radiant blue lake (blue-jay feathers)
  Tiny particles scatter blue most.

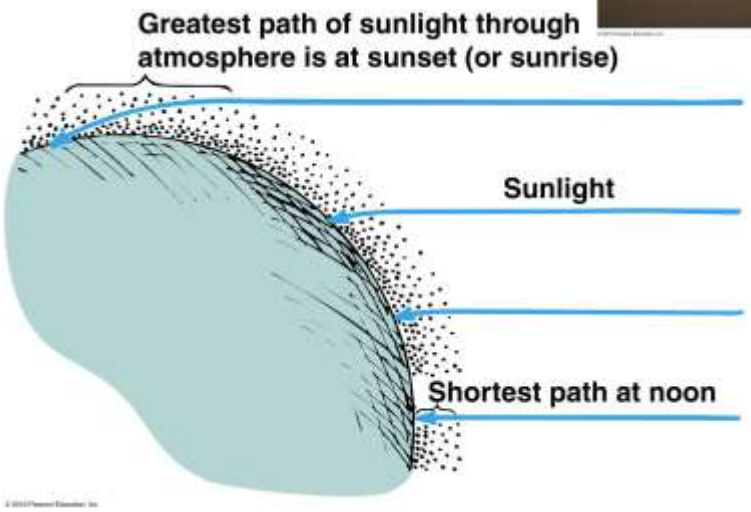
12.3 Color Science

- Check Your Thinking (Pg. 229)

1. When you see a blue sky, are you looking at blue frequencies that have been scattered, absorbed, or transmitted?

2. If molecules of the atmosphere transmitted blue light frequencies and scattered red light frequencies, what color would the sky appear?

Why sunsets are red



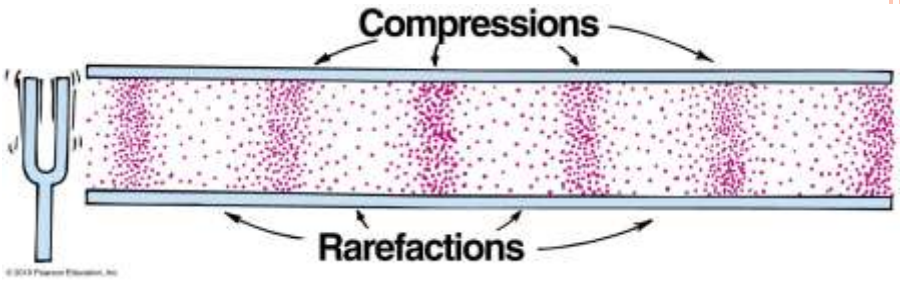
Why Clouds are White and Bright And Gray when Rainy

11.5 Speed of Sound

- Page 200 Check Your Thinking
- 1. Do compressions and rarefactions in a sound wave travel in the same direction or in opposite directions from one another?
- 2. What is the approximate distance of a thunderstorm when you note a 3-s delay between the flash of lightning and the sound of thunder? (Use 340 m/s for the speed of sound).
- You are at a concert sitting 45 m from stage. If you listen with a radio feed in one ear and nonbroadcast sound signal in the other, which signal will reach your ear first?

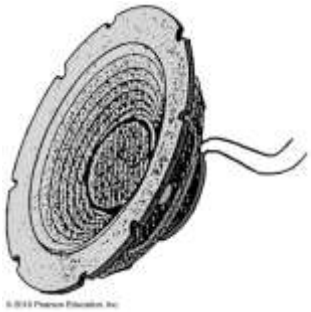
11.4 Sound travels in waves.

- Wavelength?



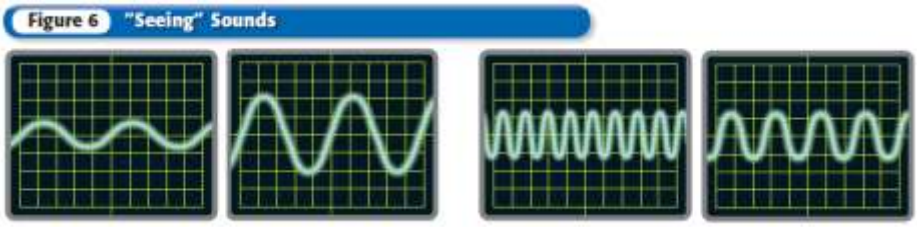
LOUDSPEAKERS

- Electromagnet: coil wound around neck of paper cone.
- Push or pull toward permanent magnet
- to create pressure (sound waves) in air.



21.2 "SEEING" SOUND

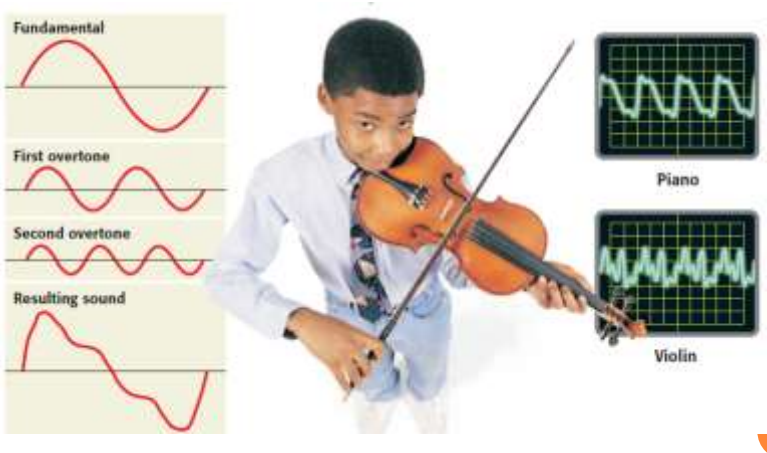
- Amplitude [smaller][bigger][same]
- Frequency [smaller][bigger][same]



- How do the sounds sound?

21.4 Sound Quality

- Sound Quality, timbre



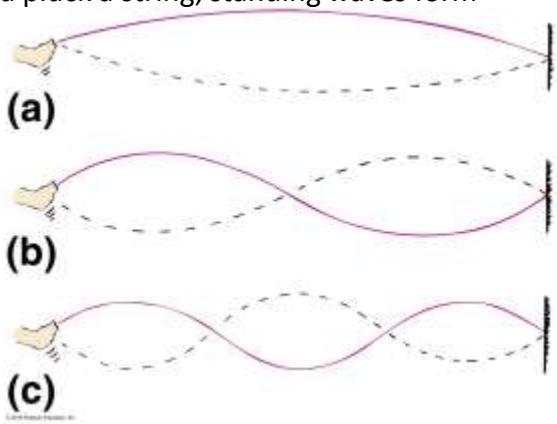
21.2 Loudness (Amplitude)

Table 3 Decibel Levels of Common Sounds	
Decibel level	**Sound**
0	the softest sounds you can hear
20	whisper
25	purring cat
60	normal conversation
80	lawn mower, vacuum cleaner, truck traffic
100	chain saw, snowmobile
115	sandblaster, loud rock concert, automobile horn
120	threshold of pain
140	jet engine 30 m away
200	rocket engine 50 m away

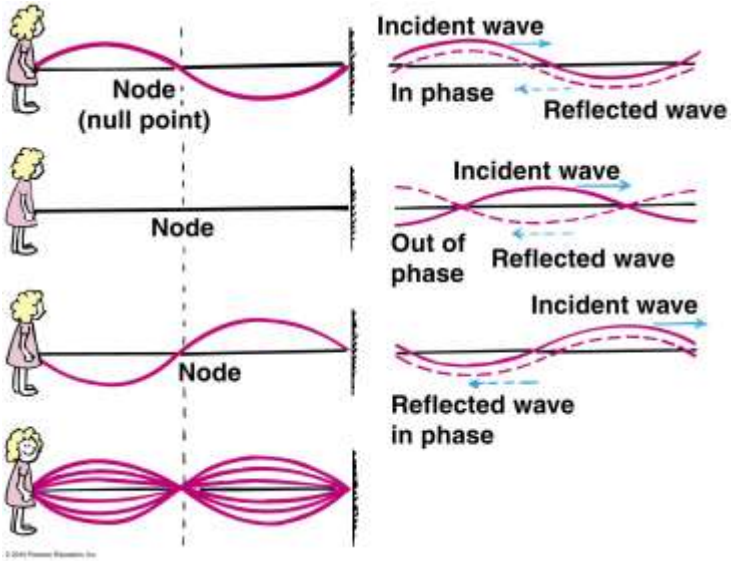
11.10 Interference

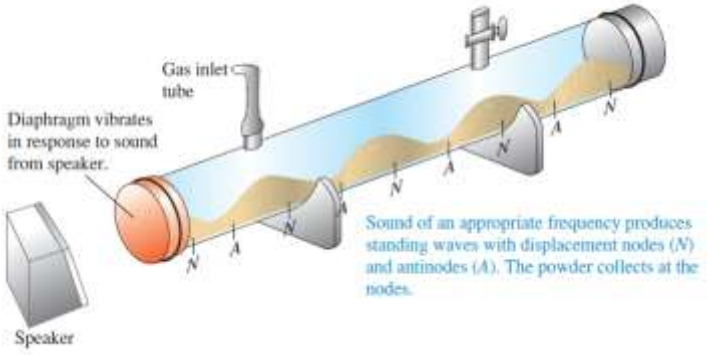
- Standing Waves

  When you pluck a string, standing waves form



11.10 Interference





Sound of an appropriate frequency produces standing waves with displacement nodes (*N*) and antinodes (*A*). The powder collects at the nodes.

CHECK YOUR THINKING (PG. 200)

- Singer sings a high-pitched note and low-pitched note.
- 1) vocal cords vibrate slower for…
- 2) Air is set into higher-frequency vibration for…
- 3) Which note has longer wavelength?
- Which note makes your eardrum vibrate faster?

11.5 Speed of Sound

- In air, high-pitch (_____ frequency) and low-pitch (_____ frequency) travel at the same/different speed.

- Speed of sound at 0°C = 330 m/s
- at room temperature dry air: 340 m/s.
- In water: 4 times
- In steel: 15 times
- In concrete: hardly travels