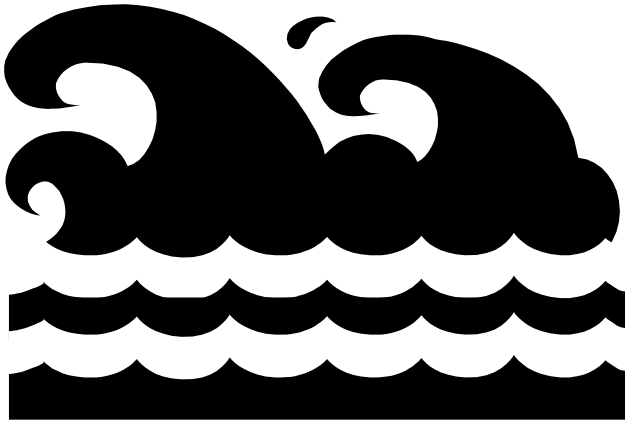
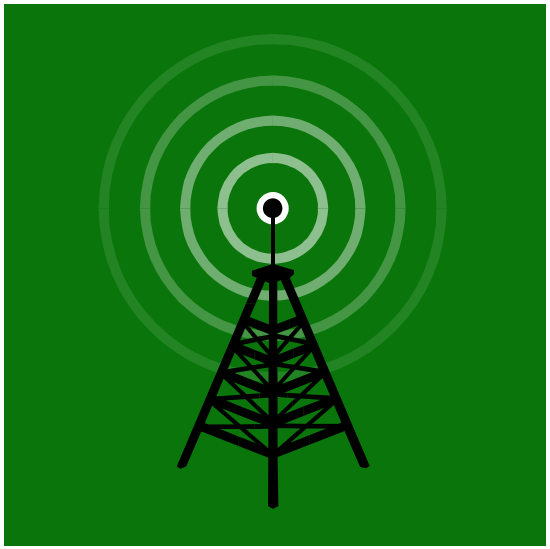
# PHSC 1013: Physical Science
# Waves



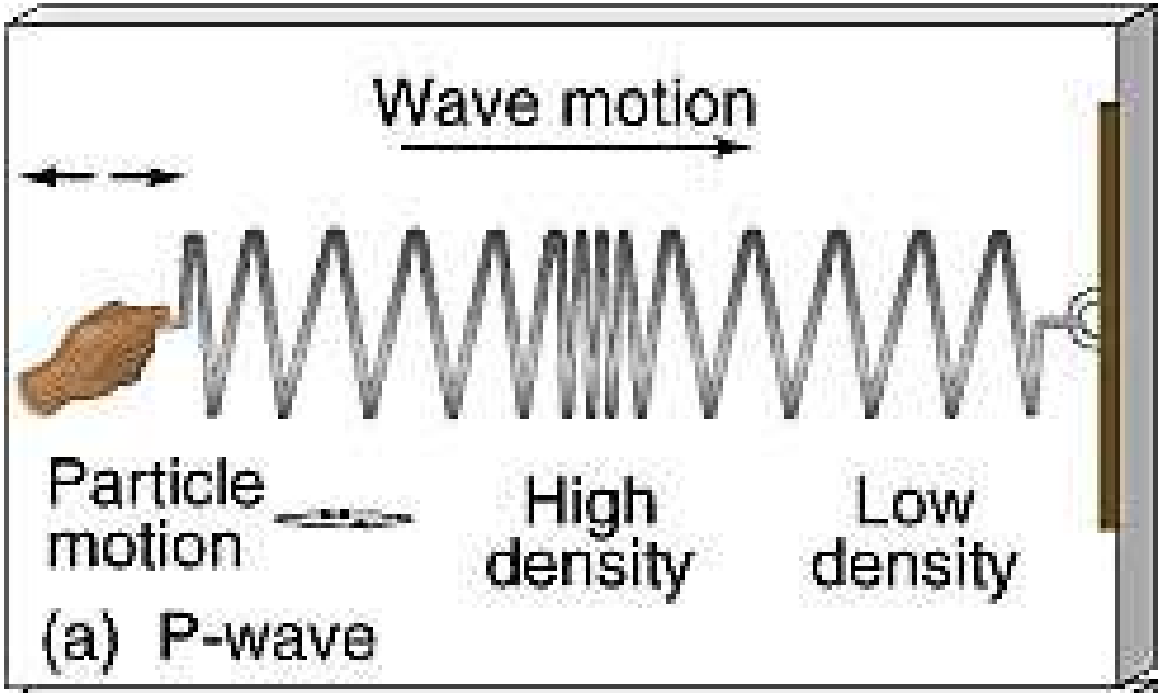


- Lecture Notes Download

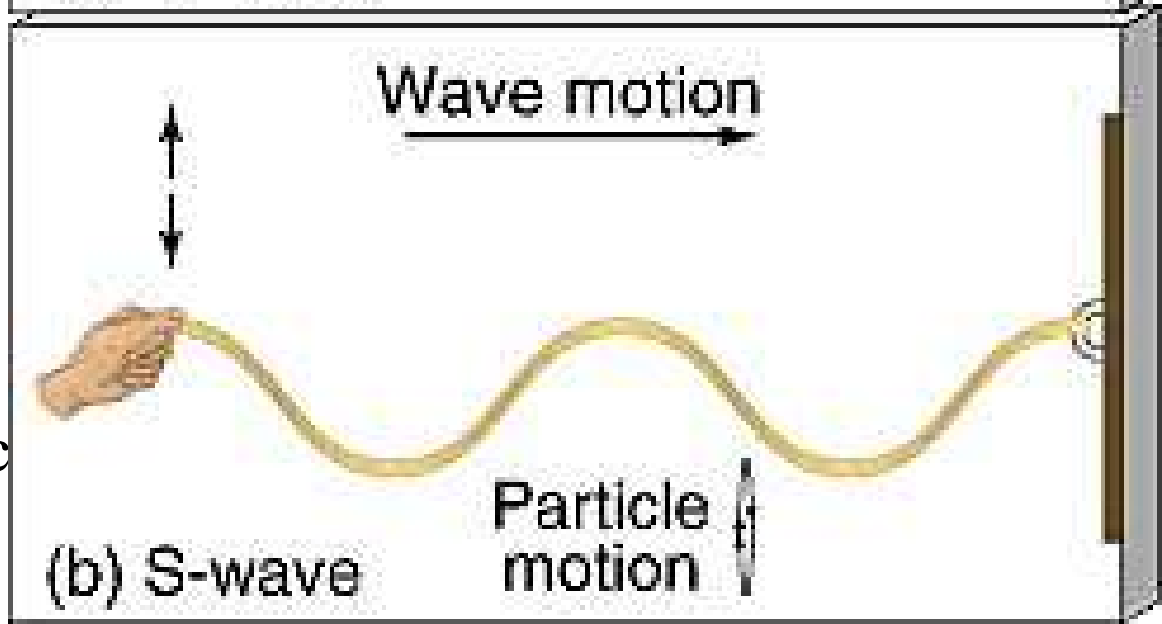
PDF Document **Waves.pdf**Powerpoint Slides **Waves.ppt**

# Types of Waves

- Longitudinal wave
  oscillations are in the direction of motion (parallel to the motion)




- Transverse Wave
  oscillations are perpendic to the direction of



# Physical Examples

- Longitudinal wave
  - sound waves
  - earthquake P-waves

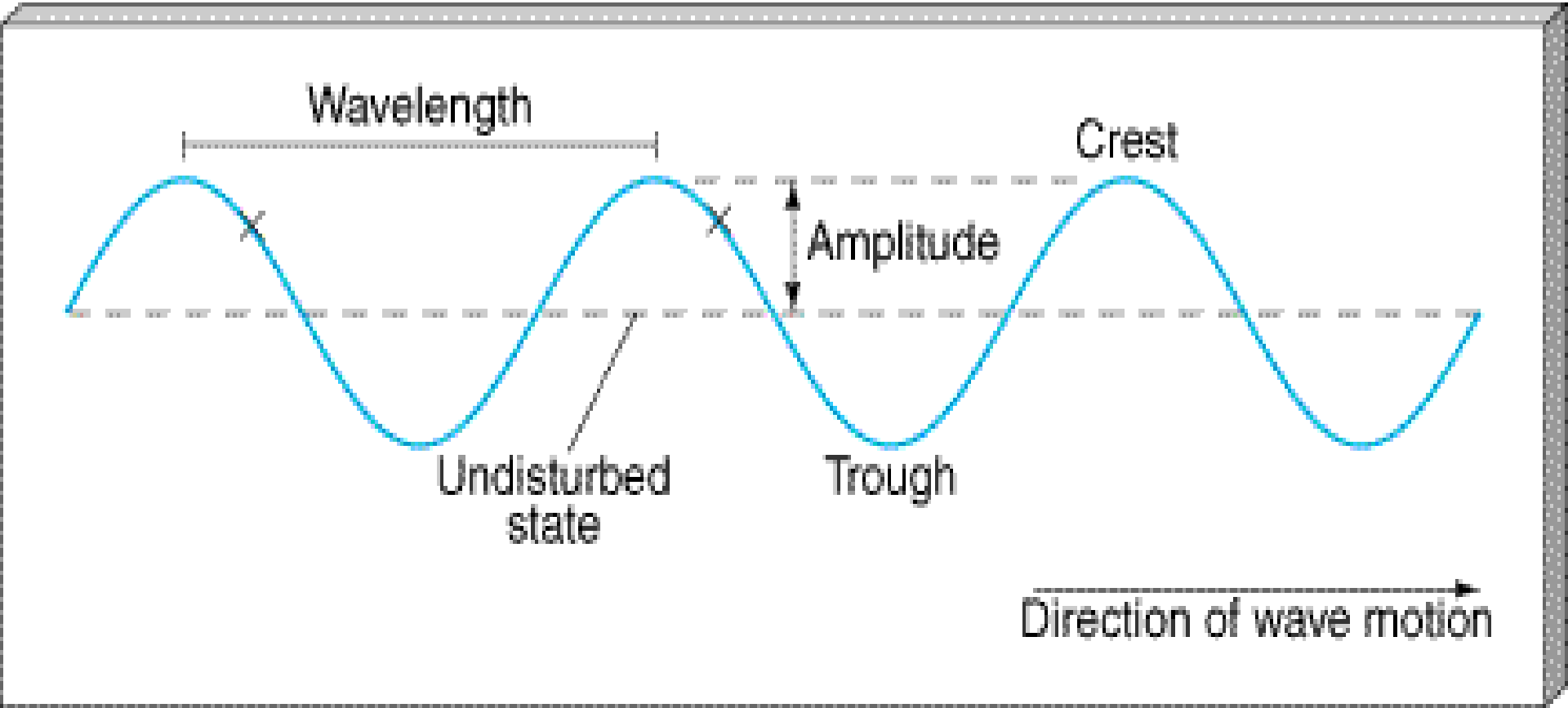
- Transverse Wave
  - water waves
  - earthquake S-waves
  - light waves

# Wave Parameters

Wavelength (λ) length or size of one oscillation

Amplitude (A) strength of disturbance (intensity)

Frequency (f) repetition / how often they occur per second



# Wave Properties

Waves are oscillations and they transport energy.

The energy of a wave is proportional to its frequency.

Fast oscillation = high frequency = high energy

Slow oscillation = low frequency = low energy

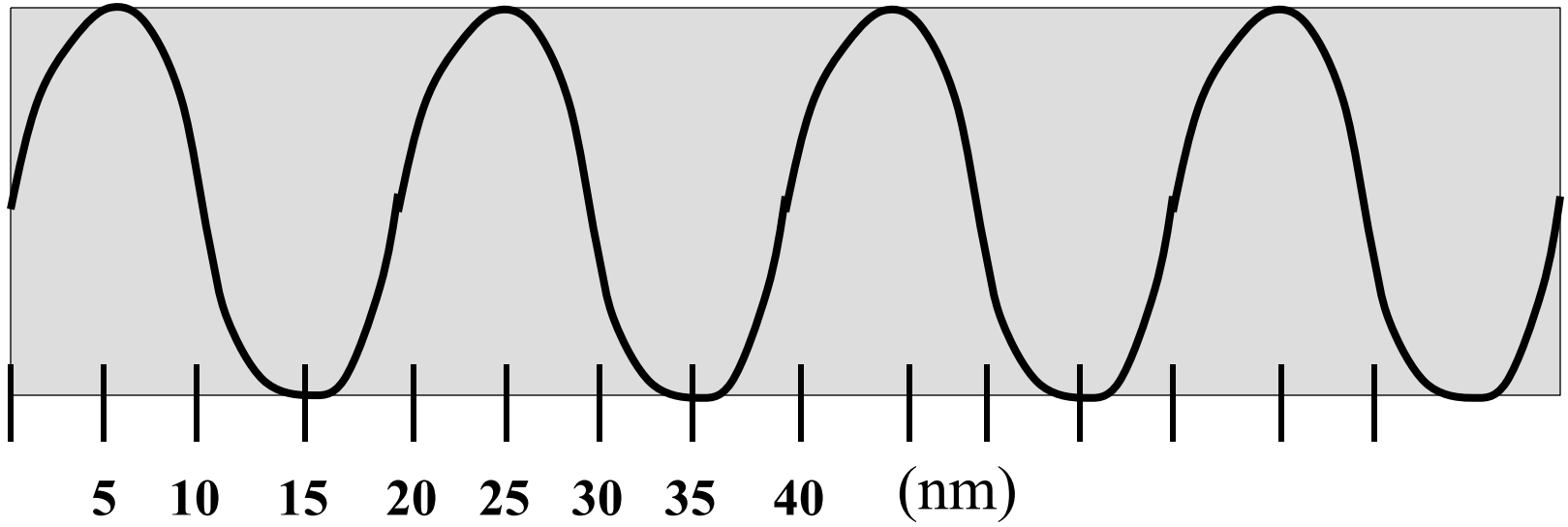
The amplitude is a measure of the wave intensity.

SOUND: amplitude corresponds to loudness

LIGHT: amplitude corresponds to brightness

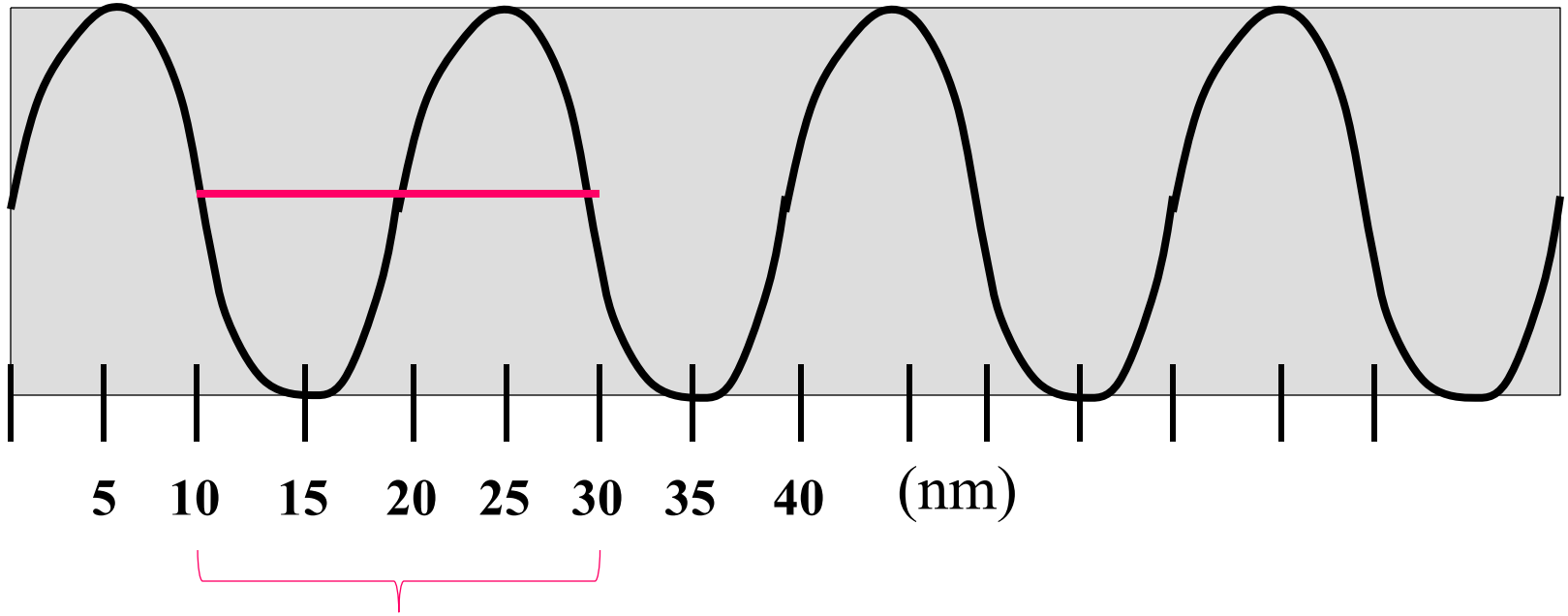
# What is the Wave length?

- Measure from any identical two successive points



# What is the Wave length?

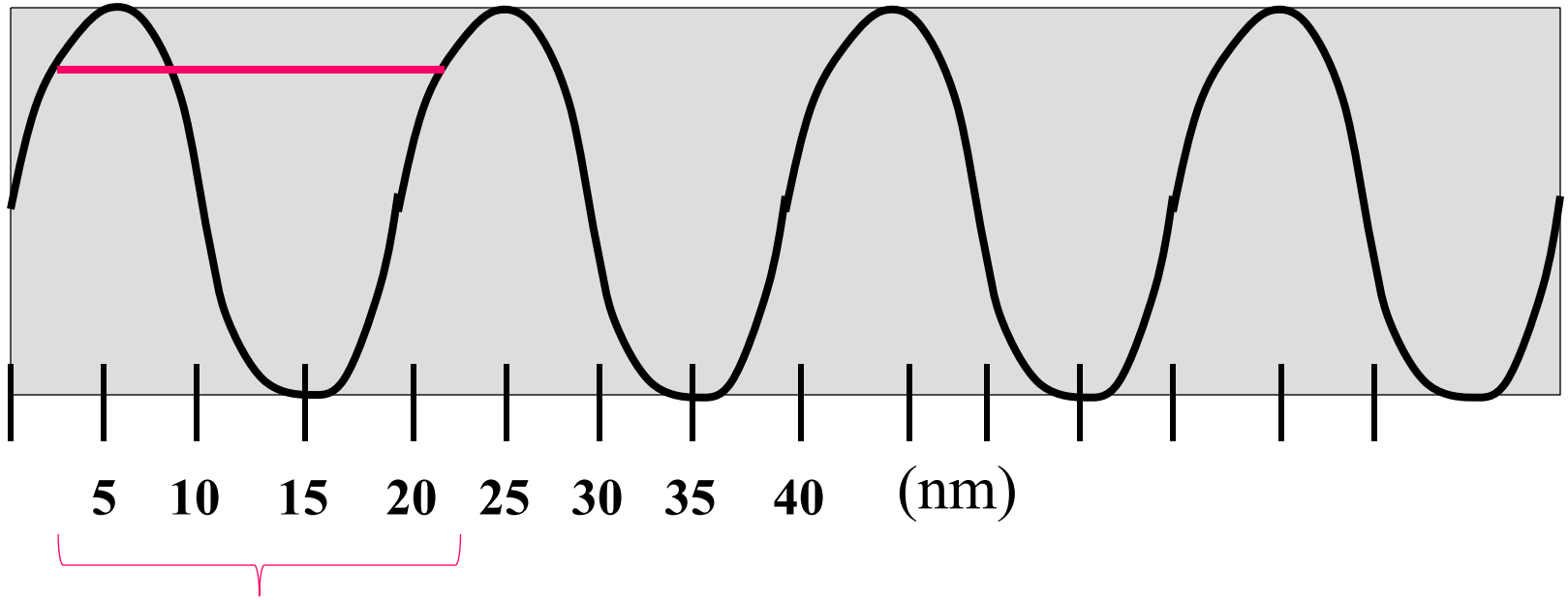
- Measure from any identical two successive points




30nm – 10nm = 20nm

# What is the Wave length?

- Measure from any identical two successive points

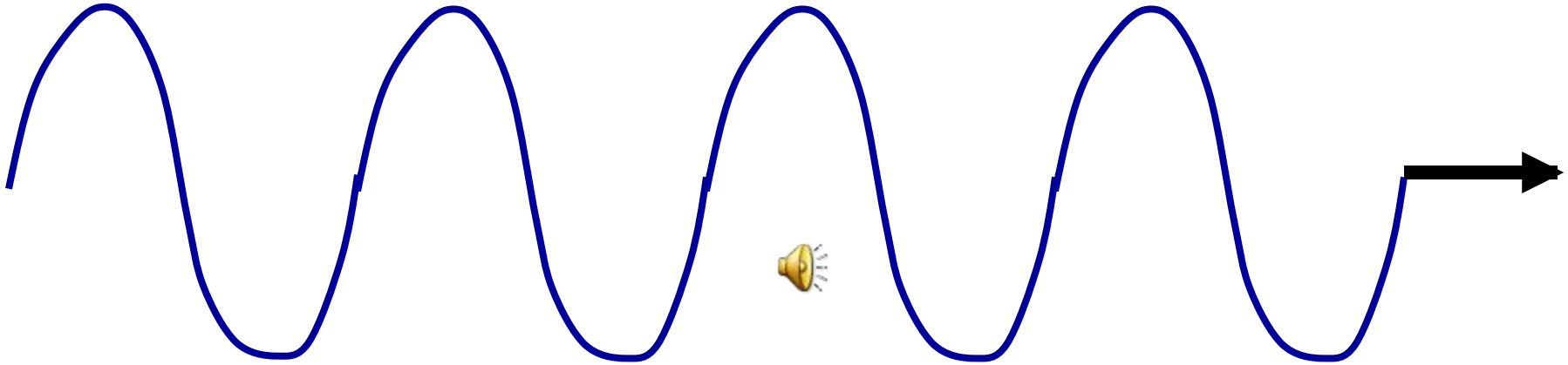


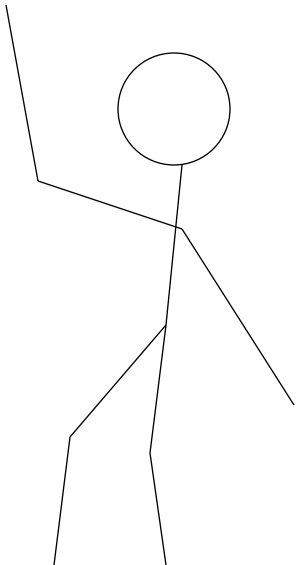

22.5nm - 2.5nm = 20nm

- There are 4 complete oscillations depicted here
- ONE WAVE = 1 COMPLETE OSCILLATION

# Frequency

- Frequency = number of WAVES passing a stationary point per second (Hertz)





# Frequency and Period

Frequency ($f$) = number of oscillations passing by per second

Period (T) = length of time for one oscillation

$T = 1/f$ $f = 1/T$

If a source is oscillating with a period of 0.1 seconds, what is the frequency?

$f = 1/(0.1) = 10$ Hz

It will complete 10 oscillations in one second. (10 Hz)

If a source oscillates every 5 seconds, its period is

5 seconds, and then the frequency is…????

- $f = 1/5 = 0.2$ Hz.

# Wave Speed

Wave speed depends on the wavelength and frequency.

wave speed $v = \lambda f$

Which animal can hear a shorter wavelength?

Cats (70,000 Hertz) or Bats (120,000 Hertz)

$\lambda = v/f$

# Wave Speed

$v = \lambda f$

Which animal can hear a shorter wavelength?

Cats (70,000 Hertz) or Bats (120,000 Hertz)

$\lambda = v/f$

Higher frequency = shorter wavelength

Lower frequency = longer wavelength

# Doppler Effect

- Change in frequency of a wave due to relative motion between source and observer.
- A sound wave frequency change is noticed as a change in pitch.

# Doppler Effect for Light Waves

- Change in frequency of a wave due to relative motion between source and observer.

- $c = \lambda f$ speed of light = wavelength x frequency

$c = 3 \times 10^8$ m/s

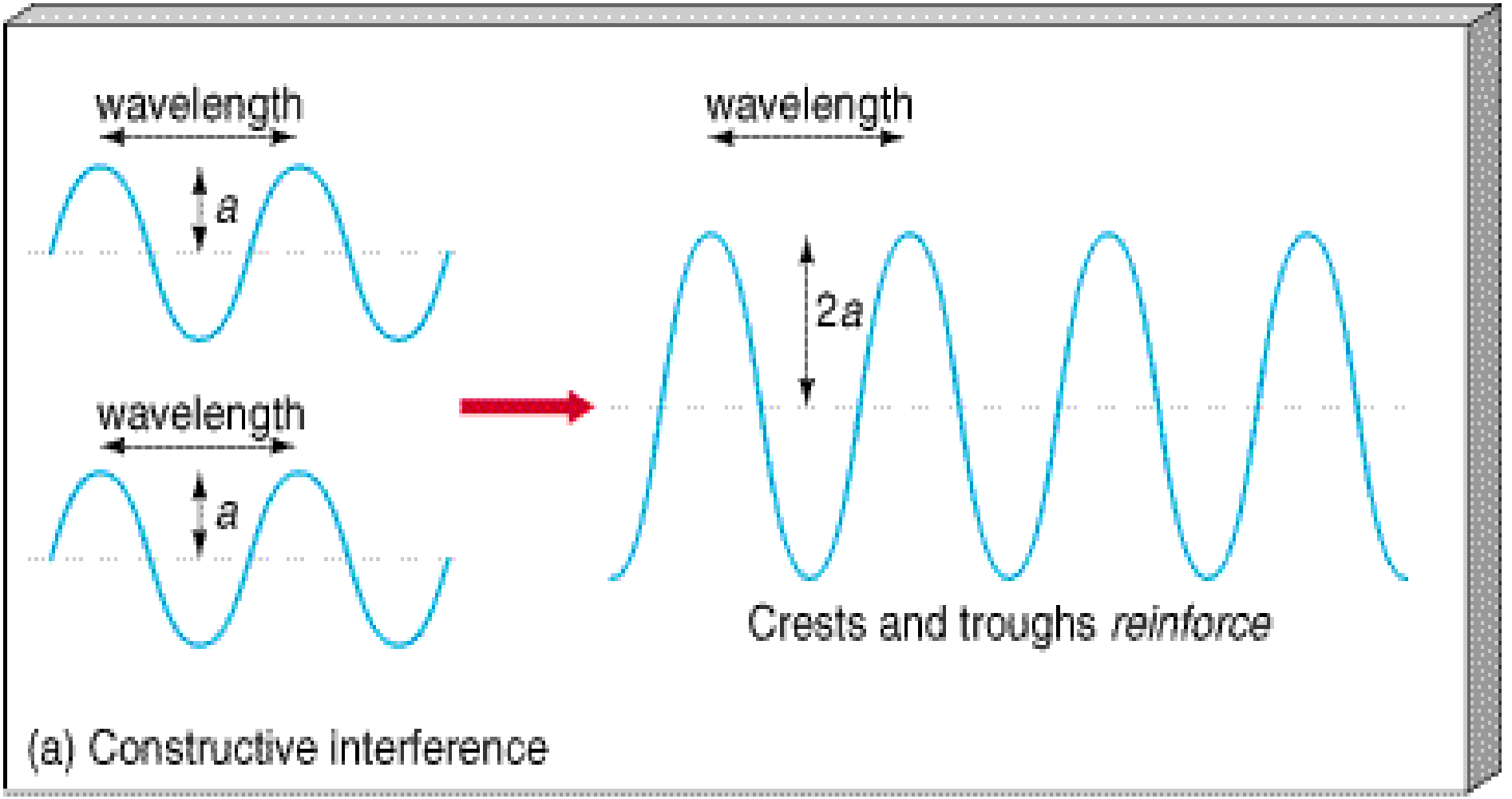
$E = hf = hc/\lambda$ energy of a light wave, a photon of frequency (f) or wavelength ($\lambda$)

h = planck's constant $6.63 \times 10^{-34}$ J-sec

A light wave change in frequency is noticed as a change in "color".

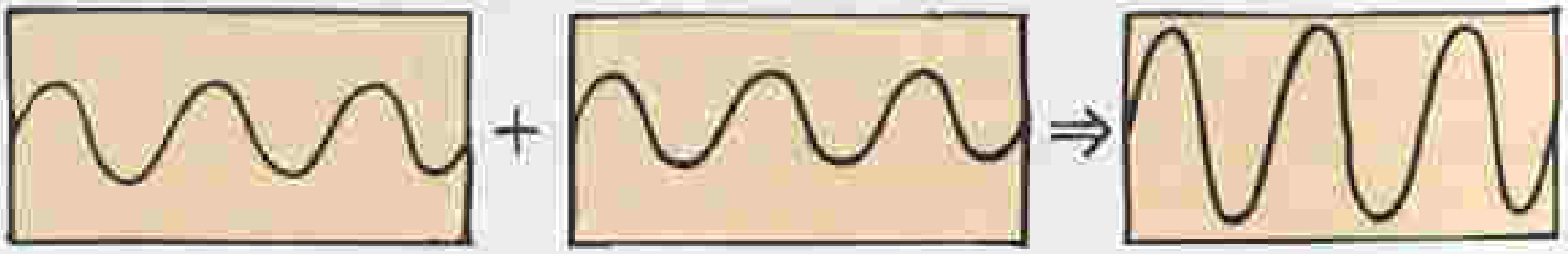
# Constructive Interference

- Waves combine without any phase difference
- When they oscillate together ("in phase")

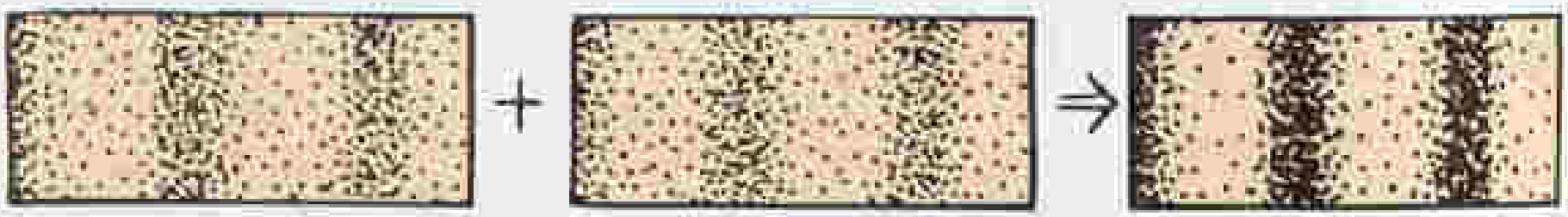


# Wave Addition

Amplitude ~ Intensity



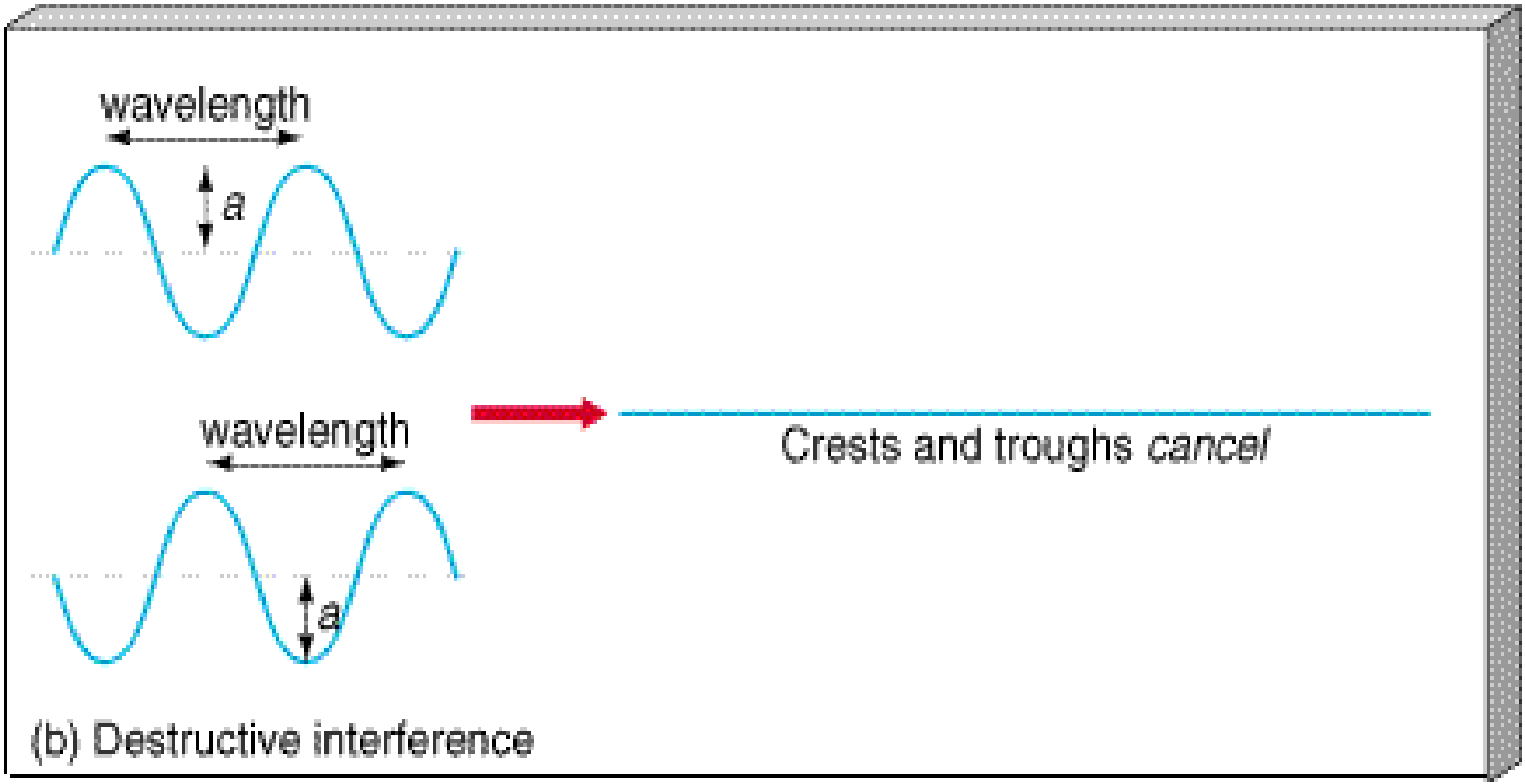
The superposition of two identical transverse waves in phase produces a wave of increased amplitude.



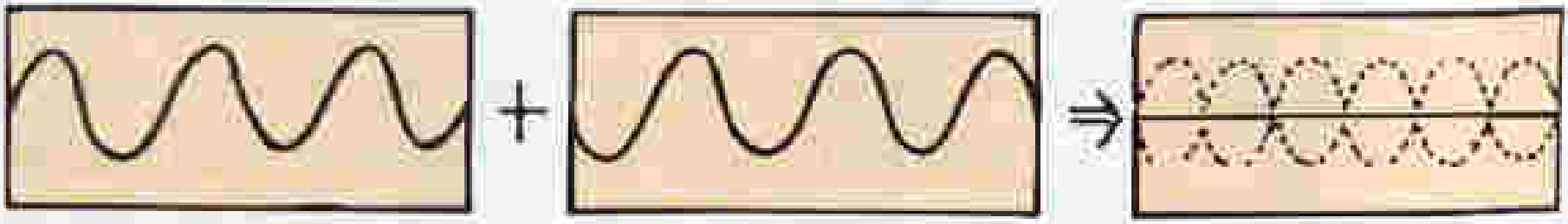
The superposition of two identical longitudinal waves in phase produces a wave of increased intensity.

# Destructive Interference

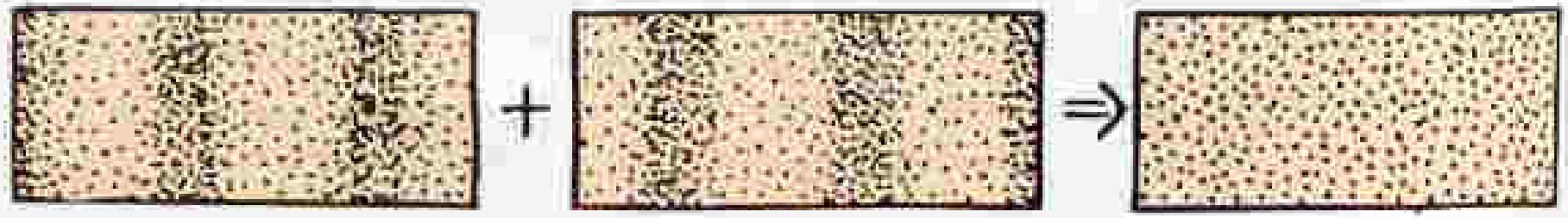
- Waves combine differing by multiples of 1/2 wavelength
- They oscillate “out-of-phase”



# Wave Subtraction



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



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

# Wave Properties

Amplitude:

Size of wave (perpendicular to direction of propagation)

Proportional to Intensity(Sound loudness, Light brightness)

Wavelength:

$\lambda$ Size of wave (in the direction of propagation)

Frequency:

Number of waves passing a fixed position per second

f (cycles/second, Hertz)

Wave Speed: $v = \lambda f$

| | |
|---|---|
| Frequency increases | Frequency decreases |
| Energy increases | Energy decreases |
| Wavelength decreases | Wavelength increases |

# Interactive Demonstrations On The WEB

- Wave Addition
- Two-slit Light Interference
- Doppler Shift
- Simple Geometric Optics

http://pls.atu.edu/physci/physics/people/robertson/applets/applets.html