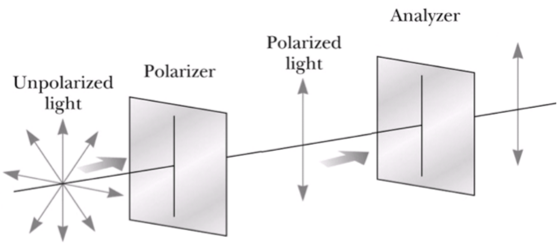
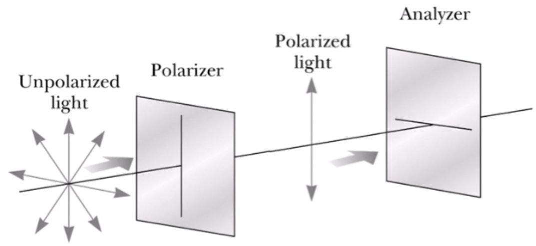
Analyzer – polarizer used to detect polarized light



When the transmission axis of the analyzer is parallel to that of the polarizer . . .

polarized light passes through

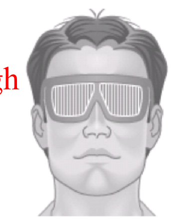


When the transmission axis of the analyzer is perpendicular to that of the polarizer . . .

no light passes through

How do polarized sunglasses reduce glare?

Transmission axis is vertical – does not allow glare to pass through since glare is light that has been horizontally polarized by reflection from non-metallic surface

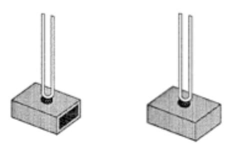


Natural Frequency and Resonance

Natural frequency: the frequency at which an object naturally vibrates due to its physical properties

Resonance: energy is transferred to a system by making it vibrate at its natural frequency resulting in large amplitude standing waves

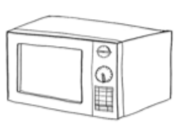
Explain the results of the tuning fork demonstration

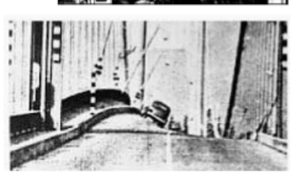


Sound energy is transferred from one tuning fork to the other if they have the same natural frequency – the second tuning fork is resonating with the first

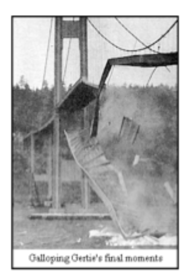
Other examples of resonance:

1. Two instruments
2. Swings
3. Wine glasses
4. Bridges
5. Buildings in earthquakes
6. Microwave ovens
7. MRI (Magnetic Resonance Imaging)





The Tacoma Narrows Bridge (Nov. 7, 1940)

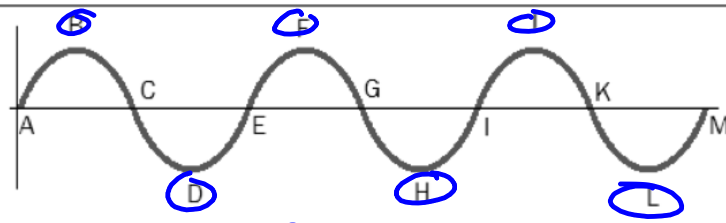


Phase and Reflections

Phase:

relative position

Inspect the labeled graph at right and name points that are:



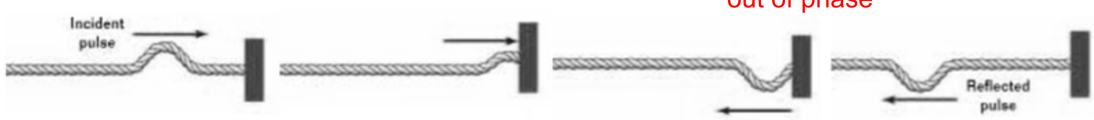
a) in phase B, F D, H

b) out of phase by 180° B D CE

c) out of phase by 90° G H

Fixed End Reflection (Hard Reflection): Reflected pulse is . . .

out of phase



Free End Reflection (Soft Reflection): Reflected pulse is . . .

in phase

Waves Crossing Boundaries

In general, whenever a wave (or pulse) reaches a boundary between two media . . .

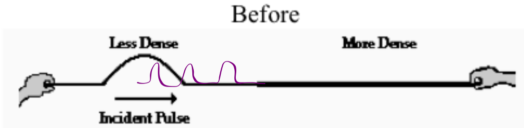
- part reflected, part transmitted

Before

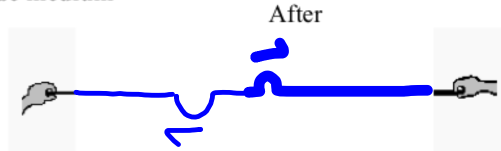
After

1. When a pulse travels from a less dense to a more dense medium

Before

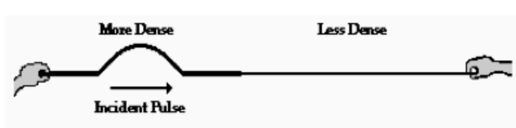


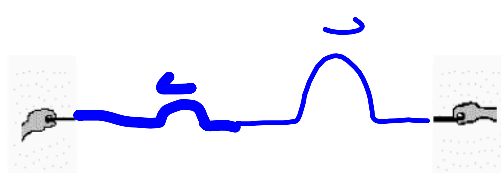
After



2. When a pulse travels from a more dense to a less dense medium

Before





http://surendranath.tripod.com/Applets.html

3. When a wave crosses a boundary

What characteristic(s) of a wave must remain the same as the wave crosses a boundary between two different media? Explain.

same frequency (period) , phase

Compare the characteristics of the wave in the two media

Thick rope

Thin rope

Light Crossing a Boundary	**Sound Crossing a Boundary**
A swimmer underwater looks up to see the Sun. Compare the light wave in air and water.	A swimmer underwater hears a boat's engine. Compare the sound wave in air and water.
as light enters water, speed, wavelength go down	as sound enters water, speed, wavelength go up

One Medium	**Two Media**
When a wave travels in a single medium, what is the control variable?	When a wave crosses a boundary between two media, what is the control variable?
speed	frequency

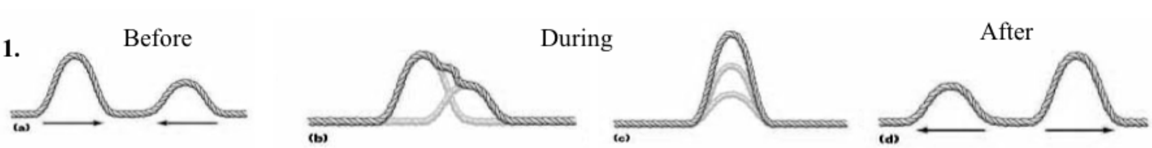
Superposition and Interference

The Principle of Superposition: When two or more waves (pulses) meet, the resultant displacement is the vector sum of the displacements of the individual component waves

Constructive Interference:

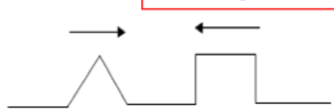
pulses in phase

1.



http://www2.biglobe.ne.jp/~norimari/science/JavaEd/e-wave2.html

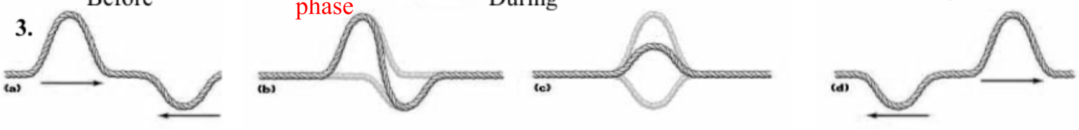
2.



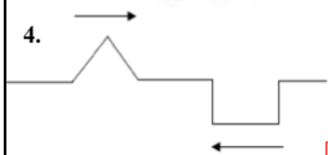
Destructive Interference: the superposition of two or more waves out of phase

Before During After

3.



4.



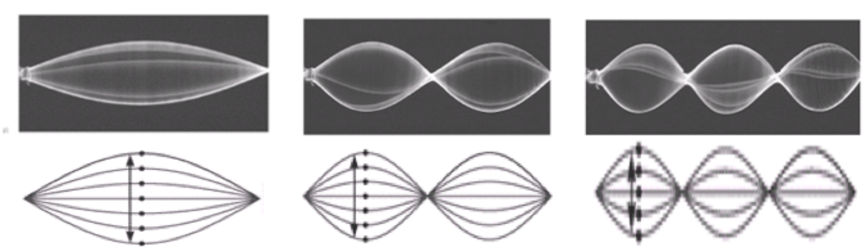
http://id.mind.net/~zona/mstm/physics/waves/interference/waveInterference1/WaveInterference1.html

http://id.mind.net/~zona/mstm/physics/waves/interference/waveInterference2/WaveInterference2.htm

Standing Waves

Traveling Wave: a series of pulses or oscillations that move through a medium

Standing Wave: The resultant wave formed when two waves of equal amplitude and frequency traveling in opposite directions in the same medium interfere



Time elapsed photographs of three possible standing waves on a string

Node: location of constant destructive interference

Anti-node: location of maximum constructive interference

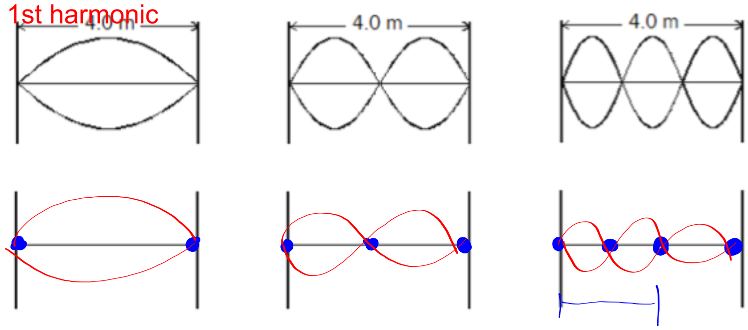
	Sound	Light
Node	quiet	dark
Anti-node	loud	bright

For the standing waves shown below, sketch them in the spaces provided and determine their characteristics. The speed of the component waves making up these standing waves is 12 m/s.

Name: fundamental, 1st harmonic

Name: 2nd harmonic

Name: 3rd harmonic



Wavelength	8m
Node(s)	2
Antinode(s)	1
Frequency	1.5Hz

Wavelength	$\frac{8m}{2}$
Node(s)	3
Antinode(s)	2
Frequency	3.0Hz

Wavelength	$\frac{8m}{3}$
Node(s)	4
Antinode(s)	3
Frequency	4.5Hz

$$v = \lambda \cdot f$$

$$\lambda_n = \frac{2L}{n}$$

$$f_n = n f_1 = n\left(\frac{v}{2L}\right)$$

How do the frequencies of the harmonic waves compare to the frequency of the fundamental wave?

integer multiples

What wave phenomena are responsible for the occurrence of standing waves?

reflection, interference, superposition