Waves & Sound Review

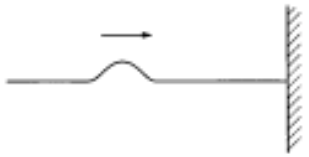
Pulses

- A pulse is a packet of energy
- Waves transfer energy through a medium, not matter
- The speed of a wave depends on the medium through which it propagates
- When a wave changes media, the frequency doesn't change.
- Longitudinal waves have particles that vibrate parallel to the wave's propagation
- Transverse waves have particles vibrating perpendicular to the wave's propagation.

A person vibrates the end of a string sending transverse waves down the string. If the person then doubles the rate at which he vibrates the string while maintaining the same tension, the speed of the waves
(a) doubles and the wavelength is unchanged
(b) doubles and the wavelength doubled
(c) doubles while the wavelength is halved
(d) is unchanged while the wavelength is doubled
(e) is unchanged while the wavelength is halved.

Reflection, Refraction, Diffraction

- Reflection occurs when a wave strikes a boundary and "bounces back" into original medium.
  - Fixed-end reflection: wave reflects with 180-degree phase change. This occurs when reflecting medium has greater density.
  - Free-end reflection: wave reflects with same phase. This occurs when reflecting medium has lesser density.
- Refraction is a change in medium, which causes a change in speed and sometimes direction, but never a change in frequency.
- Diffraction is the spreading out of a wave around an obstacle, which happens when an obstacle is about a wavelength in size.

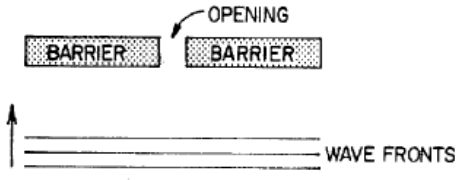


One end of a horizontal string is fixed to a wall. A transverse wave pulse is generated at the other end, moves toward the wall as shown and is reflected at the wall. Properties of the reflected pulse include which of the following?

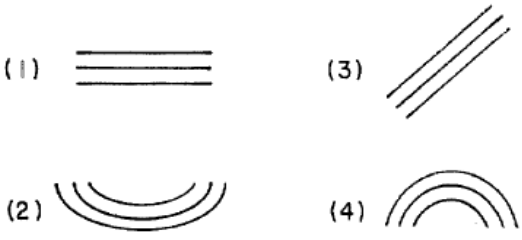
I. It has a greater speed than that of the incident pulse.
II. It has a greater amplitude than that of the incident pulse.
III. It is on the opposite side of the string from the incident pulse.

(A) I only (B) III only (C) I and II only
(D) II and III only (E) I, II, and III

The diagram below represents straight wave fronts approaching an opening in a barrier.



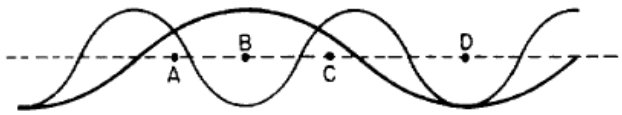
Which diagram best represents the shape of the waves after passing through the opening?



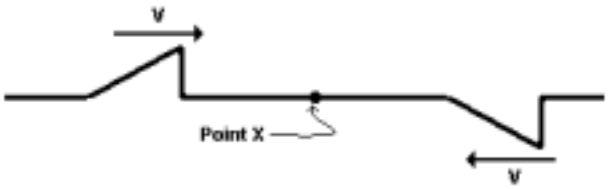
Interference

- When two waves collide, they interfere constructively and/or destructively. The colliding waves' amplitudes add algebraically.

The diagram below represents two waves traveling simultaneously in the same medium. At which of the given points will maximum constructive interference occur?

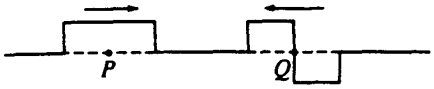


(1) *A*
(2) *B*
(3) *C*
(4) *D*



The diagram shows two transverse pulses moving along a string. One pulse is moving to the right and the second is moving to the left. Both pulses reach point x at the same instant. What would be the resulting motion of point x as the two pulses pass each other?

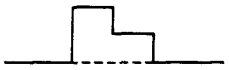
A) up then down
B) down then up
C) up, down, up
D) down, up, down
E) there would be no motion, the pulses cancel one another



The figure above shows two wave pulses that are approaching each other. Which of the following best shows the shape of the resultant pulse when the centers of the pulses, points P and Q coincide?

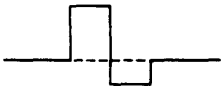
(A)

(B)

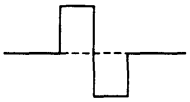


(C)

(D)



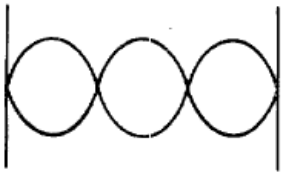
(E)



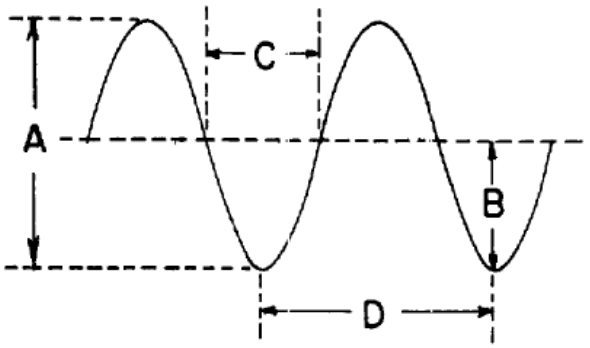
Standing Waves

- A standing wave is an interference pattern of propagating pulses.
- Crest: high point, maximum displacement
- Trough: low point, maximum displacement
- Node: mid point, zero displacement
- Amplitude: vertical distance from equilibrium to crest or trough
- Wavelength: horizontal distance for one full cycle (crest to crest, trough to trough, or every other node)

Two waves of the same wavelength (λ) interfere to form a standing wave pattern as shown in the diagram. What is the straight-line distance between consecutive nodes?



(1) 1λ
(2) 2λ
(3) $\frac{1}{2}\lambda$
(4) $\frac{1}{4}\lambda$



In the standing wave shown above, __ shows the wave's amplitude and __ shows the wave's wavelength.

(A) A; C
(B) A; D
(C) B; C
(D) B; D
(E) D; A

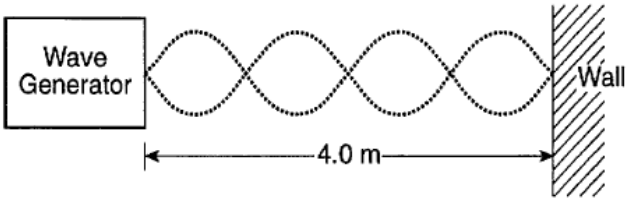
Wave Speed

- v = d/t
  d: distance
  t: time
- v = λf
  v : speed (m/s)
  λ : wavelength (m)
  f : frequency (Hz)
- T = 1/f
  T : period (s)
  f : frequency (s^{-1}, Hz)

A metal bar is vibrating with a frequency of 200 Hz. The resulting period of oscillation would be
A) 200 s B) 141 s C) 0.007 s D) 0.002 s E) none of the above

Assume that waves are propagating in a uniform medium. If the frequency of the wave source doubles then
A) The speed of the waves doubles B) the wavelength do the waves doubles C) the speed of the waves halves
D) the wavelength of the waves halves E) none of the above

38 A wave generator located 4.0 meters from a reflecting wall produces a standing wave in a string, as shown in the diagram below.



If the speed of the wave is 10. meters per second, what is its frequency?

(1) 0.40 Hz
(2) 5.0 Hz
(3) 10. Hz
(4) 40. Hz

Sound

- Sound is a longitudinal wave that propagates about 340 m/s through air.
- Sound requires a medium, and cannot propagate through a vacuum (no sound in space).
- The loudness of a sound is related to the amplitude; the pitch of a sound is related to the frequency.

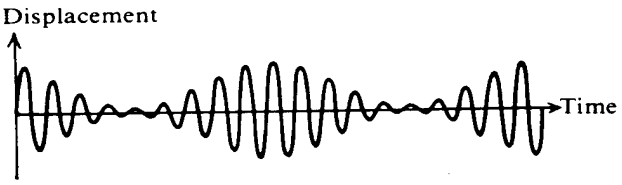
A vibrating tuning fork sends sound waves into the air surrounding it. During the time in which the tuning fork makes one complete vibration, the emitted wave travels
(A) one wavelength
(B) about 340 meters
(C) a distance directly proportional to the frequency of the vibration
(D) a distance directly proportional to the square root of the air density
(E) a distance inversely proportional to the square root of the pressure

Resonance

- Occurs when a vibration of one object matches the natural frequency for another object
- The first object will cause the second to vibrate (resonate).

Sound interference (Beats)

- Two sound waves whose frequencies are close together will produce a "beat frequency" equal to the difference between the two waves' frequencies.



One stereo loudspeaker produces a sound with a wavelength of 0.68 meters while the other speaker produces sound with a wavelength of 0.65 m. What would be the resulting beat frequency?

A) 3 Hz B) 23 Hz C) 66.5 Hz D) 500 Hz E) 11333 Hz

Doppler Effect

- The Doppler Effect is the raising or lowering of the perceived pitch of a sound based on the relative motion of the observer and the source of the sound.
  - When an ambulance is racing toward you, the sound of its siren appears to be higher in pitch.
  - When the ambulance is racing away from you, the sound of its siren appears to be lower in pitch.

The driver of a car sounds the horn while traveling toward a stationary person. Compared to the sound of the horn heard by the driver, the sound heard by the stationary person has

1 lower pitch and shorter wavelength
2 lower pitch and longer wavelength
3 higher pitch and shorter wavelength
4 higher pitch and longer wavelength

Harmonics

- Open and closed pipes, guitar string
- Tips: If a tuning fork is used, the frequency is constant. If the medium (string, gas) doesn't change, the speed is constant.