HW 6.1 Waves Per _____ Name Key

1. A piano emits frequencies that range from a low of about 28 Hz to a high of about 4200 Hz. Find the range of wavelengths in air attained by this instrument when the speed of sound in air is 340 m/s.

$v = 340$ m/s, $f_1 = 28$ Hz, $f_2 = 4200$ Hz, $\lambda_1 = ?$, $\lambda_2 = ?$

$v = f\lambda$

$\lambda_1 = \frac{v}{f} = \frac{340}{28}$, $\lambda_1 = 12.14$ m

$\lambda_2 = \frac{340}{4200}$, $\lambda_2 = 0.08$ m

0.08 – 12.14 m

2. The speed of all electromagnetic waves in empty space is 3.00 E 8 m/s. Calculate the wavelength of electromagnetic waves emitted at the following frequencies:

a) radio waves at 88.0 MHz

$\lambda = \frac{v}{f} = \frac{3E8}{88\times10^6} = \frac{3\times10^8}{88\times10^6} = 3.409$

3.4 m

b) visible light at 6.0 E 8 MHz

$\lambda = \frac{v}{f} = \frac{3\times10^8}{6\times10^{8+6}} = \frac{3\times10^8}{6\times10^{14}} = 5\times10^{-7}$ m

5×10^{-7} m

c) X-rays at 3.0 E 12 MHz

$\lambda = \frac{v}{f} = \frac{3\times10^8}{3\times10^{12+6}} = \frac{3\times10^8}{3\times10^{18}} = 1\times10^{-10}$ m

1×10^{-10} m

3. The red light emitted by a He-Ne laser has a wavelength of 633 nm in air and travels at 3.00 E 8 m/s. Find the frequency of the laser light. (1 nm = 1 E –9 m)

$\lambda = 633\times10^{-9}$ m, $v = 3\times10^8$ m/s, $f = ?$

$v = f\cdot\lambda$

$f = \frac{v}{\lambda} = \frac{3\times10^8}{633\times10^{-9}} = 4.74\times10^{14}$

4.74×10^{14} Hz

4. A tuning fork produces a sound with a frequency of 256 Hz and a wavelength in air of 1.35 m.

a) What value does this give for the speed of sound in air?

$f = 256$ Hz, $\lambda = 1.35$ m, $v = ?$

$v = f\cdot\lambda = (256)(1.35) = 345.6$ m/s

345.6 m/s

b) What would be the wavelength of the wave produced by this tuning fork in water in which sound travels at 1500 m/s?

$v = 1500$ m/s, $\lambda = ?$, $f = 256$ Hz

$\lambda = \frac{v}{f} = \frac{1500}{256} = 5.86$ m

5.86 m

5. As waves pass by a duck floating on a lake, the duck bobs up and down but remains in essentially one place. Explain why the duck is not carried along by the wave motion.

waves transfer energy, not matter

6. The smallest insects that a bat can detect are approximately the size of one wavelength of the sound the bat makes. What is the minimum frequency of sound waves required for the bat to detect an insect that is 0.57 cm long? (Assume the speed of sound is 340 m/s.)

= 0.0057 m

$\lambda = 0.0057$ m, $v = 340$ m/s, $f = ?$

$v = f\cdot\lambda$

$f = \frac{v}{\lambda} = \frac{340}{0.0057} = 59{,}649$

59,649 Hz

A 1. A leaf on a pond oscillates up and down two complete cycles each second as a water wave passes. What is the wave's frequency?

a. 2 Hz b. 6 Hz c. 1 Hz d. .5 Hz

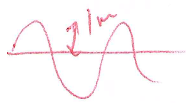
A 2. The higher the frequency of a wave

a. the shorter its wavelength
b. the lower its speed
c. the longer its period
d. the greater its amplitude

D 3. In space no one can hear you scream because sound is a(n) ___ wave.

a. transverse mechanical
b. transverse electromagnetic
c. compressional electromagnetic
d. compressional mechanical

B 4. The amplitude of a particular wave is 1 meter. The total distance from the top of a crest to the bottom of a trough would be



a. 1 m
b. 2 m
c. 0.5 m
d. none of the answers is correct

D 5. The distance between successive identical parts of a wave is called its

a. amplitude b. frequency c. period d. wavelength

A 6. An unsuccessful fisherman fishing from a pier observes that four wave crests pass by in 7.0 s and estimates the distance between two successive crests to be 4.0 m. The timing starts with the first crest and ends with the fourth. What is the speed of the wave?

a. 2.29 m/s b. 7 m/s c. 1.7 m/s d. 0.571 m/s

B 7. Waves move along a string at a speed of 8 m / s. The end of the string vibrates up and down once every 1.5 seconds. What is the wavelength of the waves traveling along the string?

a. 5.3 m b. 12 m c. 6 m d. 3 m

C 8. A periodic longitudinal wave that has a frequency of 20 Hz travels along a slinky. An overzealous physics student notes that the distance between successive compressions is 0.4 m. What is the speed of the wave?

a. 3 E 8 m/s b. 0.02 m/s c. 8 m/s d. 50 m/s

A 9. The source of all wave motion is a

a. vibrating object
b. variable high and low pressure region
c. harmonic object
d. wave pattern

B 10. Which of the following is the region of a longitudinal wave in which the density and pressure are lower than normal?

a. compression
b. rarefaction
c. spherical wave
d. Doppler effect

HW 6.2 Waves and Sound   Per ____ Name Key

1. My favorite FM radio station in Austin is KASE100.7 MHz ($\times 10^6$) and my favorite AM station is KVET 1300 kHz ($\times 10^3$). Radio waves are a form of electromagnetic radiation and, just like light, travel at 3.0 E 8 m / s. What are the wavelengths of my favorite radio stations?

$f_1 = 100.7 \times 10^6$ Hz
$f_2 = 1300 \times 10^3$ Hz
$v = 3.0 \times 10^8$ m/s

$\lambda_1 = \frac{v}{f_1} = \frac{3.0E8}{100.7 \times 10^6}$ $\lambda_2 = \frac{v}{f_2} = \frac{3.E8}{1300 \times 10^3}$

2.98 m
230.77 m

2. A cork bobber resting on the surface of a pond bobs up and down two times per second on some ripples having a wavelength of 8.5 cm. If the cork is 10.0 m from shore, how long does it take a ripple passing the cork to reach the shore?

$f = 2$ Hz
$\lambda = 0.085$ m
$\Delta x = 10.0$ m
$t = ?$

$v = [f\lambda = \frac{\Delta x}{t}]$

$t = \frac{\Delta x}{f\lambda} = \frac{10}{(2)(0.85)} = 5.88$ s

5.88 s

3. When a particular wave is vibrating with a frequency of 4 Hz, a transverse wave of length 60 cm is produced. Determine the speed of the wave pulses along the wire.

$f = 4$ Hz
$\lambda = 0.6$ m
$v = ?$

$v = f \cdot \lambda = (4)(0.6)$

2.4 m/s

4. A wave is traveling along a rope. It is observed that the wave completes 40 vibrations in 30 seconds. Also, a given crest travels 425 cm along the rope in 10 seconds. What is the wavelength of the wave?

$f = \frac{40}{30}$ Hz $= 1.\bar{3}$ Hz
$v = \frac{4.25}{10}$ m/s $= 0.425$
$\lambda = ?$

$v = f\lambda$
$\lambda = \frac{v}{f} \rightarrow \lambda = \frac{0.425}{1.3}$

0.31875 m

5. For a certain transverse wave, it is observed that the distance between two successive crests is 1.2 meters. It is also noted that eight crests pass a given point along the direction of travel every 12 seconds. What is the speed of the wave?

$\lambda = 1.2$ m
$f = \frac{8}{12}$ Hz
$v = ?$

$v = f \cdot \lambda = \left(\frac{8}{12}\right)(1.2) = 0.8$ m/s

0.8 m/s

6. How long does it take **light** from the sun to reach us (in minutes)? (The sun is 93 million miles away; 1600 meters = 1 mile) SHOW ALL CALCULATIONS!!!

$t = ?$
$v = 3 \times 10^8$ m/s
$\Delta x = (93 \times 10^6)(1600)$ m

$v = \frac{\Delta x}{t}$

$t = \frac{\Delta x}{v} = \frac{(93 \times 10^6)(1600)}{3 \times 10^8} = 496$ s

$\frac{496}{60} \rightarrow$

8.2$\bar{6}$ m

7. An astronaut communicates with Earth from the Moon (3.84 E 8 meters away). How long does it take his signal to reach us?

$\Delta x = 3.84 \times 10^8$ m
$t = ?$
$v = 3 \times 10^8$ m/s

$v = \frac{\Delta x}{t}$

$t = \frac{\Delta x}{v}$ $\frac{3.84 \times 10^8}{3 \times 10^8}$

1.28 s

8. How long does it take **light** from Proxima Centauri (the star nearest our sun) to reach Earth which is 4 E 16 meters away?

$t = ?$
$v = 3 \times 10^8$ m/s
$\Delta x = 4 \times 10^{16}$ m

$v = \frac{\Delta x}{t}$

$t = \frac{\Delta x}{v} = \frac{4 \times 10^{16}}{3 \times 10^8}$

$1.\bar{3} \times 10^8$ s

D 1. Through which of the following does sound travel fastest?
a. water b. helium c. alcohol (d.) iron - most dense

C 2. Resonance occurs when you
a. push an object
b. hit an object with a hammer
(c.) cause an object to vibrate at its natural frequency
d. vibrate an object

D 3. The normal range of hearing for a human is
a. 20-2,000 Hz b. 20-40,000 Hz c. 10-10,000 Hz (d.) 20-20,000 Hz

A 4. Beats are formed by ___________ interference of two waves
(a.) both constructive and destructive
b. beats are vegetables and have nothing to do with sound.
c. constructive
d. destructive

D 5. In a very famous Memorex commercial, Ella Fitzgerald makes a wine glass shatter with her voice. This is a demonstration of
a. interference
b. beats
c. sound refraction
(d.) resonance

C 6. A tuning fork of frequency 200 Hz will resonate if a sound wave incident on it has a frequency of
a. 300 Hz b. 400 Hz (c.) 200 Hz d. 100 Hz

A 7. If you hear the pitch of a siren become lower, you know that
(a.) the siren is getting farther from you
b. neither you nor the siren is moving.
c. you are moving toward the siren
d. the siren is getting closer to you

D 8. The speed of a sound wave in air depends on
a. its frequency
b. its amplitude
c. its wavelength
(d.) the air temperature

B 9. Five seconds after a gun is fired, the person who fired hears an echo. How far away was the surface that reflected the sound? (v =340 m/s)
a. 1700 m (b.) 850 m c. 34 m d. 68 m

$t = 2.5\,s$ $v = 340\,m/s$ $\Delta x = ?$ $v = \frac{\Delta x}{t}$ $\Delta x = v \cdot t = (340)(2.5) = 850$

D 10. Two whistles produce sounds of wavelengths 3.4 m and 3.3 m. What is the beat frequency produced? (speed of sound = 340 m / s)
a. 1 Hz b. 2 Hz c. .1 Hz (d.) 3 Hz

$\lambda_1 = 3.3m$ $\lambda_2 = 3.4m$
$v = 340\,m/s$ $v = 340\,m/s$
$f = \frac{v}{\lambda} = 103.03Hz$ $f = 100Hz$
$103.03 - 100 = 3.03Hz$

11. What is forced vibration?

forcing an object to vibrate

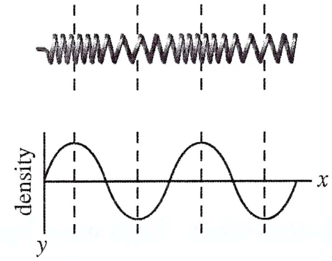
12. What is meant by natural frequency?

the frequency an object tends to vibrate at

13. Describe resonance

when an object is forced to vibrate at its natural frequency

HW 6.3 Wave Behavior Per ____ Name Key

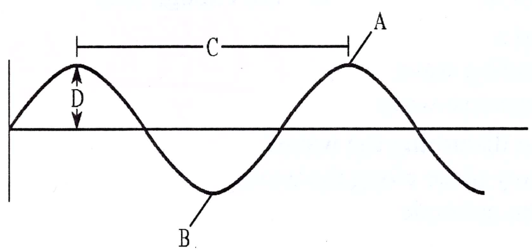


1. In the waveform of the longitudinal wave shown to the left, the compressed regions correspond to crests, while the stretched regions correspond to troughs.

2. What type of interference results when individual displacements on the same side of the equilibrium position are added together to form the resultant wave?
constructive interference

3. What type of interference results when individual displacements on the opposite side of the equilibrium position are added together to form the resultant wave?
destructive interference

4. In the wave shown below identify each letter.



A. crest
B. trough
C. wavelength
D. amplitude

5. What happens to the energy of a wave when the amplitude is increased?
energy increases

6. What is pitch?
our interpretation of frequency

7. What is wave interference?
when waves interact with each other to form new waves

8. If you hear the pitch of a siren becoming lower you know the siren is moving away from you / towards you. (Circle the correct answer)

9. Two vibrating tuning forks held side by side will create a beat frequency of what value if the individual frequencies of the two forks are 216 Hz and 224 Hz, respectively?
224 - 216 = 8 Hz

10. Which carries a sound wave more rapidly, a solid or a gas? Explain.
a solid - the molecules are closer together

11. When does resonance occur?
when an object vibrates at its natural frequency

C ____ 1. Resonance occurs when you
a. push an object
b. hit an object with a hammer
c. cause an object to vibrate at its natural frequency
d. vibrate an object

D ____ 2. Constructive interference occurs when
a. a sound wave and a light wave overlap
b. the crest of one wave meets the trough of another
c. two waves have the same amplitude
d. the crest of one wave meets the crest of another

B ____ 3. Two waves arrive at the same place at the same time exactly in phase with each other. Each wave has amplitude of 1 m. The resulting wave has amplitude of
a. 1 m b. 2 m c. 0 m d. 0.5 m

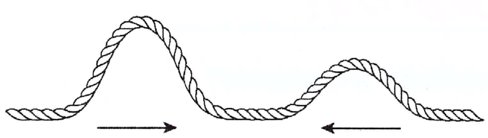
B ____ 4. Five seconds after a gun is fired, the person who fired hears an echo. How far away was the surface that reflected the sound? (v =340 m/s) $t = 2.5$ s $v = 340$ m/s $\Delta x = ?$ $v = \frac{\Delta x}{t}$
a. 1700 m b. 850 m c. 34 m d. 68 m
$\Delta x = v \cdot t = (340)(2.5)$

B ____ 5. Sound waves can interfere with one another so that no sound results.
a. impossible to say b. true c. false

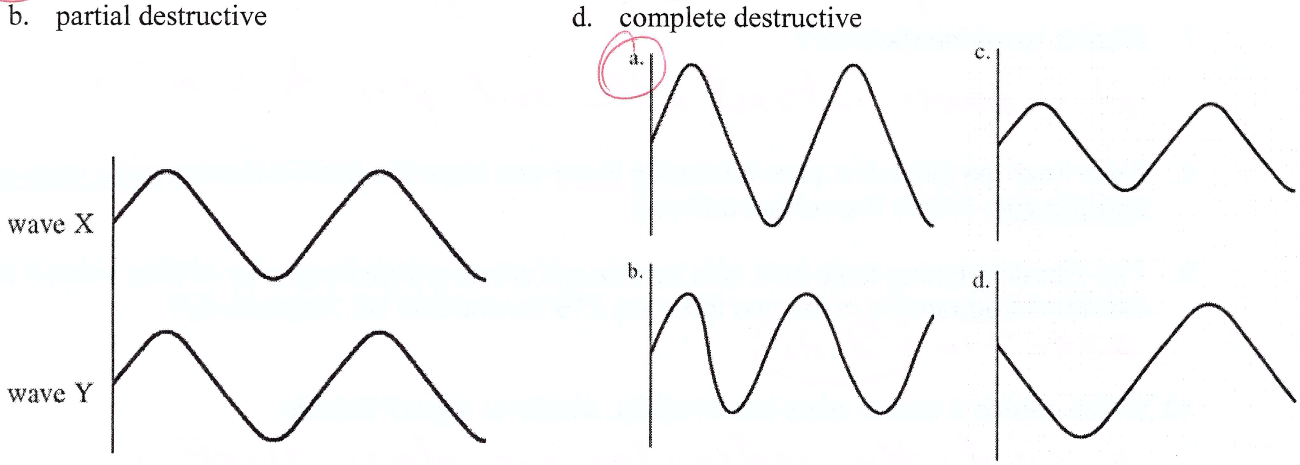
C ____ 6. A tuning fork with a frequency of 256 Hz is held over an air column. Resonance of the first harmonic will occur at an air tube length of ______. (speed of sound is 340 m / s) $\frac{1}{4}\lambda = ?$
a. 64 m b. 0.19 m c. 0.33 m d. not enough info
$\frac{v}{f} = \frac{(340 \text{ m/s})/(256 \text{ Hz})}{4} = \frac{1.328}{4} = 0.33$

C ____ 7. A wave created by shaking a rope up and down is called a
a. longitudinal wave
b. constructive wave
c. standing wave
d. transverse wave

A ____ 8. Where can you touch a standing wave on a rope without disturbing the wave?
a. at a node
b. at the wavelength
c. at any place along the wave
d. at an antinode



A ____ 9. Which of the following types of interference will occur in the figure above?
a. partial constructive
b. partial destructive
c. complete constructive
d. complete destructive



A ____ 10. In the diagram above, use the superposition principle to find the resultant wave of waves X and Y.
a. a b. b c. c d. d