

Determining the Speed of a Wave

The Wave Equation

$$v = \lambda f$$

Derivation

$$v = \frac{d}{t}$$

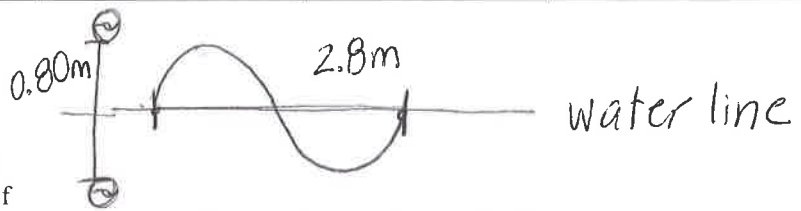
$$v = \frac{\lambda}{T} \left[\frac{m}{s} \right]$$

$$T = \frac{1}{f}$$

$$v = \lambda f \left[m \cdot \frac{1}{s} \right]$$

Variable:	v (or c)	λ	f
Quantity:	speed	wavelength	frequency
Units:	$[m/s]$	$[m]$	$(\frac{1}{s}) = [Hz] = s^{-1}$
Type:	scalar	scalar	scalar

1. A buoy moored off-shore bobs up and down as waves pass by. A nearby boater notices that it takes 1.6 seconds for the buoy to move from its lowest position to its highest position, a distance of 0.80 meters. She also notices that the crests of the waves are approximately 2.8 meters apart.



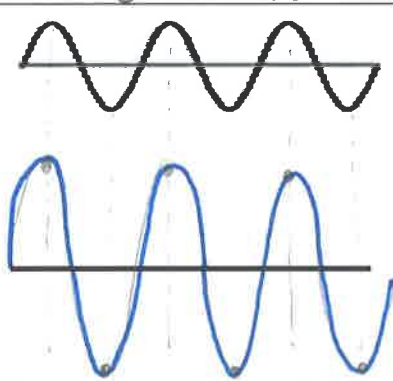
$$\lambda = 2.8m \quad T = 3.2s$$

- a) What is the average speed of the buoy?

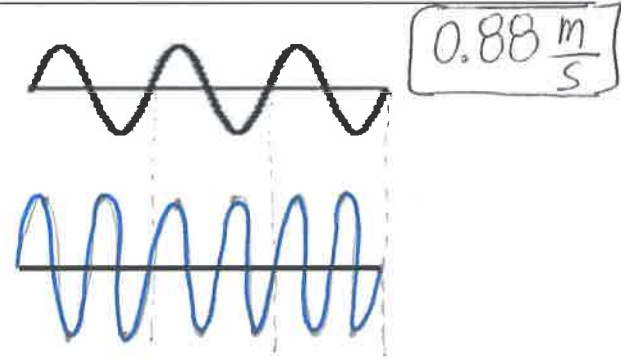
$$v = \frac{d}{t} = \frac{0.80m}{1.6s} = \boxed{0.50 \frac{m}{s}}$$

- b) What is the average speed of the wave?

$$v = \lambda f = (2.8m) \left(\frac{1}{3.2s} \right) = 0.875 \frac{m}{s}$$



2. a) On the bottom, sketch a wave that has the same wavelength as the wave on top but a higher amplitude.



3. a) On the bottom, sketch a wave that has the same amplitude as the wave on top but a higher frequency.

$$E \propto A^2$$

b) A mechanical wave with a higher amplitude has more ... energy

- c) Will increasing the amplitude change the speed of the wave? NO

b) A wave with a higher frequency has a ... shorter λ + shorter period

- c) Will increasing the frequency change the speed of the wave?

speed stays the same $v = \lambda f$
(in the same medium)

high f $\lambda \downarrow$ as $f \uparrow$
low f $\lambda \uparrow$ as $f \downarrow$ 3

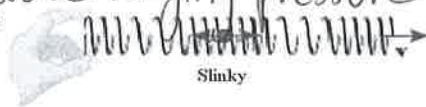
4. How can the speed of a wave be changed?
change properties of medium

Sound Waves

1. How are sound waves produced?

Vibrating objects produce varying pressure

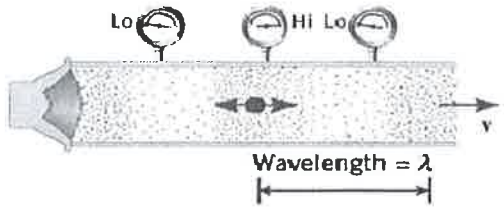
2. What type of a wave is sound?



a) *mechanical*

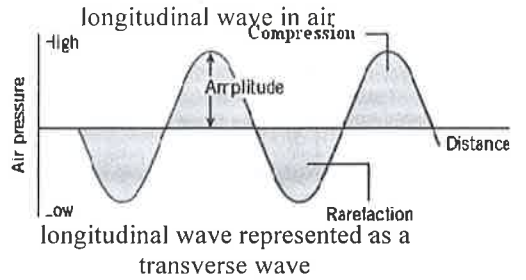
b) *longitudinal or compressional*

longitudinal wave in a Slinky



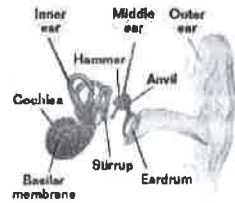
3. How can a longitudinal wave be represented as a transverse wave?

crests = compressions
troughs = rarefactions



4. What happens when this wave of varying air pressure reaches your ear?

vibrations of ear drum send electrical signals to the brain



5. Can sound be heard in outer space? Explain.



no : there is no medium to travel through

6. Speed of sound in air at STP: at 0°C = 331.5 m/s

7. Speed of sound in air at room temp: (≈ 20°C) 343 m/s

$$331.5 \frac{m}{s} + \left(\frac{0.607 \frac{m}{s}}{^{\circ}C} \right) (-^{\circ}C)$$

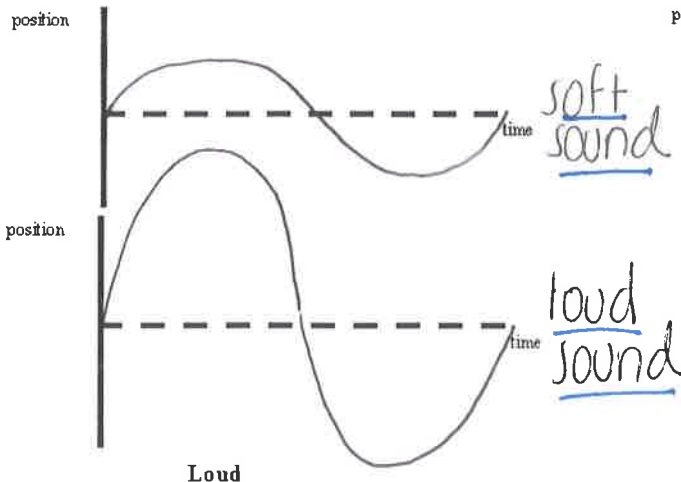
8. How is the speed of sound related to air temperature? Explain.

As air temperature increases, the speed of sound increases because molecules are moving faster.

9. Does sound travel fastest in a solid, a liquid, or a gas?

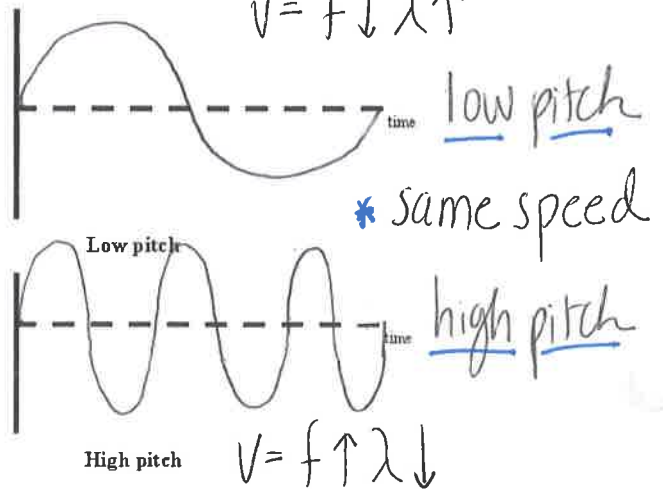
solid - because molecules are closest

10. As you increase the loudness (volume) of a sound, you increase its ...



Loud

you ...



12. In a classroom experiment, a student strikes first a 256 hertz tuning fork and then a 394 hertz one.

a) Which fork plays a note with a higher pitch?

394 Hz

b) Which fork has a greater period?

$$f = \frac{1}{T} \quad 256 \text{ Hz}$$

c) Which note has a longer wavelength?

256 Hz

d) Which note is traveling fastest?

same speed

e) Calculate the wavelength and period of the 256 Hz tuning fork.

$$\lambda = \frac{v}{f}$$

$$\frac{343 \text{ m/s}}{256 \text{ Hz}} = 1.34 \text{ m}$$

$$T = \frac{1}{256 \text{ Hz}} = 0.0039 \text{ s}$$

f) How long would it take a second student to hear a note from the 256 Hz tuning fork if they are sitting 7.5 meters away?

$$t = \frac{d}{v}$$

$$\frac{7.5 \text{ m}}{343 \text{ m/s}} = 0.022 \text{ s}$$

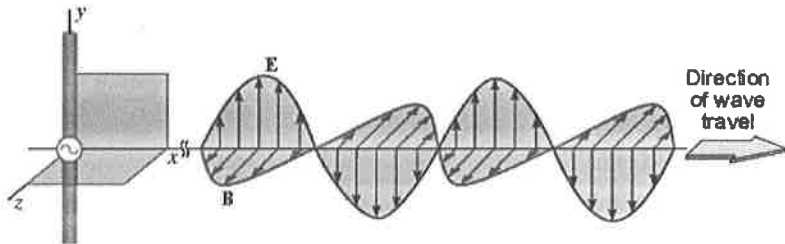
Light Waves

1. How are light waves (and all electromagnetic waves) produced

2. What type of a wave is light?

a)

b)

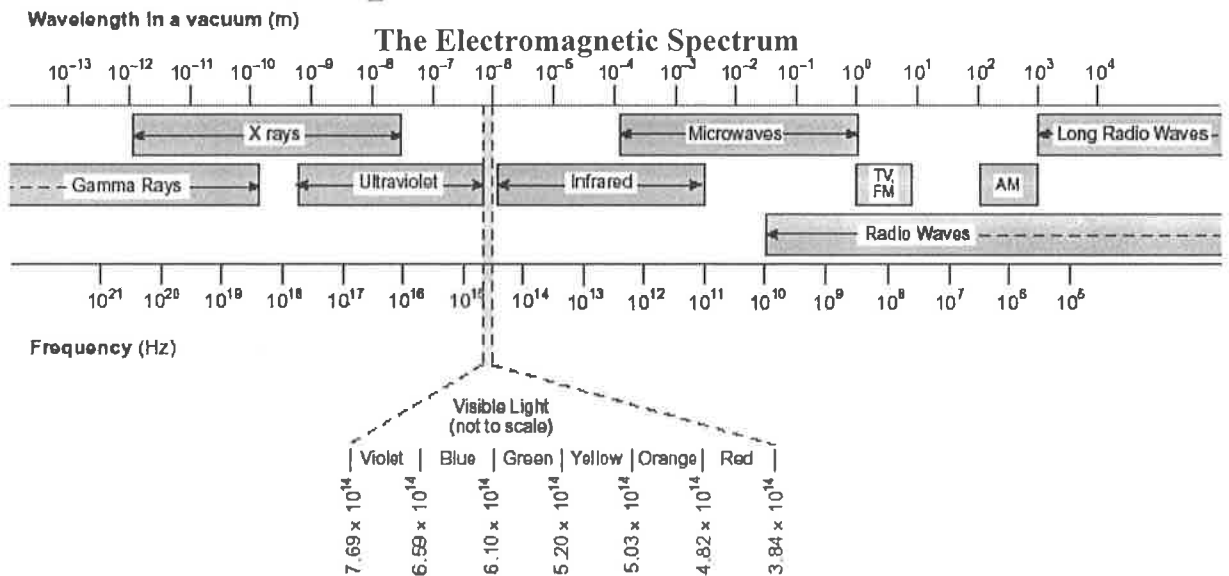


3. How fast does light travel?

in a vacuum:

in air:

in other materials:



4. What is the difference between an X-ray and a microwave?

5. What is the difference between a radio wave and a sound wave?

6. Which type of electromagnetic radiation has the highest frequency? Longest wavelength? Highest speed?

7. What range of frequencies is considered to be green light?

8. Which color of visible light has the highest frequency? Longest wavelength?