P.3 Spring 2018

Waves

1. Medium — the material through which the wave (energy) is traveling
2. Pulse — a single oscillation or disturbance of the medium
3. Traveling wave — a series of pulses or oscillations that move through a medium

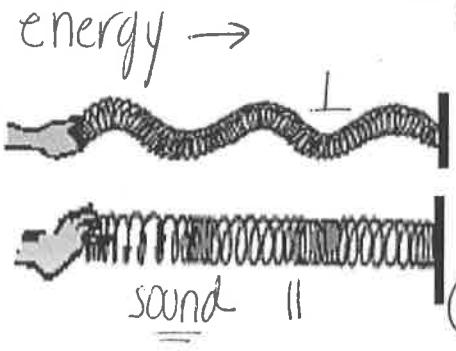
Energy Transfer

Particle – transfers both energy and matter

Wave – transfers energy without transferring matter

Electromagnetic – a wave that does not require a medium to transfer energy
Examples: x-rays, visible light, microwaves

Mechanical – a wave that requires a medium to transfer energy
Examples: seismic, sound, spring, water



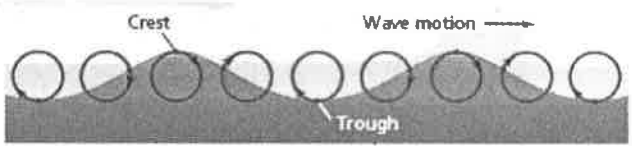
Transverse – the particles of the medium move perpendicular to the direction of the wave energy

Longitudinal – the particles of the medium move parallel to the direction of the wave energy (compressional)

4. Other types of mechanical waves

Elliptical wave (surface wave): combo of transverse + longitudinal

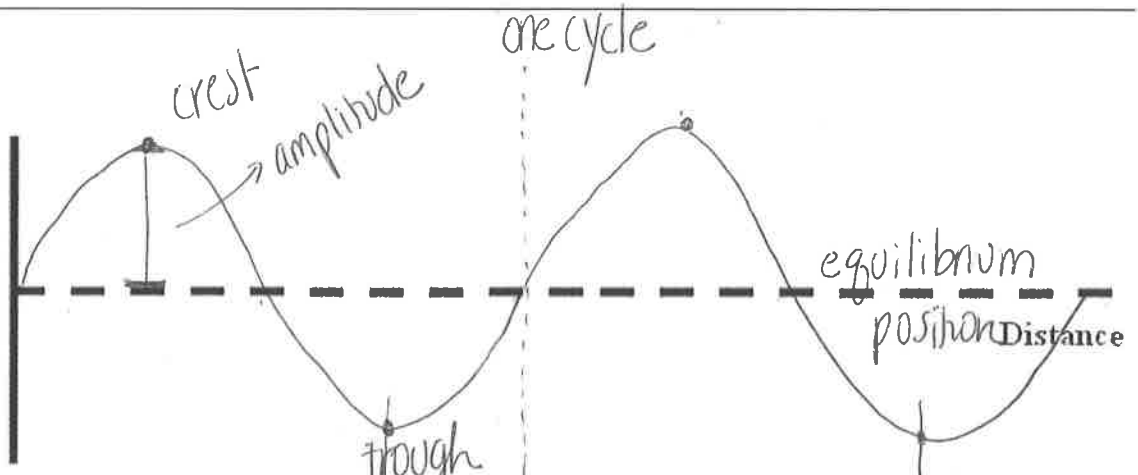
Torsional wave: twisting



Wave Characteristics

Cycle:

5. On the axes at right, sketch two cycles of a transverse wave.



6. Label the following parts of the wave you drew: **equilibrium position, crest, trough, amplitude, wavelength**

7. Identify each of the following terms:

a) Amplitude — maximum displacement from the equilibrium position

b) Wavelength — shortest distance along the wave between two points that are in phase

c) Period — time taken for one cycle (s)

d) frequency — number of cycles per second $\left(\frac{1}{s}\right)$

Symbol	Units
A	m
λ	m
T	s
f	$\left(\frac{1}{s}\right)$ = Hz

8. What is the relationship between period and frequency?

Period

$T = \frac{\text{seconds}}{\text{cycle}}$

Frequency

$f = \frac{\text{cycles}}{\text{second}}$

Relationship

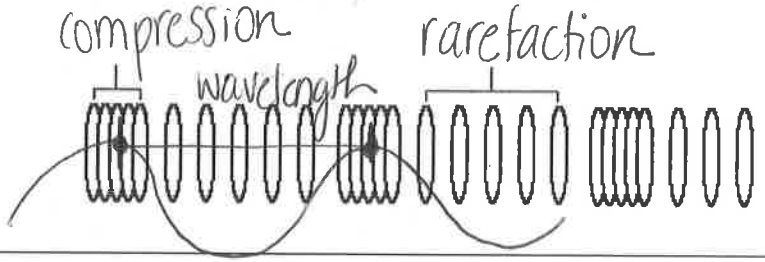
$f = \frac{1}{T}$

Examples:

$T = 2s$

$f = 0.5Hz$

9. Name each part of the longitudinal wave shown at right. Indicate the amplitude and wavelength of the wave.

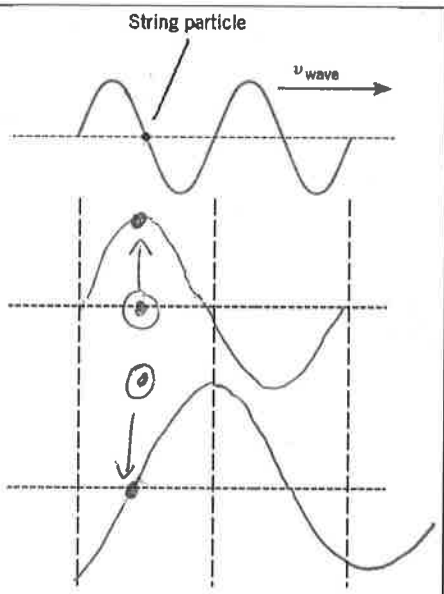


Wave Motion vs. Particle Motion

a) In which direction is the string particle moving at this instant?

b) Sketch the wave and particle after ¼ of a period from the time shown in a).

c) Sketch the wave and particle after ½ of a period from the time shown in a).



d) How far will the wave energy travel in one period? one wavelength

In a full period = 4 amplitudes

e) How long does it take one complete cycle to pass a given point? one period

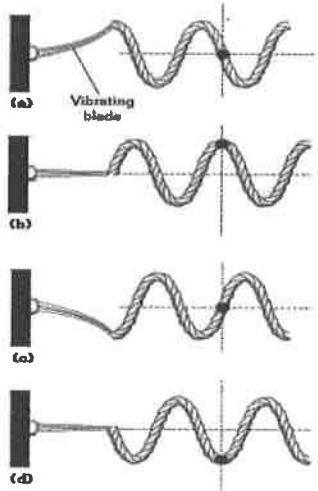
crest

equilibrium

trough

rest

Compare the motion of the wave with the motion of a single particle of the medium.



Wave (energy) motion

constant speed in horizontal direction

Particle motion

simple harmonic motion

SHM

speeding up/slowing down

Determining the Speed of a Wave The Wave Equation

Derivation

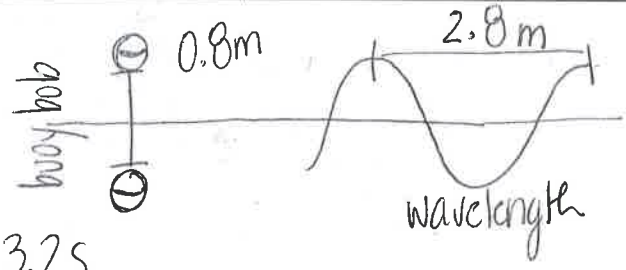
$V = \frac{d}{t} = \frac{\lambda}{T} = \left(\frac{m}{s}\right)$

$V = \lambda f$

$\frac{m}{s} = m\left(\frac{1}{s}\right)$

Variable:	V (or c)	λ	f
Quantity:	speed	wavelength	frequency
Units:	m/s	m	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.



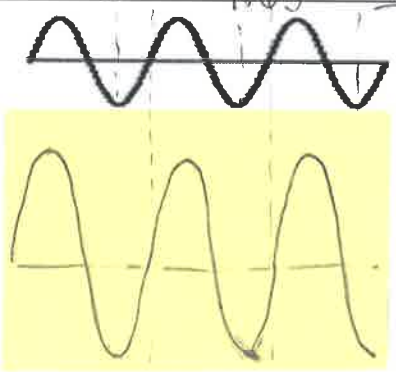
$T = 3.2s$

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?

$V = \lambda f$ $(2.8m)\left(\frac{1}{3.2s}\right) = 0.875\frac{m}{s} \downarrow \boxed{0.88\frac{m}{s}}$



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

b) A mechanical wave with a higher amplitude has more . . . energy $E \propto A^2$

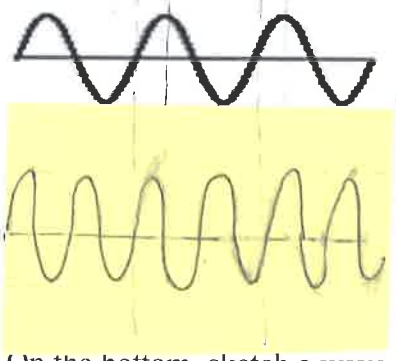
c) Will increasing the amplitude change the speed of the wave?

no

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

change the medium

or change the properties of medium



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

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

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

no