Reference material:

Chapter 10.4 (pg 248) of JMH Physics

Chapter 8 of MHR

⇨ A wave is a transfer of energy, in a form of a disturbance usually through a material substance, or medium.

- ⇨ Electromagnetic Waves
- ⇨ Sound waves
- ⇨ Water waves
- ⇨ Pressure waves
- ⇨ Gravity waves
- ⇨ Matter waves

*Demos to visualize new terms.

⇨When objects repeat a pattern of motion (e.g. a pendulum), we say that object is vibrating or oscillating. (wiimote demo)

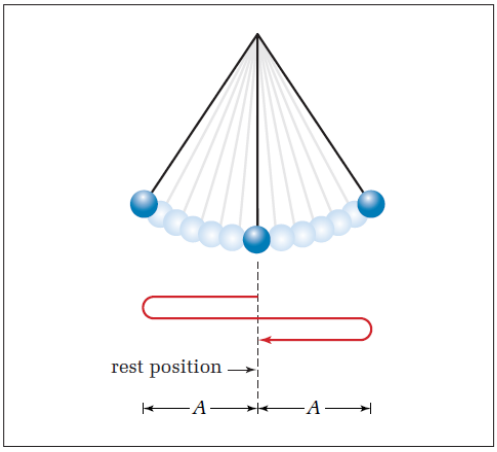
⇨The oscillation is repeated over and over with the same time interval each time.

⇨One complete oscillation is called a cycle.

⇨The number of cycles per second is called the frequency, f. The frequency is measured in Hertz (Hz).

⇨ The period, T, usually measured in seconds, is the time required for one cycle. The frequency and period are reciprocals of each other.

Close Read Pg 338 - 339 of MHR. Pay attention to and note the many terms introduced.



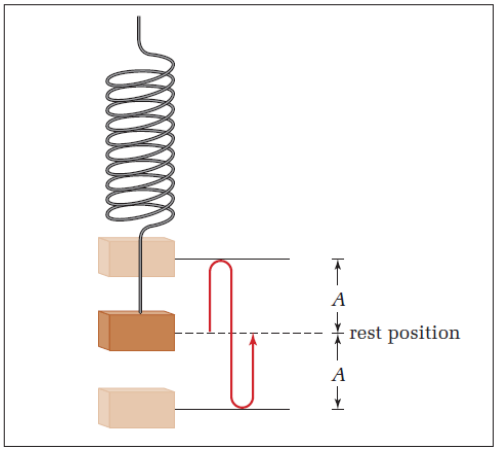


Figure 8.2 **(A)** When a simple pendulum completes one full cycle of its motion, it is in its original position. **(B)** One full cycle of the motion of the mass on a spring brings the mass back to the rest position.

PERIOD AND FREQUENCY

The period is the quotient of the time interval and the number of cycles. $T = \frac{\Delta t}{N}$

The frequency is the quotient of the number of cycles and the time interval. $f = \frac{N}{\Delta t}$

The frequency is the reciprocal, or inverse, of the period. $f = \frac{1}{T}$

Quantity	Symbol	SI unit
period	T	s (seconds)
frequency	f	Hz (hertz)
time interval	Δt	s (seconds)
number of cycles	N	none (pure number)

Note: $1\ \text{Hz} = \frac{1}{\text{s}} = 1\ \text{s}^{-1}$

Example. A pendulum completes 30 cycles in 15 seconds. Calculate its frequency and period.

$f = \frac{N}{\Delta t} = \frac{30}{15\text{s}} = \boxed{2.0\ \text{Hz}}$ $T = \frac{\Delta t}{N}$

$= \frac{15\text{s}}{30} = \boxed{0.5\text{s}}$

$N = 30$
$\Delta t = 15\text{s}$

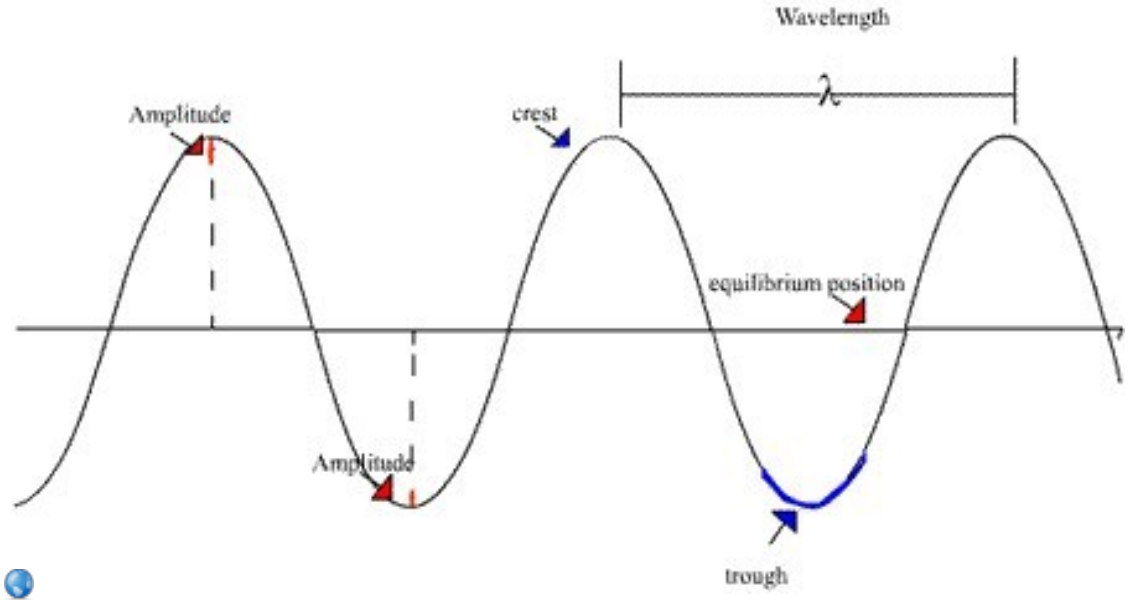
Pg 28

Read MHR pg 344 - top of 345.

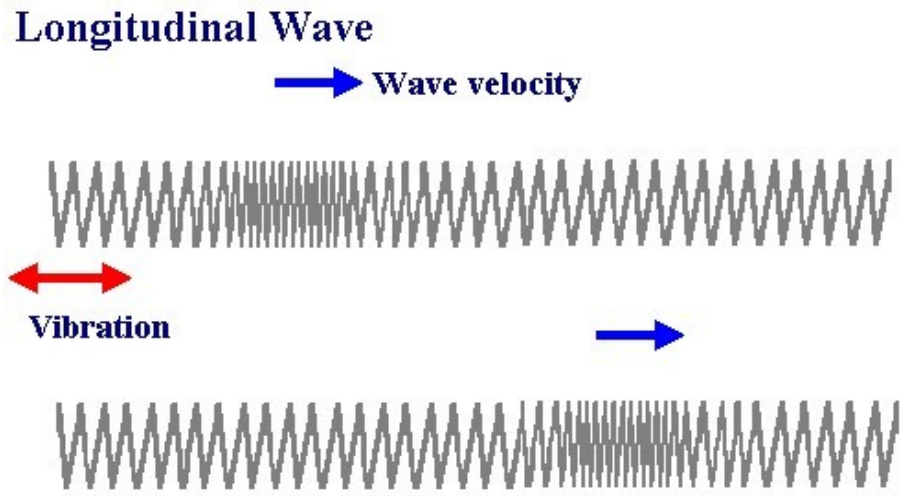
Follow Up Questions:

1. What is a medium when talking about waves?
2. Summarize the properties of mechanical waves.
3. What determines the speed of a mechanical wave? Provide an explanation for your answer.
4. What affect does friction have within a mechanical wave?

Transverse Waves



- The particles in the medium vibrate at right angles to the direction in which the wave travels.
- The high section is called the crest, and the low section is called the trough.
- The height of the crest or depth of the trough, from the equilibrium position is called the amplitude.
- For periodic waves, the distance between successive crests and troughs is equal and is called the wavelength. The symbol for the wavelength is the Greek letter lambda, λ
- The period of a transverse wave is the time it takes for one wavelength (one cycle) to pass a fixed point.
- The frequency is the number of wavelengths that passed a fixed point in one second.
- Examples include water waves and making vibrations on a rope.



Longitudinal Waves

- The vibrations of the particles are parallel to the direction of motion.
- There are a compressions and rarefactions created in longitudinal waves.
- One wavelength is the distance between the midpoints of successive compressions or rarefactions.
- The amplitude is the maximum displacement of the particles from their rest position. Amplitude is a measure of the wave's energy.
- Sound waves, pressure waves are examples.

Wave Characteristics Review

Grade:11

Subject:Physics 112

Date:2016

1 The time required to complete one cycle is called the frequency.

True

False

2 Maximum displacement from rest or equilibrium position is called the amplitude.

True

False

3 The number of cycles in a certain amount of time is called the _____.

A period

B frequency

C amplitude

D wavelength

4 The unit of Hertz, Hz, is only used if the time is measured in seconds.

True

False

5 A child on a swings completes 15 cycles in 45 seconds. The period is:

A 3.0 s

B 0.33 s

C 3.0 Hz

D 0.33 Hz

6 The period of a strobe light is 0.062 seconds. Calculate the frequency.

A 0.062 s

B 16.1 s

C 0.062 Hz

D 16.1 Hz

7 In a particular medium, what aspect of a mechanical wave always remains constant? (select all that apply)

A wavelength

B frequency

C period

D speed

E amplitude

8 In what type of wave does the particles of a medium vibrate parallel to the direction of the wave?

A transverse

B longitudinal

C sound

D water

Relationship of Wave Speed, Frequency and Wavelength

⇨ When a wave is generated in a spring or a rope, the wave travels a distance of one wavelength, λ, along the rope in the time required for one complete vibration of the source (the period). We can use the formula for velocity to derive the wave equation:

$$\text{velocity, } v = \frac{\text{change in position, } \Delta d}{\text{change in time, } \Delta t}$$

$$\text{and} \qquad \Delta d = \lambda, \text{ and } \Delta t = T$$

$$\text{therefore} \qquad v = \frac{\lambda}{T}$$

$$\text{but} \qquad f = \frac{1}{T}$$

$$\text{Therefore} \qquad v = f\lambda$$

⇨ The wave equation, $v = f\lambda$, applies to all waves, visible and invisible.

Examples

1. The wavelength of a water wave in a ripple tank is 0.080 m. If the frequency of the wave is 2.5 Hz, what is its speed?

$\lambda = 0.080\ m$

$f = 2.5\ Hz$

$v = ?$

$v = f\lambda$

$= (2.5\ Hz)(0.080\ m)$

$= 0.20\ m/s$

2. The distance between successive crests in a series of water waves is 4.0 m, and the crests travel 9.0 m in 4.5 s. What is the frequency of the waves?

$\lambda = 4.0\ m$

$d = 9.0\ m$

$t = 4.5\ s$ (time to travel 9.0 m)

$f = ?$

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

$v = \frac{9.0\ m}{4.5\ s} = 2.0\ m/s$

$v = f\lambda$

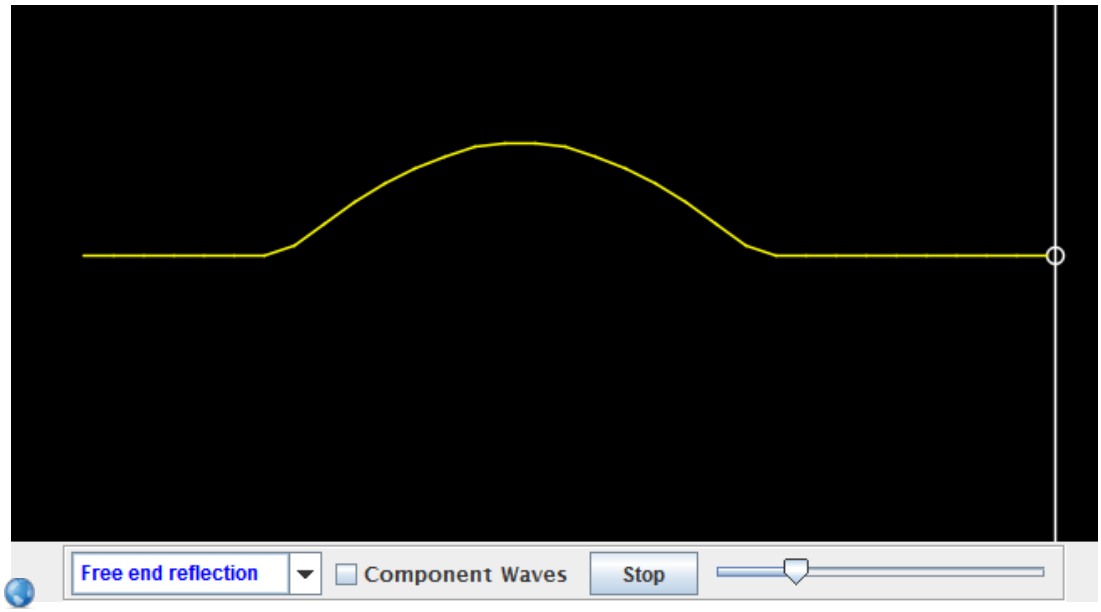
$2.0\ m/s = f(4\ m)$

$0.5\ Hz = f$

Wave Transmission & Reflection:

Waves at Boundaries

- When a wave moves from one medium to another its frequency remains constant.
- The other quantities change and how they change depends on the properties of the medium.
- The frequency of a wave is totally depended on the source of vibrations and cannot be changed during propagation.



- Explore free and fixed-end reflection.
- Qualitative analysis of waves traveling into a different medium.

Close Read MHR page 351 - 352, concept questions page 352 #'s 1 & 2.

Free-End Reflection Review

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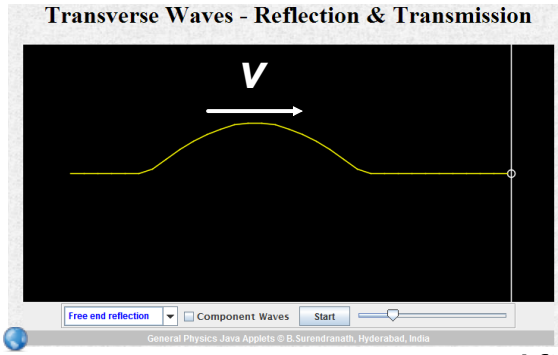

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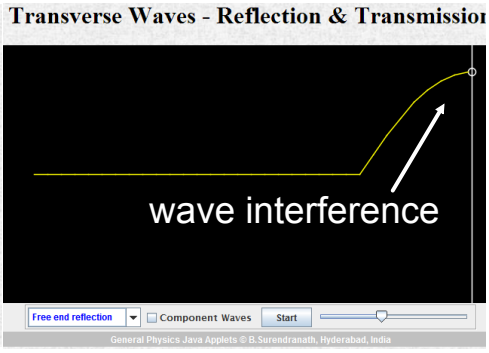

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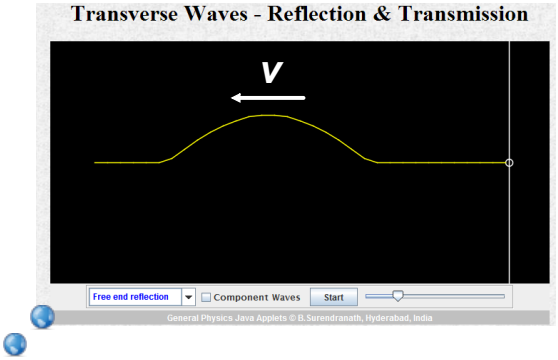
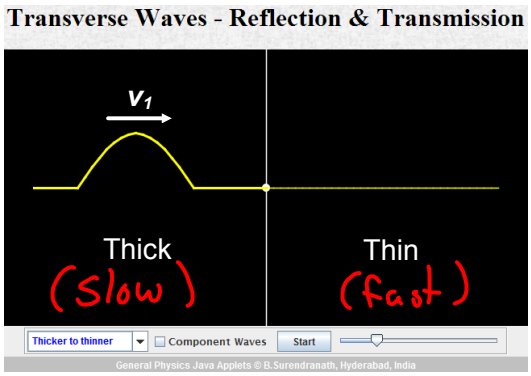


Wave Transmission

Before



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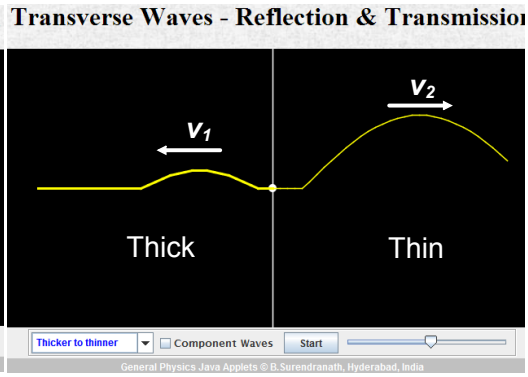
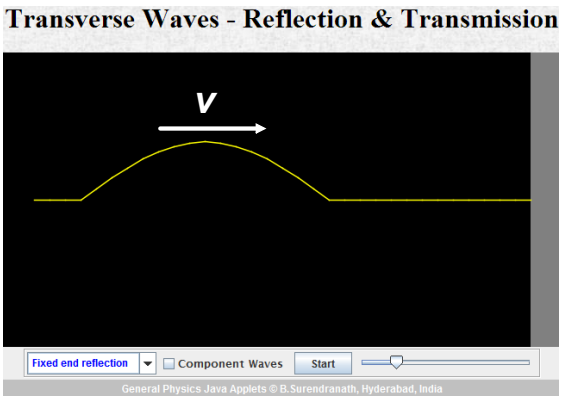


$v_2 > v_1$

- Boundary acts like free-end reflection.
- Reflected wave is same orientation as original.
- Transmitted wave is always the same orientation and frequency as original.

Fixed-End Reflection Review

Before



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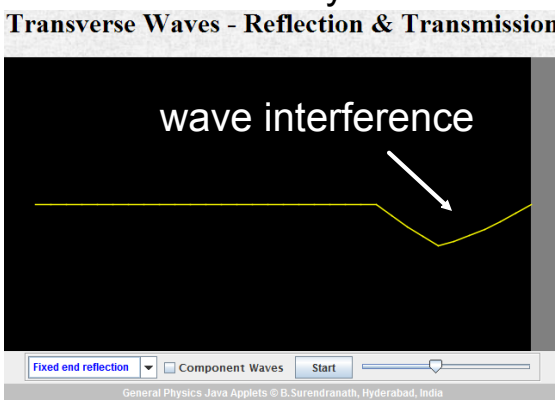

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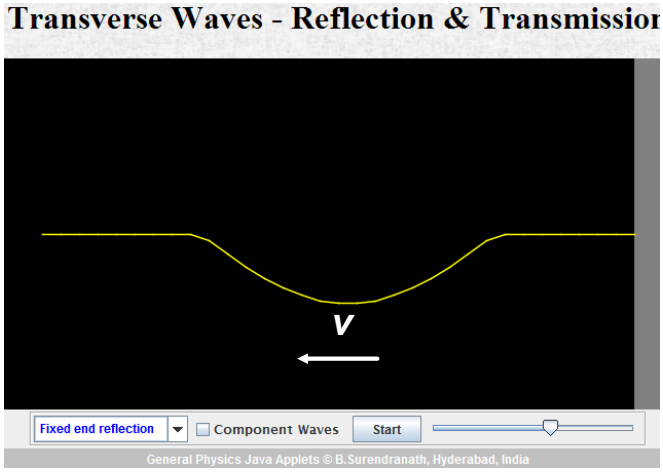
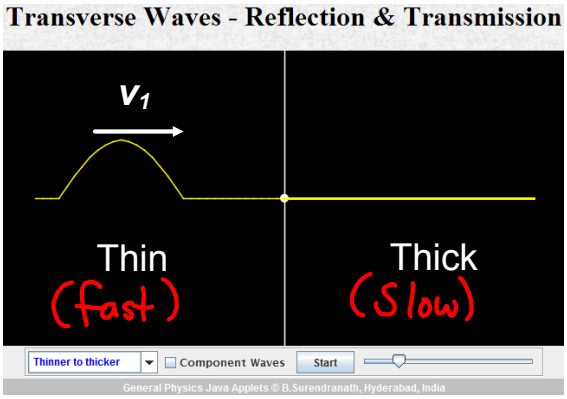


Wave Transmission

Before



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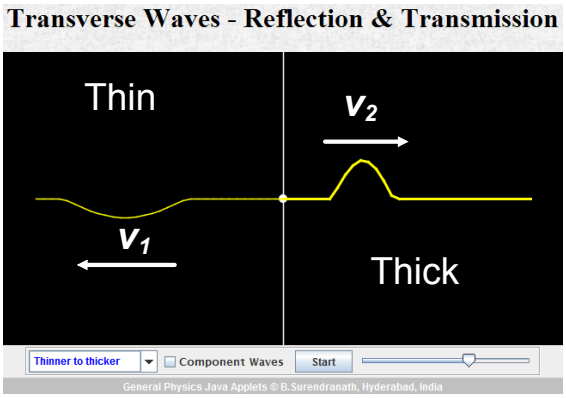

$v_1 > v_2$

- Boundary acts like a fixed end.
- Reflected wave is inverted.
- Transmitted wave is the same orientation and frequency as original.