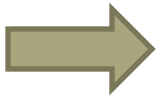
The Wave Equation

Objectives

- Calculate period, frequency, and wavelength and understand their relationship.

Frequency

- The frequency (f) of a wave describes the number of waves that pass a given point in a time period of one second.
  - Higher frequencies  more waves pass.
- Units are waves per second (1/s), also known as Hertz (Hz).

Period

- The period (T) of a wave describes how long it takes for a single wave to pass a given point.
- Period is the reciprocal of frequency.
- Units are seconds.

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

Sample problem 1

- What is the period of a 60-hertz electromagnetic wave traveling at 3.0 x 10^8 meters per second?

Sample Problem 2

- The product of a wave's frequency and its period is

a) one
b) its velocity
c) its wavelength
d) Plank's constant

Wave Velocity

- Waves travel through space, and therefore have a velocity.
- Velocity of a wave is a function of the type of wave, and the medium it travels through.
- Electromagnetic waves moving through a vacuum travel at $3x10^8$ m/s (c).

The Wave Equation

- For a given wave speed, as frequency increases, wavelength must decrease.
- (Inverse relationship.)

$$v = f\lambda$$

Sample Problem 3

- What is the wavelength of a wave having a frequency of 5 hertz and a speed of 10 meters per second?

Sample Problem 4

- If the amplitude of a wave is increased, the frequency of the wave will

a) Decrease

b) Increase

c) Remain the same

Sample Problem 5

- An electromagnetic wave traveling through a vacuum has a wavelength of 1.5x10-1 meters. What is the period of this electromagnetic wave?

Interference

Objectives

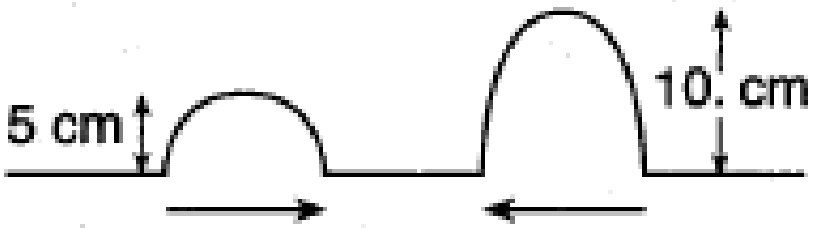
- Apply the principle of superposition to the phenomenon of wave interference.

Principle of Superposition

- Behavior of multiple waves traveling through the same location at the same time in the same medium is governed by superposition.
- Total displacement is the sum of all the individual displacements of the waves. (When two waves meet, you add the amplitudes together.)

Sample Problem 1

- The diagram shows two pulses approaching each other in a uniform medium. Diagram the superposition of the two pulses.



Wave Interference

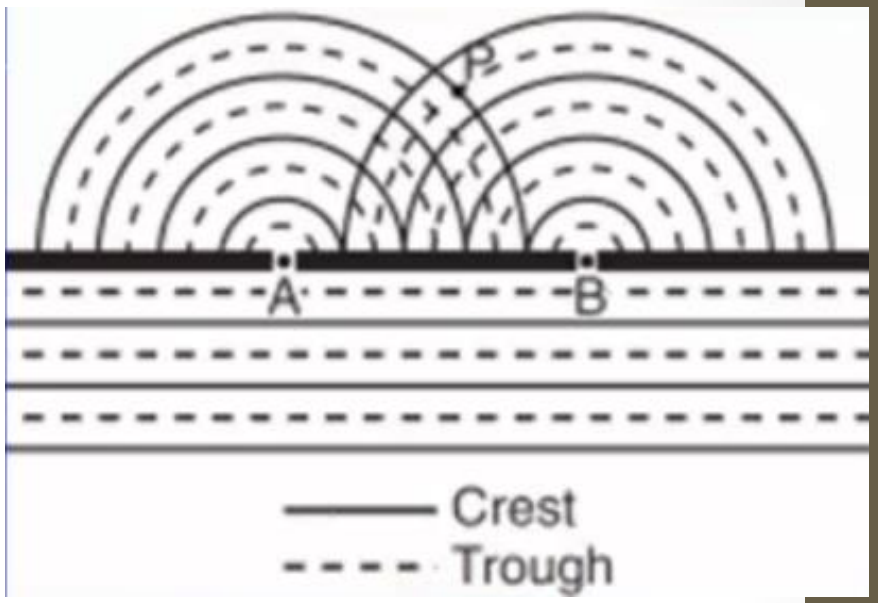
- Interaction of multiple waves following superposition principle is known as wave interference
  - Constructive – resulting displacement is greater than original pulses
  - Destructive – resulting displacements negate each other.
- Once the pulses pass each other, they continue along their original path in their original shape, as if they had never met.

Sample Problem 2

- The diagram represents two pulses approaching each other from the opposite directions in the same medium. Sketch the pulses when they meet and after they have passed through each other.

Sample Problem 3

The diagram represents shallow water waves of constant wavelength passing through two small openings, A and B, in a barrier. Which statement best describes the interference at point P?



a) Constructive: causes a longer wavelength
b) Constructive: causes an increase in amplitude.
c) Destructive: causes a shorter wavelength.
d) Destructive: causes a decreases in amplitude.