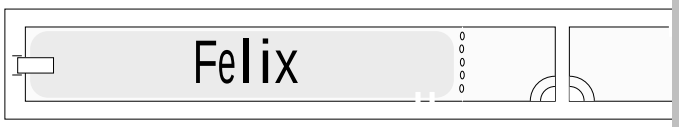
PhyzSpringboard: The Wave Equation



QUESTIONS

How fast do ocean waves travel if their wavelength is 12m and their frequency is 0.5Hz? What is the wavelength of sound waves that travel at 350m/s from a 384Hz tuning fork? What is the frequency of 670nm waves that travel at 300Mm/s? We shall soon find out.

WATCHING THE TRAIN GO BY

1. Suppose you're stuck at a railroad crossing watching a train go by. You estimate the length of each railroad car to be 10m. And in 60 seconds, you count 84 cars.

a. Write and evaluate a ratio that represents the number of seconds it takes for each car to go by.

$$60/84$$

b. Write and evaluate a ratio that represents the number of cars that go by in each second.

$$84/60$$

c. Which of the ratios above relates better to the **period** of train car passage? $60/84$

d. Which of the ratios above relates better to the **frequency** of train car passage? $84/60$

e. Use the information provided above to determine the speed of the train. Express your solution in the space below.

$$84/60 \text{ cars/second} \cdot 10 \text{ m/car} = 14\text{m/s}$$

f. Using λ for the length of each railroad car and T for number of seconds it takes for each car to go by, write an equation for v, the speed of the train.

$$v = \lambda/T$$

g. Using λ for the length of each railroad car and f for the number of cars that pass each second, write an equation for v, the speed of the train.

$$v = \lambda f$$

THE WAVE EQUATION

2. The equation in part g. above is **the wave equation**; it relates the speed of a wave to its wavelength and frequency.

a. Ocean waves 12m in length strike a seawall with a frequency of 0.5Hz. How fast do these waves move?

$$v = \lambda f = 12\text{m} \cdot 0.5\text{Hz} = 6\text{m/s}$$

b. Sound waves traveling at 350m/s are made by a tuning fork that vibrates 384 times each second. What is the wavelength of the sound waves produced?

$$\lambda = v/f = 350\text{m/s} / 384\text{Hz} = 0.91\text{m}$$

c. The light waves from a laser pointer have a wavelength of 670nm and travel at 300Mm/s. What is the frequency of the oscillating source of these waves?

$$f = v/\lambda = 300\text{x}10^{6}\text{m/s} / 670\text{x}10^{-9}\text{m} = 4.5\text{x}10^{-14}\text{Hz}$$