

Math Skills

Wave Speed

PROBLEM

The musical note A above middle C has a frequency of 440 Hz. If the speed of sound is known to be 350 m/s, what is the wavelength of this note?

SOLUTION

Step 1: List the given and unknown values.

Given: frequency, $f = 440$ Hz
wave speed, $v = 350$ m/s

Unknown: wavelength, $\lambda = ?$ m

Step 2: Write the equation for wave speed, and rearrange it to solve for wavelength.

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

Step 3: Insert the known values into the equation, and solve.

$$\lambda = \frac{350 \text{ m/s}}{440 \text{ Hz}}$$

$$\lambda = 0.80 \text{ m}$$

PRACTICE

1. A certain FM radio station broadcasts electromagnetic waves at a frequency of 9.05×10^7 Hz. These radio waves travel at a speed of 3.00×10^8 m/s. What is the wavelength of these radio waves?

Name: _____ Period: _____ Date: _____

PROBLEM

A buoy bobs up and down in the ocean. The waves have a wavelength of 2.5 m, and they pass the buoy at a speed of 4.0 m/s. What is the frequency of the waves? How much time does it take for one wave to pass under the buoy?

SOLUTION

Step 1: List the given and unknown values.

Given: wavelength, $\lambda = 2.5$ m
wave speed, $v = 4.0$ m/s

Unknown: frequency, $f = ?$ Hz
period, $T = ?$ s

Step 2: Write the equation for wave speed, and rearrange it to solve for frequency. Write the equation for period.

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

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

Step 3: Insert the known values into the equations, and solve.

$$f = \frac{4.0 \text{ m/s}}{2.5 \text{ m}}$$

$$f = 1.6 \text{ Hz}$$

$$T = \frac{1}{1.6 \text{ Hz}}$$

$$T = 0.62 \text{ s}$$

PRACTICE

6. Cicadas produce a buzzing sound that has a wavelength in air of 2.69 m. If the speed of sound in air is 346 m/s, what is the frequency of the sound produced by a cicada? What is its period?

Name: _____ Period: _____ Date: _____

7. A drum is struck, producing a wave with a wavelength of 1.10 m and a speed of 2.42×10^4 m/s. What is the frequency of the wave? What is the period?

8. One of the largest organ pipes is in the auditorium organ in the convention hall in Atlantic City, New Jersey. The pipe is 38.6 ft long and produces a sound with a wavelength of about 10.6 m. If the speed of sound in air is 346 m/s, what is the frequency of this sound?

9. Yellow light with a wavelength of 5.89×10^{-7} m travels through quartz glass with a speed of 1.94×10^8 m/s. What is the frequency of the light?

Name: _____ Period: _____ Date: _____

PROBLEM

Waves in a lake are 6 m apart and pass a person on a raft every 2 s. What is the speed of the waves?

SOLUTION

Step 1: List the given and unknown values.

Given: wavelength, $\lambda = 6$ m

period, $T = 2$ s

Unknown: wave speed, $v = ?$ m/s

Step 2: Write the equations for period and wave speed. Calculate the frequency from the period, and then determine the wave speed.

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

$$v = f \times \lambda$$

Step 3: Insert the known values into the equations, and solve.

$$f = \frac{1}{2 \text{ s}} = 0.5 \text{ Hz}$$

$$v = (0.5 \text{ Hz}) \times (6 \text{ m})$$

$$v = 3 \text{ m/s}$$

PRACTICE

10. A wave with a frequency of 60.0 Hz travels through vulcanized rubber with a wavelength of 0.90 m. What is the speed of this wave?

11. A wave with a frequency of 60.0 Hz travels through steel with a wavelength of 85.5 m. What is the speed of this wave?

Name: _____ Period: _____ Date: _____

12. Earthquakes generate shock waves that travel through Earth's interior to other parts of the world. The fastest of these waves are longitudinal waves, like sound waves, and are called *primary waves*, or just *p-waves*. A p-wave has a very low frequency, typically around 0.050 Hz. If the speed of a p-wave with this frequency is 8000 m/s, what is its wavelength?
13. Earthquakes also produce transverse waves that move more slowly than the p-waves. These waves are called *secondary waves*, or *s-waves*. If the wavelength of an s-wave is 2.3×10^4 m, and its speed is 4500 m/s, what is its frequency?
14. A dolphin can typically hear sounds with frequencies up to 150,000 Hz. What is the speed of sound in water if a wave with this frequency has a wavelength of 0.01 m?
15. A ship anchored at sea is rocked by waves that have crests 14 m apart. The waves travel at 7.0 m/s. With what frequency do the wave crests reach the ship?