

Vibrations and Waves

Problem D**WAVE SPEED****PROBLEM**

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 very low frequencies, typically around 0.050 Hz. If the wavelength of a p-wave is 160 km, what is its speed?

SOLUTION

Given: $\lambda = 160 \text{ km} = 1.6 \times 10^5 \text{ m}$ $f = 0.050 \text{ Hz}$

Unknown: $v = ?$

Choose the equation(s) or situation: Use the equation relating speed, wavelength, and frequency for a wave.

$$v = f\lambda = (1.6 \times 10^5 \text{ m})(0.050 \text{ s}^{-1}) = \boxed{8.0 \times 10^3 \text{ m/s}}$$

ADDITIONAL PRACTICE

1. 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 $2.3 \times 10^4 \text{ m}$, and its frequency is 0.065 Hz, what is its speed?
2. A dolphin can hear sounds with frequencies up to 280 kHz. What is the speed of sound in water if a wave with this frequency has a wavelength of 0.51 cm?
3. Waves in a lake are 6.0 m apart and pass a person on a raft every 2.0 s. What is the speed of the waves?
4. Sonar is a device that uses reflected sound waves to measure underwater depths. If a sonar signal has a frequency of 288 Hz, and the wavelength is 5.00 m, what is the speed of the sonar signal in water?
5. A buoy on the ocean bobs up and down. The waves have a wavelength of 2.5 m, and a frequency of 1.6 Hz. What is the speed of the waves?
6. A dog whistle is designed to produce a sound with a frequency beyond that which can be heard by humans (between 20 000 Hz and 27 000 Hz). If a particular whistle produces a sound with a frequency of $2.5 \times 10^4 \text{ Hz}$, what is the sound's wavelength? Assume the speed of sound in air to be 331 m/s.
7. The lowest pitch that the average human can hear has a frequency of 20.0 Hz. If sound with this frequency travels through air with a speed of 331 m/s, what is its wavelength?

Name: _____ Class: _____ Date: _____

8. A ship anchored at sea is rocked by waves whose crests are 14 m apart. The waves travel at 7.0 m/s. How often do the wave crests reach the ship?
9. One of the largest organ pipes is in the Auditorium Organ in the Atlantic City Convention Hall, 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 331 m/s, what is the frequency of this sound?
10. A drum is struck, producing a wave with a wavelength of 110 cm and a speed of 2.42×10^4 m/s. What is the frequency of the wave?