

**Wave Speed Problems**

Name \_\_\_\_\_ Date \_\_\_\_\_ Block \_\_\_\_\_

Recall that the speed of an object is the distance it travels divided by the time it takes. ( $s = \frac{d}{t}$ ) waves are no different, they travel a certain distance in an amount of time. The terminology however is different. The velocity (*aka speed*) of a wave can be found by multiplying the  $f$  (*frequency – how many times a wave passes a given point in a second*) by the  $\lambda$  (*wavelength – the length of one complete wave, either crest to crest or trough to trough, etc.*) The  $T$  is the period (*the time for one complete wave cycle, and period is the inverse of the frequency.*)

$$V = f \times \lambda \quad \lambda = \frac{V}{f} \quad f = \frac{V}{\lambda} \quad T = \frac{1}{f} \quad f = \frac{1}{T}$$

**Solve the following problems. Show your work (G.U.E.S.S.) for full credit. Make sure to include units in your answer.**

1. 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?

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

3. 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  $2.5 \times 10^4$  Hz, what is the sound's wavelength? Assume the speed of sound in air is 331 m/s.

4. 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?

5. A 10.0 m wire is hung from a high ceiling and held tightly below by a large mass. Standing waves are created in the wire by air currents that pass over the wire, setting it in motion. If the speed of the standing wave is 335 m/s and its frequency is 67 Hz, what is its wavelength?

6. 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 speed of sound in water is  $1.45 \times 10^3$  m/s, what is the wavelength of the sonar signal?

7. 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?

8. How much time does it take for one wave to pass under the buoy from # 7?

9. 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?
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10. A drum is struck, producing a wave with a wavelength of 110 cm and a speed of  $2.42 \times 10^4$  m/s. What is the frequency of the wave? What is the period?
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11. 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?
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12. A ship anchored at sea is rocked by waves that have crests 14 m apart. The waves travel at 7.0 m/s. How often do the wave crests go past the ship? (*This question is asking for the period.*)
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13. 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? (*Hint: Use period to find the frequency before solving for the velocity.*)
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14. 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?
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15. 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?
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16. 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 8.0 km/s, what is its wavelength?
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17. 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  $2.0 \times 10^4$  m, and its speed is 4.5 km/s, what is its frequency?
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18. A dolphin can typically hear sounds with frequencies up to 150 kHz. What is the speed of sound in water if a wave with this frequency has a wavelength of 1.0 cm?
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