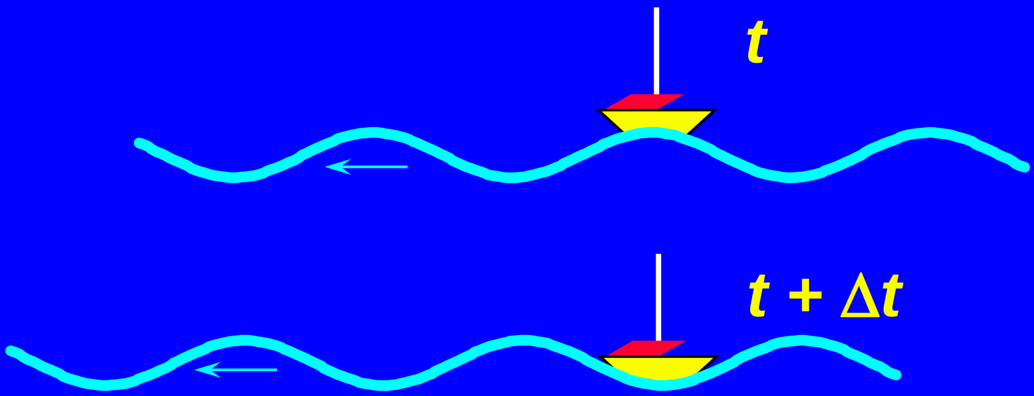
ConcepTest 15.4 Out to Sea

A boat is moored in a fixed location, and waves make it move up and down. If the spacing between wave crests is *20 m* and the speed of the waves is *5 m/s*, how long does it take the boat to go from the top of a crest to the bottom of a trough ?

1) 1 second
2) 2 seconds
3) 4 seconds
4) 8 seconds
5) 16 seconds



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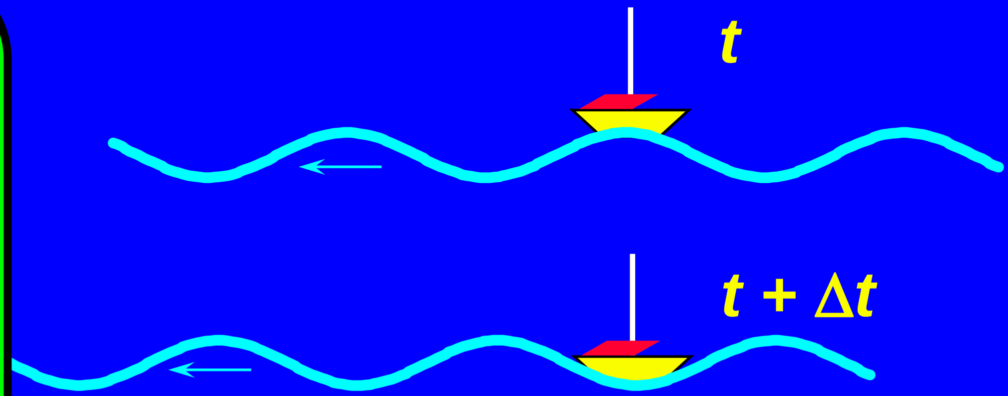
5) 16 seconds

We know that: $v = f\lambda = \lambda / T$, hence $T = \lambda / v$. If $\lambda = 20\ m$ and $v = 5\ m/s$, so $T = 4$ secs.

The time to go from a crest to a trough is only *T/2* (half a period), so it takes *2 secs !!*



ConcepTest 15.6a Wave Speed I

A wave pulse can be sent down a rope by jerking sharply on the free end. If the tension of the rope is increased, how will that affect the speed of the wave?

1) speed increases
2) speed does not change
3) speed decreases

ConcepTest 15.6a Wave Speed I

A wave pulse can be sent down a rope by jerking sharply on the free end. If the tension of the rope is increased, how will that affect the speed of the wave?

1) speed increases
2) speed does not change
3) speed decreases

The wave speed depends on the square root of the tension, so if the tension increases, then the wave speed will also increase.

ConcepTest 15.6b Wave Speed II

A wave pulse is sent down a rope of a certain thickness and a certain tension. A second rope made of the same material is twice as thick, but is held at the same tension. How will the wave speed in the second rope compare to that of the first?

1) speed increases
2) speed does not change
3) speed decreases

ConcepTest 15.6b Wave Speed II

A wave pulse is sent down a rope of a certain thickness and a certain tension. A second rope made of the same material is twice as thick, but is held at the same tension. How will the wave speed in the second rope compare to that of the first?

1) speed increases
2) speed does not change
3) speed decreases

The wave speed goes inversely as the square root of the mass per unit length, which is a measure of the inertia of the rope. So in a thicker (more massive) rope at the same tension, the wave speed will decrease.

Which of the following actions would make a pulse travel faster down a stretched string?

1. Move your hand up and down more quickly as you generate the pulse.
2. Move your hand up and down a larger distance as you generate the pulse.
3. Use a heavier string of the same length, under the same tension.
4. Use a lighter string of the same length, under the same tension.
5. Use a longer string of the same thickness, density and tension.

Which of the following actions would make a pulse travel faster down a stretched string?

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4. ✔ **Use a lighter string of the same length, under the same tension.**
5. Use a longer string of the same thickness, density and tension.

ConcepTest 16.1a Sound Bite I

When a sound wave passes from air into water, what properties of the wave will change?

1) the frequency f
2) the wavelength λ
3) the speed of the wave
4) both f and λ
5) both v_{wave} and λ

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1) the frequency f
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5) both v_{wave} and λ

Wave speed must change (different medium). Frequency does not change (determined by the source). Now, $v = f\lambda$ and since v has changed and f is constant then **λ must also change**.

Follow-up: Does the wave speed increase or decrease in water?

ConcepTest 16.1b Sound Bite II

We just determined that the wavelength of the sound wave will change when it passes from air into water. How will the wavelength change?

1) wavelength will increase
2) wavelength will not change
3) wavelength will decrease

ConcepTest 16.1b Sound Bite II

We just determined that the wavelength of the sound wave will change when it passes from air into water. How will the wavelength change?

1) wavelength will increase
2) wavelength will not change
3) wavelength will decrease

The speed of sound is greater in water, because the force holding the molecules together is greater. This is generally true for liquids, as compared to gases. If the speed is greater and the frequency has not changed (determined by the source), then the wavelength must also have increased ($v = f\lambda$).

ConcepTest 16.2a Speed of Sound I

Do sound waves travel faster in water or in ice?

(1) water

(2) ice

(3) same speed in both

(4) sound can only travel in a gas

ConcepTest 16.2a Speed of Sound I

Do sound waves travel faster in water or in ice?

(1) water

(2) ice

(3) same speed in both

(4) sound can only travel in a gas

Speed of sound depends on the **inertia** of the medium and the **restoring force**. Since ice and water both consist of water molecules, the inertia is the same for both. **However, the force holding the molecules together is greater in ice (because it is a solid), so the restoring force is greater.** Since $v = \sqrt{(\text{force / inertia})}$, the speed of sound must be **greater in ice** !

ConcepTest 16.2b Speed of Sound II

Do you expect an echo to return to you more quickly or less quickly on a hot day, as compared to a cold day?

1) more quickly on a hot day
2) equal times on both days
3) more quickly on a cold day

ConcepTest 16.2b Speed of Sound II

Do you expect an echo to return to you more quickly or less quickly on a hot day, as compared to a cold day?

1) more quickly on a hot day
2) equal times on both days
3) more quickly on a cold day

The speed of sound in a gas increases with temperature. This is because the molecules are bumping into each other faster and more often, so it is easier to propagate the compression wave (sound wave).

ConcepTest 16.2c Speed of Sound III

If you fill your lungs with helium and then try talking, you sound like Donald Duck. What conclusion can you reach about the speed of sound in helium?

1) speed of sound is less in helium
2) speed of sound is the same in helium
3) speed of sound is greater in helium
4) this effect has nothing to do with the speed in helium

ConcepTest 16.2c Speed of Sound III

If you fill your lungs with helium and then try talking, you sound like Donald Duck. What conclusion can you reach about the speed of sound in helium?

1) speed of sound is less in helium
2) speed of sound is the same in helium
3) speed of sound is greater in helium
4) this effect has nothing to do with the speed in helium

The higher pitch implies a higher frequency. In turn, since $v = f\lambda$, this means that the speed of the wave has increased (as long as the wavelength, determined by the length of the vocal chords, remains constant).

Follow-up: Why is the speed of sound greater in helium than in air?