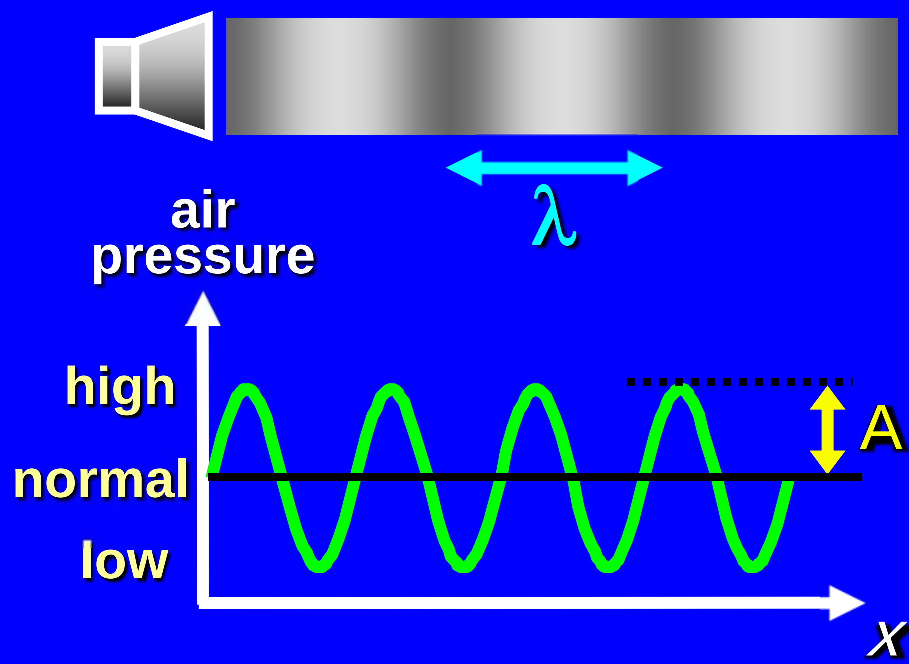
ConcepTest 15.1 Sound It Out

Does a longitudinal wave, such as a sound wave, have an amplitude?

1) yes
2) no
3) it depends on the medium the wave is in



ConcepTest 15.1 Sound It Out

Does a longitudinal wave, such as a sound wave, have an amplitude?

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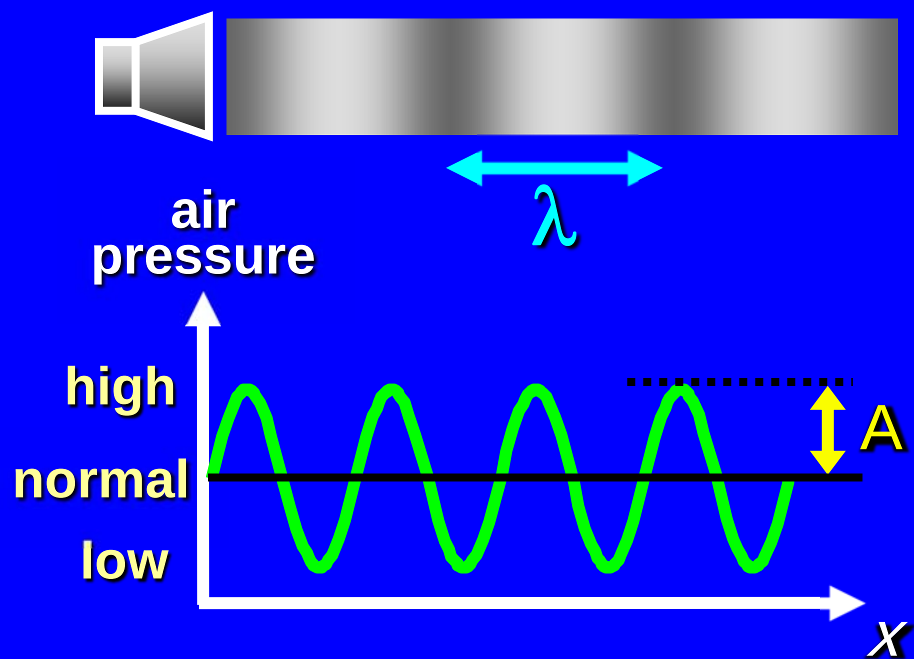
All wave types—transverse, longitudinal, surface—have all of these properties: **wavelength, frequency, amplitude, velocity, period.**



ConcepTest 15.2 The Wave

At a football game, the "wave" might circulate through the stands and move around the stadium. In this wave motion, people stand up and sit down as the wave passes. What type of wave would this be characterized as?

1) polarized wave
2) longitudinal wave
3) lateral wave
4) transverse wave
5) soliton wave

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1) polarized wave
2) longitudinal wave
3) lateral wave
4) transverse wave
5) soliton wave

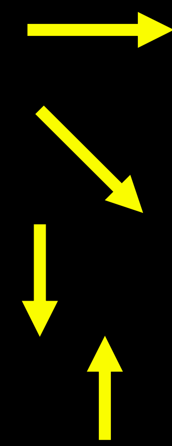
The people are moving up and down, and the wave is traveling around the stadium. Thus, the motion of the wave is perpendicular to the oscillation direction of the people, and so this is a transverse wave.

Follow-up: What type of wave occurs when you toss a pebble in a pond?

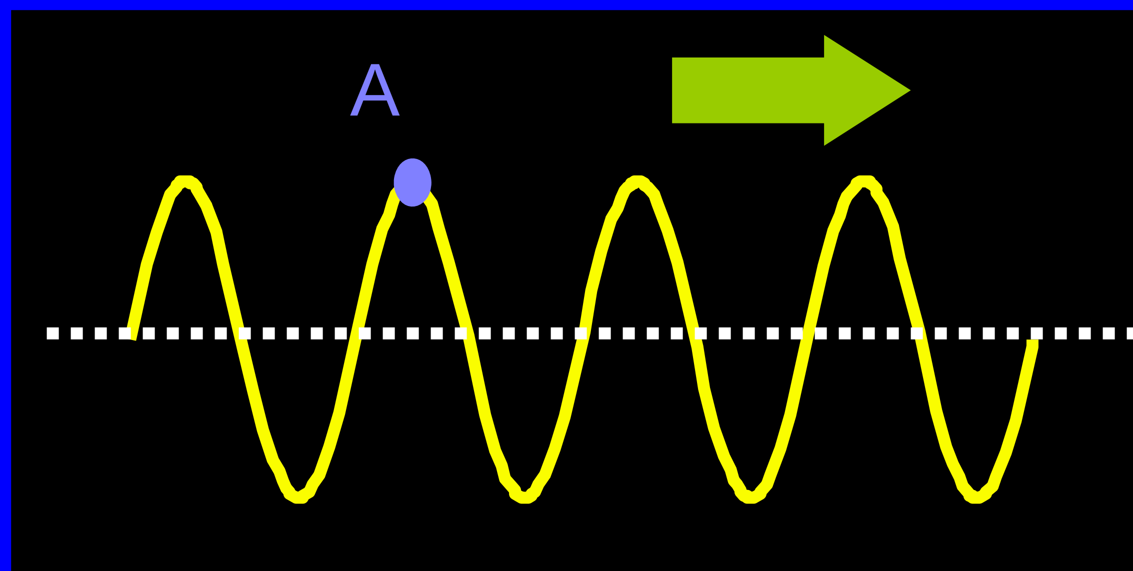
ConcepTest 15.3a Wave Motion I

Consider a wave on a string moving to the right, as shown below.

What is the direction of the velocity of a particle at the point labeled A ?



1)
2)
3)
4)
5) zero



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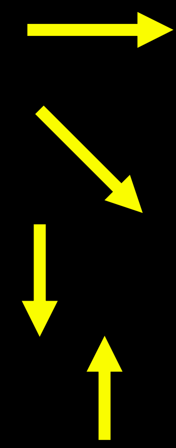
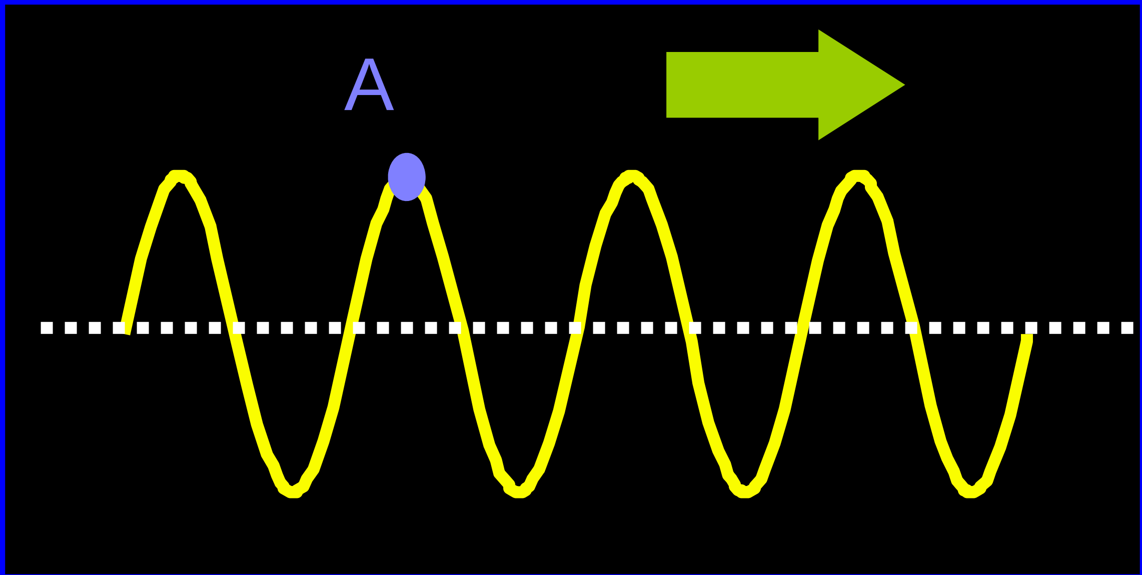


The velocity of an oscillating particle is (momentarily) *zero* at its maximum displacement.



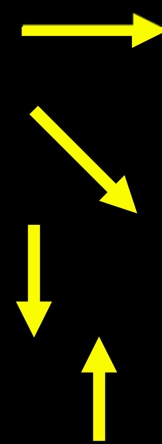
Follow-up: What is the acceleration of the particle at point A?

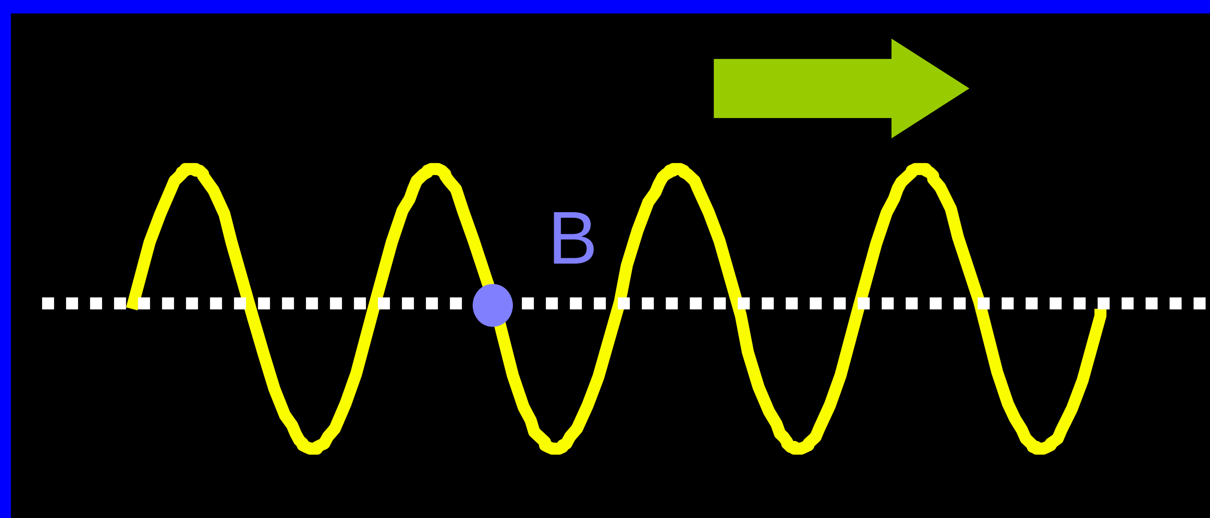
ConcepTest 15.3b Wave Motion II

Consider a wave on a string moving to the right, as shown below.

What is the direction of the velocity of a particle at the point labeled B ?

1)
2)
3)
4)
5) zero



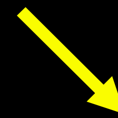


ConcepTest 15.3b Wave Motion II

Consider a wave on a string moving to the right, as shown below.

What is the direction of the velocity of a particle at the point labeled B ?

1) 

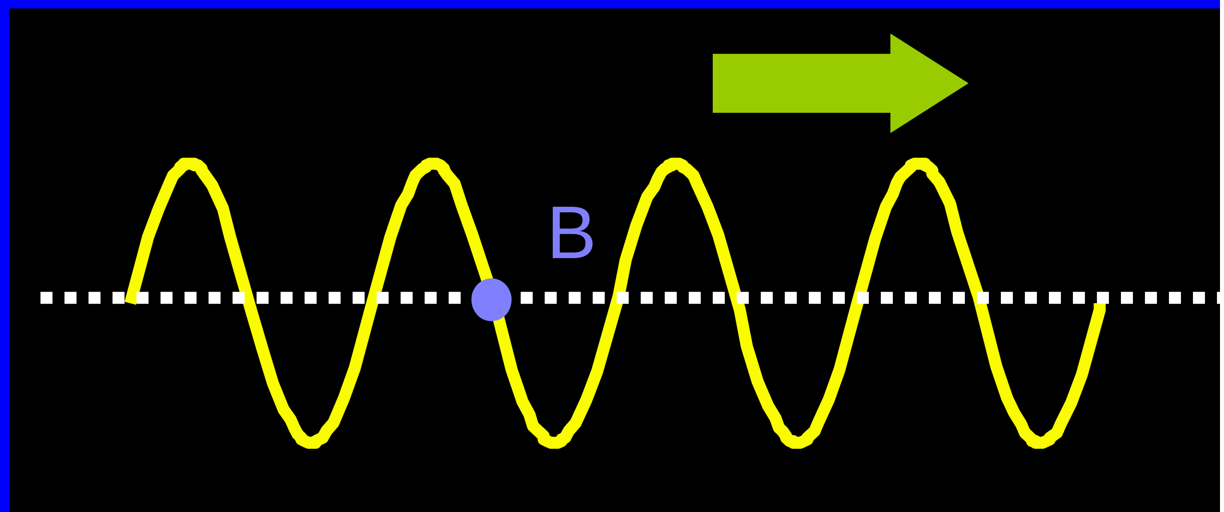
2) 

3) 

4) 

5) zero

The wave is moving to the **right**, so the particle at B has to start **moving upward** in the next instant of time.

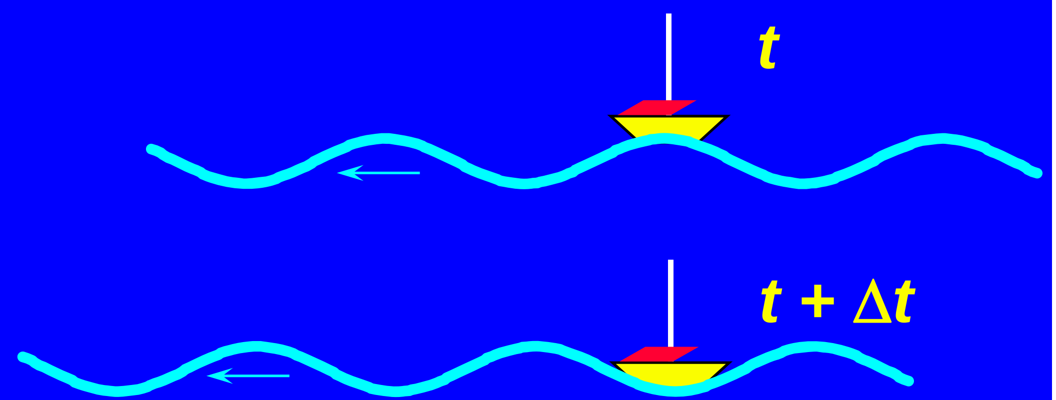


Follow-up: What is the acceleration of the particle at point B?

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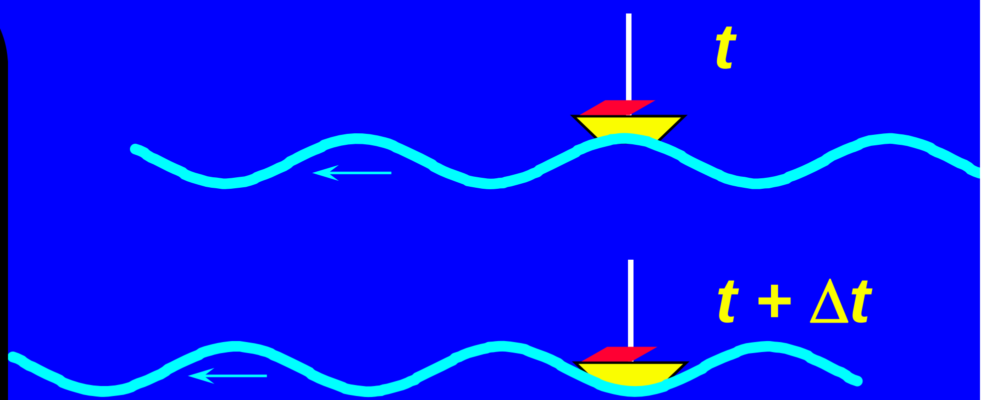
1) 1 second
2) 2 seconds
3) 4 seconds
4) 8 seconds
5) 16 seconds

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

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

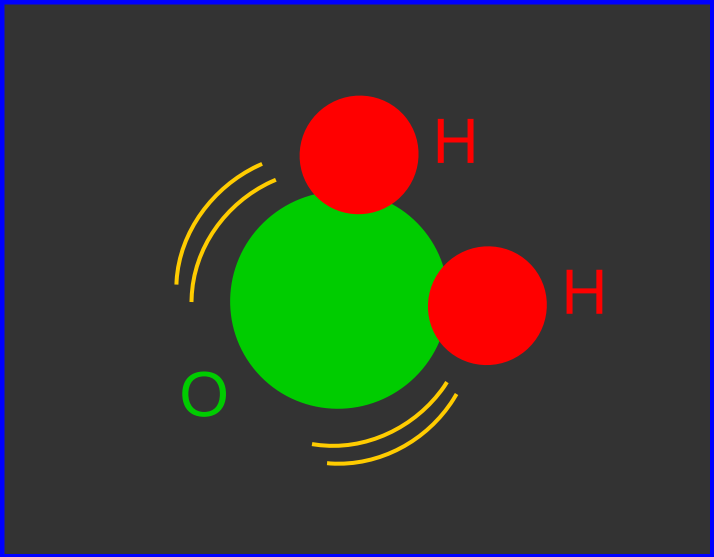


ConcepTest 15.5 Lunch Time

Microwaves travel with the speed of light, $c = 3 \times 10^8$ m/s. At a frequency of 10 GHz these waves cause the water molecules in your burrito to vibrate. What is their wavelength?

1 GHz = 1 Gigahertz = 10^9 cycles/sec

1) 0.3 mm
2) 3 cm
3) 30 cm
4) 300 m
5) 3 km



ConcepTest 15.5 Lunch Time

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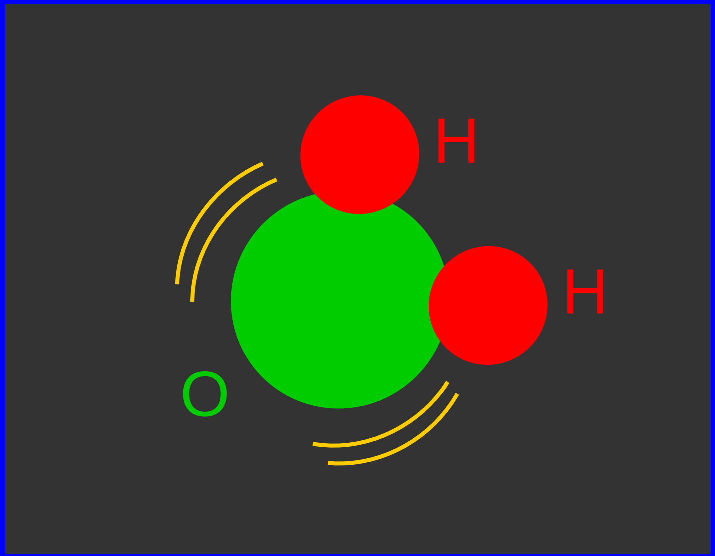
1) 0.3 mm
2) 3 cm
3) 30 cm
4) 300 m
5) 3 km

We know $v_{wave} = \frac{\lambda}{T} = f\lambda$

so $\lambda = \frac{v}{f} = \frac{3 \times 10^8 \text{ m/s}}{10 \times 10^9 \text{ Hz}}$

$\lambda = 3 \times 10^{-2}$ m = 3 cm



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.

ConcepTest 15.6c Wave Speed III

A length of rope *L* and mass *M* hangs from a ceiling. If the bottom of the rope is jerked sharply, a wave pulse will travel up the rope. As the wave travels upward, what happens to its speed? Keep in mind that the rope is *not* massless.

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

ConcepTest 15.6c Wave Speed III

A length of rope *L* and mass *M* hangs from a ceiling. If the bottom of the rope is jerked sharply, a wave pulse will travel up the rope. As the wave travels upward, what happens to its speed? Keep in mind that the rope is ***not*** massless.

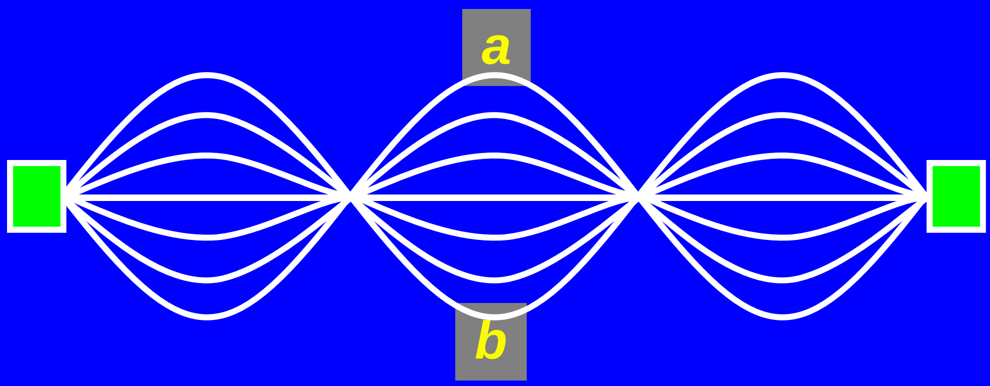
1) speed increases
2) speed does not change
3) speed decreases

The tension in the rope is not constant in the case of a massive rope! The tension increases as you move up higher along the rope, because that part of the rope has to support all of the mass below it! Because the tension increases as you go up, so does the wave speed.

ConcepTest 15.7a Standing Waves I

A string is clamped at both ends and plucked so it vibrates in a standing mode between two extreme positions *a* and *b*. Let upward motion correspond to positive velocities. When the string is in position *b*, the instantaneous velocity of points on the string:

1) is zero everywhere
2) is positive everywhere
3) is negative everywhere
4) depends on the position along the string



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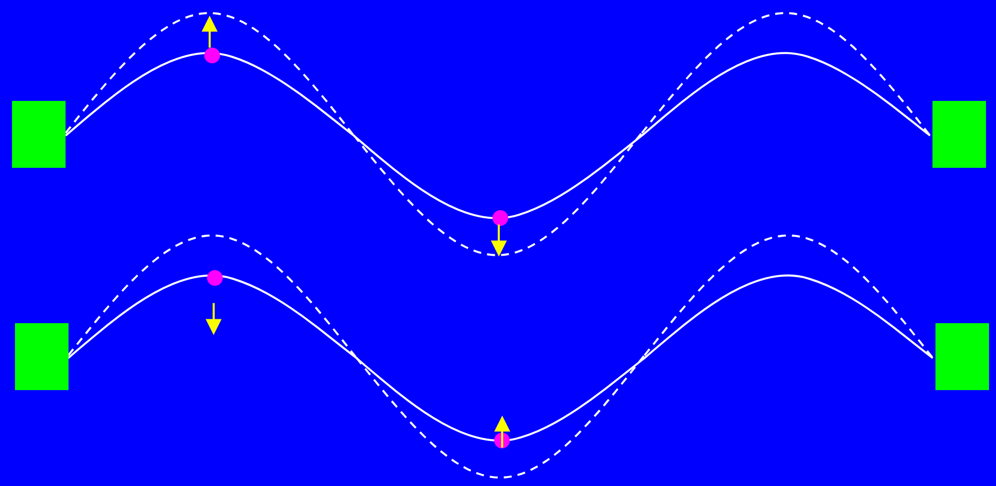
Observe two points:

Just before *b*

Just after *b*

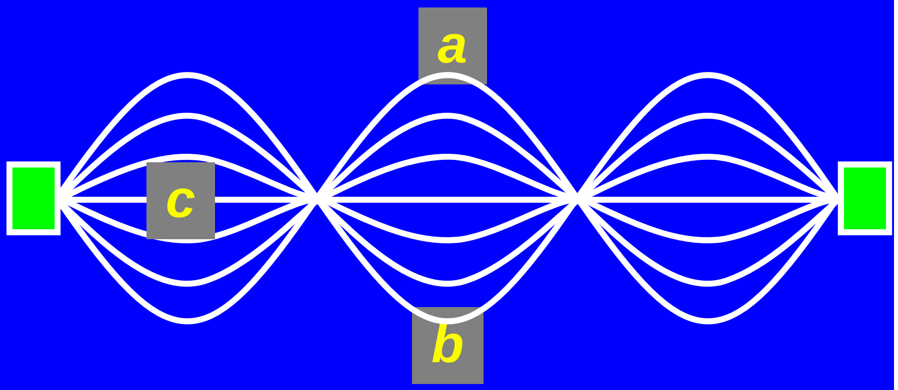


Both points change direction before and after *b*, so at *b* all points must have zero velocity.

ConcepTest 15.7b Standing Waves II

A string is clamped at both ends and plucked so it vibrates in a standing mode between two extreme positions ***a*** and ***b***. Let upward motion correspond to positive velocities. When the string is in position ***c***, the instantaneous velocity of points on the string:

1) is zero everywhere
2) is positive everywhere
3) is negative everywhere
4) depends on the position along the string



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A string is clamped at both ends and plucked so it vibrates in a standing mode between two extreme positions *a* and *b*. Let upward motion correspond to positive velocities. When the string is in position *c*, the instantaneous velocity of points on the string:

1) is zero everywhere
2) is positive everywhere
3) is negative everywhere
4) depends on the position along the string

When the string is flat, all points are moving through the equilibrium position and are therefore at their maximum velocity. However, the **direction depends on the location** of the point. Some points are moving upward rapidly, and some points are moving downward rapidly.