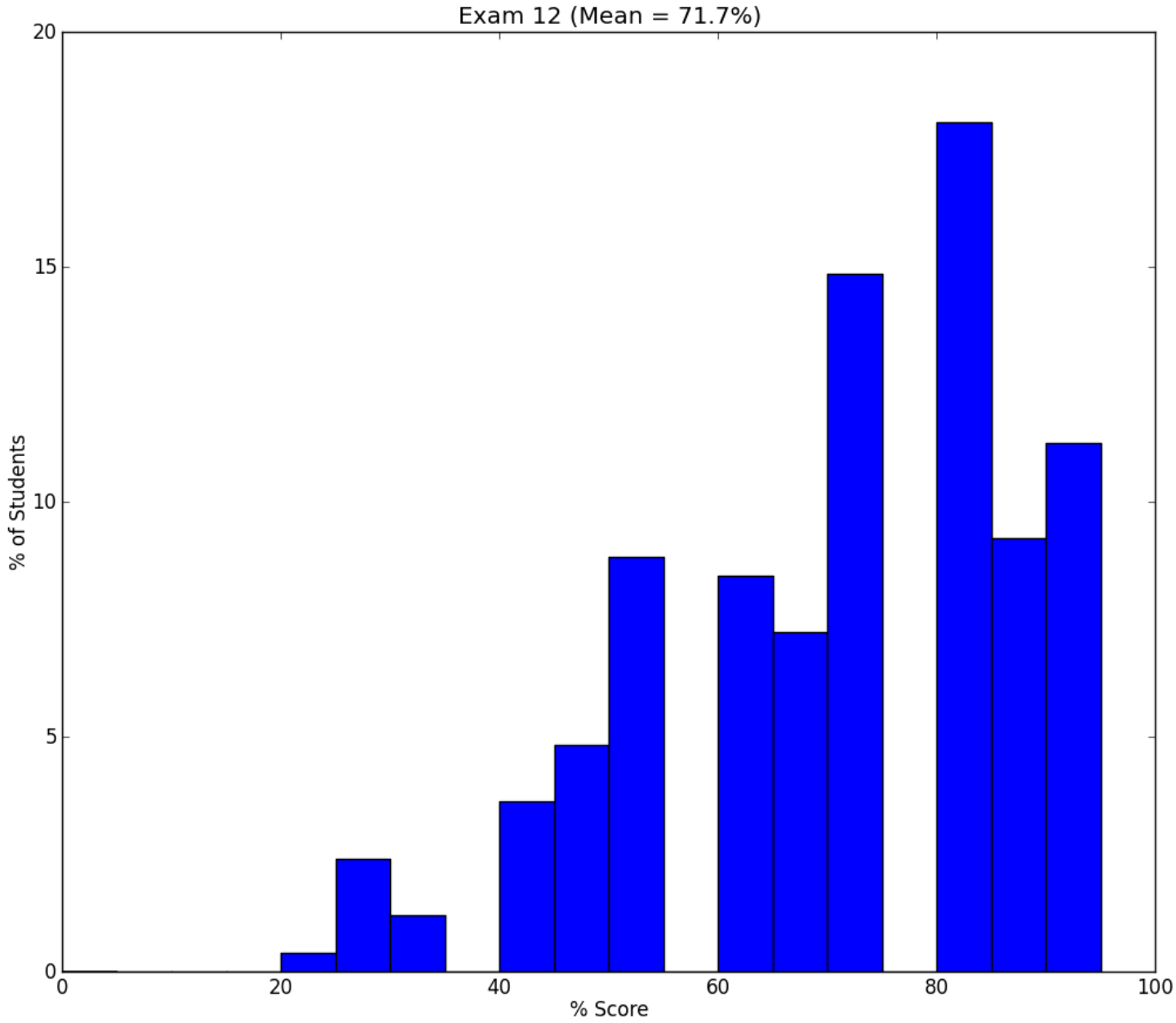
Your semester “abroad” wasn’t so abroad; it was more “hobo-ing.” So, you’re riding in a boxcar across the US and decide to stop off in Freer, TX to see the world’s largest rattlesnake. Unfortunately, the train only stops in Laredo, which is 60 miles away. You decide to jump off the boxcar. Which way should you jump to minimize injuries?

A) In the direction of the train’s motion
B) Opposite the direction of the train’s motion
C) Perpendicular to the train’s motion


Exam 12 (Mean = 71.7%)
% of Students
% Score
0
5
10
15
20
0
20
40
60
80
100

Announcements

- Final Exam, Thursday Dec. 12th, 8pm-10pm
  - Will include Oscillations and Waves
- Official end-of-course survey online now
  - https://sirsonline.msu.edu
- Optional feedback survey open now
  - "What would you suggest to a student taking our class who wants to do well?"

Tomorrow's class will not be cancelled. Will you be attending class tomorrow?

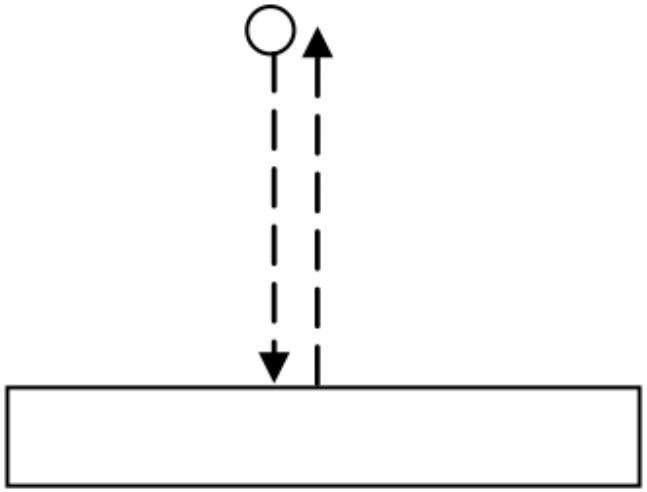
A) Yes
B) No

14-1) A ball bounces up and down on a floor with perfectly elastic bounces, so that the ball bounces forever:

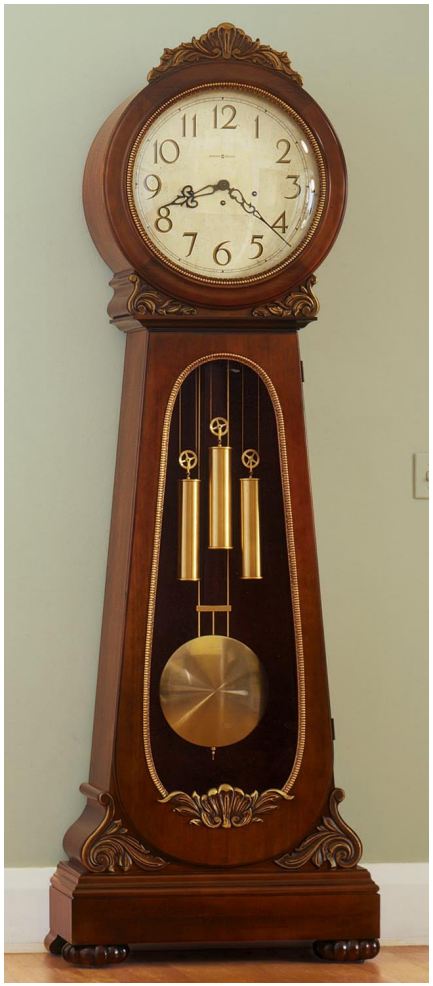
Is this an example of simple harmonic motion?

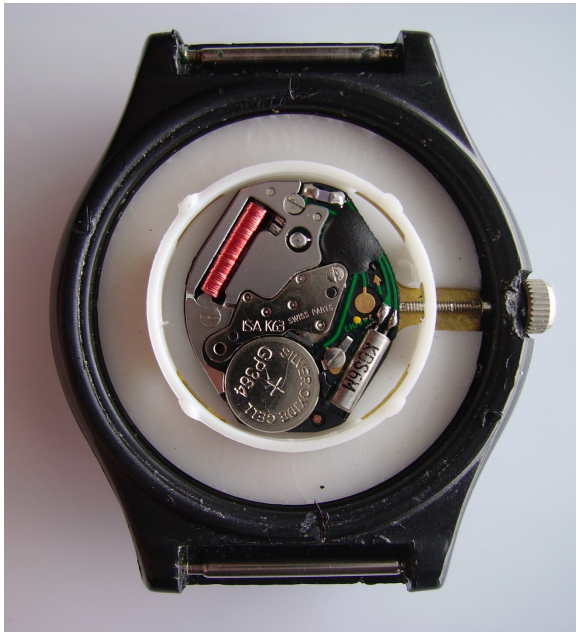
A) Yes

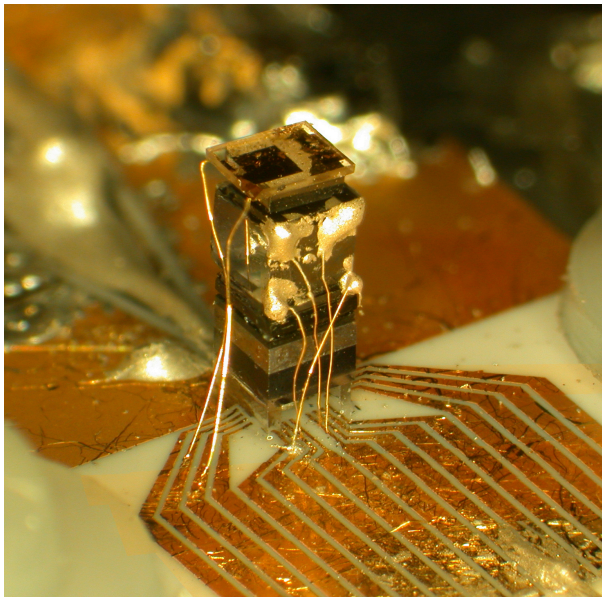
B) No



Oscillations







14-1) A ball bounces up and down on a floor with perfectly elastic bounces, so that the ball bounces forever:

Is this an example of simple harmonic motion?

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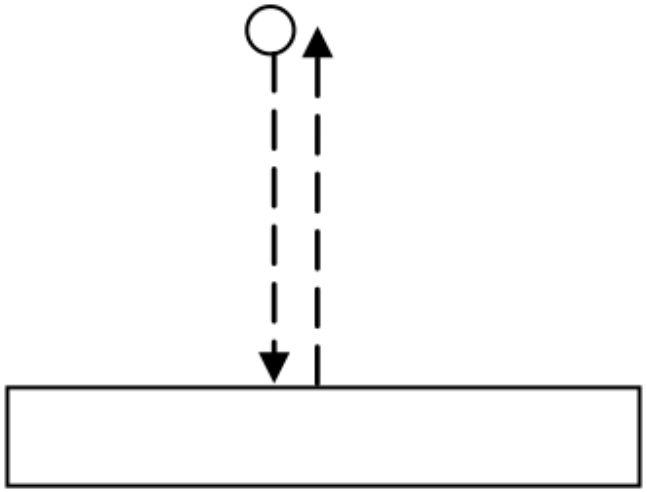
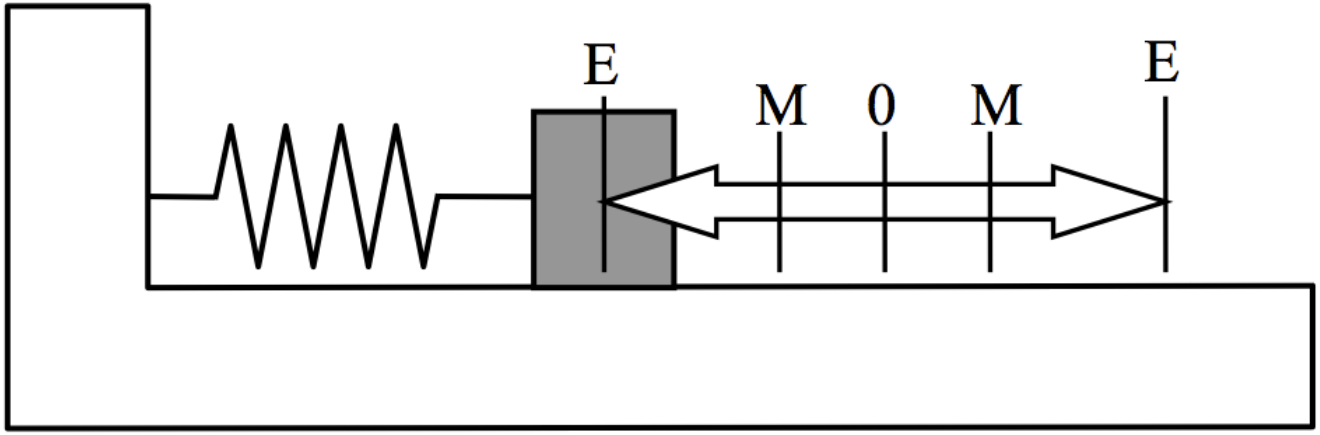


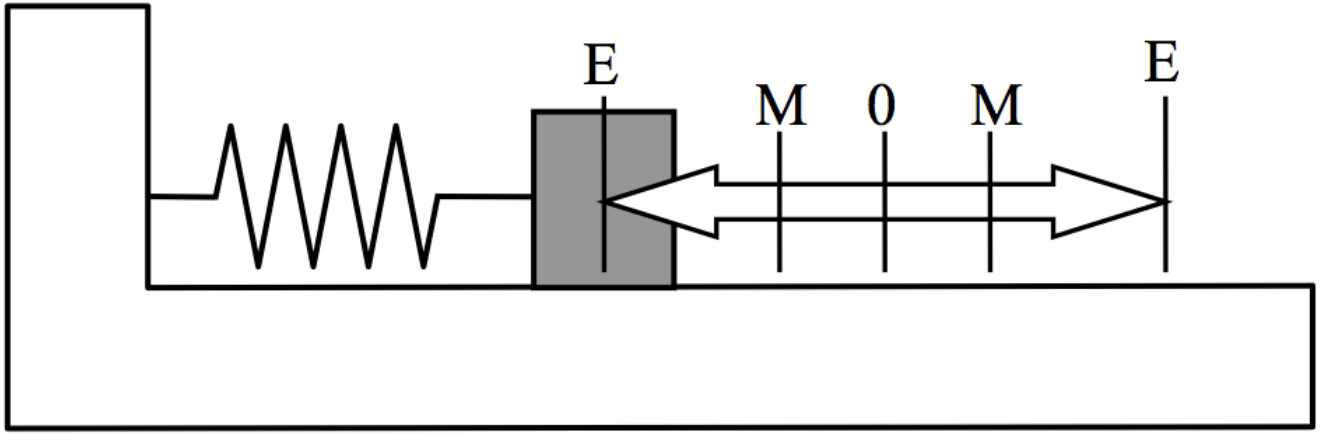
14-2a) A mass is oscillating back and forth on a spring as shown. Position 0 is the equilibrium position. No friction.



At which position is the magnitude of the acceleration of the mass maximum?

A) 0 B) M C) E D) *a* is constant everywhere

14-2b) A mass is oscillating back and forth on a spring as shown. Position 0 is the equilibrium position. No friction.



At which position is the force on the mass a maximum?

A) 0 B) M C) E D) force is constant everywhere

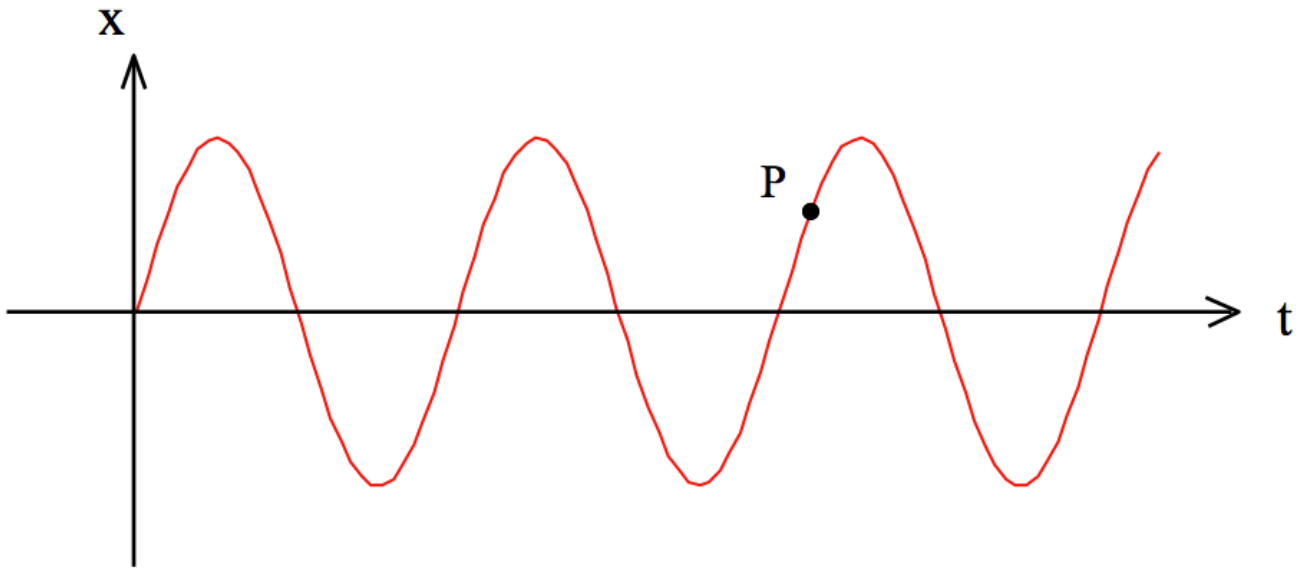
14-5) Consider a variable $x = x(\theta)$ and the differential equation $d^2x/dx^2 = - x$.
Here are some proposed solutions of this equation:

I) $x = \sin(\theta)$ II) $x = \cos(\theta)$ III) $x = e^{\theta}$

How many of them are actually solutions?

A) All of them
B) None of them
C) 1 of them
D) 2 of them

14-4a) The position of a mass on a spring as a function of time is shown below. When the mass is at point P on the graph, the *velocity* is …



A) > 0 B) < 0 C) = 0

Announcements

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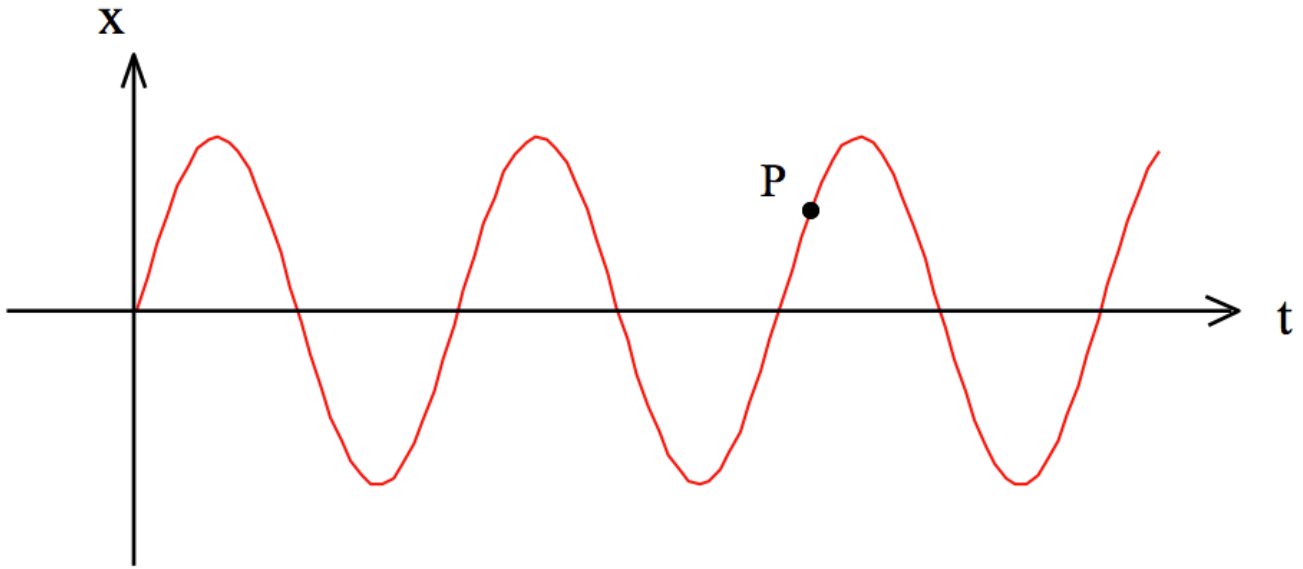
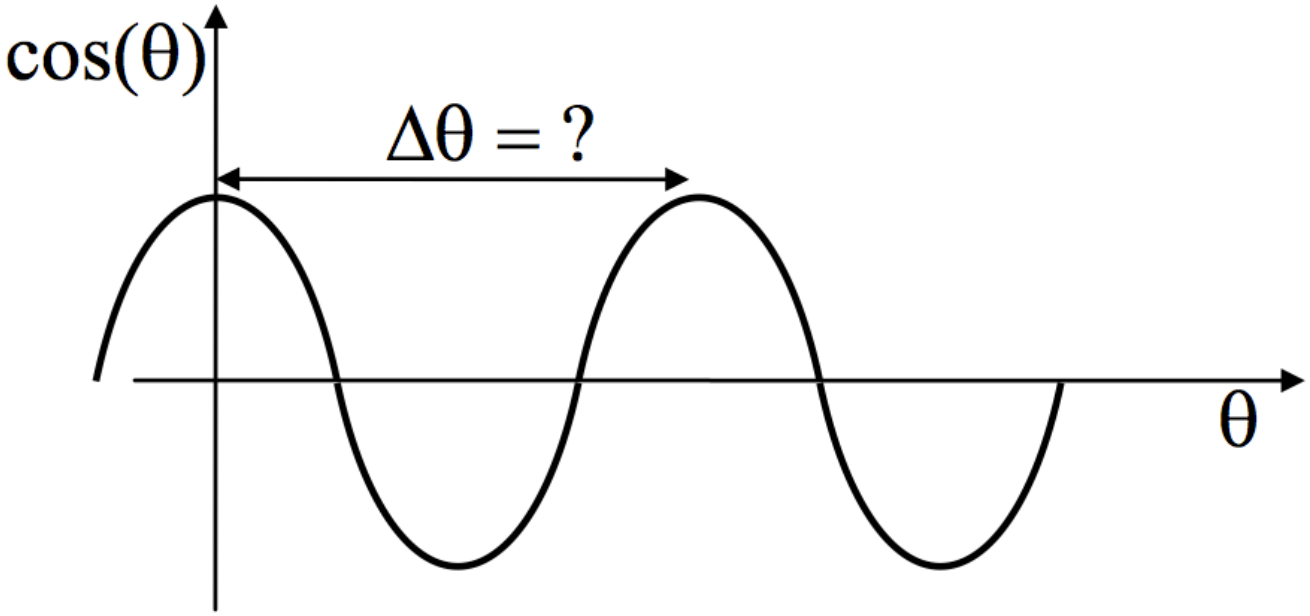
14-4b) The position of a mass on a spring as a function of time is shown below. When the mass is at point P on the graph, the *acceleration* is …



A) > 0 B) < 0 C) = 0

14-8) Consider the function $f(\theta) = \cos(\theta)$



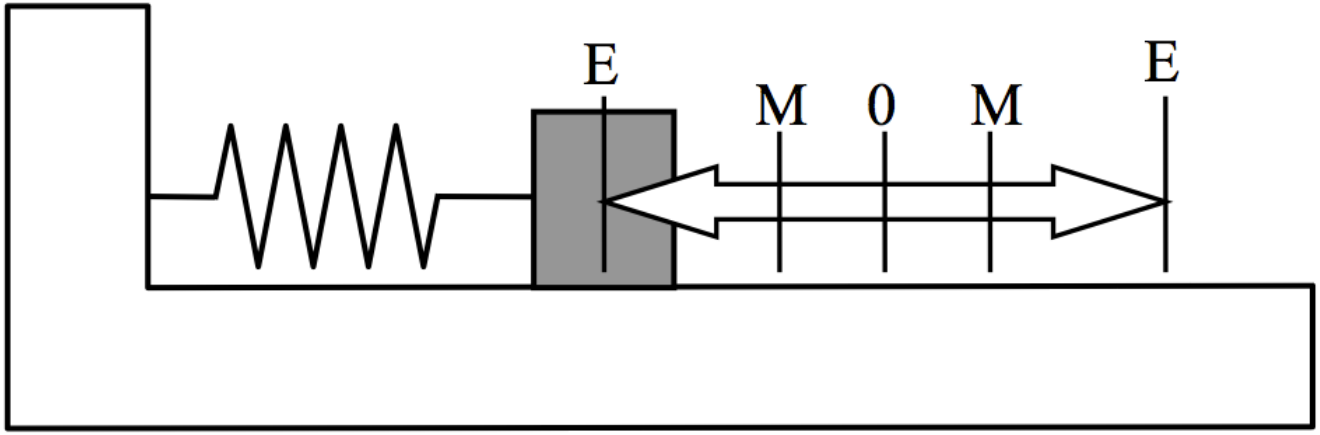
What is $\Delta\theta$ for one period?

A) π B) 1 C) 2π D) 2 E) T

14-13) What does it mean to have a big ω?

A) Rapid oscillations due to a floppy spring attached to a big mass.
B) Rapid oscillations due to a stiff spring attached to a big mass.
C) Slow oscillations due to a floppy spring attached to a big mass.
D) Slow oscillations due to a stiff spring attached to a big mass.
E) None of these; something else.

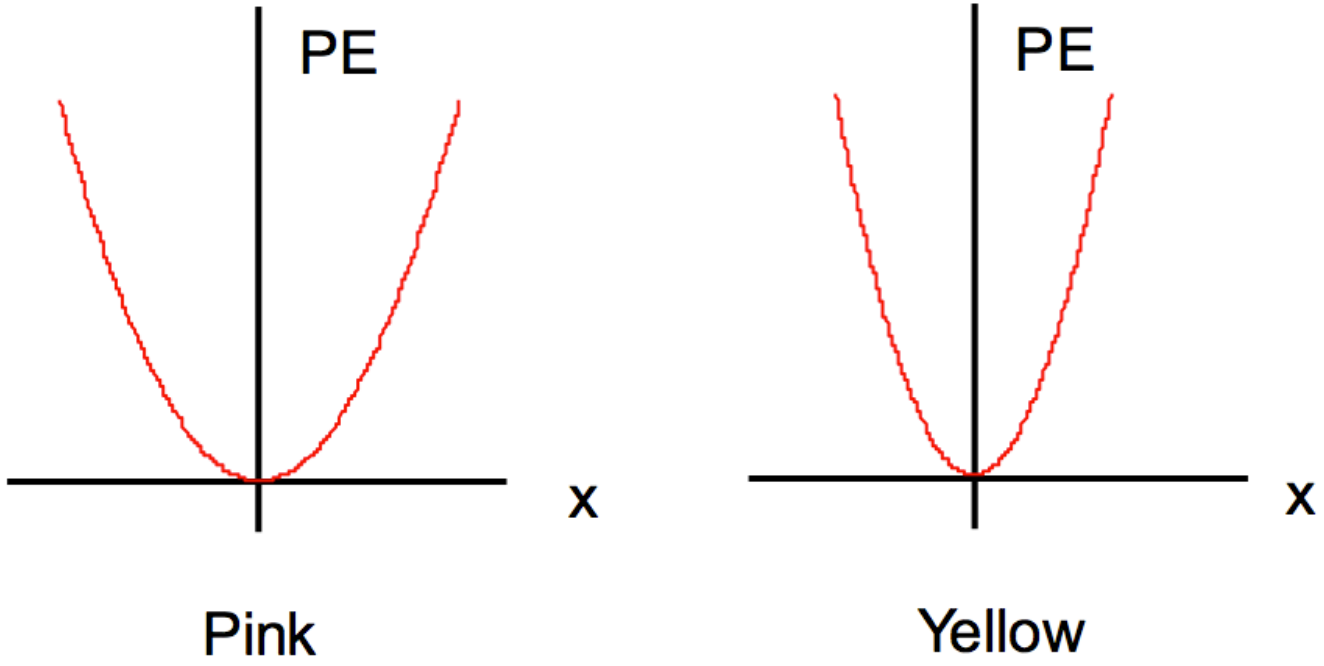
14-2c) A mass is oscillating back and forth on a spring as shown. Position 0 is the equilibrium position. No friction.



At which position is the total energy (PE + KE) a maximum?

A) 0 B) M C) E D) energy is constant everywhere

14-3a) A stiff spring and a floppy spring have potential energy diagrams shown below. Which is the stiff spring?



A) Pink B) Yellow

14-3b) Two masses are identical. One is attached to a stiff spring; the other to a floppy spring. Both are positioned at x = 0 and given the same initial speeds. Which spring produces the largest amplitude motion?

A) The stiff spring
B) The floppy spring
C) Same!

14-3c) Now the identical masses on the two different springs are pulled to the side and released from rest with the same initial amplitude. Which spring produces the largest maximum speed of its mass?

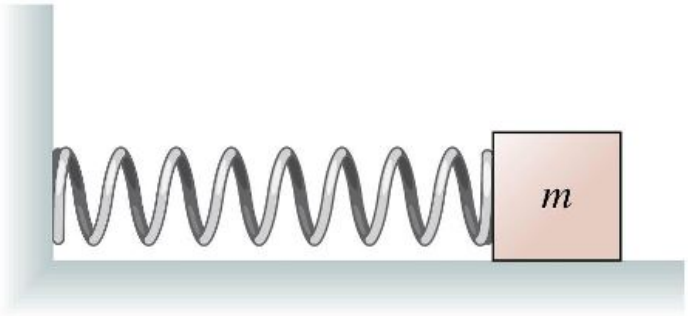
A) The stiff spring
B) The floppy spring
C) Same!

14-3d) If the spring constant is increased, but the total energy of a mass/spring system is kept constant, what happens to the amplitude A of the motion?

A) Amplitude increases
B) Amplitude decreases
C) Amplitude stays constant

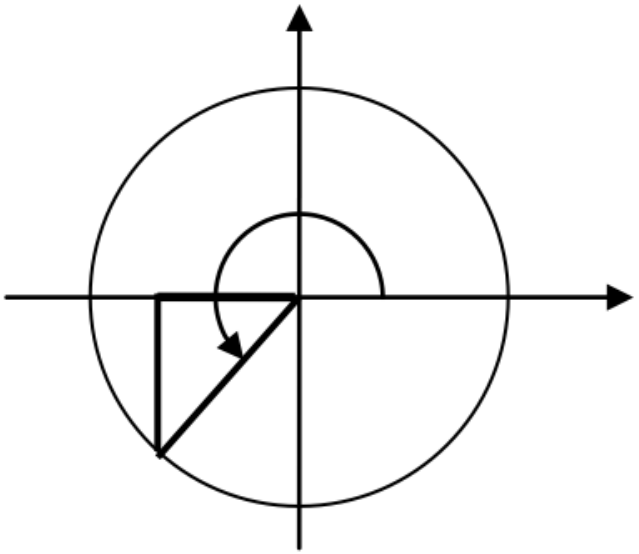
Example: Mass on spring

A mass (m) is attached to a spring (k) on a horizontal frictionless table. Observations show the amplitude of the oscillation is A. What is the velocity of the mass as a function of position?



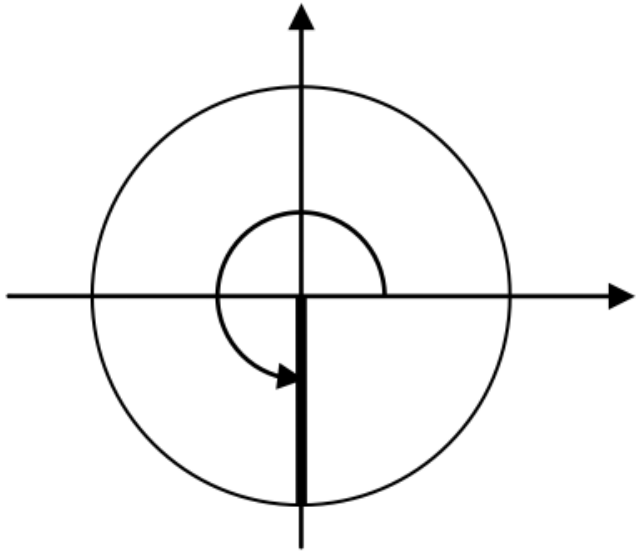
14-10a) What is the sign of cos(225°)? Sign of sin(225°)?

A) cos(225°) = (+), sin(225°) = (–)
B) cos(225°) = (–), sin(225°) = (+)
C) cos(225°) = (+), sin(225°) = (+)
D) cos(225°) = (–), sin(225°) = (–)
E) None of these. One of them is zero.

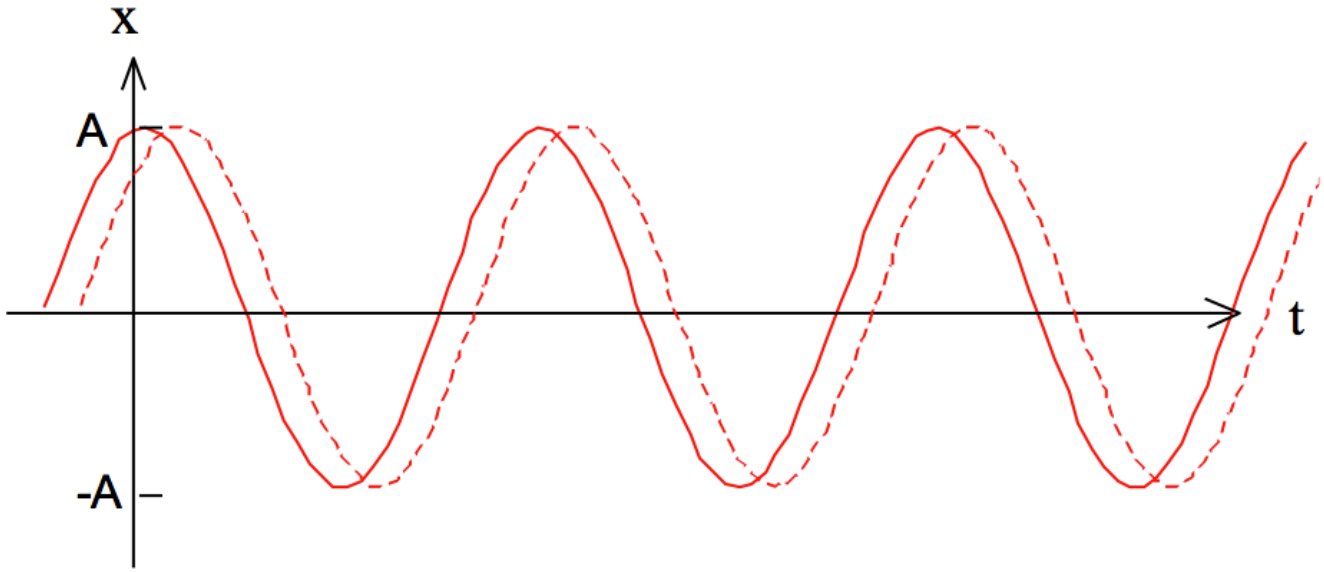


14-10b) $270° = (3/2)\,\pi$.
What is $\cos[(3/2)\pi]$ and what is $\sin[(3/2)\,\pi]$?

A) $\cos[(3/2)\pi] = -1$, $\sin[(3/2)\pi] = 0$
B) $\cos[(3/2)\pi] = 0$, $\sin[(3/2)\pi] = -1$
C) $\cos[(3/2)\pi] = -1$, $\sin[(3/2)\pi] = -1$
D) $\cos[(3/2)\pi] = 0$, $\sin[(3/2)\pi] = 0$
E) None of these

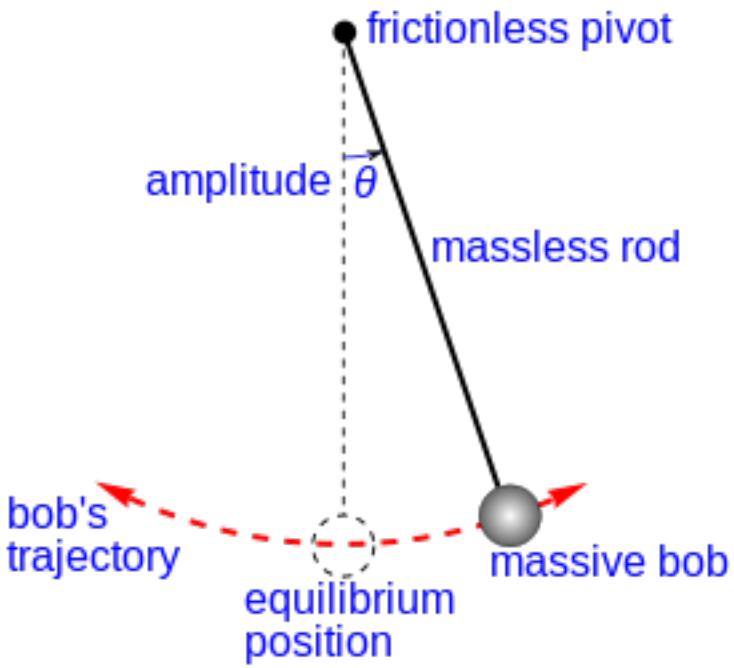


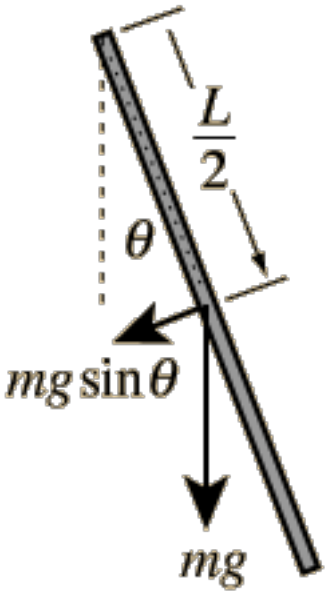
14-7) The solid curve is a graph of $x(t) = A\cos(\omega t)$. The dotted curve is a graph of $x(t) = A\cos(\omega t + \varphi)$ where φ is a phase constant whose magnitude is less than $\pi/2$. Is φ positive or negative?

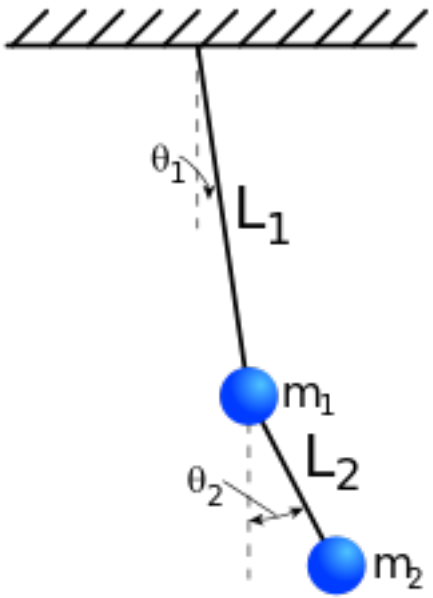


A) Positive B) Negative

Example: Pendulum Motion







14-11) A kid is swinging on a swing with a period T. A second kid climbs on with the first, doubling the weight on the swing. The period of the swing is now...

A) the same, T
B) 2*T
C) sqrt(2)*T
D) none of these.

14-12) You take your grandfather clock (a pendulum clock) to the Moon. On the Moon, does the clock keep good time, or run slow or fast?

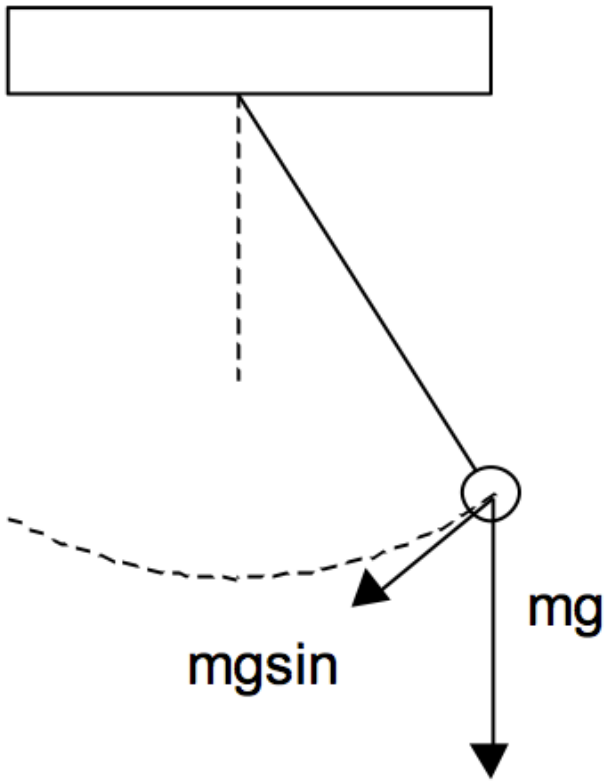
A) keeps good time
B) runs slow
C) runs fast

14-14) The force on a pendulum mass along the direction of motion is $mg\sin\theta$. For small θ, $mg\sin\theta \approx mg\theta$, and the period is independent of amplitude.

For larger amplitude motion, the period

A) Increases
B) Decreases
C) Remains constant

Hint: does $\sin\theta$ get bigger or smaller than θ as θ increases?



14-15a) Two springs in *parallel* always results in a _____ effective spring.

A) stiffer
B) floppier
C) It depends.

14-15a) Two springs in *series* always results in a _____ effective spring.

A) stiffer
B) floppier
C) It depends.

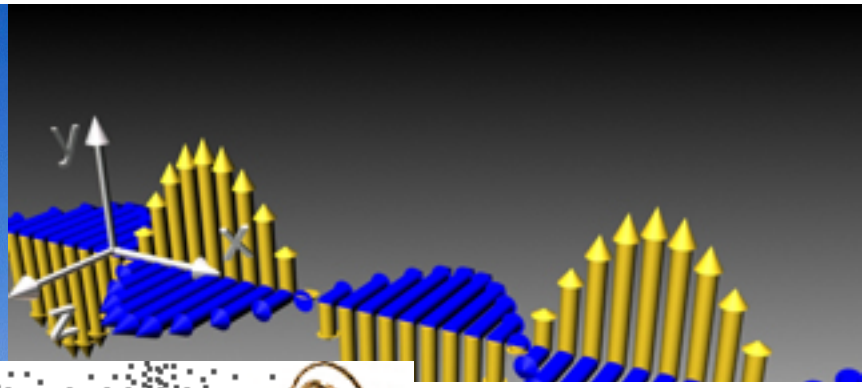
14-6) A mass on a spring oscillates with a certain amplitude A and a certain period T. If the mass m is doubled, the spring constant k of the spring is doubled, and the amplitude of motion A is doubled, THEN the period T…

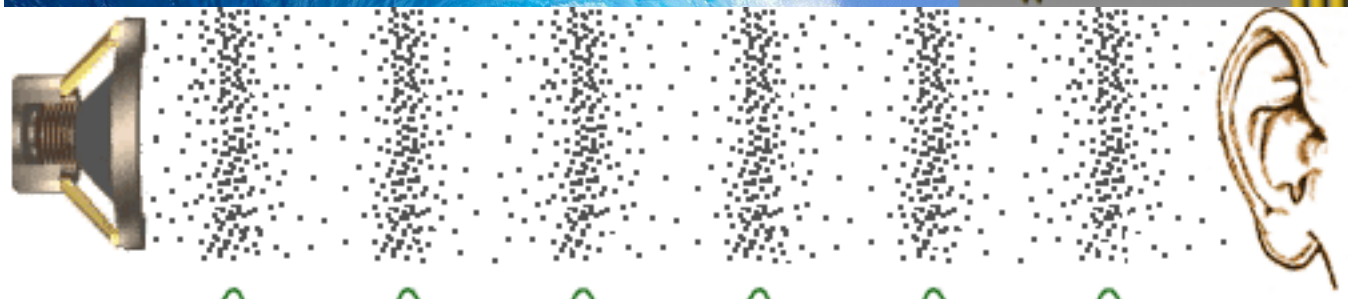
A) increases
B) decreases
C) stays the same.

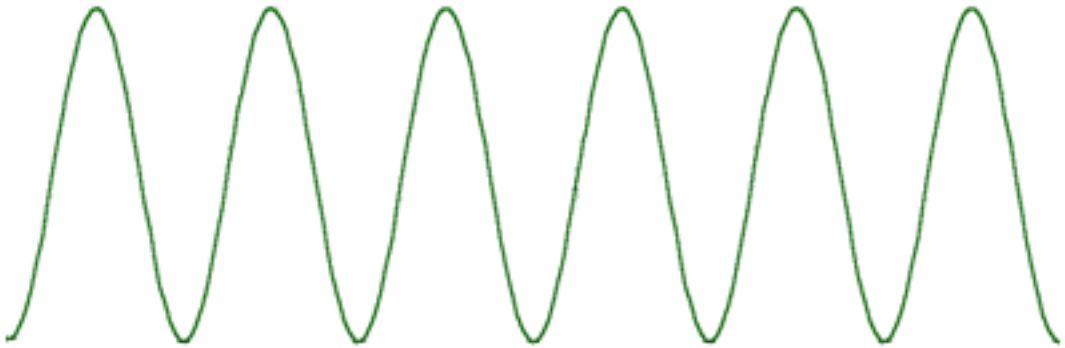
14-9) A mass on a spring oscillates with a certain amplitude A and a certain period T. If the mass m is doubled, the spring constant k of the spring is doubled, and the amplitude of motion A is doubled, THEN the period T …

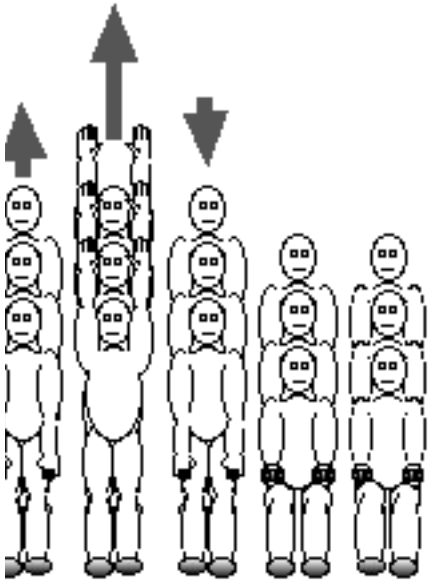
A) increases
B) decreases
C) stays the same.

Waves









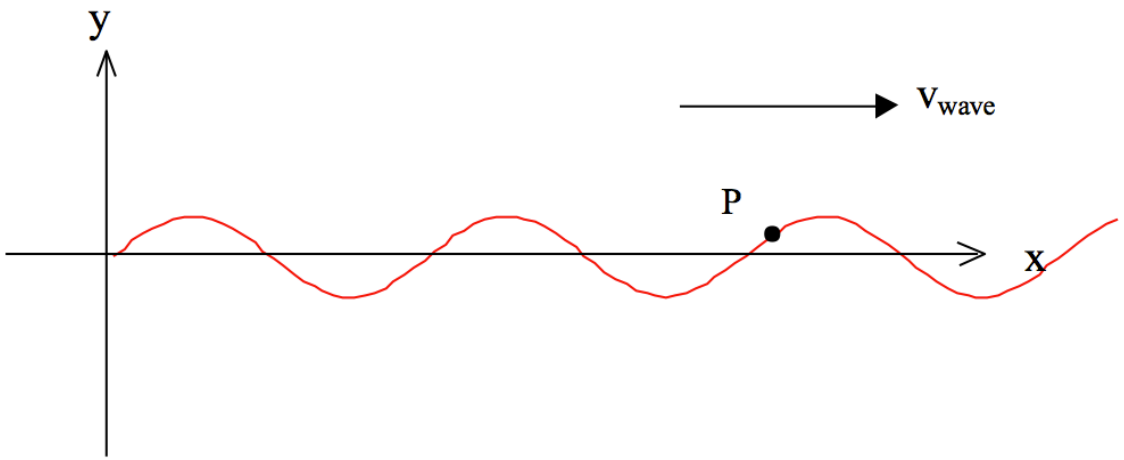
15-1) Is “The Wave” at the stadium a transverse wave or a longitudinal wave?

A) Transverse
B) Longitudinal
C) neither

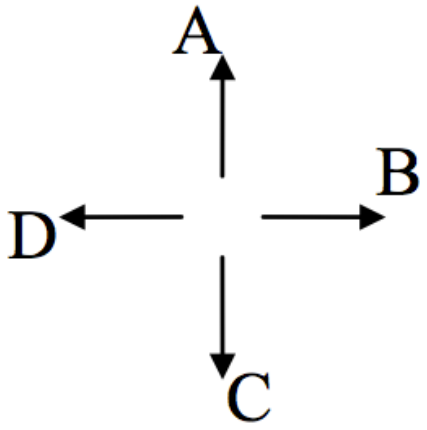
15-2) A wave on a stretched drum head is an example of a

A) Transverse wave
B) Longitudinal wave
C) it's not a wave at all

15-3a) The graph below shows a snapshot of a wave on a string which is traveling to the right. There is a bit of paint on the string at point P.

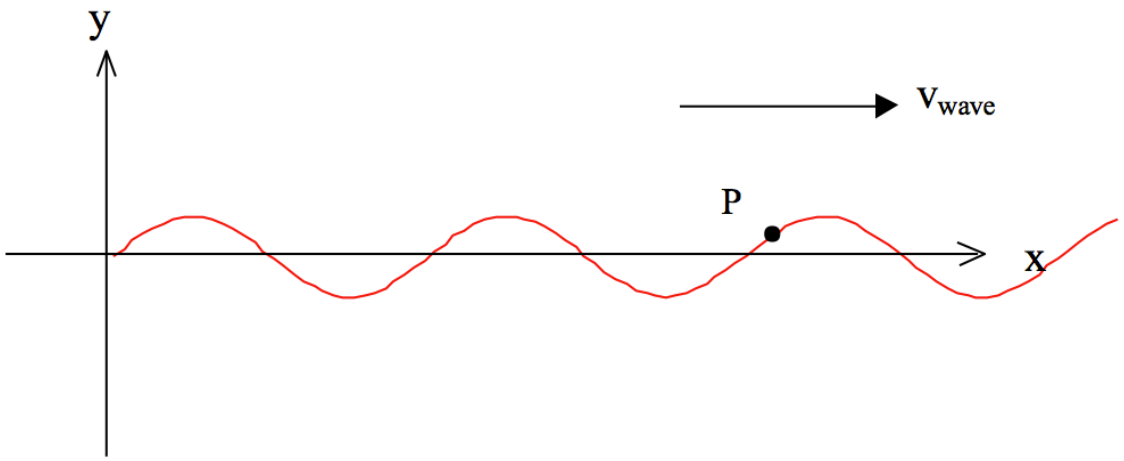


At the instant shown, the velocity of the paint point P has which direction?

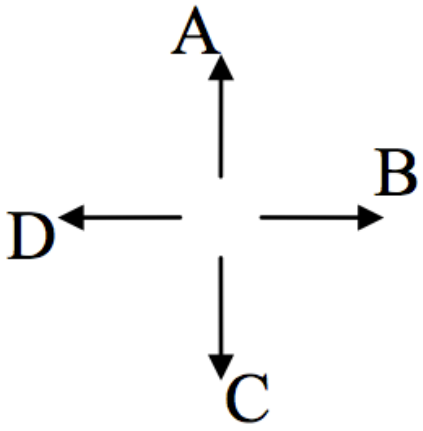


E) None of these

15-3b) The graph below shows a snapshot of a wave on a string which is traveling to the right. There is a bit of paint on the string at point P.

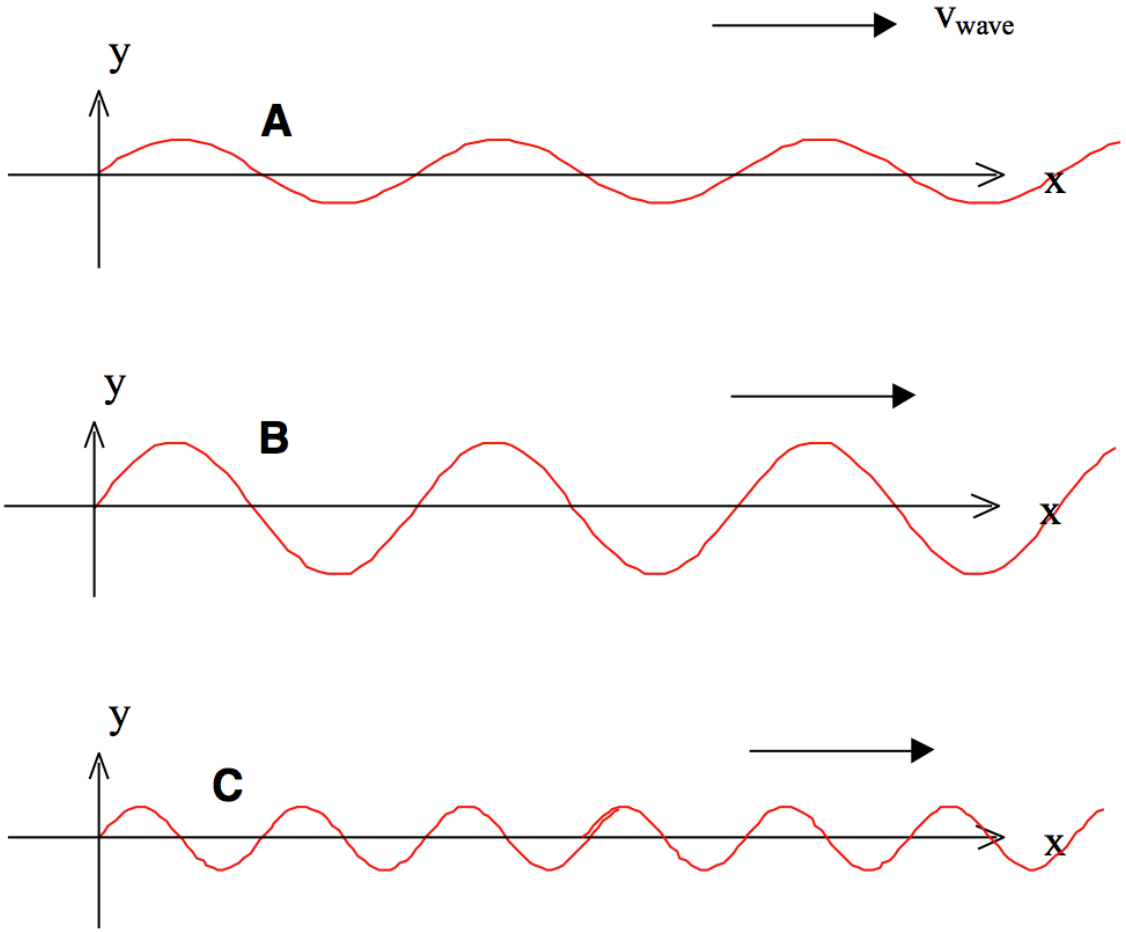


At the instant shown, the acceleration of the paint point P has which direction?



E) None of these

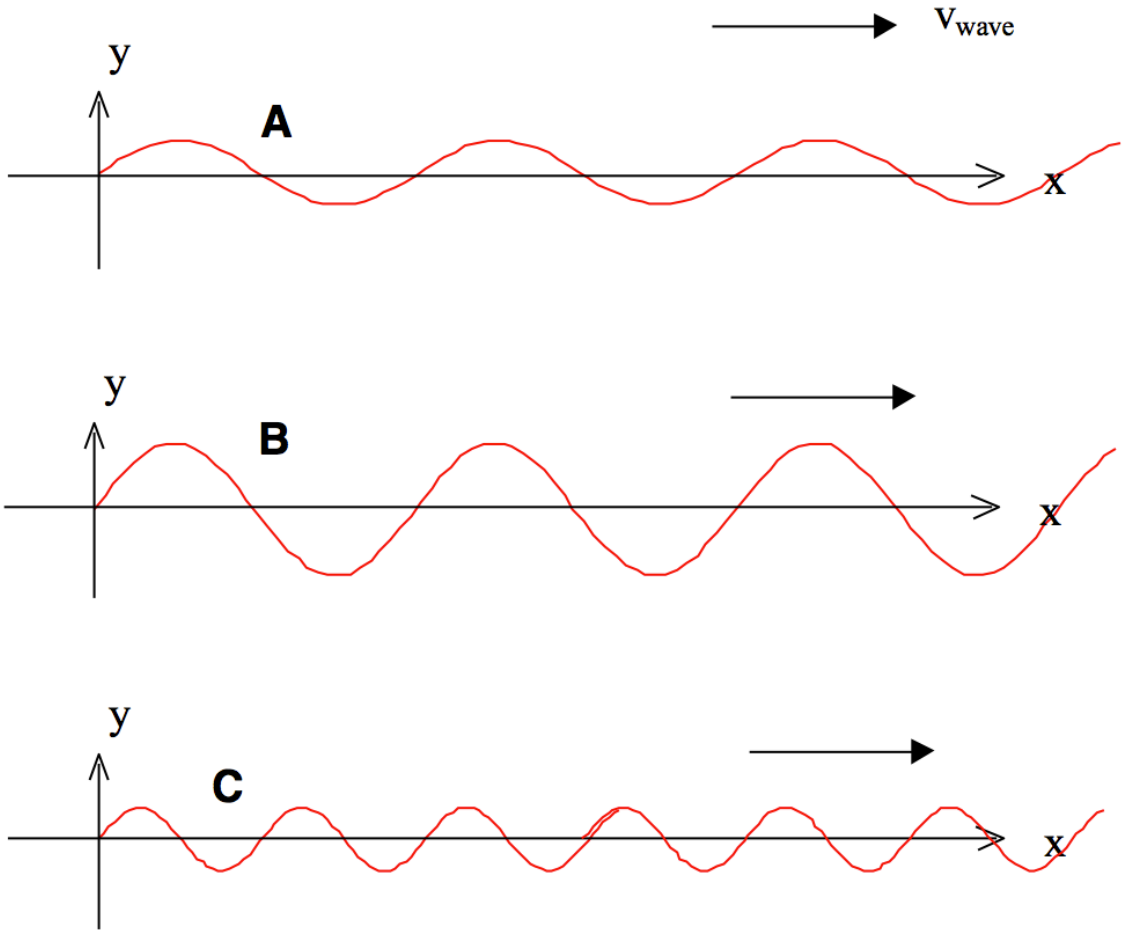
15-4a) Three waves are traveling along identical strings (same mass per length, same tension, same everything). Wave B has twice the amplitude of the other two. Wave C has 1/2 the wavelength than A or B. Which wave goes the slowest?



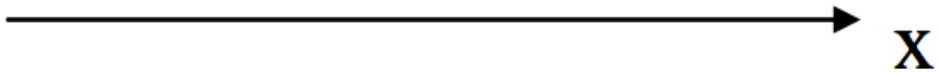
D) All have the same v

15-4b) Which wave has the highest frequency?

A B C D) All 3 have the same frequency



15-5) Consider the equation $x - vt = \theta$, where v and θ are constants. The variable x is position and t is the time. A point x that obeys this equation is a point that



A) increases (moves to the right) with speed v
B) decreases (moves to the left) with speed v
C) is constant x (not moving)
D) increases (moves to the right) with speed θ
E) decreases (moves to the left) with speed θ

15-6a) Two traveling waves 1 and 2 are described by the equations.

$$y_1(x,t) = 2\sin(2x - t)$$

$$y_2(x,t) = 4\sin(x - 0.8t)$$

All the numbers are in the appropriate SI (mks) units.
Which wave has a higher speed?

A) 1 B) 2 C)Both have the same speed.

15-6b) Two traveling waves 1 and 2 are described by the equations.

$$y_1(x,t) = 2\sin(2x - t)$$

$$y_2(x,t) = 4\sin(x - 0.8t)$$

All the numbers are in the appropriate SI (mks) units.
The wavelength λ of wave 1 is most nearly
A) 1m B) 2m C) 3m D) 4m

15-6c) Two traveling waves 1 and 2 are described by the equations.

$$y_1(x,t) = 2\sin(2x - t)$$

$$y_2(x,t) = 4\sin(x - 0.8t)$$

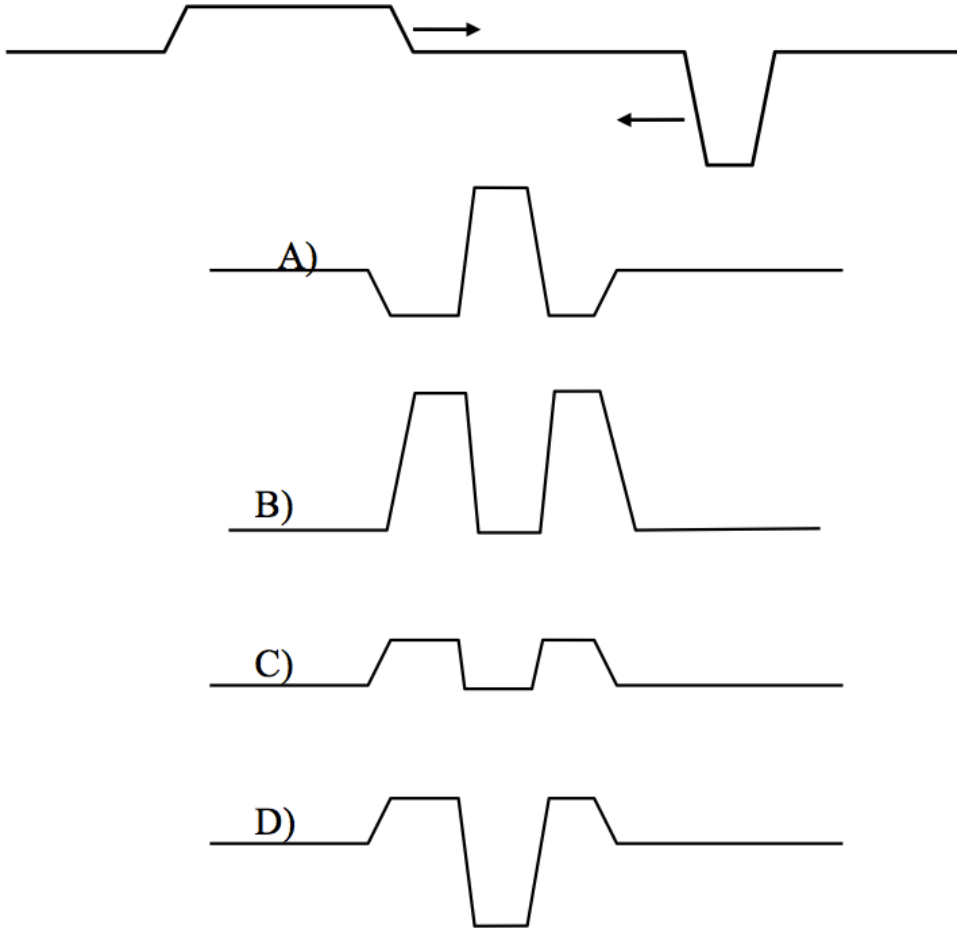
All the numbers are in the appropriate SI (mks) units.
The period of wave 1 is most nearly

A) 1s B) 2s C) 3s D) 6s

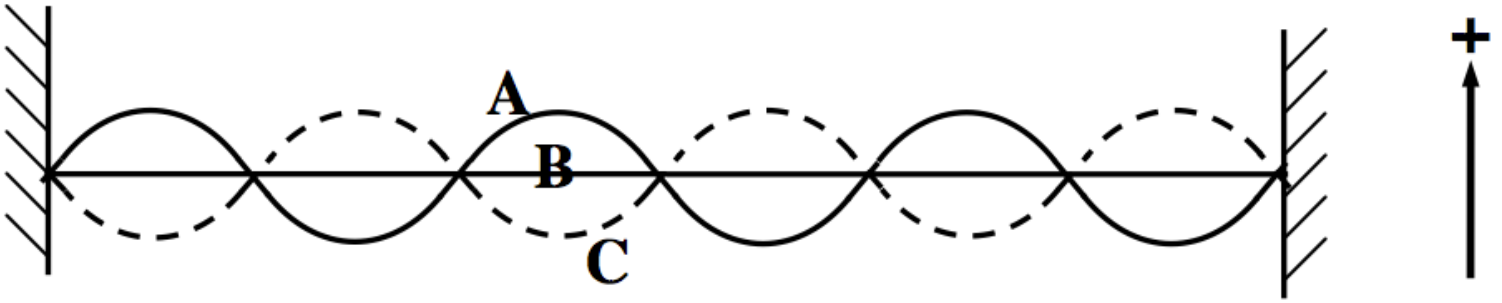
15-7) A 1D sinusoidal traveling wave is given by
$y(x,t) = A \sin(kx-\omega t)$, where amplitude A, wavenumber $k=2\pi/\lambda$, and angular frequency $\omega=2\pi/T$ are constants.

If we take the derivative dy/dt while holding x constant, (called the *partial derivative*), then the magnitude |dy/dt| is
A) the speed of the wave B) something else

15-8) Two impulse waves are approaching each other, as shown. Which picture correctly shows the total wave when the two waves are passing through each other?

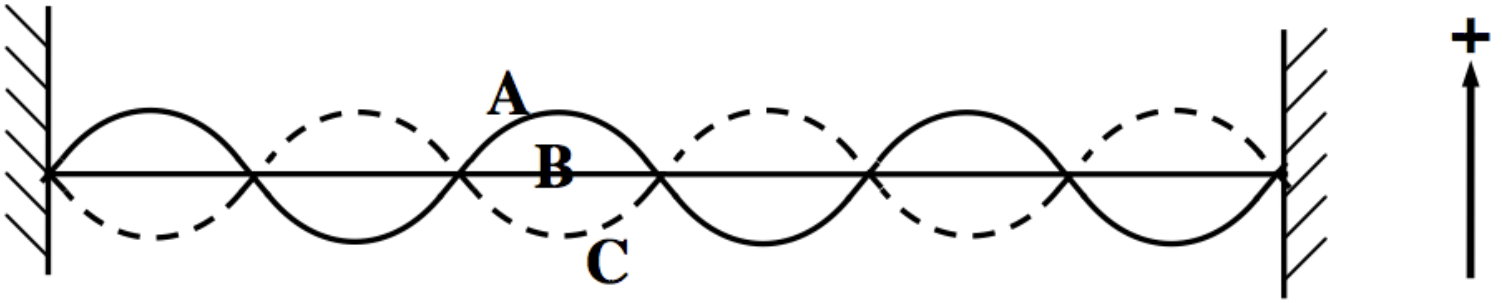


15-10a) A string is clamped at both ends and then plucked so that it vibrates in a standing wave mode between two extreme positions A and C. Let upward motion correspond to positive velocities. When the string is in position B, the instantaneous velocity of points along the string is …



A) zero everywhere.
B) positive everywhere.
C) negative everywhere.
D) depends on the position.

15-10b) A string is clamped at both ends and then plucked so that it vibrates in a standing wave mode between two extreme positions A and C. Let upward motion correspond to positive velocities. When the string is in position C, the instantaneous velocity of points along the string is...



A) zero everywhere.
B) positive everywhere.
C) negative everywhere.
D) depends on the position.

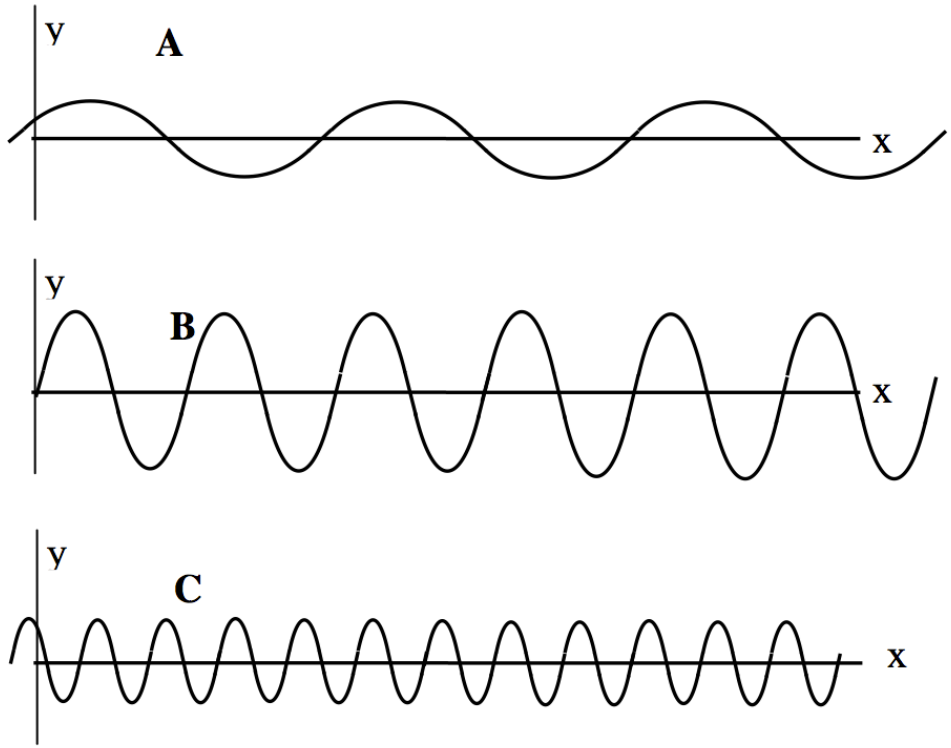
15-9) When you turn up the volume on your sound system …

A) the speaker cone oscillates back and forth more rapidly, completing more cycles per second
B) the speaker cone oscillates back and forth more slowly, completing fewer cycles per second
C) the speaker cones oscillates back and forth a farther distance in each cycle
D) the speaker cones oscillates back and forth a shorter distance in each cycle
E) None of these

15-11a) Three pressure waves in air (sound waves), all with the mathematical form

$$y(x,t) = A\sin\left[2\pi\left(\frac{x}{\lambda} - \frac{t}{T}\right)\right]$$

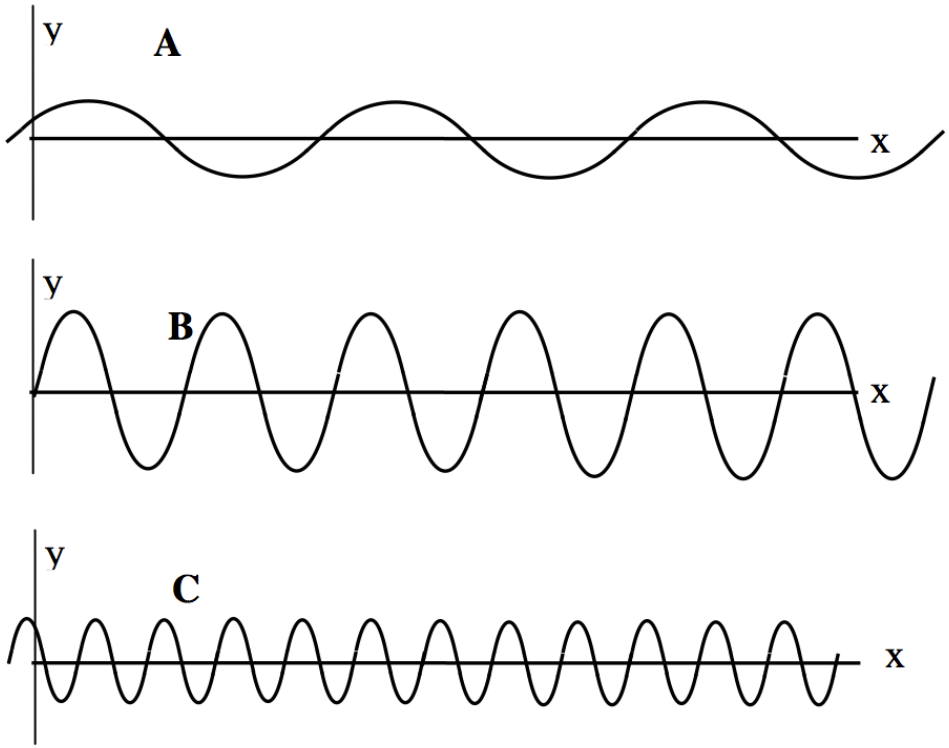
are labeled A, B, and C. Which sound is the loudest?



15-11b) Three pressure waves in air (sound waves), all with the mathematical form

$$y(x,t) = A\sin\left[2\pi\left(\frac{x}{\lambda} - \frac{t}{T}\right)\right]$$

are labeled A, B, and C. Which sound has the highest pitch?



15-12) Inhaling helium gas makes your voice higher-pitched. From this observation, you can deduce what about the speed of sound in helium gas compared to that in air?

A) Nothing at all
B) The speed of sound in He in faster than in air
C) The speed of sound in He is slower than in air