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✚ Practice Exam 5

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Practice Exam 5

Due: 11:59pm on Wednesday, December 1, 2021

To understand how points are awarded, read the Grading Policy for this assignment.

11.1.1 Simple Harmonic Motion Question 3

Description: (a) An object is executing simple harmonic motion. What is true about the acceleration of this object? (There may be more than one correct choice.)...

Part A

An object is executing simple harmonic motion. What is true about the acceleration of this object? (There may be more than one correct choice.)

Check all that apply.

ANSWER:

- ✓ The acceleration is a maximum when the object is instantaneously at rest. True
- ✓ The acceleration is zero when the speed of the object is a maximum. True
- The acceleration is a maximum when the speed of the object is a maximum.
- The acceleration is a maximum when the displacement of the object is zero.
- ✓ The acceleration is a maximum when the displacement of the object is a maximum. True

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11.1.2 Mass On A Spring Question 1

Description: (a) A mass M is attached to an ideal massless spring. When this system is set in motion with amplitude A, it has a period T. What is the period if the amplitude of the motion is increased to 2A?

Part A

A mass M is attached to an ideal massless spring. When this system is set in motion with amplitude A, it has a period T. What is the period if the amplitude of the motion is increased to $2A$?

ANSWER:

- $4T$
- $\sqrt{2}\,T$
- $2T$
- $T/2$
- [✓ T]

$\omega = \frac{2\pi}{T} = \sqrt{\frac{k}{m}}$

$\boxed{T = 2\pi\sqrt{\frac{m}{k}}}$

Does not depend on A.

11.1.3 Energy In SHM Question 3

Description: (a) If we double only the mass of a vibrating ideal mass-and-spring system, the mechanical energy of the system...

Part A

If we double only the mass of a vibrating ideal mass-and-spring system, the mechanical energy of the system

ANSWER:

- [✓ does not change.]
- increases by a factor of $\sqrt{2}$.
- increases by a factor of 2.
- increases by a factor of 3.
- increases by a factor of 4.

$E = \frac{1}{2}kA^2$

E does not depend on the mass "m".

11.2.3 Energy in SHM Problem 4

Description: (a) A 0.025-kg block on a horizontal frictionless surface is attached to an ideal massless spring whose spring constant is 150 N/m. The block is pulled from its equilibrium position at x = 0.00 m to a displacement x = +0.080 m and is released from...

Part A

A 0.025-kg block on a horizontal frictionless surface is attached to an ideal massless spring whose spring constant is 150 N/m. The block is pulled from its equilibrium position at $x = 0.00$ m to a displacement $x = +0.080$ m and is released from rest. The block then executes simple harmonic motion along the horizontal x-axis. When the displacement is $x = 0.024$ m, what is the kinetic energy of the block?

ANSWER:

0.52 J

0.46 J

0.41 J

0.49 J

[✓ 0.44 J]

$$\omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{150}{.025}} = \sqrt{40(150)} = \sqrt{6,000}$$

$$V = \omega\sqrt{A^2 - x^2} = \sqrt{6000}\,\sqrt{(.08)^2 - (.024)^2}$$

$$V^2 = 34.94\ m^2/s^2$$

$$\frac{1}{2}mv^2 = \frac{1}{2}(.025)(34.94) = \boxed{0.437\ J}$$

11.2.4 Simple Pendulum Problem 2

Description: The angle that a swinging simple pendulum makes with the vertical obeys the equation Θ(t) = (0.150 rad) cos[(2.85 rad/s)t + 1.66]. (a) What is the length of the pendulum? (b) What is the mass of the swinging bob at the end of the pendulum?

The angle that a swinging simple pendulum makes with the vertical obeys the equation $\Theta(t) = (0.150 \text{ rad}) \cos[(2.85 \text{ rad/s})t + 1.66]$.

Part A

What is the length of the pendulum?

ANSWER:

2.02 m

0.15 m

0.83 m

[✓ 1.21 m]

It cannot be determined from the information given.

$$\omega^2 = \frac{g}{\ell} \qquad \ell = \frac{g}{\omega^2}$$

$$\ell = \frac{9.8\ m/s^2}{(2.85\ rad/s)^2}$$

$$\boxed{\ell = 1.21\ \text{meters}}$$

Part B

What is the mass of the swinging bob at the end of the pendulum?

ANSWER:

0.150 kg

1.66 kg

2.85 kg

0.454 kg

[✓ It cannot be determined from the information given.]

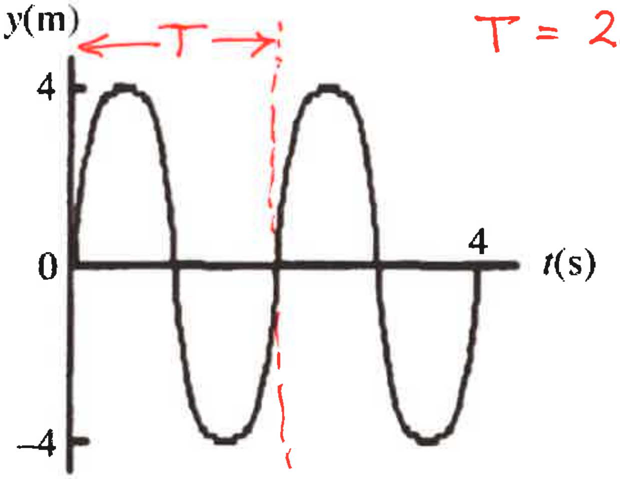
$\omega^2 = \frac{g}{\ell}$ independent of the mass on the string.

13.1.1 Mathematics of Traveling Waves Question 4

Description: (a) For the wave shown in the figure, the frequency is...

Part A

For the wave shown in the figure, the frequency is



T = 2.00 seconds

$f = \frac{1}{T} = \frac{1}{2}\ s^{-1}$ or $\boxed{\frac{1}{2} Hz}$

ANSWER:

2 Hz.

4 Hz.

[✓ 0.5 Hz.]

1 Hz.

unable to be determined from the given information.

13.1.4 Standing Waves On A String Question 4

Description: (a) Consider the waves on a vibrating guitar string and the sound waves the guitar produces in the surrounding air. The string waves and the sound waves must have the same...

Part A

Consider the waves on a vibrating guitar string and the sound waves the guitar produces in the surrounding air. The string waves and the sound waves must have the same

ANSWER:

[✓ frequency.]

wavelength.

velocity.

amplitude.

More than one of the above is true.

$V = f\lambda$

① On the guitar string:

$V_{string} = \underline{f_{string}}\, \lambda_{string}$

② In the air:

$= f_{Air}$

$V_{Air} = \underline{f_{string}}\, \lambda_{air}$

13.1.7 Standing Sound Waves Question 3

Description: (a) The lowest-pitch tone to resonate in a pipe of length L that is open at both ends is 200 Hz. Which one of the following frequencies will NOT resonate in the same pipe?

Part A

The lowest-pitch tone to resonate in a pipe of length *L* that is open at both ends is 200 Hz. Which one of the following frequencies will NOT resonate in the same pipe?

ANSWER:

1000 Hz

800 Hz

[✓ 900 Hz] ⇐ Cannot be 900 Hz

400 Hz

600 Hz

$f_n = n f_1 \quad n = 1, 2, 3, \ldots$

$f_n = n\,(200 Hz)$

If this were "closed" at one end, then, $f_n = n f_1 \quad n = 1, 3, 5, 7, \ldots$

13.1.9 Doppler Effect Question 1

Description: (a) When a rocket is traveling toward a mountain at 100 m/s, the sound waves from this rocket's engine approach the mountain at speed V. If the rocket doubles its speed to 200 m/s, the sound waves from the engine will now approach the mountain at...

Part A

When a rocket is traveling toward a mountain at 100 m/s, the sound waves from this rocket's engine approach the mountain at speed *V*. If the rocket doubles its speed to 200 m/s, the sound waves from the engine will now approach the mountain at speed

ANSWER:

4*V*.

2*V*.

$\sqrt{2}$ *V*.

[✓ *V*.]

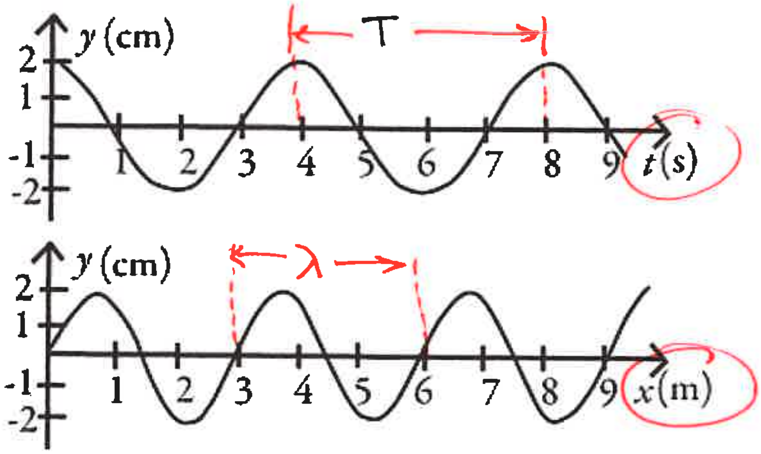
The speed of sound traveling through air is <u>the same</u> in both cases.

13.2.1 Mathematics of Traveling Waves Problem 1

Description: (a) The figure shows the displacement y of a traveling wave at a given position as a function of time and the displacement of the same wave at a given time as a function of position. How fast is the wave traveling?

Part A

The figure shows the displacement *y* of a traveling wave at a given position as a function of time and the displacement of the same wave at a given time as a function of position. How fast is the wave traveling?



T = 4.0 sec

$f = \frac{1}{T} = 0.25 s$

$\lambda = 3.0$ m

$V = f\lambda = (0.25 Hz)\ 3.0m$

$\boxed{V = 0.75\ m/s}$

ANSWER:

1.5 m/s

[✓ 0.75 m/s]

3.0 m/s

2.0 m/s

0.66 m/s

13.2.4 Standing Waves On A String Problem 4

Description: (a) A thin 2.00-m string of mass 50.0 g is fixed at both ends and under a tension of 70.0 N. If it is set into small-amplitude oscillation, what is the frequency of the first harmonic mode?

Part A

A thin 2.00-m string of mass 50.0 g is fixed at both ends and under a tension of 70.0 N. If it is set into small-amplitude oscillation, what is the frequency of the first harmonic mode?

ANSWER:

52.9 Hz

6.61 Hz

[✓ 13.2 Hz]

26.5 Hz

$$v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{70\,(2)}{0.050}} = \sqrt{140(20)}$$

$$\underline{v = 52.9\ m/s}$$

$$f_1 = \frac{v}{\lambda_1 = 4.00\,m} = \frac{52.9\ m/s}{4.0\ m}$$

$$\boxed{f_1 = 13.2\ Hz}$$

13.2.10 Doppler Effect Problem 3

Description: (a) As you stand by the side of the road, a car approaches you at a constant speed, sounding its horn, and you hear a frequency of 80.0 Hz. After the car goes by, you hear a frequency of 60.0 Hz. What is the speed of the car? The speed of sound in...

Part A

As you stand by the side of the road, a car approaches you at a constant speed, sounding its horn, and you hear a frequency of 80.0 Hz. After the car goes by, you hear a frequency of 60.0 Hz. What is the speed of the car? The speed of sound in the air is 343 m/s.

ANSWER:

Corrected Version

36.0 m/s

[✓ 49.0 m/s]

25.0 m/s

16.0 m/s

64.0 m/s

$$f' = f\left(\frac{V \pm V_L}{V \mp V_s}\right)$$

V_L 80 Hz

$$\frac{f^{app} = f\left(\frac{V+\overset{V_L}{0}}{V-V_s}\right)}{f^{rec} = f\left(\frac{V+0}{V+V_s}\right)} \Rightarrow \frac{\overset{80\,Hz}{f^{app}}}{\underset{60\,Hz}{f^{rec}}} = \frac{V+V_s}{V-V_s}$$

60 Hz

$$4/3 = \frac{V+V_s}{V-V_s} \Rightarrow \frac{4}{3}(V-V_s) = V+V_s$$

$$\frac{1}{3}V = \frac{7}{3}V_s \qquad V_s = \frac{1}{7}V = \frac{1}{7}\,343\,\frac{m}{s}$$

$$\boxed{V_s = 49\ m/s}$$

14.2.8 Ideal Gas Law Problem 5

Description: (a) A sealed 26-m3 tank is filled with 2000 moles of oxygen gas (O2) at an initial temperature of 270 K. The gas is heated to a final temperature of 460 K. The ATOMIC mass of oxygen is 16.0 g/mol, and the ideal gas constant is R = 8.314 J/mol · K = ...

Part A

A sealed 26-m^3 tank is filled with 2000 moles of oxygen gas (O_2) at an initial temperature of 270 K. The gas is heated to a final temperature of 460 K. The ATOMIC mass of oxygen is 16.0 g/mol, and the ideal gas constant is R = 8.314 J/mol · K = 0.0821 L · atm/mol · K. The final pressure of the gas is closest to

ANSWER:

0.31 MPa.

[✓ 0.29 MPa.]

0.34 MPa.

0.36 MPa.

0.33 MPa.

$$P_i V = nRT_i \qquad \frac{P_i}{T_i} = \frac{P_f}{T_f} \Rightarrow$$
$$P_f V = nRT_f$$

$$\Rightarrow P_f = (P_i)\frac{T_f}{T_i} = \left(\frac{nR\cancel{T_i}}{V}\right)\frac{T_f}{\cancel{T_i}}$$

$$P_f = \frac{nR}{V}T_f = \frac{2000(8.31)}{26}\,460\ K$$

$$\boxed{P_f = 0.294\ MPa}$$

14.2.9 Molecular Speeds Problem 8

Description: (a) The root-mean-square speed (thermal speed) of a certain sample of carbon dioxide molecules, with a molecular weight of 44 g/mol, is 396 m/s. What is the root-mean-square speed (thermal speed) of water vapor molecules, with a molecular weight of ...

Part A

The root-mean-square speed (thermal speed) of a certain sample of carbon dioxide molecules, with a molecular weight of 44 g/mol, is 396 m/s. What is the root-mean-square speed (thermal speed) of water vapor molecules, with a molecular weight of 18 g/mol, at the same temperature?

ANSWER:

421 m/s

396 m/s

253 m/s

[✓ 619 m/s]

506 m/s

$$V_{rms} = \sqrt{\frac{3kT}{m}} = \sqrt{3\left(\frac{R}{M}\right)T}$$

$$\frac{V_{rms}^{H_2O} = \sqrt{\frac{3R}{M_{H_2O}}T}}{V_{rms}^{CO_2} = \sqrt{\frac{3R}{M_{CO_2}}T}} \Rightarrow \frac{V_{rms}^{H_2O}}{V_{rms}^{CO_2}} = \sqrt{\frac{M_{CO_2}}{M_{H_2O}}}$$

396 m/s

$$V_{rms}^{H_2O} = 396\frac{m}{s}\sqrt{\frac{44\ g/mol}{18\ g/mol}} = \boxed{619\ m/s}$$

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