Scalar Product:

$$\vec{A}\cdot\vec{B}=\left|\vec{A}\right|\left|\vec{B}\right|\cos\theta_{AB}=A_xB_x+A_yB_y+A_zB_z$$

Vector Product:

$$\vec{A}\times\vec{B}=\left|\vec{A}\right|\left|\vec{B}\right|\sin\theta_{AB}=\left(A_yB_z-A_zB_y\right)\hat{i}+\left(A_zB_x-A_xB_z\right)\hat{j}+\left(A_xB_y-A_yB_x\right)\hat{k}$$

Equations of motion:

$$v=v_0+at$$

$$x=x_0+v_0t+\frac{1}{2}at^2$$

$$v^2={v_0}^2+2a(x-x_0)$$

Radial Acceleration:

$$a_{rad}=\frac{v^2}{r}$$

Newton's second law

$$\sum\vec{F}=m\vec{a}$$

Magnitude of kinetic friction

$$F_{f_k}=\mu_kF_N$$

Magnitude of static friction

$$F_{f_s}\leq\mu_sF_N$$

Definition of work

$$W=\int\vec{F}\cdot d\vec{x}$$

Definition of kinetic energy:

$$KE=\frac{1}{2}mv^2$$

Change in gravitational potential energy:

$$\Delta U_g=mg\Delta y$$

Elastic potential energy:

$$U_{el}=\frac{1}{2}kx^2$$

Work-Energy Theorem:

$$W=\Delta U+\Delta KE$$

Center-of-mass position

$$X_{COM}=\frac{1}{M}\sum_{i=1}^{n}x_im_i$$

Definition of momentum

$$\vec{p}=m\vec{v}$$

Conservation of momentum

$$\vec{p}_i=\vec{p}_f$$

Definition of torque

$$\vec{\tau}=\vec{r}\times\vec{F}$$

CONTINUED ON BACK!!!

Newton’s second law for rotation

$$\sum \vec{\tau} = I\vec{\alpha}$$

Conditions for rolling: $a_{COM} = \alpha R$ and $v_{COM} = \omega R$

Angular momentum: $\vec{L} = \vec{r} \times \vec{p}$ or $\vec{L} = I\vec{\omega}$, where $I = \sum_i m_i r_i^2$

Newton’s Law of Gravitation:

$F_G = \dfrac{Gm_1 m_2}{r^2}$ and $U_G = -\dfrac{Gm_1 m_2}{r}$ with $U_G = 0$ at infinity

Bernoulli's Equation:

$$p_1 + \rho g y_1 + \frac{1}{2}\rho v_1^2 = p_2 + \rho g y_2 + \frac{1}{2}\rho v_2^2$$

Equation for Simple Harmonic Motion:

$$\frac{d^2 x}{dt^2} = -\omega^2 x$$

Solution for above equation:

$$x(t) = A\cos(\omega t + \varphi)$$

Where,

$$\omega = 2\pi f = \frac{2\pi}{T}$$

For a spring mass oscillator,

$$\omega = \sqrt{\frac{k}{m}}$$

For a simple pendulum,

$$\omega = \sqrt{\frac{g}{L}}$$

Wave Equation:

$$\frac{\partial^2 y(x,t)}{\partial x^2} = \frac{1}{v^2}\frac{\partial^2 y(x,t)}{\partial t^2}$$

Solution to above equation:

$$y(x,t) = A\cos(kx - \omega t)$$

Where,

$$k = \frac{2\pi}{\lambda}, \quad \omega = 2\pi f, \quad v = \lambda f$$

Standing waves on fixed string:

$$y(x,t) = A_{SW}\sin(kx)\sin(\omega t)$$

$$f_n = n\frac{v}{2L}$$

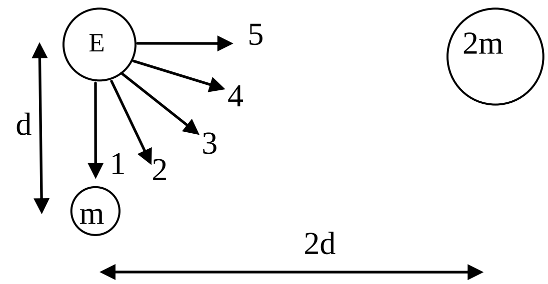
Doppler Effect:

$$f_L = \frac{v + v_L}{v + v_S} f_S$$

Exam #4 Name:____________________Box #______ Physics 160-01

6 points each.

1) A planet of mass m is a distance d from Earth. Another planet of mass 2m is a distance 2d from Earth. Which force vector best represents the direction of the total gravitation force on Earth?



A) 1
B) 2
C) 3
D) 4
E) 5
F) Depends on the mass of the earth.
G) It depends on the distance, d.
H) Not enough information to solve.

2) A meteoroid, heading straight for Earth, has a speed of 10.2 km/s relative to the center of Earth when it is a distance of 8.00×10^8 m from the earth's center. What is the meteoroid's speed as it hits the earth? You can neglect the effects of the moon, earth's atmosphere, and any motion of the earth. ($G = 6.67 \times 10^{-11}$ N · m^2/kg^2, $M_{earth} = 5.97 \times 10^{24}$ kg, $R_{earth} = 6.37 \times 10^6$ m)

A) 87.3 km/s
B) 32.4 km/s
C) 18.5 km/s
D) 21.5 km/s
E) 45.6 km/s
F) 96.0 km/s
G) 15.1 km/s
H) 28.7 km/s
I) 11.5 km/s
J) 10.5 km/s

3) In order to have simple harmonic motion, the acceleration must be proportional to the:

A) amplitude
B) frequency
C) velocity
D) displacement
E) displacement squared

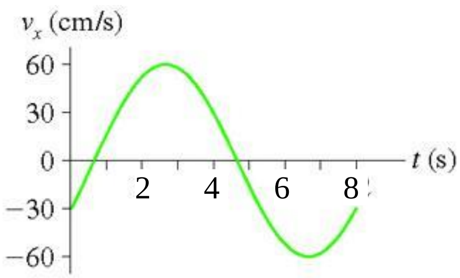
4) An object attached to one end of a spring makes 25 complete oscillations in 5s. Its period is:

A) 4 Hz
B) 0.2 s
C) 0.5 Hz
D) 2 s
E) 0.50 s
F) 3 s
G) 0.3 s
H) 5 s
I) 25 Hz
J) 5 Hz

5) A 2.5 kg ideal harmonic oscillator has a total mechanical energy of 35 J. If the oscillation amplitude is 20.0 cm, what is the oscillation frequency?

A) 4.2 Hz
B) 2.1 Hz
C) 7 Hz
D) 3.5 Hz
E) 26.4 Hz
F) 13.2 Hz
G) 8.9 Hz
H) 119.4 Hz
I) 63.1 Hz
J) 42.0 Hz

6) The figure below is the velocity-versus-time graph of a particle in simple harmonic motion. What is the amplitude of oscillations?



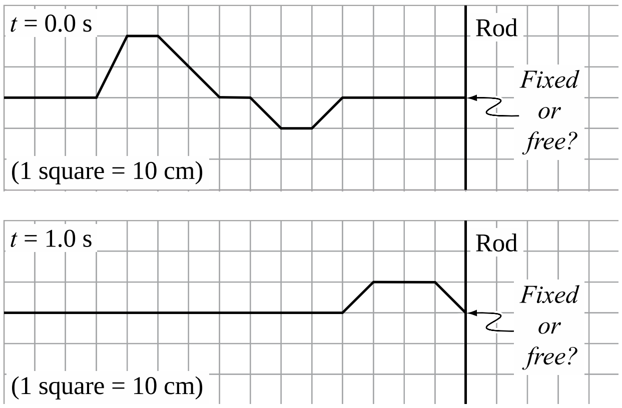
A) 76 cm
B) 30 cm
C) 12 s
D) 24 cm
E) 60 cm
F) 53 cm
G) 5.0 cm
H) 12 cm
I) 120 cm
J) No way to determine.

7) A particle is in simple harmonic motion along the horizontal x axis. The amplitude of the motion is x_m. When it is at $x = 1/2x_m$, its kinetic energy is K = 4J and its potential energy (measured with U = 0 at x = 0) is U = 2J. When it is at $x = -x_m$, the kinetic and potential energies are:

A) K = 2J and U = 4J
B) K = 0J and U = 4J
C) K = 6J and U = 0
D) K = 0 and U = 6J
E) K = 0 and U = -6J
F) K = 2J and U = -4J
G) K = 0J and U = 2J
H) K = 4J and U = 2J
I) K = 4J and U = 6J
J) Not enough information to determine.

8) A pulse moves toward one end of a spring at a speed of 80 cm/s. It is not known whether the end of the spring is fixed to a rod or free to slide along it. The diagrams at right show the shape of the spring at *t* = 0.0 s and at *t* = 1.0 s.

Is the end of the spring *fixed* or *free?*



A) The end must be fixed
B) The end must be free
C) The end could be fixed or it could be free
D) The end cannot be fixed and it cannot be free
E) Not enough information

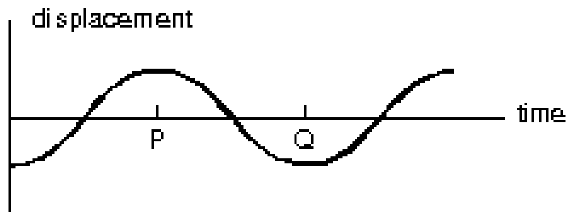
9) A simple harmonic oscillator has an amplitude of 3.00 cm and a maximum speed of 20 cm/s. What is its speed when the displacement is 2.00 cm?

A) 12.3 cm/s
B) 10.0 cm/s
C) 7.25 cm/s
D) 8.66 cm/s
E) 17.6 cm/s
F) 2.00 cm/s
G) 15.4 cm/s
H) 14.9 cm/s
I) 11.3 cm/s
J) Need more information.

10) A sinusoidal force with a fixed amplitude, but adjustable frequency is applied to an oscillator. To obtain the largest amplitude oscillation the frequency of the applied force should be:

A) half the natural frequency of the oscillator
B) the same as the natural frequency of the oscillator
C) twice the natural frequency of the oscillator
D) unrelated to the natural frequency of the oscillator
E) determined from the maximum speed desired

11) In the diagram below, the interval PQ represents the:



A) wavelength/2
B) wavelength
C) 2 x amplitude
D) period
E) amplitude/2
F) period/2
G) 2 x wavelength
H) 2 x period
I) frequency
J) angular frequency

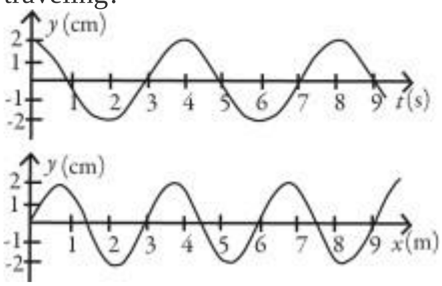
12) A mass oscillates in simple harmonic motion with amplitude A. If the mass is halved, but the amplitude is not changed, what will happen to the total mechanical energy of the system?

A) total energy will increase
B) total energy will decrease
C) total energy will stay the same
D) none of these

13) The transverse wave shown is traveling from left to right in a medium. The direction of the instantaneous velocity of the medium at point P is:

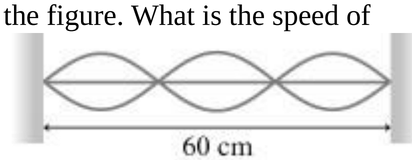
A) ↑
B) ↓
C) ←
D) →
E) no direction since v = 0

14) 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?



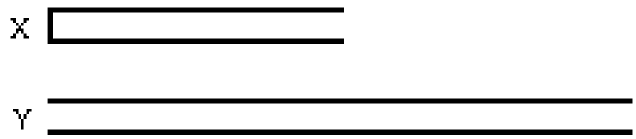
A) 2.0 m/s
B) 0.66 m/s
C) 3.0 m/s
D) 1.5 m/s
E) 1.0 m/s
F) 4.0 m/s
G) 1.75 m/s
H) 2.5 m/s
I) 2.75 m/s
J) 0.75 m/s

15) A standing wave is oscillating at 1210 Hz on a string, as shown in the figure. What is the speed of traveling waves on this string?



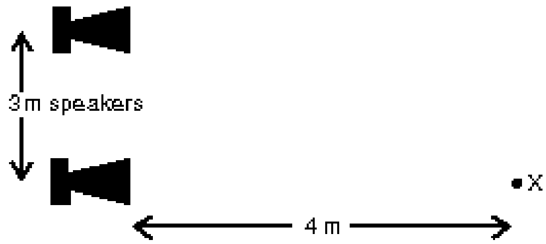
A) 598 m/s
B) 484 m/s
C) 296 m/s
D) 392 m/s
E) 1017 m/s
F) 196 m/s
G) 726 m/s
H) 363 m/s
I) 242 m/s
J) 148 m/s

16) Organ pipe Y (open at both ends) is twice as long as organ pipe X (open at one end) as shown. The ratio of their fundamental frequencies f_X:f_Y is:



A) 1:1
B) 1:2
C) 2:1
D) 1:4
E) 4:1
F) 1:3
G) 3:1
H) 1.5:1
I) 1:1.5
J) Not enough information.

17) Two small identical speakers are connected (in phase) to the same source. The speakers are 3 m apart and at ear level. An observer stands at X, 4 m in front of one speaker as shown. The sound he hears will be most intense if the wavelength is:



A) 1 m
B) 1.5 m
C) 2 m
D) 2.5 m
E) 3 m
F) 3.5 m
G) 4 m
H) 4.5 m
I) 5 m
J) 5.5 m

18) The diagram shows four situations in which a source of sound S and a detector D are either moving or stationary. The arrows indicate the directions of motion. The speeds are all the same. Detector 3 is stationary. Rank the situations according to the frequency detected, highest to lowest.

A) 1, 2, 3, 4
B) 4, 3, 2, 1
C) 1, 3, 4, 2
D) 2, 1, 2, 3
E) None of the above