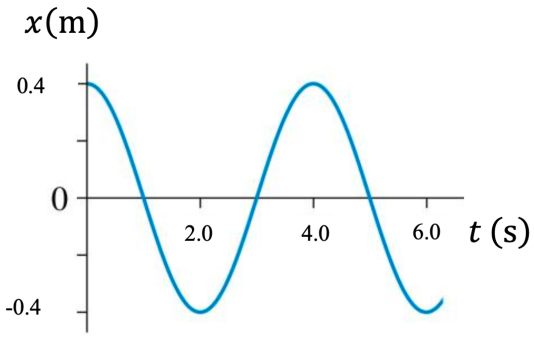
Name _____ **Student ID** _____
last *first*

I. Lecture multi choice (60 points)

Use the following scenarios for the following three questions.

The graph below shows the position versus time of a 2kg object undergoing simple harmonic motion.



1) (5 pts.) Which one of the following equations describes the motion of the object?

A. $x(t) = (0.4\text{m})\cos[(1.57\text{s}^{-1})t]$
B. $x(t) = (0.4\text{m})\cos[(0.25\text{s}^{-1})t]$
C. $x(t) = (0.8\text{m})\cos[(1.57\text{s}^{-1})t]$
D. $x(t) = (0.8\text{m})\sin[(0.25\text{s}^{-1})t]$
E. None of the above

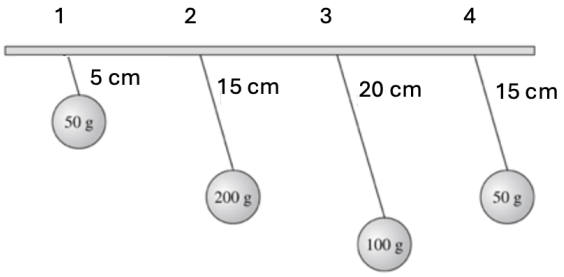
2) (5 pts.) What is the acceleration of the object at time = 3 sec?

A. -2.46 m/s^2
B. -0.99 m/s^2
C. 0 m/s^2
D. 0.99 m/s^2
E. 2.46 m/s^2

3) (5 pts.) What is the maximum kinetic energy?

A. 0.25 J
B. 0.39 J
C. 0.63 J
D. 0.79 J
E. 1.57 J

4) (5 pts.) Several simple pendulums are shown below, each with varying string lengths and bob masses. All pendulums are initially displaced by the same small angle and then released to oscillate. From the set of pendulums shown, identify ΰKŜ LJI·ΛN where one pendulum oscillates at twice the frequency of the other.



A. Pendulum 1 vs Pendulum 2
B. Pendulum 1 vs Pendulum 3
C. Pendulum 2 vs Pendulum 3
D. Pendulum 2 vs Pendulum 4
E. None of the above

5) (5 pts.) A spring-mass system is experiencing damped oscillations. It consists of a 0.5 kg object attached to a spring with a spring constant of 0.5 N/m, and the system has a time constant of 60 seconds. After 20 seconds have elapsed, what fraction of the initial energy remains in the system?

A. 10%
B. 25%
C. 51%
D. 71%
E. 100%

6) (5 pts.) When the head vibrates at a frequency that matches the natural frequency of the eyeball in its socket, vision becomes blurred. Consider an eyeball with a typical mass of 7.0×10^{-3} kg, held in place by musculature with an effective spring constant of 210 N/m. Calculate the specific vibration frequency of the head that would cause this blurring effect on vision.

A. 0.87 Hz
B. 5.5 Hz
C. 28 Hz
D. 360 Hz
E. 1088 Hz

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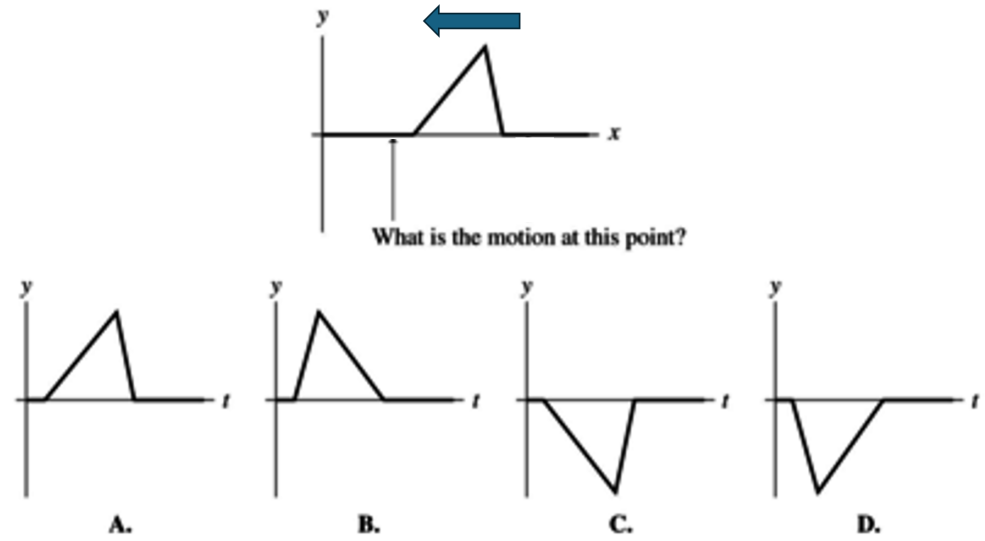
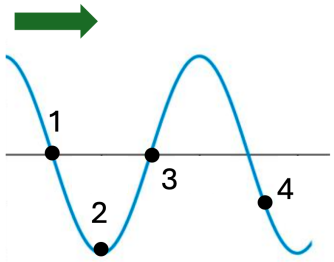
7) (5 pts.) The graph below shows a snapshot graph of a wave on a string that is moving to the **LEFT**. A point on the string is noted. Which of the choices is the correct history graph for the subsequent motion of this point?



A. Graph A
B. Graph B
C. Graph C
D. Graph D
E. None of the above

8) (5 pts.) A snapshot of a wave traveling rightward on a string is shown below. Which of the numbered points on the wave are moving downward in the instant shown?



A. Only point 1
B. Only point 2
C. Only point 3
D. Only point 4
E. More than one of the numbered points.

The next two questions will be based on the scenarios described below.

A speaker is producing sound waves that radiate equally in all directions. You are standing 1 meter away from the speaker. The radius of your eardrum is 1×10^{-3} m. At your position, the intensity of the sound reaching your eardrum is measured to be 4.4×10^{-9} watts per square meter (W/m^2).

9) (5 pts.) Determine the total power that your eardrum receives from this sound wave.

   A. 1.4×10^{-14} W
   B. 5.5×10^{-14} W
   C. 3.5×10^{-10} W
   D. 1.4×10^{-8} W
   E. 5.5×10^{-8} W

10) (5 pts.) You then move to a new position 20 meters away from the speaker. Calculate the absolute value of the difference in intensity level (in decibels) between your measurements at these two locations.

   A. 13
   B. 20
   C. 26
   D. 40
   E. 60

11) (5 pts.) Consider a sinusoidal wave on a string described by a wave function: $y(x,t) = (0.25\text{m})\cos[(36\text{m}^{-1})x - (25\text{s}^{-1})t]$. Which of the following statements about this wave is/are correct?

I. The wave is traveling in the -x direction
II. The wavelength is 0.17 m
III. The wave speed is 0.69 m/s

A. I only
B. II only
C. I and II
D. II and III
E. All statements are correct.

12) (5 pts.) String A is vibrating in a standing wave pattern as depicted below. Identify which modification to the string's conditions would result in the standing wave pattern shown for String B, while maintaining the same oscillation frequency. Note the length of the strings in the figures is not to scale.

String A

String B

A. Double the length, keep the same Tension and Line Density
B. Half the Tension, keep the same Length and Line Density
C. Double the Line Density, keep the same Tension and Length
D. Double the Line Density and double the Tension, keep the same Length
E. None of the above

II. Lecture free response (20 points)

13) (6 pts.) A buzzer is being rotated in a circular motion by an instructor, emitting a sound at a constant frequency f_s. The maximum speed at which the buzzer approaches and moves away from you is *V*. When the buzzer is moving at its maximum speed towards you, you hear a frequency f_a. When it's moving away at maximum speed, you hear a frequency f_r. The ratio of these two frequencies (f_a/f_r) is 1.05. Given that the speed of sound is 343 m/s, calculate the maximum speed V of the buzzer's motion.

14) (6 pts.) Two stationary sound sources are producing beats at a rate of 3 per second when played simultaneously. When source 2 is moved away from source 1 at a constant speed while source 1 remains stationary, the beats cease to be heard by a stationary person. Given that the frequency of source 1 is 600 Hz, determine the frequency of source 2.

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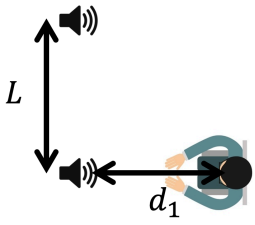
Using the condition below to solve two following questions.

A pair of in-phase stereo speakers is placed side by side, separated by a distance of $L = 2.3$ m. You are sitting a distance $d_1 = 2.06$ m directly in front of one of the speakers. The speakers play a constant note with frequency of 1000 Hz. Assuming the speed of sound is 343 m/s.

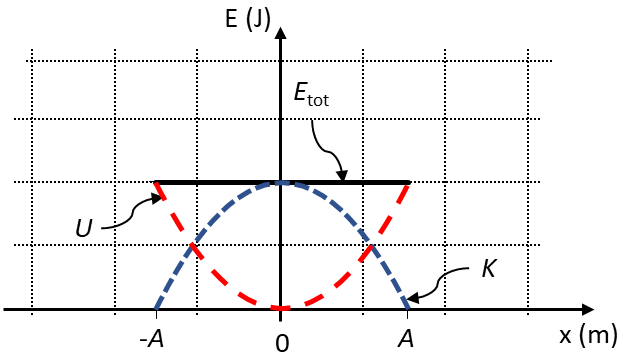


15) (4 pts.) How many wavelengths of this sound wave fit in the distance between you and the speaker, d_1?

16) (4 pts.) Do you hear constructive or destructive interference?

III. Tutorial free response (20 points)

17) (6 pts.) A block with mass m is attached to a spring with spring constant k. The block is pulled a distance A from the equilibrium position and released such that it oscillates with simple harmonic motion. For the block-spring system the figure shows the potential energy, kinetic energy, and total energy, as a function of the position of the block with respect to its equilibrium position.



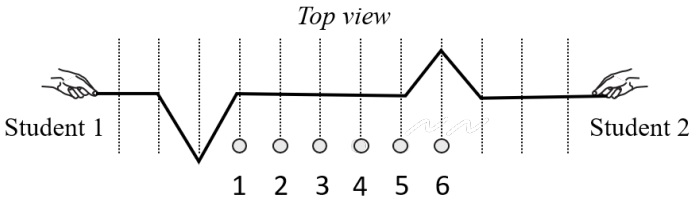
Now the spring is replaced with a spring with spring constant $2k$ and the block is again pulled a distance A from the equilibrium position and released.
For the new situation, on the graph above draw and clearly label the following:

A. Potential energy. Explain your reasoning.

B. Kinetic energy. Explain your reasoning.

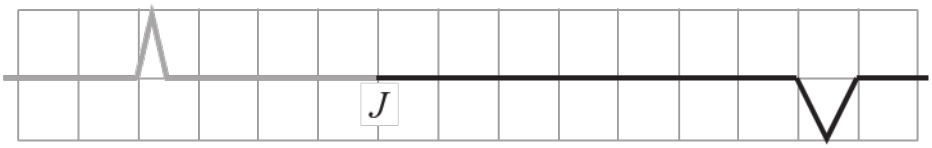
C. Total energy. Explain your reasoning.

18) (7 pts) Students 1 and 2 each generate a single transverse pulse by moving the ends of a spring at *unknown* times. Originally, there was a line of cups, numbered 1 to 6, below the spring, as shown below. In the time for the pulses to travel to the end of the spring, which of the cups are knocked over? Explain your reasoning.



MORE QUESTIONS ON OTHER SIDE

19) (7 pts) Two springs are connected at a junction J. You are not told which spring has a greater mass per unit length. A student generates a pulse at one end of the connected springs. The shape of the springs a short time after the pulse reached junction J is shown below.



Is the mass per unit length of the left spring *greater than*, *less than*, or *equal to*, the mass per unit length of the right spring? Explain your reasoning.