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1. [5 pts] A particle undergoes simple harmonic motion with an amplitude $A = 0.10$ m and period $T = 2.0$ s. What is the maximum speed of the particle?

   A) 0.050 m/s

   B) 0.080 m

   C) 0.10 m/s

   D) 0.16 m/s

   E) 0.31 m/s

2. [5 pts] A mass on a spring has an angular frequency of oscillation $\omega_0 = 5.0$ rad/s. The mass is then submerged in a viscous oil, and the new angular frequency of oscillations is now $\omega = 4.0$ rad/s. What is the time constant τ for this system?

   A) 0.17 s

   B) 0.33 s

   C) 0.66 s

   D) 1.0 s

   E) Not enough information

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3. [5 pts] Three cylindrical strings are shown above with lengths L_1, L_2, and L_3, where $L_1 < L_3 < L_2$. The material in each string is different, such that the mass of each string is the same ($m_1 = m_2 = m_3$). Is it possible to adjust the tension to make the wave speeds the same on each string?

A) Yes, set $T_1 = T_2 = T_3$

B) Yes, set $\frac{T_1}{L_1} = \frac{T_2}{L_2} = \frac{T_3}{L_3}$

C) Yes, set $T_1 L_1 = T_2 L_2 = T_3 L_3$

D) Yes, the wave speeds will be the same no matter what the tension is.

E) No, this is not possible.

4. [5 pts] At an indoor concert, the sound waves emitted from speakers are reflected off the front and back walls, interfering with the sound from the speakers and creating a standing wave [the side walls have absorbent material and do not reflect]. You are at a quiet spot (node) while your friend standing 1.00 m in front of you is at a loud spot (antinode). If there are no nodes or antinodes in between you and your friend, what is the frequency of the emitted sound from the speakers? The speed of sound in air is 343 m/s.

A) 86.0 Hz

B) 172 Hz

C) 257 Hz

D) 343 Hz

E) 686 Hz

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5. [5 pts] You are walking along a dock and see a thin film of oil ($n_{oil} = 1.50$) floating on water ($n_{water} = 1.33$). You notice constructive interference for monochromatic light with wavelength λ = 600 nm incident at 0 degrees to the film. What minimum thickness, t_{min}, of oil will lead to constructive interference?

   A) 100 nm

   B) 113 nm

   C) 200 nm

   D) 226 nm

   E) 400 nm

6. [5 pts] If one could transport a simple pendulum of constant length from the Earth's surface to the Moon's, where the acceleration due to gravity is one-sixth (1/6) that of the Earth, by what factor would the pendulum frequency be changed?

   A) 0.17

   B) 0.41

   C) 1.0 (No Change)

   D) 2.5

   E) 6.0

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A loudspeaker at a rock concert generates an intensity of 1.0×10^{-2} W/m^2 at 19.0 m at a frequency of 1.0 kHz. Assume the speaker spreads its energy uniformly in three dimensions. The next two questions refer to this setup.

7. [5 pts] What is the total acoustic power output of the speaker?

   A) 0.055 W
   B) 0.13 W
   C) 2.4 W
   D) 22 W
   E) 45 W

8. [5 pts] At what distance will the intensity be at the pain threshold of 1.0 W/m^2?

   A) 0.06 m
   B) 0.10 m
   C) 1.9 m
   D) 3.6 m
   E) 19 m

9. [5 pts] Two waves, 1 and 2, are propagating along a string, where the vertical displacements are given by the following equations:

$$y_1(x,t) = A_1 \sin(kx - \omega t)$$
$$y_2(x,t) = A_2 \cos(kx - \omega t + \delta)$$

   Which value of δ will make for total constructive interference?

   A) -π
   B) $-\pi/2$
   A) $\pi/2$
   B) π
   C) Since they are traveling in the same direction, there will never be constructive interference with these waves.

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Lab Multiple Choice Questions

10. [5 pts] A group of students, group A, is running the same experiment as that in Lab A1. Their goal is to find a relationship between the standing wave frequency and the length of the string. The table at right shows possible variables for this experiment. Identify which variables the students should choose as independent, dependent and control for their experiment.

No.	Variable
1	Standing Wave Frequency
2	String length
3	Mass attached to the hanger
4	Number of antinodes
5	Linear mass density of the string

A) Variable (1) is independent, (2) is dependent and all others are control.

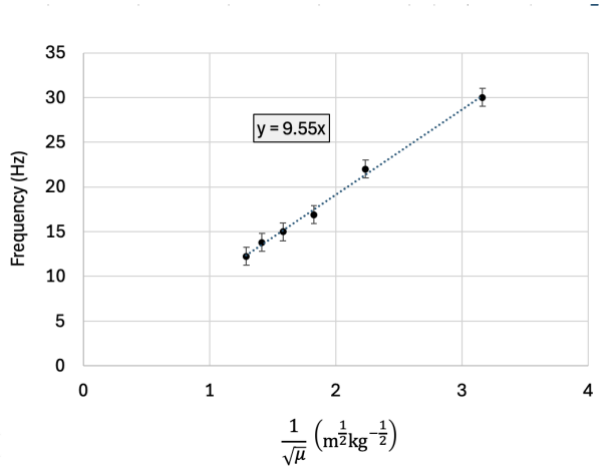
B) Variable (3) is independent, (4) is dependent and all others are control.

C) Variable (4) is independent, (3) is dependent and all others are control.

D) Variable (2) is independent, (1) is dependent and all others are control.

E) Variable (2) is independent, (5) is dependent and all others are control.

11. [5 pts] A different group of students, group B, is examining the relationship between standing wave frequency (f) and the linear mass density of the string (μ) using the same equipment as that in Lab A1. They collect data and form the linearized plot at right. Which of the statements below are consistent with the student's data?



I. f is *proportional* to $\sqrt{\mu}$.

II. As the value of μ increases, the value of f also increases.

III. As the value of μ increases, the value of f decreases.

IV. μ was the independent variable for this experiment.

A) Statements I, III, and IV

B) Statements I and II

C) Statements II and IV

D) Statements III and IV

E) Statement III only

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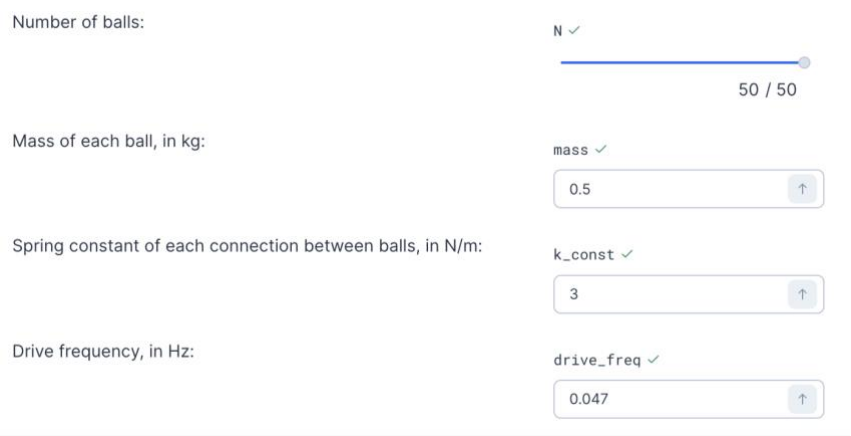
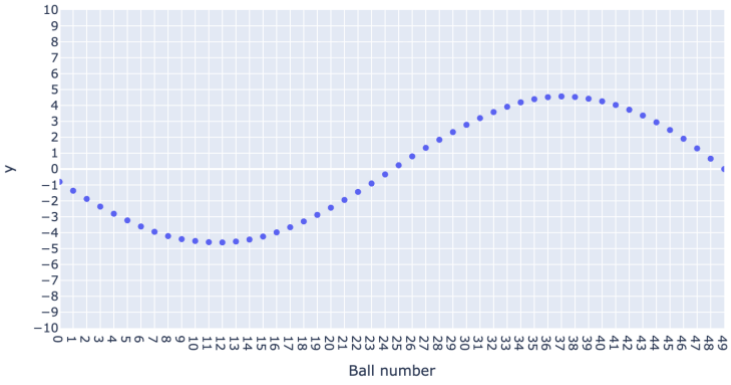
12. [5 pts] Group B (from *Q*11) is now trying to replicate their experiment using the simulation in Labs A1 and A2. Using the settings at right, the students form a standing wave with two antinodes.



The students then change the mass of each ball to 1.0 kg. Based on their data in *Q*11, if they want to replicate the standing wave as shown, what approximate drive frequency should they use?



A) 0.024 Hz

B) 0.033 Hz

C) 0.058 Hz

D) 0.066 Hz

E) 0.094 Hz

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Lecture Free Response

13. [5 pts] An ambulance is driving down the street at a speed of 25 m/s emitting a sound at 800 Hz with power 100W. The speed of sound in air is 343 m/s. What is the ratio of the frequency you hear as the ambulance drives towards you, to the frequency of the sound you hear as it is driving away from you? Show your work.

14. [5 pts] An ambulance is driving down the street a speed of 25 m/s emitting a sound at 800 Hz with power 100W. How much louder (in decibels) is the sound you hear when the ambulance is 2 m away from you, in comparison with when the ambulance is 100 m away from you? Show your work.

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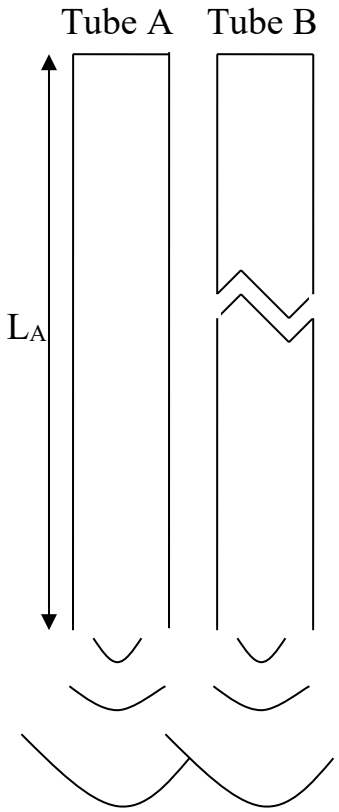
Two open-at-one-end tubes play slightly different notes when they resonate in their fundamental mode (lowest tone). Tube A, with length L_A, has a higher pitch (frequency) than tube B. The tubes are identical other than their length. The speed of sound is v_s. When both tubes resonate simultaneously a beat frequency, f_T, is heard.



15. [5 pts] If the frequency of tube A is f_A, write down the frequency of tube B, f_B, in terms of the given quantities. Show your work.

16. [5 pts] Write down the frequency of tube A, f_A, in terms of the given quantities. Show your work.

17. [5 pts] Is $L_A > L_B, L_A < L_B$, or $L_A = L_B$? Make sure to explain your reasoning.

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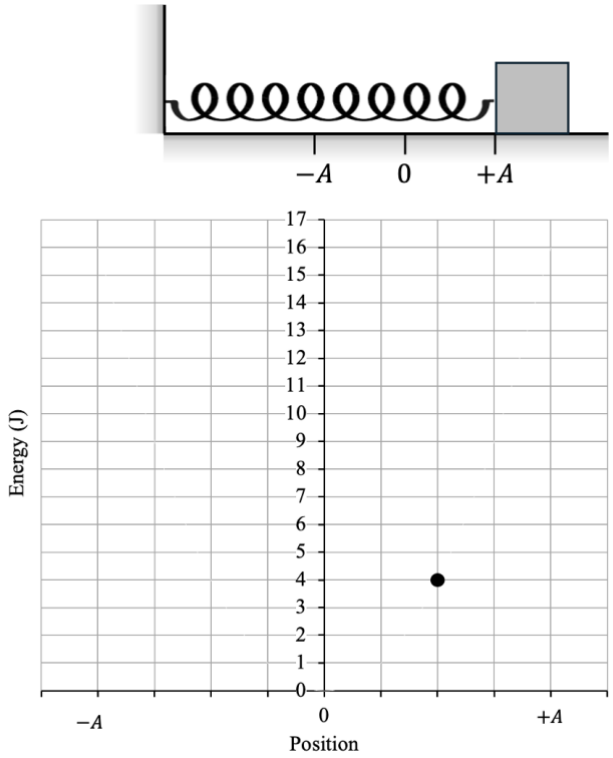
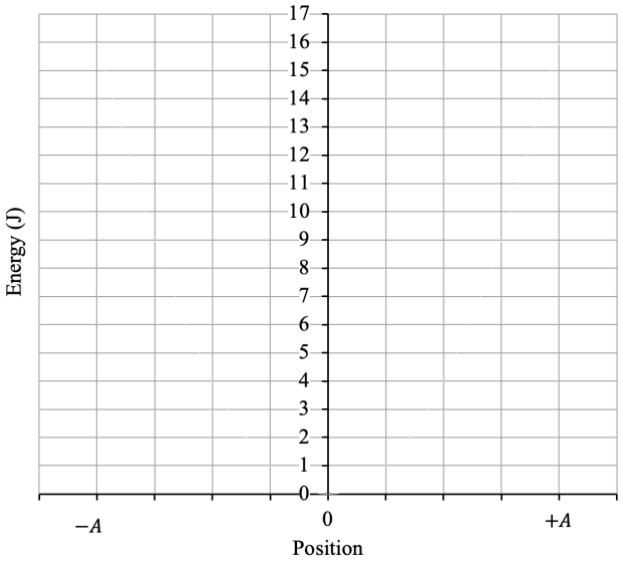
Tutorial Free Response Questions

18. [6 pts] Case 1: A block of mass m is attached to an ideal spring and oscillates between $x = +A$ and $x = -A$ on a frictionless horizontal surface. The graph shows a single data point of the block-spring system's potential energy when the block is located at $x = +A/2$. On the graph sketch curves or lines that represent the system's total energy, potential energy and kinetic energy. Label clearly and explain.



19. [4 pts] Case 2: The mass of the block is halved and released from rest at $x = +A$. The scale of the graph at right is identical to that in $Q18$. Sketch the total energy, kinetic energy and potential energy of the block-spring system for this case. Explain. If not enough information is given, state so explicitly.



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20. [5 pts] The graph at right shows the velocity-time curve of the block in Case 1. On the graph, sketch a velocity-time curve for the block in Case 2. Your graph only needs to be qualitatively correct. Explain.