Physics 115 Prof. Menningen Name: ____________________________

In-Class Questions & Exercises

1. The position of a mass attached to a vertical spring is given by: $y = A\sin(\omega t + \phi)$, where A, ω, and ϕ have values of 10.0 cm, 450.0 deg/s, and 10.0 deg, respectively. What is the period of its motion?

$$T = \frac{1}{f} = \frac{360°}{\omega} = \frac{360°}{450.0°/\text{s}} = \boxed{0.800 \text{ s}}$$

2. A 1.28-kg mass is attached to a spring (k = 512 N/m) and is undergoing simple harmonic motion.
   (a) What is the period of the motion?

$$T = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{1.28 \text{ kg}}{512 \text{ N/m}}} = \boxed{0.314 \text{ s}}$$

   (b) What is the frequency of the motion?

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} = \frac{1}{T} = \frac{1}{0.314 \text{ s}} = \boxed{3.18 \text{ Hz}}$$

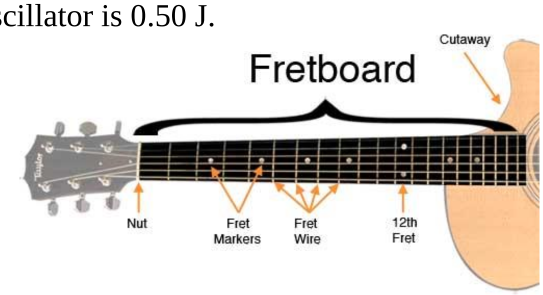
$$T = 2\pi\sqrt{m/k} \quad \Rightarrow m = kT^2/4\pi^2$$

$$\frac{m_{\text{new}}}{m_{\text{old}}} = \frac{kT_{\text{new}}^2/4\pi^2}{kT_{\text{old}}^2/4\pi^2} = \left(\frac{T_{\text{new}}}{T_{\text{old}}}\right)^2 = \left(\frac{2T_{\text{old}}}{T_{\text{old}}}\right)^2 = 2^2 = 4$$

3. In problem 2 above, the mass would have to be **4** times greater in order to double the period of the motion. (Assume nothing else has changed.)

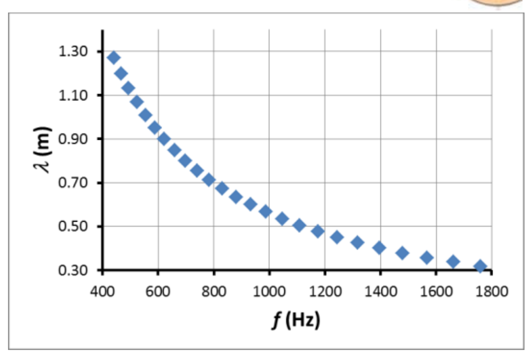
4. In problem 2 above, the spring constant would have to be **4** times greater in order to double the frequency of the motion. (Assume nothing else has changed.)

5. The maximum kinetic energy of a particular simple harmonic oscillator is 0.50 J.
   (a) What is its maximum potential energy? **0.50** J
   (b) What is its total mechanical energy? **0.50** J



6. Why are the frets on a guitar spaced closer together as you move down the fretboard toward the bridge? Consider answering this question by referring to the graph of λ vs. f for every note on a guitar string from A_4 (440 Hz) to A_6 (1760 Hz).

The string is shortened by pressing on a fret so that only the portion from the fret to the bridge is vibrating. This distance must correspond to half the wavelength of the correct note. The frets must be spaced closer together because the wavelengths are spaced closer together as the frequencies become higher.



7. Every 5 seconds of time delay between a flash of lightning and the sound of thunder is said to represent one mile of distance. Is this a good rule of thumb? Let's check it for a range of air temperatures, from 5.0°C (41°F) to 35°C (95°F). (Note: 1 mi = 1609 m, $c_{\text{air}} = 331.4 + 0.589T_{\text{C}}$ m/s)

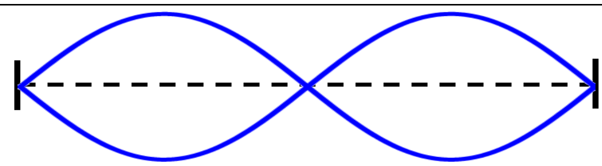
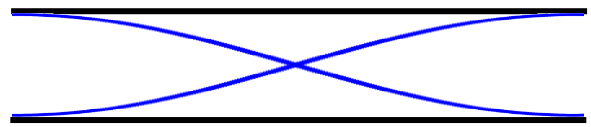
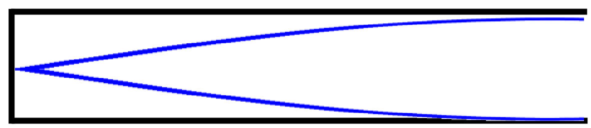
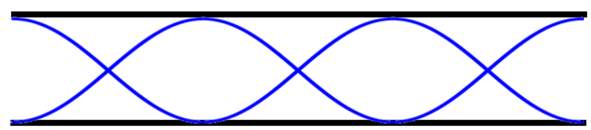
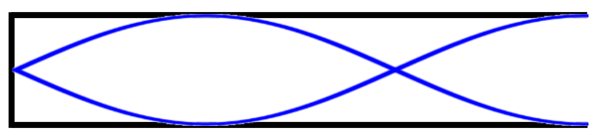
c_{air} at 5.0°C ______________ ______ (units) t_{mile} = ______________ ______ (units)

c_{air} at 35°C ______________ ______ (units) t_{mile} = ______________ ______ (units)

$$c_5 = 331.4 + 0.589(5.0°\text{C}) = \boxed{334.35 \text{ m/s}} \quad \Rightarrow t_5 = \frac{d}{c_5} = \frac{1609 \text{ m}}{334.35 \text{ m/s}} = \boxed{4.81 \text{ s}}$$

$$c_{35} = 331.4 + 0.589(35°\text{C}) = \boxed{352.02 \text{ m/s}} \quad \Rightarrow t_{35} = \frac{d}{c_{35}} = \frac{1609 \text{ m}}{352.02 \text{ m/s}} = \boxed{4.57 \text{ s}}$$

8. Sketch the following harmonics in a manner that shows the locations of the displacement nodes and displacement antinodes. (Use sketch formats similar to the notes and textbook.)

System	Harmonic	Sketch	Number of displacement nodes
String	2		**3**
Open cylindrical tube	1		**1**
Closed cylindrical tube	1		**1**
Open cylindrical tube	3		**3**
Closed cylindrical tube	3		**2**

9. The "internodal distance" for a particular standing wave pattern in an open cylindrical tube is found to be 0.25 m.

(a) What is the wavelength of this standing wave?

$$\lambda = 2 \times \text{internodal distance} = 2(0.25\text{ m}) = \boxed{0.50\text{ m}}$$

(b) If the wave propagation speed is known to be 350 m/s, what is the frequency of this standing wave?

$$f = \frac{c}{\lambda} = \frac{350\text{ m/s}}{0.50\text{ m}} = \boxed{700\text{ Hz}}$$

(c) If the length of the tube is 1.0 m, then is this standing wave the "first harmonic"? If not, which harmonic is it?

$$\text{A wavelength } \lambda = \frac{L}{2} = \frac{2L}{4} \text{ corresponds to the } \boxed{\text{fourth harmonic}}$$