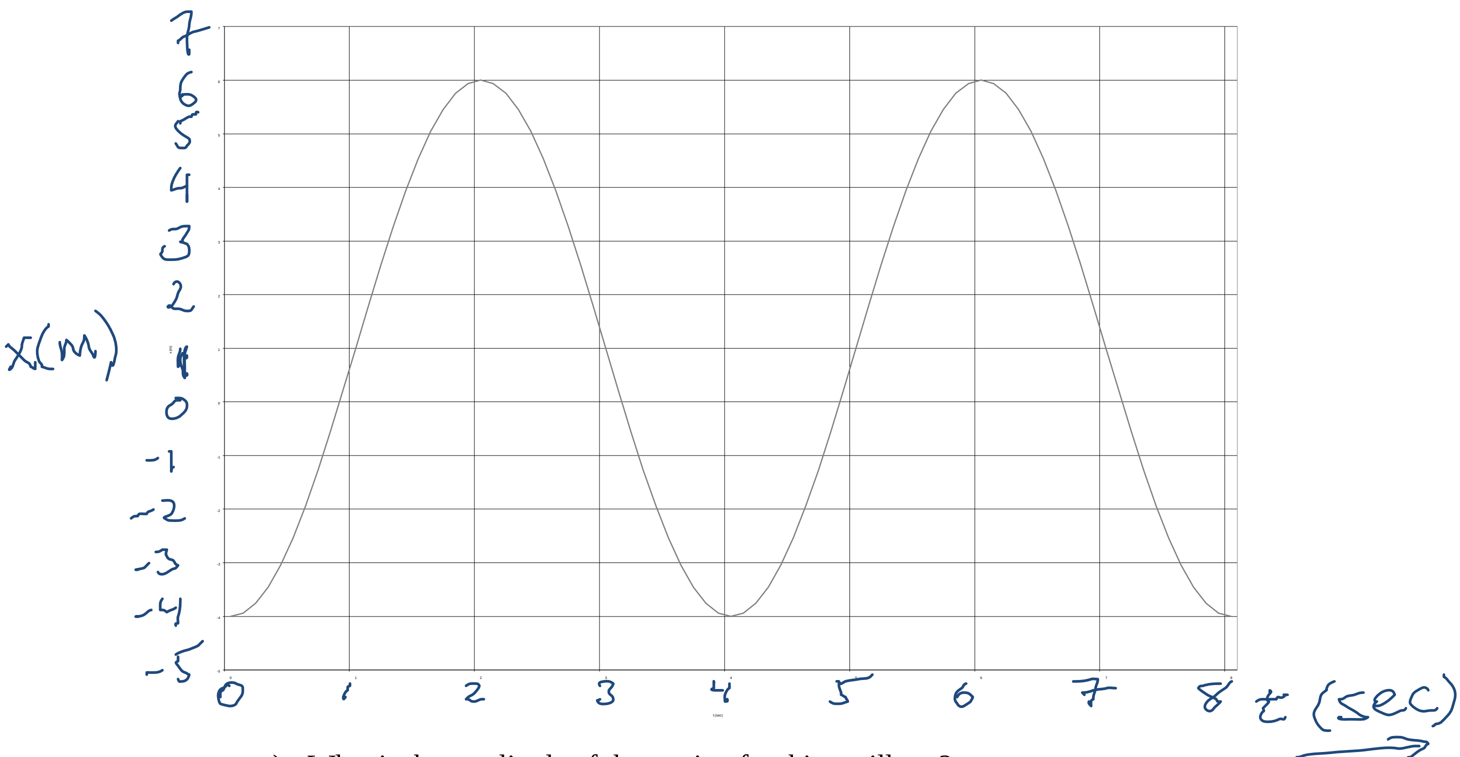
Workshop module 11 - Physics 113, Fall 2013

1. A 2 kg mass is attached to a massless, ideal spring. It is constrained to oscillate along one dimension on a horizontal frictionless surface. A mark has been placed at an arbitrary location on the table to designate the x=0 position for a graph of the motion. As the mass oscillates without loss of energy it traces the path shown on the graph below.



a) What is the amplitude of the motion for this oscillator?

b) What is the period of the oscillator?

c) When is the mass moving the slowest?

d) When does the mass have its greatest acceleration?

e) What is the spring constant of the spring?

2. A buoy of uniform cross section A and mass M floats in sea water of density ρ.
   (a) Draw a free body diagram for the object.
   (b) How far below the surface of the fluid is the bottom of the buoy?
   (c) Suppose a bird of mass m lands on top of the buoy, forcing it to sink further into the water. At the new equilibrium position, how much farther below the surface of the fluid is the bottom of the buoy than it was in part (b)?
   (d) Suppose the bird flies away suddenly. Show the buoy will oscillate up and down in simple harmonic motion.
   (e) What is the period of that up and down motion?

(f) What is the frequency of that up and down motion?
(g) What is the amplitude of that up and down motion?

3. What is the frequency of a simple pendulum 2.0 m long (a) in a room, (b) in an elevator accelerating upward at 2.0 m/s^2, and (c) in free fall?

4. Why do you see lightning before you hear the thunder? Would you see a rocket lift off from the moon before you heard it? You see a baseball player swing at a ball 1.0 seconds before you hear the crack of the bat on the ball. How far away from home plate are you sitting?

5. Erving Von Humbolt, famed Professor of Pre-Columbian Artifacts has discovered a musical instrument he believes was once used by native peoples in what is now southeast Paraguay for "some serious jammin', rockin', and gettin' down" during adolescent mating rituals. Unfortunately, the instrument he has discovered is broken. He comes to you for help in understanding what sounds the instrument might have made. Please help him out!

The instrument has one string. That string is tied at one end and constrained to move freely up and down a thin rod on the other end. Break up into small groups and determine the correct expression for the frequency of the n^{th} harmonic of the string in terms of the length (L), tension (T), and the mass/length (μ) of the string. Try to convince the other groups of your answer. Below are are a few possibilities, one of which is the correct answer.

(a)

$$\nu_n = \frac{n}{2L}\sqrt{\frac{T}{\mu}}$$

where n=1,3,5 …

(b)

$$\nu_n = \frac{n}{2L}\sqrt{\frac{T}{\mu}}$$

where n=1,2,3, …

(c)

$$\nu_n = \frac{n}{2L}\sqrt{\frac{gT}{\mu}}$$

where n=1,2,3, …

(d)

$$\nu_n = \frac{n}{4L}\sqrt{\frac{T}{\mu}}$$

where n = 1,3,5, …

(e)

$$\nu_n = \frac{n}{4L}\sqrt{\frac{T}{\mu}}$$

where n=1,2,3, …

6. Mick Jaguar, famous rock musician, sits in the stadium during a sound check before his concert. He sits in front of the stage 20 meters from one speaker and 23 meters from another. These are the only two speakers on the stage. As part of the sound check, the frequency emitted by the speakers is swept slowly through the entire audible range from 20 to 20,000 Hz. Mick notices that the intensity of the sound he hears depends on the frequency.

(Intensity is a measure of the energy/area flowing through a point due to the wave passing by. It is the time average of the square of the total wave amplitude at a point. A total wave amplitude that is large gives a large intensity.)

Should he be worried that there is something wrong with his hearing? Suppose Mick's ears have a perfectly flat frequency response. What else could cause a variation in the intensity of the sound

Mick hears? At what frequencies should Mick hear a minimum intensity? At what frequencies will he hear a maximum intensity?