Question A:
Does the acceleration of a simple harmonic oscillator remain constant during its motion? Is the acceleration ever zero? Explain.

Question B:
When a 150 g mass is hung from a spring scale, it causes the spring to stretch a distance of 3.5 cm.
a) Calculate the spring constant of the spring.
b) Calculate the amount of weight that would cause the spring scale to stretch a distance of 4.2 cm.

Question C:
An 8.0 N object is attached to a vertical spring of spring constant 115 N/m.
a) Calculate the distance that the spring stretches when the object is attached.
b) The spring is then positioned so that the object is submerged in a beaker of fresh water. In this situation, the spring stretches only .0618 m. Explain why the spring stretches a shorter distance when the object is submerged.
c) Calculate the volume of the object.

Question D:
A 25 g mass oscillates in simple harmonic motion on a vertical spring with spring constant 15.0 N/m. The maximum velocity of the mass as it oscillates is 2.1 m/s. What is the amplitude of the oscillation of the mass?
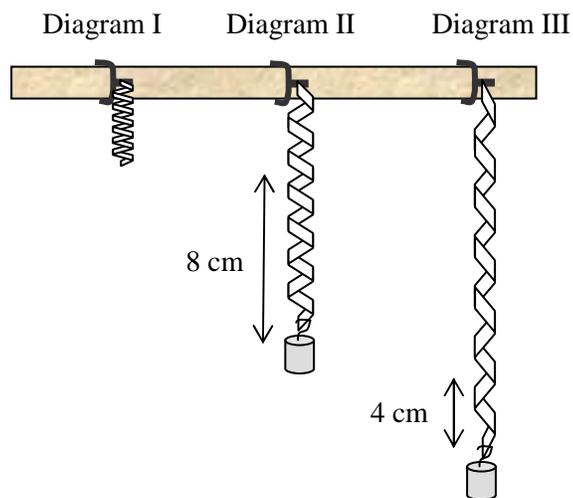
Question E:
A vertical spring is shown unstretched in Diagram I. A 500 g mass is placed on the end of the spring, causing it to stretch to a distance of 8.0 cm longer than its original length, as shown in Diagram II. The mass on the spring is then stretched an additional 4.0 cm, as shown in Diagram III. It is released, and oscillates in simple harmonic motion.
a) Calculate the spring constant of the spring.
b) Calculate the maximum velocity of the mass as it oscillates.
c) Calculate the kinetic energy possessed by the mass as it oscillates at a point halfway between Diagrams II and III.

Diagram I   Diagram II   Diagram III

8 cm

4 cm

Question F:
Use the situation described in Question E to determine the following (*NOTE: Assume k = 61.25 N/m*):
a) the time period of oscillation of the mass.
b) the position equation describing the simple harmonic motion of the mass.

Question G:

An air track cart of mass .5 kg is attached to an unstretched horizontal spring of spring constant 625 N/m. A second identical cart traveling at a velocity of 6.0 m/s collides with the first cart, as shown in the diagram below. The two carts stick together and compress the spring, beginning a cycle of simple harmonic motion.

  a) Calculate the velocity of the two combined carts immediately after the collision.
  b) Calculate the maximum distance that the spring is compressed by the carts if the surface is frictionless.
  c) Calculate the frequency of oscillation of the system.
  d) Write an equation describing the position of the two carts in simple harmonic motion.

$v = 6.0$ m/s

$k = 625$ N/m

.5 kg   .5 kg

Air Track
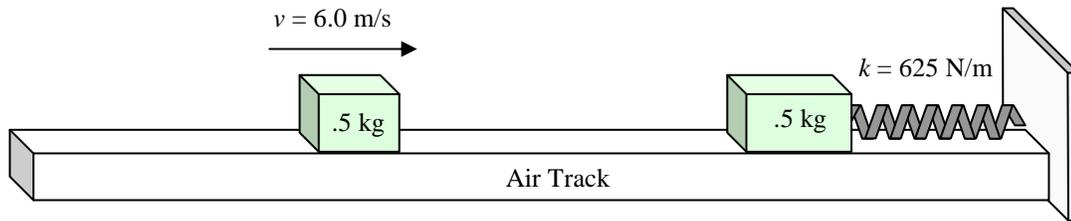
Question H:

The position of a .25 kg object attached to a spring is described by the equation: $y = (.15) \cdot \cos (.4 \cdot \pi \cdot t)$

  a) Determine the amplitude of the object's motion.
  b) Determine the spring constant of the spring.
  c) Determine the position of the object at time t = .75 seconds.

Question I:

The frequency of vibration of a mass-spring system is 5.00 Hz when a 4.00 g mass is attached to the spring. What is the force constant of the spring?
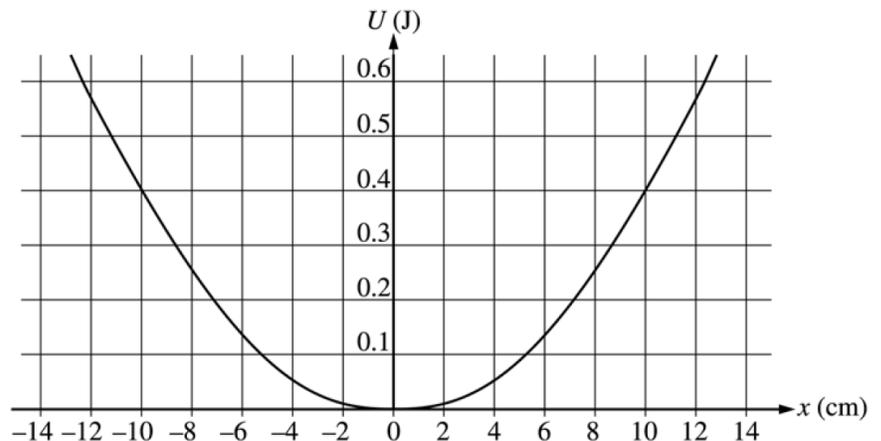
Question J:

An object moves in simple harmonic motion with amplitude A. What is the total distance traveled by the object in a time equal to its time period?

Question K:

A 3.0 kg object subject to a restoring force F is undergoing simple harmonic motion with a small amplitude. The potential energy U of the object as a function of distance x from its equilibrium position is shown below. This particular object has a total energy E: of 0.4 J.

  a) What is the object's potential energy when its displacement is +4 cm from its equilibrium position?
  b) What is the farthest the object moves along the x-axis in the positive direction? Explain your reasoning.
  c) Determine the object's kinetic energy when its displacement is -7 cm.
  d) What is the object's speed at $x = 0$?

U (J)

0.6
0.5
0.4
0.3
0.2
0.1

−14 −12 −10 −8 −6 −4 −2   0   2   4   6   8   10   12   14

x (cm)

Question A:
An airplane traveling with half the speed of sound emits a sound of frequency 5.00 kHz. (Assume a speed of sound of 344 m/s.) At what frequency does a stationary listener hear the sound . . .
  a) as the airplane approaches?
  b) after the airplane passes?

Question B:
A tuning fork is held above a graduated cylinder partially filled with water, as shown in the diagram at right. The air in the cylinder resonates for the first time when the water level is adjusted so that the tuning fork is held above .08 m of air.
  a) Calculate the frequency of the tuning fork.
  b) Sketch a diagram of the wave formed at the third resonant point. Label each node and antinode.
  c) Calculate the length of an air column required to vibrate the tuning fork at its third resonant point.
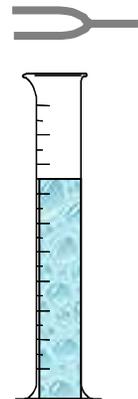
Question C:
A pipe open at each end has a fundamental frequency of 300 Hz when the speed of sound in air is 333 m/s.
  a) Calculate the length of the pipe.
  b) What is the frequency of the second harmonic when the temperature of the air is increased so that the speed of sound in the pipe is 344 m/s?

Question D:
A 5.0 kg mass connected to a spring is found to resonate when it is pushed at a frequency of 2.4 Hz. Determine the spring constant for the spring.

Question E:
The chains suspending a child's playground swing are 2.00 m long.
  a) How much time should elapse between each push by the child's big brother in order for the child to swing with the largest amplitude?
  b) At what frequency does the child's big brother push the swing?

Question F:
A violin string vibrates, playing a G note of frequency 196 Hz. The wavelength of the sound on the string is .60 m. Calculate the velocity of sound on this particular violin string.

Question G:
Hans stands at the rim of the Grand Canyon and yodels down to the bottom with a frequency of 210 Hz. He hears his yodel echo back from the canyon floor 5.20 seconds later. Assume that the speed of sound in air is 340.0 m/s.
  a) How deep is the canyon at this location?
  b) How many complete waves are formed as the sound travels from the rim to the bottom of the canyon?

Question H:
The steel wire playing middle C in a properly tuned piano has a length of .700 m and a velocity of sound of 366.24 m/s.
  a) Determine the fundamental frequency of the middle C wire.
  b) Determine the 1st overtone frequency of the middle C wire.

Question I:
Sound waves travel on Zeke's guitar string with a velocity of 400.0 m/s. How long is the string that produces a second harmonic sound of 522.2 Hz?