University Physics II

Homework Set 12

1. The position of a particle is given by the expression:

$$x(t) = 4.00\cos(3.00\pi t - \pi),$$

where x is in meters and t is in seconds. Determine:

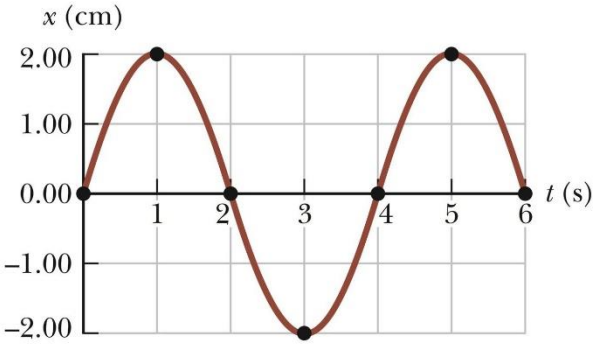
   a. The frequency of oscillation
   b. The period of oscillation
   c. The amplitude of the motion
   d. The phase constant
   e. The position of the particle at t = 0.250 sec.
   f. The velocity of the particle at t = 0.250 sec.

2. **A particle moving along the x-axis in simple harmonic motion starts from its equilibrium position, the origin, at t = 0 and moves to the right. The amplitude of its motion is 2.00 *cm* and the frequency of oscillation is 1.50 Hz. Find an expression for the position of the particle as a function of time.

3. A particle executes simple harmonic motion with an amplitude of 3.00 *cm*. At what position does its speed equal half of its maximum speed?

4. A simple pendulum has a mass of 0.250 *kg* and a length of 1.00 *m*. It is displaced through an angle of 15.0° and then released. Find:
   a. The maximum speed of the bob
   b. The maximum tangential acceleration of the bob
   c. The maximum angular acceleration of the bob

5. An object attached to a spring vibrates with simple harmonic motion as described in the figure at right. For this motion, find:
   a. The Amplitude
   b. The period
   c. The angular frequency
   d. The maximum speed
   e. The maximum acceleration
   f. An equation for its position as a function of time



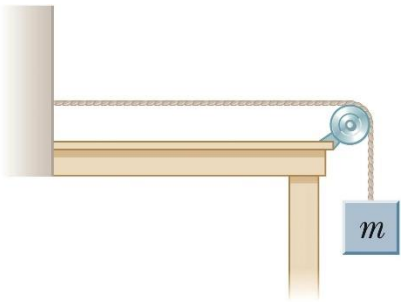
6. What is the period of a simple pendulum that is 1.00 *m* long in each of the following situations?
   a. In the physics lab
   b. In an elevator accelerating at 2.10 m/s^2 upward
   c. In an elevator accelerating at 2.10 m/s^2 downward
   d. In an elevator in free fall

7. To measure the "weight" of astronauts in space, a special 42.5 *kg* chair is attached to a spring and allowed to oscillate. When the chair is empty, the chair takes 1.30 *s* to complete one vibration. Suppose an astronaut sits in the chair, with feet off the floor, and it takes 2.54 *s* to complete one vibration. What is the mass of the astronaut?

   Note: To find their actual weight, you would need to know how far above the earth they were orbiting.

8. A sinusoidal wave traveling in the negative x direction on a string has an amplitude of 20.0 *cm*, a wavelength of 35.0 *cm*, and a frequency of 12.0 Hz. The transverse position of an element of the string at $t = x = 0$ is $y = -3.00$ *cm*, and the element has a positive velocity here.
   a. Find the angular wave number k (*in* cm^{-1})
   b. Find the period of the wave
   c. Find the angular frequency ω of the wave
   d. Find the wave speed v of the wave (*in m/s*)
   e. Using the initial conditions of the wave at $x = t = 0$, find the phase constant ϕ
   f. Find the complete expression for $\Psi(x,t)$, the wave function of this wave
   g. Plot the wave function at $t = 0$ for $x = 0$ to 40 *cm*

9. Tension is maintained on a string as shown in the setup at right. The observed wave speed is 24.0 *m/s* when the suspended mass is 3.00 *kg*.
   a. What is the linear mass density (μ) of the string?
   b. What is the wave speed when the suspended mass is 2.00 *kg*.



10. On December 26, 2004, a great earthquake occurred off the coast of Sumatra and triggered immense tsunami waves that killed some 200,000 people. Satellites observing these waves from space measured 800 km from one wave crest to the next and a period between the waves of 1.0 hour.
   a. What wave the speed of these waves in *m/s* and *mph*?
   b. Does your answer help you understand why the waves caused so much devastation? Explain

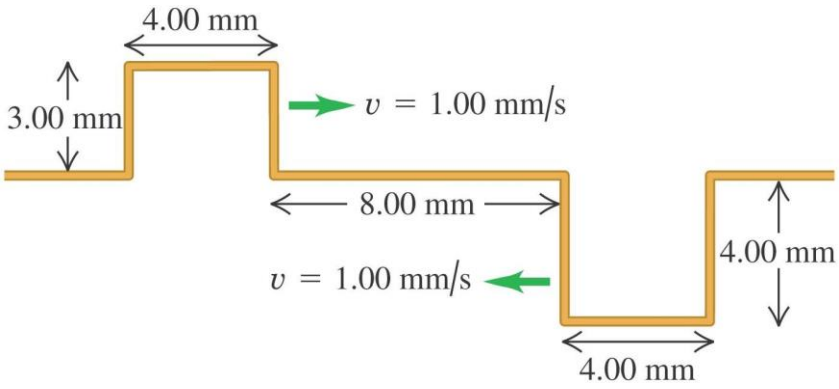
11. A water wave traveling in a straight line on a lake is described by the equation

$$y(x,t) = (2.75\,cm)\cos(0.410\,x + 6.20\,t)$$

   where x is in *cm*, t in *sec*, and y is the displacement perpendicular to the undisturbed surface of the lake.

   a. How much time does it take for one complete wavelength to go past a fisherman in a boat?
   b. What is the number of waves per second that pass the fisherman? (*i.e. the frequency*)
   c. How fast does the wave crest travel past the fisherman (*in m/s*)?
   d. What horizontal distance does the wave peak travel in that time (*in m*)?
   e. What is the maximum transverse oscillation speed of his cork floater as the wave causes it to bob up and down (*in m/s*)?

12. **The figure below shows two square waves on a stretched string traveling toward each other. Each pulse is traveling with a speed of 1.00 *mm*/*s*. If the leading edges of the pulses are 8.00 *mm* apart at $t = 0$, sketch the observed shape on the string at $t = 4.0$ *s*, 6.0 *s* and 10.0 *s*.



13. **Show that the wave function $y = e^{b(x-vt)}$ is a solution of the linear wave equation, where b is constant.