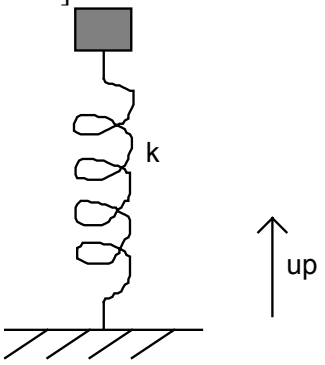
PHY 140Y – FOUNDATIONS OF PHYSICS
2001-2002
Tutorial Questions #9
November 12/13

Note: Answers are given in brackets. Try getting full solutions before the tutorials!

Conservation of Energy and Springs

1. One end of a massless spring is placed on a flat surface, with the other end pointing upward, as shown below. A mass of 3.0 kg is placed on top of the spring, compressing it by 25 cm. The 3.0 kg mass is removed and replaced by a 5.0 kg mass. Then the spring is compressed by hand so that the end of the spring is 67 cm lower than the position of the spring with no mass attached. The spring is then released. What is the maximum kinetic energy of the 5.0 kg mass? [3.7 J]



Simple Harmonic Motion

2. A 340-g mass is attached to a vertical spring and lowered slowly until it rests at a new equilibrium position, which is 30. cm below the spring's original equilibrium position. The system is then set into simple harmonic motion. What is the period of the motion? [1.1 s]

3. A 0.500 kg block on a frictionless horizontal surface is attached to an ideal spring and is found to complete one oscillation every 2.00 s. The range of the oscillation is measured to be 0.40 m, and the block has zero speed when t = 0.
   (a) Determine the period, frequency, and angular frequency of the motion. [T=2.00 s]
   (b) Find the spring constant of this spring. [4.93 N/m]
   (c) Determine the amplitude and phase shift of the oscillation. [0.20 m, 0]
   (d) Find x(t), where x = 0 m is the equilibrium position of the mass on the spring. [eqn]
   (e) Determine $v_x(t)$ and the maximum speed. [eqn, and 0.63 m/s]
   (f) Determine $a_x(t)$ and the magnitude of the maximum acceleration. [eqn, and 2.0 m/s^2]

4. You can measure the acceration due to gravity, g, with a simple pendulum. Set up a pendulum of length 1.75 m. With a stopwatch, you should find that it executes 25 complete small oscillations in 66.4 seconds.
(a) What value of g do these data imply? [g…]
(b) If the oscillation amplitude were reduced to half the original value, what would be the period of the pendulum's motion? […]

5. A mass M is connected to two rubber bands of length L. Each rubber band has a constant tension T. The mass is displaced by a very small distance y and is released. It then exhibits simple harmonic motion. What is the angular frequency of this motion? (Only consider the tension forces – ignore gravity.) $[(2T/mL)^{0.5}]$