Physics 206a

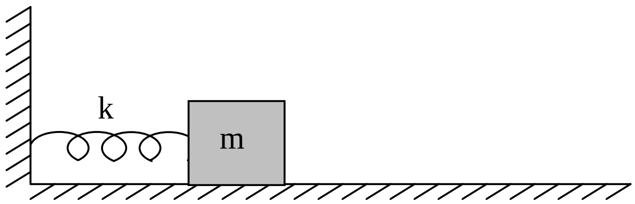
Homework Assignment XIII

due April 23, 2007

(Note: The due-date is a Monday.)

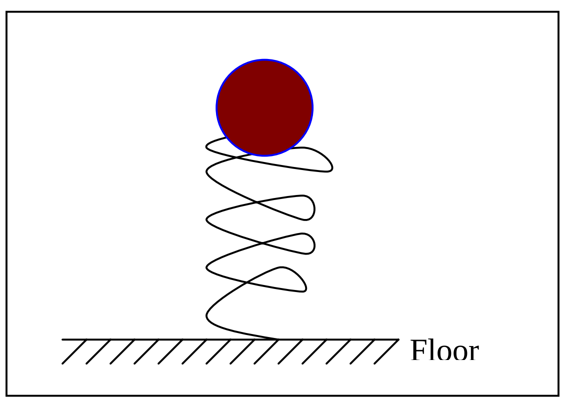
1. What is the period of a pendulum with a bob mass of 1 kg, an initial angle of 0.1 radian, and a length of 3 meters?
2. For the pendulum in the previous problem, what is the circular frequency? What is the angular frequency?
3. For the pendulum discussed in the previous problems, what is the equation giving the position (in the x direction) as a function of time? Take t=0 as the moment when the pendulum is released from its initial displacement. Be sure to include the phase!
4. If the pendulum in the previous problems has its bob replaced with one of twice the mass, what happens to the frequency?
5. If the pendulum in the previous problems has is shaft (the “string”) replaced with one of twice the length, what happens to the frequency?
6. A spring has a constant $k = 7\frac{\text{Newtons}}{\text{meter}}$. The spring is oriented vertically and a mass of 30 grams is hung from it.
   a. Draw a free-body diagram for the mass when it at rest at its equilibrium position. Give the sizes of all the forces in your diagram.
   b. The mass is pulled down 5 cm by someone’s hand and held in that position. Now draw a free-body diagram for the mass. Give the sizes of all the forces in your diagram.
   c. The spring is released. How high up does it go?
   d. At the top of its travel, just when it has stopped and is about to begin moving down again, draw a free body diagram for the mass.
7. For the system in the previous problem, what is the frequency of oscillation of the mass?

8. A molecule of carbon monoxide vibrates as though the two atoms in it were held together by a spring. The spring constant in this situation is $k = 465.5\dfrac{\text{Newtons}}{\text{meter}}$. Find the **circular** frequency of the vibrations of this molecule. Note: Because the two masses move together rather than one mass moving while the other end of the spring stays fixed (as in our usual setup) you must use the "reduced mass" for this system. This is $\mu = \dfrac{m_1 m_2}{m_1 + m_2}$ where the masses are those of the carbon and oxygen atoms, respectively. Just use μ anywhere you would normally use *m* in this calculation.



9. A 2 kg mass rests on a frictionless, horizontal surface. It is attached to a spring connected to a wall, as shown above. It is pulled 11 cm from its equilibrium position before being released. The spring constant is $k = 15\dfrac{\text{Newtons}}{\text{meter}}$. What is the speed of the mass as it passes through the equilibrium position?

10. Consider the previous problem. If there were a coefficient of sliding friction between the surface and the mass, μ_k, what value would this coefficient need to have for the mass to come to a complete stop upon reaching its equilibrium position after being released?



11. One end of a spring is attached to the floor. The spring constant of it is $k = 23\dfrac{\text{Newtons}}{\text{meter}}$. A ball with a mass of 210 gram rests on the spring in its equilibrium position, as shown in the picture above. (The ball simply rests on the spring. They are not attached.) The spring is compressed from its equilibrium position by ½ meter and then released. How high does the ball fly?