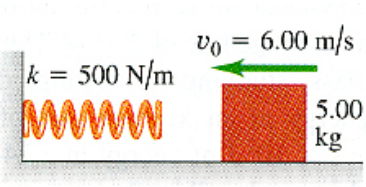
AP Physics Whiteboards

Work and Energy

1. A 5.00 kg block is moving at an initial velocity of 6.00 m/s along a frictionless, horizontal surface toward a spring with a spring constant of k = 500 N/m that is attached to a wall. The spring has negligible mass.

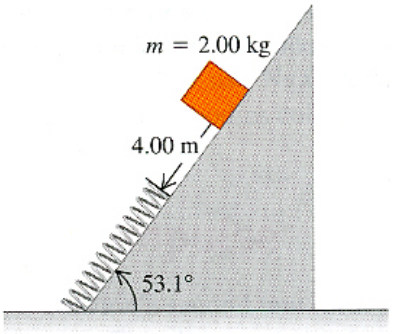


   A. Find the maximum distance the spring will be compressed.
   B. If the spring is to compress no more than 0.150 m, what should be the maximum value of the initial velocity?

2. The human heart is a powerful and extremely reliable pump. Each day it takes in and discharges about 7500 L of blood. Assume that the work done by the heart is equal to the work required to lift this amount of blood a height equal to that of the average American woman (1.63 m). The density of blood is 1.05 x 10^3 kg/m^3.
   A. How much work does the heart do in a day?
   B. What is the heart's power output in watts?

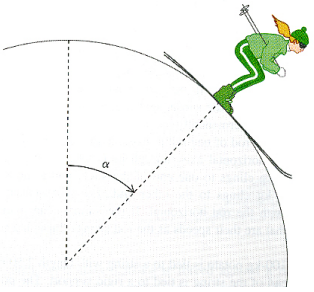
3. All birds, independent of their size, must maintain a power output of 10 to 25 watts per kilogram of body mass in order to fly by flapping their wings. The Andean giant hummingbird (not an unladen swallow) has a mass of 70 g and flaps its wings ten times per second while hovering.
   A. Estimate the amount of work done by the hummingbird in each wing beat.
   B. A 70 kg athlete can maintain a power output of 1.4 kW for no more than a few seconds. The steady power output of a typical athlete is only 500 W or so. Is it possible for a human-powered aircraft to fly for extended periods by flapping its wings? Explain.

4. A 2.00 kg package is released on a 53.1° incline, 4.00 m from a long spring with a spring constant of 120 N/m that is attached to be bottom of the incline. The coefficients of friction between that package are μ_s = 0.40 and μ_k = 0.20. The mass of the spring is negligible.



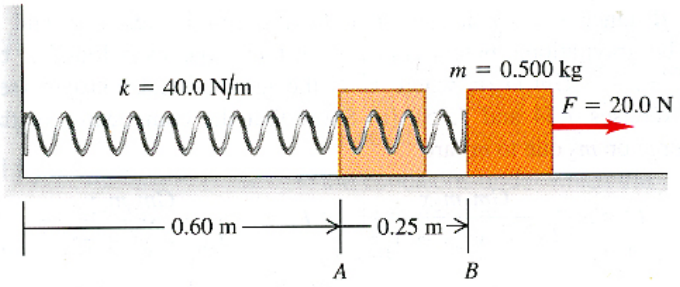
   A. What is the speed of the package just before it reaches the spring?
   B. What is the maximum compression of the spring?

5. A skier starts at the top of a very large, frictionless snowball, with a very small initial speed, and skis straight down the side. At what point does she lose contact with the snowball and fly off at a tangent? That is, at the instant she loses contact with the snowball, what angle α does a radial line from the center of the snowball to skier make with the vertical?



6. A particle of mass m is acted on by a conservative force and moves along a path given by [ ] and [ ] where x_0, y_0, and ω_0 are constants.
   A. Find the components of the force that act on the particle.
   B. Find the potential energy of the particle as a function of x and y.
   C. Find the total energy of the particle when $x = x_0$, $y = 0$

7. A 0.500 kg block, attached to a spring with length 0.60 m and spring constant of 40.0 N/m, is at rest with the back of the block at point A on a frictionless, horizontal table. The mass of the spring is negligible. You move the block to the right along the surface by pulling with a constant 20.0 N horizontal force.
   A. What is the block's speed when the back of the block reaches point B, which is 0.25 m to the right of point A?
   B. When the back of the block reaches point B, you let go of the block. In the subsequent motion, how close does the block get to the wall where the left end of the spring is attached?



8. A 3.00 kg block is connected to two ideal horizontal springs having spring constants $k_1 = 2500.0$ N/m and $k_2 = 2000.0$ N/m. The system is initially in equilibrium on a horizontal, frictionless table. The block is now pushed 0.15 m to the right and released from rest.
   A. What is the maximum speed of the block? Where in its motion does it occur?
   B. What is the maximum compression of spring 1?