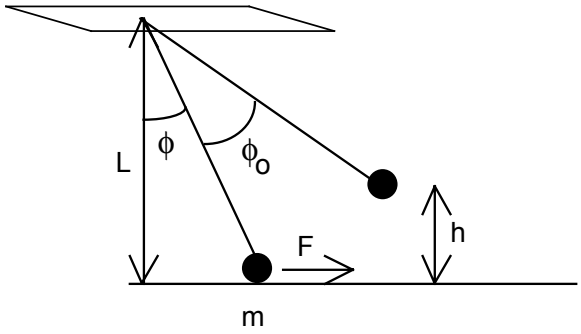
PHY 140Y – FOUNDATIONS OF PHYSICS
2001-2002
Tutorial Questions #7
October 29/30

Note: As requested, answers are given in brackets. Try getting full solutions before the tutorials!

Work, Energy, and Power

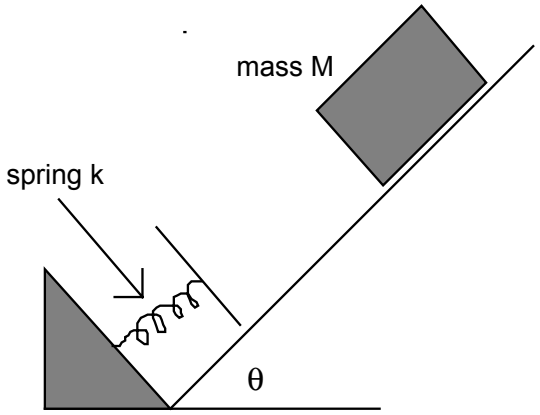
1. A particle of mass m is suspended from a massless string of length L. The particle is displaced along a circular path of radius L from $\phi=0$ to $\phi=\phi_o$, as shown below, by applying a force $\vec{F}$ that is always horizontal (for example by pulling horizontally with another string attached to the particle). The particle is thus displaced a vertical distance h. Assume that there is no acceleration, so that the motion is very slow.
   (a) What is the magnitude F? [mg tan ϕ]
   (b) What is the work done by the applied force as the mass moves from $\phi=0$ to $\phi=\phi_o$? [mgh]
   (c) What is the work done by the applied force as the mass moves from $\phi=0$ to $\phi=\phi_o$ if $\vec{F}$ is always directed along the arc rather than horizontally? [mgh]



2. By measuring oxygen uptake, sports physiologists have found that the power output of long-distance runners is given approximately by P = m(bv-c), where m and v are the runner's mass and speed, respectively, and b and c are constants given by b = 4.27 J kg^{-1} m^{-1} and c = 1.83 W kg^{-1}.
   (a) Determine the average power output and work done by a 65-kg runner who runs a 10-km race at a speed of 5.2 m/s. [1.3 kW, 2.5 MJ]
   (b) If the same runner starts at speed v_o = 4.8 m/s and accelerates to 6.1 m/s over a 25-s interval, what is the runner's power output as a function of time? [m{b(v_o+at)-c}]
   (c) How much work does the runner do during the acceleration period in part (b)? [35 kJ]

Conservation of Energy

3. A block of mass M is released from rest near the top of a frictionless incline, as shown below. The angle of the incline is θ. The block comes to rest momentarily after it has compressed a spring by a distance L. The spring constant is k.
(a) How far has the block moved down the incline when the spring is compressed by distance L? [eqn…]
(b) What is the speed of the block just as it touches the spring? [eqn…]
(c) What is the distance along the incline between the point of first contact and the point where the block's speed is the greatest? [(mg/k)sin θ]



4. A block slides along a track from one level to a higher level by moving through an intermediate valley. The track is frictionless until the block reaches the higher level. At the higher level a friction force stops the block in a distance d. If the block's initial speed is V_o, the height difference is h, and the coefficient of kinetic friction is μ_k, what is d? [eqn…]