UNIVERSITY OF OTTAWA
Principles of Physics
PHY1321/1331 FALL 2011
Dr. A. Czajkowski

CLASS:	PHY_____
STUDENT #:	________________
NAME:	____________________

Assignment 5: Work and Energy

Assigned: Oct 7 14:30 Due: Oct14 18:00

1. When a 4.00-kg object is hung vertically on a certain light spring that obeys Hooke's law, the spring stretches 2.50 cm. If the 4.00-kg object is removed, (a) how far will the spring stretch if a 1.50-kg block is hung on it, and (b) how much work must an external agent do to stretch the same spring 4.00 cm from its unstretched position?

$$kx - mg = 0$$

$$k = \frac{mg}{x} = \frac{4(9.8)N}{0.025\ m} = 784\ \frac{N}{m}$$

$$kx = Mg$$

$$x = \frac{(1.5)(9.8)}{784} = 0.01875m = 1.88cm$$

$$W = \frac{1}{2}kx^2 = (0.5)784(0.04)^2 = 0.627W$$

2 If it takes 4.00 J of work to stretch a Hooke's-law spring 10.0 cm from its unstressed length, determine the extra work required to stretch it an additional 10.0 cm.

$$W = \frac{1}{2}kx^2 \Rightarrow k = \frac{2W}{x^2} = 800\ \frac{N}{m}$$

so to stretch by 0.2m one needs

$$W = \frac{1}{2}800\,(0.2)^2 = 16\,W$$

ANS one needs extra 12 W to stretch by additional 10cm

3. A 100-g bullet is fired from a rifle having a barrel 0.600 m long. Assuming the origin is placed where the bullet begins to move, the force (in newtons) exerted by the expanding gas on the bullet is 15 000 + 10 000x – 25 000x^2, where x is in meters.
(a) Determine the work done by the gas on the bullet as the bullet travels the length of the barrel.
(b) **What if?** If the barrel is 1.00 m long, how much work is done, and how does this value compare to the work calculated in (a)
NOTE: this problem requires integration

$$W = \int_0^{0.6}(15000 + 10000\,x - 25000\,x^2)dx = \left[15000\,x + 5000\,x^2 - \frac{25000}{3}x^3\right]_0^{0.6} = 9000\,W$$

$$W = \int_0^{1.0}(15000 + 10000\,x - 25000\,x^2)dx = \left[15000\,x + 5000\,x^2 - \frac{25000}{3}x^3\right]_0^{1.0} = 11{,}667\,W$$

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Assignment 5: Work and Energy Cont.

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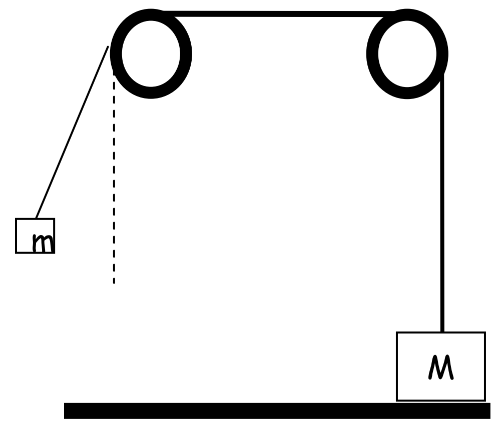
4 . The mass m =1 kg is set up as a pendulum of length 0.6m as shown on the diagram. Initially in the position of h = 0.2m above the lowest point, and the pendulum is given initial speed of 1m/s. What is the largest mass M that could be temporarily lifted in such setup?



This problem is very similar to the one we discussed in class already
The only difference is the presence of initial velocity.
We may find what is the extra energy associated with the kinetic energy and find what extra height it would correspond to.

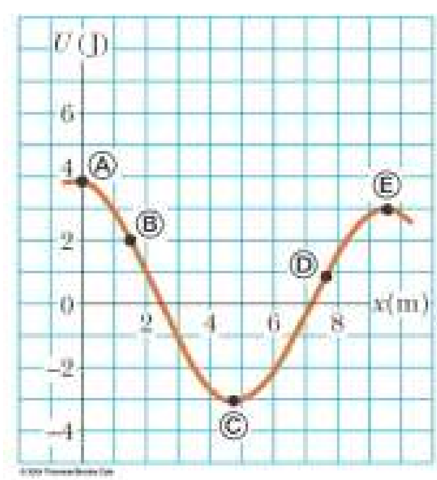
$$\frac{mv^2}{2} = mgh' \Rightarrow h' = \frac{v^2}{2g} = \frac{1}{2 \cdot 9.8} = 0.051\ m$$

So the extra initial velocity has the same effect as adding 5.1cm to original height above the lowest point. If we use the result of the analysis completed during the lecture we will get:

$$\frac{M}{m} = 1 + 2\frac{h}{L} \Rightarrow \frac{M}{m} = 1 + 2\frac{0.251}{0.6} = 1.837$$

$$M = 1.837\ kg$$

5 For the potential energy curve shown in Figure P8.45, (a) determine whether the force F_x is positive, negative, or zero at the five points indicated. (b) Indicate points of stable, unstable, and neutral equilibrium. (c) Sketch the curve for F_x versus x from $x = 0$ to $x = 9.5$ m.



P8.45 (a) F_x is zero at points A, C and E; F_x is positive at point B and negative at point D.

(b) A and E are unstable, and C is stable.