Physics 9B Fall 2013 - Discussion #1

1. The initial position, velocity, and acceleration of an object moving in simple harmonic motion are x_0, v_0, and a_0; the angular frequency of oscillation is ω.

   (a) Show that the position and velocity of the object for all time can be written as

   $$x(t) = x_0 \cos \omega t + \left(\frac{v_0}{\omega}\right) \sin \omega t, \quad v(t) = -x_0 \omega \sin \omega t + v_0 \cos \omega t.$$

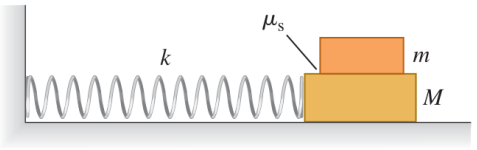
   (b) Using A to represent the amplitude of the motion, show that $v^2 - ax = v_0^2 - a_0 x_0 = \omega^2 A^2$.

2. A block with mass M rests on a frictionless surface and is connected to a horizontal spring of force constant k. The other end of the spring is attached to a wall. A second block with mass m rests on top of the first block. The coefficient of static friction between the blocks is μ_s.

   (a) Draw a free-body-diagram for each block.

   (b) Write down Newton's 2nd Law for each block (don't forget all action-reaction pairs, and remember how friction relates to normal forces).

   (c) Find the *maximum* amplitude of oscillation such that the top block will not slip on the bottom block.



3. An object of mass m moves in simple harmonic motion with amplitude $A = 12.0$ cm on a light spring. Its maximum acceleration is $a_{\max} = 108$ cm/s^2. Regard m as a variable.

   (a) Find the period T of the object. (b) Find its frequency f. (c) Find the maximum speed $v_{\max}$ of the object. (d) Find the total energy E of the object-spring system. (e) Find the force constant k of the spring. (f) Describe the pattern of dependence of each of the quantities T, f, $v_{\max}$, E, and k on m.

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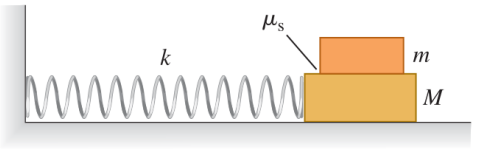

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