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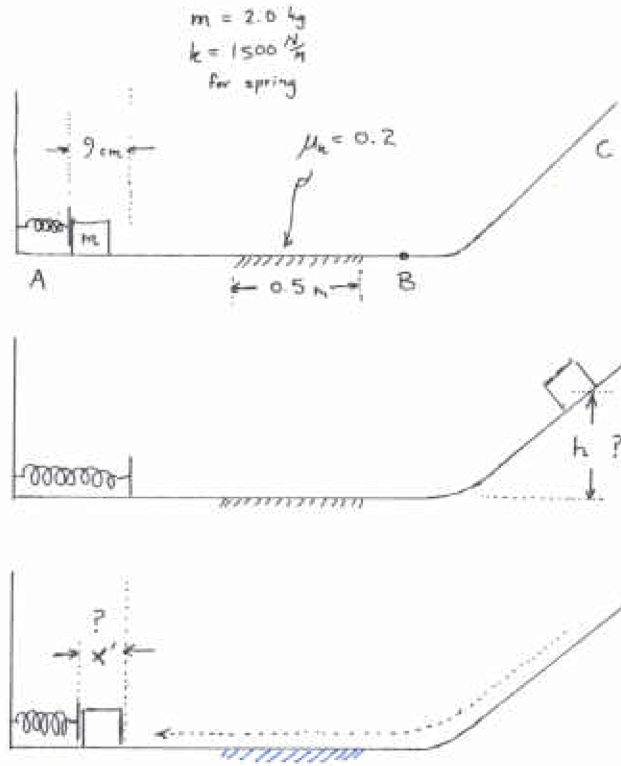
Phys 221 (Section 8)
Quiz #3



1. A 2.0-kg block is pushed against a spring of force constant $k = 1500\frac{\text{N}}{\text{m}}$ at point A on the track ABC shown here, which is frictionless except for a section of length 0.5 m which has coefficient of kinetic friction $\mu_k = 0.2$ on the level part of it. The spring is compressed by $x = 9.0$ cm; the mass is then released, starting from rest.

a) What is the speed of the mass when it gets to point B (just past the rough section)?

When the mass is at its initial position, the energy of the system is $E_A = \frac{1}{2}kx^2 = \frac{1}{2}(1500\frac{N}{m})(.09m)^2 = 6.075\ J$

The change in energy in passing to B comes from friction,

$\Delta E = W_{fric} = -\mu mg d = -(0.2)(2.0\ kg)(9.8\frac{m}{s^2})(0.5m) = -1.96\ J$

So $E_B = E_A + \Delta E = 4.115\ J$. But $E_B = \frac{1}{2}mv_B^2$. Solving for v_B gives $v_B = 2.03\ \frac{m}{s}$

b) When the mass comes to rest *momentarily* on the sloped portion of the track (at point C) what is its vertical height?

No mechanical energy is lost or gained as the mass travels up the slope to the position of maximum height (where its speed is zero). So at that point,

$E = 4.115\ J = mgh$

Solving for h gives $h = 0.2099\ m = 21.0\ cm$

c) The mass then slides back down, over the rough part and compresses the spring. As the mass momentarily comes to rest against the spring, what is the new distance by which it is compressed?

As the mass slides over the rough part of the track the mechanical energy again changes by $\Delta E = -1.96\ J$ (same work done by friction). This gives $E_{final} = 4.115\ J - 1.96\ J = 2.155\ J$.
At the position where the spring is maximally compressed, the energy is the potential energy of the spring.
So $2.155\ J = \frac{1}{2}kx'^2$ Solving for x' gives $x' = 5.36\times10^{-2}\ m = 5.36\ cm$

2. A 0.4–kg ball with a velocity of $(3\hat{\imath} - 7\hat{\jmath})\frac{\text{m}}{\text{s}}$ collides with the floor and rebounds with a velocity of $(2\hat{\imath} + 6\hat{\jmath})\frac{\text{m}}{\text{s}}$. The ball was in contact with the floor for 7.0×10^{-3} s Find the change in momentum and the average force exerted by the floor during the time of contact.

$\Delta\vec{p} = m\vec{v}_2 - m\vec{v}_1 = m(\Delta\vec{v}) = (0.4\ kg)(-\hat{\imath} + 13\hat{\jmath})\frac{m}{s} = \left[(-0.4)\hat{\imath} + (5.2)\hat{\jmath}\right]\frac{kg\cdot m}{s}$

The average force (also a vector!) is:

$\vec{F} = \frac{\Delta\vec{p}}{\Delta t} = \frac{[(-0.4\hat{\imath}) + (5.2\hat{\jmath})]\frac{kg\cdot m}{s}}{(7.0\times10^{-3}\ s)} = (-57.1\hat{\imath} + 743\hat{\jmath})\ N$

$$\Delta E = \Delta K + \Delta U = W_{\text{nc}} \qquad U_{\text{spr}} = \tfrac{1}{2}kx^2 \qquad U_{\text{grav}} = mgy$$

$$\mathbf{p} = m\mathbf{v} \qquad \mathbf{F} = \frac{d\mathbf{p}}{dt}$$