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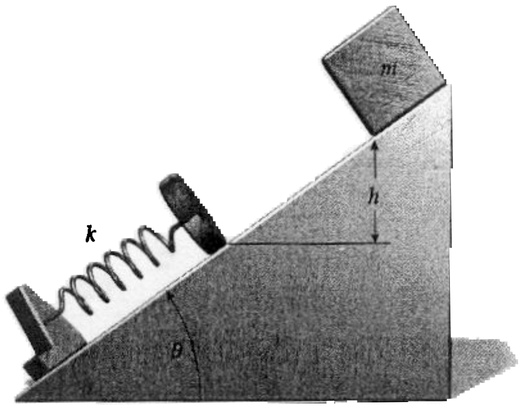
Ch-7

October 27, 2006
Physics 171 Exam 2:

Name: Solution

1.- A block of mass *m* starts from rest at height *h* and slides down a frictionless plane inclined at θ with the horizontal as shown in the figure. The block strikes a spring of force constant *k*. Find the compression of the spring when the block is momentarily at rest.



L distance before it strikes

at maximum compression. $U_g = 0$ x.

$= 0 \qquad h_1 = (L + x) \sin\theta$

$$mgh_1 = \frac{1}{2} k x^2$$

$$mg(L+x)\sin\theta = \frac{1}{2} k x^2$$

$$x^2 - 2\frac{mg\sin\theta}{k} x - \frac{2mgL\sin\theta}{k} = 0$$

$$x = \frac{mg}{k}\sin\theta \pm \sqrt{\left(\frac{mg}{k}\right)^2 \sin^2\theta + \frac{2mgL}{k}\sin\theta}$$

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2.- A bock of mass m is attached to a string and suspended inside a hollow box of mass M. The box rests on a scale that measures the weight of the system.

a) Assume that the string breaks and the mass m falls with constant acceleration g. Find the acceleration of the center of mass of the box-block system, giving both direction and magnitude.

b) Determine the reading on the scale while m is in free fall.

$$\vec{a}_{cm} = \frac{F_{net\ ext}}{m_{Tot}} = \frac{-mg}{M+m}\hat{j}$$

c)

$$F_{net\ ext} = (M+m)g - (M+m)a_{cM}$$

$$= (M+m)g - \frac{(M+m)}{(M+m)}mg$$

$$= Mg$$

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3.- Object A with mass *m* and velocity $v_o\hat{i}$ collides head-on with object B of mass *2m* and velocity 0.5 $v_o\hat{j}$. Following the collision, object B has a velocity of 0.25 $v_o\hat{i}$.

a) Determine the velocity of object A after the collision.

b) Is the collision elastic? If not, express the change in kinetic energy in terms of *m* and v_o.

a) $\vec{P}_i = \vec{P}_f$

$m v_0 \hat{i} + 2m \frac{1}{2} v_0 \hat{j} = 2m \frac{1}{4} v_0 \hat{i} + m \vec{V}_{1f}$

$v_0 \hat{i} - \frac{1}{2} v_0 \hat{i} + v_0 \hat{j} = \vec{v}_f$

$\boxed{\frac{v_0}{2} \hat{i} + v_0 \hat{j} = \vec{v}_f}$

$|v| = \sqrt{v_0^2 + \frac{1}{4} v_0^2} = \frac{\sqrt{5}}{2}$

b) $\Delta E = K_i - K_f$

$K_i = \frac{m v_0^2}{2} + \frac{2m}{2}\left(\frac{1}{4} v_0\right)^2 = \frac{3}{4} m v_0^2$

$K_f = \frac{2m}{2}\left(\frac{v_0^2}{16}\right) + \frac{m}{2} \frac{5}{4} v_0^2$

$2m \frac{v_0^2}{16} + m \frac{20}{16} v_0^2$

$\frac{2}{16} + \frac{20}{16} = \frac{11}{16}$

$\frac{8}{16} + \frac{8}{16}$

$K_i \frac{12}{16}$

$K_f \frac{1}{2}\left(\frac{1}{8} + \frac{5}{4}\right) = \frac{11}{16}$

$\boxed{\Delta K = \frac{1}{16} m v_0^2}$