Stuff that may help!

Name________________________________

$$\Delta x = \left[\frac{v_{x_0} + v_x}{2}\right]t$$

$$\Delta x = v_{x_0}\Delta t + \tfrac{1}{2}a_x t^2$$

$$v_x = v_{x_0} + a_x t$$

$$v_x^2 = v_{x_0}^2 + 2a_x\Delta x$$

$$\sum \vec{F} = m\vec{a}$$

$$\vec{v}_{ave} = \frac{\Delta\vec{r}}{\Delta t}$$

$$\vec{a}_{ave} = \frac{\Delta\vec{v}}{\Delta t}$$

$$W = Fd\cos\theta$$

$$W = \Delta KE$$

$$KE = \tfrac{1}{2}mv^2$$

$$PE_g = mgh$$

$$PE_s = \tfrac{1}{2}kx^2$$

$$\Delta KE + \Delta PE = W_f$$

$$\sin\theta = \frac{A_y}{|\vec{A}|}$$

$$\cos\theta = \frac{A_x}{|\vec{A}|}$$

$$\tan\theta = \frac{A_y}{A_x}$$

$$F_k = \mu_k N$$

$$F_s \le \mu_s N$$

$$\Delta y = \left[\frac{v_{y_0} + v_y}{2}\right]t$$

$$\Delta y = v_{y_0}t + \tfrac{1}{2}a_y t^2$$

$$v_y = v_{y_0} + a_y t$$

$$v_y^2 = v_{y_0}^2 + 2a_y\Delta y$$

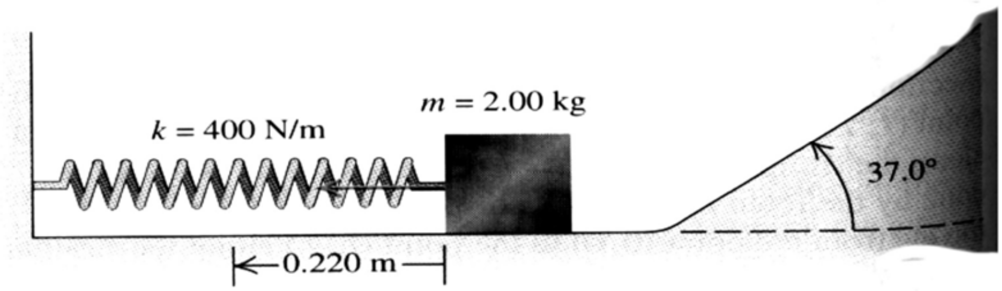
$$g = 9.8m/s^2$$

$$|\vec{A}| = \sqrt{A_x^2 + A_y^2}$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

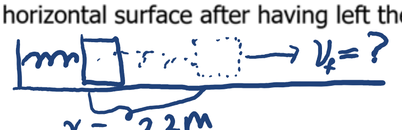
Physics I
TEST 3 Review

Show all work in the spaces provided. Unless otherwise directed you must use energy considerations.



1) A 2.00 kg block is pushed against a spring with negligible mass and force constant ~~a)~~ k=400 N/m, compressing it 0.220 m. When the block is released, it moves along a frictionless, horizontal surface and then up a frictionless incline with slope 37.0°.

b) What is the speed of the block as it slides along the horizontal surface after having left the spring? (5 pts)



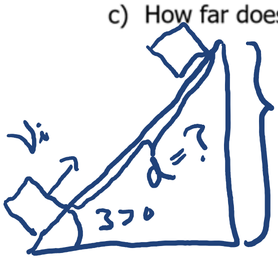
$$\Delta KE + \Delta PE = 0$$

$$KE_f - KE_i^{\to 0} + PE_f^{\to 0} - PE_i = 0$$

$$\tfrac{1}{2} m v_f^2 - \tfrac{1}{2} k x^2 = 0$$

$$v_f = \sqrt{\frac{k x^2}{m}} = x\sqrt{\frac{k}{m}} = (.22m)\sqrt{\frac{400 N/m}{2 kg}} = 3.11 m/s \leftarrow$$

c) How far does the block travel up the incline before starting to slide back down? (5 pts)



$$\Delta KE + \Delta PE = 0$$

$$KE_f^{\to 0} - KE_i + PE_f - PE_i^{\to 0} = 0$$

$$-\tfrac{1}{2} m v_i^2 + m g h = 0$$

$$h = \frac{v_i^2}{2g}$$

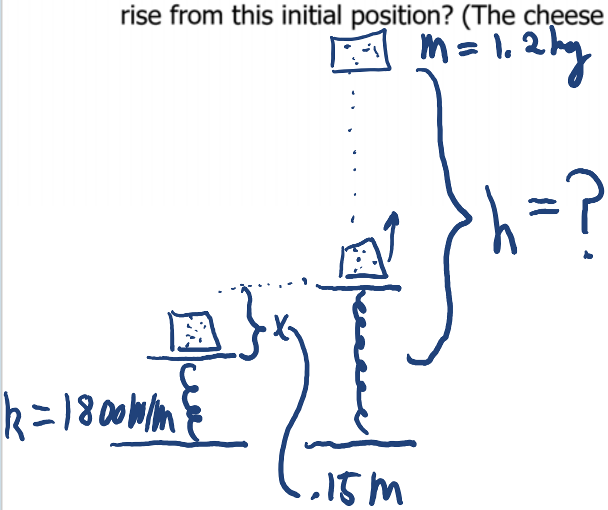
$$h = \frac{(3.11 m/s)^2}{2(9.8 m/s^2)} = 0.49 m$$

$$\sin\theta = \frac{h}{d}$$

$$d = \frac{h}{\sin\theta} = \frac{0.49m}{\sin(37°)} = .81 m$$

$$d = \frac{h}{\sin\theta} = \frac{0.49m}{\sin(37^\circ)} = .81m$$

2) A 1.20 kg piece of cheese is placed on a vertical spring of negligible mass and force constant k=1800 N/m that is compressed 15.0 cm. When the spring is released, how high does the cheese rise from this initial position? (The cheese and the spring are not attached.) (5 pts)



$$\cancel{\Delta KE}^{\to 0} + \Delta PE = 0$$

$$\Delta PE_g + \Delta PE_s = 0$$

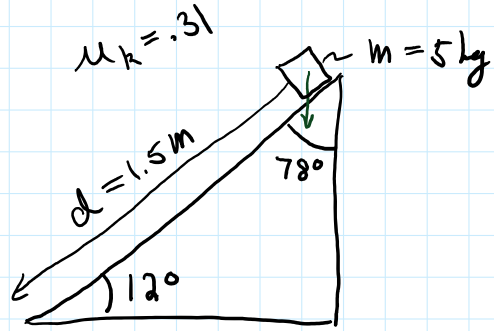
$$PE_{g_f} - \cancel{PE_{g_i}}^{\to 0} + \cancel{PE_{s_f}}^{\to 0} - PE_{s_i} = 0$$

$$mgh - \frac{1}{2}kx^2 = 0$$

$$h = \frac{kx^2}{2mg}$$

$$h = \frac{(1800\,N/m)(.15\,m)^2}{2(1.2\,kg)(9.8\,m/s^2)}$$

$$h = 1.72\,m$$



3) A 5.00 kg package slides 1.50 m down a long ramp that is inclined at 12.0° below the horizontal. The coefficient of kinetic friction between the package and the ramp is μ_k=0.310. Calculate:

a) the work done on the package by friction. (5 pts)

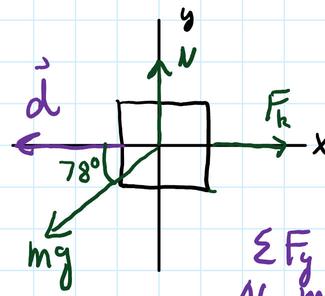
$W_F = Fd\cos\theta$

$W_F = F_k d \cos(180°)$ (cos(180°) → −1)

$W_F = -\mu_k N d$

$W_F = -\mu_k mg\sin(78°)d = -(.31)(5\,kg)(9.8\,m/s^2)\sin(78°)(1.5\,m)$

$W_F = -22.29\,J$



$\Sigma F_y = 0$

$N - mg\sin(78°) = 0$

$N = mg\sin(78°)$

b) the work done on the package by gravity. (5 pts)

$W_g = Fd\cos\theta$

$W_g = mgd\cos(78°)$

$W_g = (5\,kg)(9.8\,m/s^2)(1.5\,m)\cos(78°)$

$W_g = 15.28\,J$

c) the work done on the package by the normal force (5 pts)

$W_N = Fd\cos\theta$

$\theta = 90°$

$W_N = 0$

d) the total work done on the package. (5 pts)

$$W_{tot} = W_F + W_g + W_N$$

$$W_{tot} = -22.29J + 15.28J + 0$$

$$W_{tot} = -7.01J$$

e) If the package has a speed of 2.20 m/s at the top of the ramp, what is its speed after sliding 1.50 m down the ramp? (5 pts)

$$W = \Delta KE$$

$$W = KE_f - KE_i$$

$$W = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$$

$$W = \frac{1}{2} m (v_f^2 - v_i^2)$$

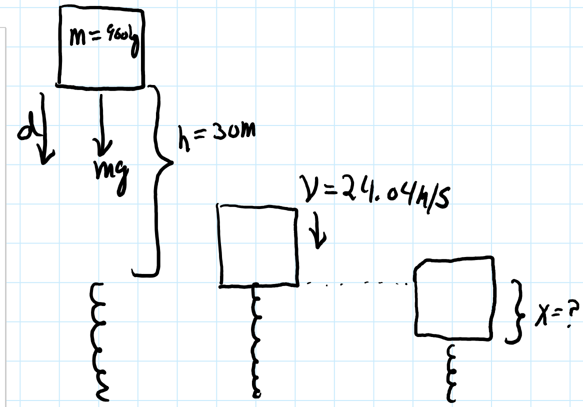
$$\frac{2W}{m} = v_f^2 - v_i^2$$

$$v_f = \sqrt{v_i^2 + \frac{2W}{m}}$$

$$v_f = \sqrt{(2.2 m/s)^2 + \frac{2(-7.01J)}{5 kg}}$$

$$v_f = \sqrt{2.036 m^2/s^2}$$

$v_f = 1.43\ m/s$



4) An elevator cable breaks when a 900 kg elevator is 30 m above a huge spring ($k=4.0\times10^5$ N/m) at the bottom of the shaft.

a) Calculate the work done by gravity on the elevator before it hits the spring. (5 pts)

$$W = Fd\cos\theta$$
$$W = mgd\cos(0)$$
$$W = (900kg)(9.8m/s^2)(30m)$$
$$W = 2.6\times10^5 J$$

b) What is the speed of the elevator just before it hits the spring? (5 pts)

$$W = \Delta KE \quad \text{or } \Delta KE + \Delta PE = 0$$
$$W = KE_f - KE_i$$
$$W = \tfrac{1}{2}mv_f^2$$
$$v_f = \sqrt{\frac{2W}{m}}$$
$$v_f = \sqrt{\frac{2(2.6\times10^5 J)}{900kg}} = 24.04 m/s$$

c) By what amount is the spring compressed? (Note that the work is being done by both the spring and gravity in this part.) (5 pts)

$$\Delta KE + \Delta PE = 0$$
$$\Delta KE + \Delta PE_s + \Delta PE_g = 0$$
$$KE_f - KE_i + PE_{s_f} - PE_{s_i} + PE_{g_f} - PE_{g_i} = 0$$
$$-\tfrac{1}{2}mv_i^2 + \tfrac{1}{2}kx^2 - mgx = 0$$

$$\tfrac{1}{2}kx^2 - mgx - \tfrac{1}{2}mv_i^2 = 0$$
$$x^2 - \frac{2mg}{k}x - \frac{m}{k}v_i^2 = 0$$
$$x^2 - \frac{2(900kg)(9.8m/s^2)}{4\times10^5 N/m}x - \frac{900kg}{4\times10^5 N/m}(24.04m/s)^2 = 0$$
$$x^2 - [.0441m]x - 1.3\ m^2 = 0$$
$$x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$$
$$x = \frac{-(-.0441m) \pm \sqrt{(-.0441m)^2 - 4(1)(-1.3m^2)}}{2}$$
$$x = \frac{.0441m \pm 2.28m}{2} = \frac{.0441m + 2.28m}{2} \text{ or } \frac{.0441m - 2.28m}{2}$$

$$\boxed{x = 1.16m \text{ or } -~~1.12~~m}$$