Name____
Physics 110 Quiz #4, May 3, 2013
Please show all work, thoughts and/or reasoning in order to receive partial credit. The quiz is worth 10 points total.

I affirm that I have carried out my academic endeavors with full academic honesty.

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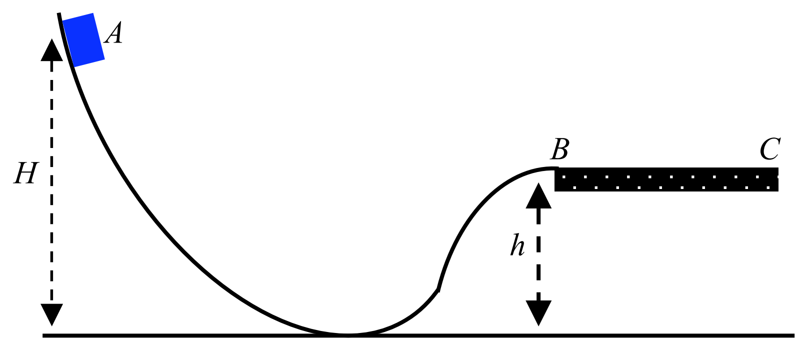
A small mass m slides down a frictionless ramp starting from rest at a point A which is located a height H above the ground as shown below. When the mass reaches point B, located a height h above the ground, it enters a region (between points B and C) where the coefficient of friction is $\mu_k = 0.5$.



1. Using energy methods, what is the speed of the block at point B?

$$\Delta E = 0 = \Delta KE + \Delta U_g + \Delta U_s = \left(\tfrac{1}{2}mv_B^2 - 0\right) + \left(mgy_B - mgy_A\right)$$
$$v_B = \sqrt{2g\left(y_A - y_B\right)} = \sqrt{2g\left(H - h\right)}$$

2. When the block enters the region between points B and C, friction brings the block to rest. How much work did the frictional force do bringing the block to rest?

$$W_{fr} = \Delta KE = \left(0 - \tfrac{1}{2}mv_B^2\right) = -\tfrac{1}{2}mv_B^2 = -mg\left(H - h\right)$$

3. What is the distance traveled by the block between points B (where the block enters the region of friction) and C (where it comes to rest due to friction)?

$$W_{fr} = \left|F_{fr}\right| \times \left|\Delta x\right| \times \cos\theta = -F_{fr}x = \Delta KE = -mg\left(H - h\right)$$
$$x = \frac{mg\left(H - h\right)}{F_{fr}} = \frac{mg\left(H - h\right)}{\mu_k mg} = \frac{\left(H - h\right)}{\mu_k}$$

4. Suppose instead that at point A, the block were given an initial speed of v_A *vertically downward*. What is the change in distance traveled by the block between points B and C?

$$\Delta E = 0 = \Delta KE + \Delta U_g + \Delta U_s = \left(\tfrac{1}{2}mv_B^2 - \tfrac{1}{2}mv_A^2\right) + \left(mgy_B - mgy_A\right)$$

$$v_B = \sqrt{v_A^2 + 2g\left(y_A - y_B\right)} = \sqrt{v_A^2 + 2g\left(H - h\right)}$$

$$W_{fr} = \Delta KE = \left(0 - \tfrac{1}{2}mv_B^2\right) = -\tfrac{1}{2}mv_B^2 = -\left(\tfrac{1}{2}mv_A^2 + mg\left(H - h\right)\right)$$

$$W_{fr} = \left|F_{fr}\right| \times \left|\Delta x\right| \times \cos\theta = -F_{fr}x = \Delta KE = -\left(\tfrac{1}{2}mv_A^2 + mg\left(H - h\right)\right)$$

$$x_{new} = \frac{\tfrac{1}{2}mv_A^2 + mg\left(H - h\right)}{F_{fr}} = \frac{\tfrac{1}{2}mv_A^2 + mg\left(H - h\right)}{\mu_k mg} = \frac{\tfrac{1}{2}v_A^2 + g\left(H - h\right)}{\mu_k g}$$

$$\Delta x = x_{new} - x_{old} = \frac{\tfrac{1}{2}v_A^2 + g\left(H - h\right)}{\mu_k g} - \frac{g\left(H - h\right)}{\mu_k g} = \frac{v_A^2}{2\mu_k g}$$

5. Suppose instead that at point A, the block were given an initial speed this time that was v_A *vertically upward*. Compared to the change in distance traveled by the block between points B and C when its initial velocity was *vertically downward* (call this distance $\Delta x_{v_A,down}$) the distance traveled when its initial velocity is directed *vertically upward* (call this distance $\Delta x_{v_A,up}$) follows the relation

   a. $\Delta x_{v_A,up} > \Delta x_{v_A,down}$.
   b. $\Delta x_{v_A,up} = \Delta x_{v_A,down}$. (See problem 4 above)
   c. $\Delta x_{v_A,up} < \Delta x_{v_A,down}$.
   d. There is not enough information given in order to solve this problem

Useful formulas:

Motion in the r = x, y or z-directions

$r_f = r_0 + v_{0r}t + \frac{1}{2}a_r t^2$

$v_{fr} = v_{0r} + a_r t$

$v_{fr}^2 = v_{0r}^2 + 2a_r \Delta r$

Uniform Circular Motion

$a_r = \frac{v^2}{r}$

$F_r = ma_r = m\frac{v^2}{r}$

$v = \frac{2\pi r}{T}$

$F_G = G\frac{m_1 m_2}{r^2}$

Geometry /Algebra

Circles	*Triangles*	*Spheres*
$C = 2\pi r$	$A = \frac{1}{2}bh$	$A = 4\pi r^2$
$A = \pi r^2$		$V = \frac{4}{3}\pi r^3$

Quadratic equation : $ax^2 + bx + c = 0$,

whose solutions are given by : $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Vectors

$$\text{magnitude of a vector} = \sqrt{v_x^2 + v_y^2}$$

$$\text{direction of a vector} \rightarrow \phi = \tan^{-1}\left(\frac{v_y}{v_x}\right)$$

Useful Constants

$g = 9.8\,{}^{m}/_{s^2}$ $\quad G = 6.67\times10^{-11}\,{}^{Nm^2}/_{kg^2}$

$N_A = 6.02\times10^{23}\,{}^{atoms}/_{mole}$ $\quad k_B = 1.38\times10^{-23}\,{}^{J}/_{K}$

$\sigma = 5.67\times10^{-8}\,{}^{W}/_{m^2K^4}$ $\quad v_{sound} = 343\,{}^{m}/_{s}$

Linear Momentum/Forces

$\vec{p} = m\vec{v}$

$\vec{p}_f = \vec{p}_i + \vec{F}\Delta t$

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

$\vec{F}_s = -k\vec{x}$

$F_f = \mu F_N$

Work/Energy

$K_t = \frac{1}{2}mv^2$

$K_r = \frac{1}{2}I\omega^2$

$U_g = mgh$

$U_S = \frac{1}{2}kx^2$

$W_T = FdCos\theta = \Delta E_T$

$W_R = \tau\theta = \Delta E_R$

$W_{net} = W_R + W_T = \Delta E_R + \Delta E_T$

$\Delta E_R + \Delta E_T + \Delta U_g + \Delta U_S = 0$

$\Delta E_R + \Delta E_T + \Delta U_g + \Delta U_S = -\Delta E_{diss}$

Heat

$T_C = \frac{5}{9}\left[T_F - 32\right]$

$T_F = \frac{9}{5}T_C + 32$

$L_{new} = L_{old}(1 + \alpha\Delta T)$

$A_{new} = A_{old}(1 + 2\alpha\Delta T)$

$V_{new} = V_{old}(1 + \beta\Delta T) : \beta = 3\alpha$

$PV = Nk_B T$

$\frac{3}{2}k_B T = \frac{1}{2}mv^2$

$\Delta Q = mc\Delta T$

$P_C = \frac{\Delta Q}{\Delta t} = \frac{kA}{L}\Delta T$

$P_R = \frac{\Delta Q}{\Delta T} = \varepsilon\sigma A\Delta T^4$

$\Delta U = \Delta Q - \Delta W$

Rotational Motion

$\theta_f = \theta_i + \omega_i t + \frac{1}{2}\alpha t^2$

$\omega_f = \omega_i + \alpha t$

$\omega^2{}_f = \omega^2{}_i + 2\alpha\Delta\theta$

$\tau = I\alpha = rF$

$L = I\omega$

$L_f = L_i + \tau\Delta t$

$\Delta s = r\Delta\theta : \; v = r\omega : \; a_t = r\alpha$

Fluids

$\rho = \frac{M}{V}$

$P = \frac{F}{A}$

$P_d = P_0 + \rho g d$

$F_B = \rho g V$

$A_1 v_1 = A_2 v_2$

$\rho_1 A_1 v_1 = \rho_2 A_2 v_2$

$P_1 + \frac{1}{2}\rho v^2{}_1 + \rho g h_1 = P_2 + \frac{1}{2}\rho v^2{}_2 + \rho g h_2$

Simple Harmonic Motion/Waves

$\omega = 2\pi f = \frac{2\pi}{T}$

$T_S = 2\pi\sqrt{\frac{m}{k}}$

$T_P = 2\pi\sqrt{\frac{l}{g}}$

$v = \pm\sqrt{\frac{k}{m}}A\left(1 - \frac{x^2}{A^2}\right)^{\frac{1}{2}}$

$x(t) = A\sin\left(\frac{2\pi t}{T}\right)$

Sound

$$v = f\lambda = (331 + 0.6T)\,\tfrac{m}{s}$$

$$\beta = 10\log\frac{I}{I_0};\quad I_o = 1\times10^{-12}\,\tfrac{W}{m^2}$$

$$f_n = nf_1 = n\frac{v}{2L};\; f_n = nf_1 = n\frac{v}{4L}$$