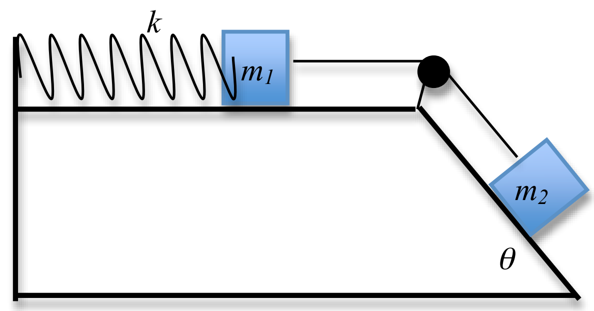
Name___________________________________
Physics 110 Quiz #4, April 30, 2010

Please show all work, thoughts and/or reasoning in order to receive partial credit. The quiz is worth 10 points total.

1. A mass m is dropped from rest from a height y acquiring a speed v_{max}. A second identical mass is dropped from rest at a height $y/4$ acquiring a speed v. Of the following, which is true?

   (a.) $v = \frac{v_{\max}}{2}$ b. $v = \frac{v_{\max}}{\sqrt{2}}$ c. $KE = \frac{KE_{\max}}{16}$ d. $v = 2v_{\max}$

2. Suppose that you are given the system of masses shown on the right in which $m_1 = 1kg$, $m_2 = 3kg$, $\theta = 42^o$, $\mu_k = 0.35$ and $k = 40\ N/m$.



a. Using energy ideas, what is the maximum extension of the spring if the surfaces are considered ***frictionless*** and the blocks are released from rest?

$$\Delta U_{g_1} + \Delta U_{g2} + \Delta U_S + \Delta KE_1 + \Delta KE_2 = \Delta E_{Total} = 0$$
$$0 + (m_2 g y_f - m_2 g y_i) + (\tfrac{1}{2} k x_{\max}^2 - 0) + 0 + 0 = 0$$
$$-m_2 g x_{\max} \sin\theta + \tfrac{1}{2} k x_{\max}^2 = 0$$
$$x_{\max} = \frac{2m_2 g \sin\theta}{k} = \frac{2 \times 3kg \times 9.8 \frac{m}{s^2} \sin 42}{40 \frac{N}{m}} = 0.98m$$

b. Using energy ideas, what is the maximum extension of the spring if the surfaces are now considered ***to not be frictionless*** and the blocks are released from rest?

$$\Delta U_{g_1} + \Delta U_{g2} + \Delta U_S + \Delta KE_1 + \Delta KE_2 = \Delta E_{Total} = -F_{fr_1} x'_{\max} - F_{fr_2} x'_{\max}$$
$$(m_2 g y_f - m_2 g y_i) + (\tfrac{1}{2} k (x'_{\max})^2 - 0) = -\mu_K m_1 g x'_{\max} - \mu_K m_2 g \cos\theta x'_{\max}$$
$$-m_2 g x'_{\max} \sin\theta + \tfrac{1}{2} k (x'_{\max})^2 = -\mu_K m_1 g x'_{\max} - \mu_K m_2 g \cos\theta x'_{\max}$$
$$x'_{\max} = \frac{2m_2 g \sin\theta}{k} - \frac{2\mu_K g}{k}(m_1 + m_2 \cos\theta) = 0.54m$$

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 $C = 2\pi r$, $A = \pi r^2$

Triangles $A = \frac{1}{2}bh$

Spheres $A = 4\pi r^2$, $V = \frac{4}{3}\pi r^3$

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

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

Vectors

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

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

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

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

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

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

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

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

$PV = Nk_BT$

$\frac{3}{2}k_BT = \frac{1}{2}mv^2$

$\Delta Q = mc\Delta T$

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

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

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

Rotational Motion

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

$\omega_f = \omega_i + \alpha t$

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

$\tau = I\alpha = rF$

$L = I\omega$

$L_f = L_i + \tau\Delta t$

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

$a_r = r\omega^2$

Fluids

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

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

$P_d = P_0 + \rho gd$

$F_B = \rho gV$

$A_1v_1 = A_2v_2$

$\rho_1A_1v_1 = \rho_2A_2v_2$

$P_1 + \frac{1}{2}\rho v^2{}_1 + \rho gh_1 = P_2 + \frac{1}{2}\rho v^2{}_2 + \rho gh_2$

Simple Harmonic Motion/Waves

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

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

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

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

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

$v(t) = A\sqrt{\frac{k}{m}}\cos\left(\frac{2\pi t}{T}\right)$

$a(t) = -A\frac{k}{m}\sin\left(\frac{2\pi t}{T}\right)$

$v = f\lambda = \sqrt{\frac{F_T}{\mu}}$

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

$I = 2\pi^2f^2\rho vA^2$

Sound

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

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

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