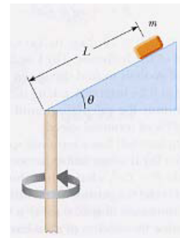
Name____
Physics 120 Quiz #5, February 17, 2012

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

1. An orange block of mass m is positioned at a distance L from the bottom of the wedge shaped incline, with angle of inclination θ. If the handle is spun at constant speed v, causing the wedge to spin in a horizontal circle at the same constant speed v, the mass will remain at the fixed distance L along the ramp. In terms of the quantities given in the problem (and perhaps the acceleration due to gravity) the speed needed to keep the orange block of mass m at this fixed distance L is given by



a. $v = \sqrt{\dfrac{Lg}{\cos\theta}}$

b. $v = \sqrt{Lg\tan\theta}$

c. $v = \sqrt{\dfrac{Lg}{\tan\theta}}$

d. $v = \sqrt{Lg\sin\theta}$

2. Suppose that you are driving your car ($m_{car} = 1250kg$) down the road at a constant velocity of $\vec{v}_i = \langle 30,0,0\rangle \frac{m}{s}$ when you when you decide that you need to brake and stop the vehicle as soon as possible.

   a. Using energy ideas, how much work would it take an external force to bring your car to rest?

$$KE_f = KE_i + W_{net} \rightarrow W_{net} = KE_f - KE_i = \left(\tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2\right) = -\tfrac{1}{2}mv_i^2$$
$$W_{net} = -\tfrac{1}{2}mv_i^2 = -\tfrac{1}{2}\times 1250kg \times \left(30\tfrac{m}{s}\right)^2 = -5.63\times 10^5 J$$

   b. If the net force on your car were $\vec{F}_{ext} = \langle -18750,0,0\rangle N$, what would be your displacement from the time you started braking until you came to rest?

$$W_{net} = -5.63\times 10^5 J = \int \vec{F}_{net}\cdot d\vec{r} = \int \langle -18750,0,\rangle N \cdot \langle dx,0,0\rangle = -18750N\Delta x$$
$$\Delta x = \frac{-5.63\times 10^5 J}{-18750N} = 30m$$

c. Suppose that when your initial velocity was $\vec{v}_i = \langle v_{ix}, 0, 0 \rangle \frac{m}{s}$ it took you a distance of Δx to come to rest. Now, suppose that your initial velocity was $\vec{v}_{i,new} = \langle \alpha v_{ix}, 0, 0 \rangle \frac{m}{s}$, where α is a positive constant, and it took you a distance of Δx_{new} to come to rest, what is the relationship between Δx_{new} and Δx if the braking force remains constant? Be sure to explain the answer you derive.

$$KE_f = KE_i + W_{net} \rightarrow 0 = KE_i + F_{net,x}\Delta x = \tfrac{1}{2} m v_i^2 - F_{net,x}\Delta x \Rightarrow \Delta x = \frac{m v_i^2}{2F_{net,x}}$$

$$KE_f = KE_i + W_{net} \rightarrow 0 = KE_i + F_{net,x}\Delta x_{new} = \tfrac{1}{2} m (\alpha v)_i^2 - F_{net,x}\Delta x \Rightarrow \Delta x_{new} = \frac{m \alpha^2 v_i^2}{2F_{net,x}} = \alpha^2 \Delta x$$

Useful formulas:

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

$\gamma = \dfrac{1}{\sqrt{1-\dfrac{v^2}{c^2}}}$

$\vec{v}_{avg} = \dfrac{\vec{v}_i + \vec{v}_f}{2}$

$\vec{F}_g = m\vec{g}$

$F_{fr} = \mu F_N$

$\vec{F}_{gravity} = \dfrac{GM_1M_2}{r_{12}^2}\hat{r}_{12}$

$\vec{F}_{spring} = -k\vec{s}; \quad \vec{s} = (L - L_o)\hat{s}$

$W = \int \vec{F} \cdot d\vec{r} = \Delta KE = -\Delta U$

$U_g = -\dfrac{GM_1M_2}{r}$

$U_g = mgy$

$U_s = \dfrac{1}{2}ks^2$

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

$KE = (\gamma - 1)mc^2$

$k_{eff,parallel} = n_{parallel}k_{individual}$

$k_{eff,series} = \dfrac{k_{individual}}{n_{series}}$

$stress = Ystrain \rightarrow \dfrac{F}{A} = Y\dfrac{\Delta L}{L}$

$v_s = \sqrt{\dfrac{k_{IAB}}{m_{atom}}}d$

$k_{IAB} = Yd$

Momentum Principle:

$$\vec{p}_f = \vec{p}_i + \vec{F}_{net}\Delta t; \quad \Delta t = \text{large}$$

$$\vec{p}_f = \vec{p}_i + \vec{F}_{net}dt; \quad dt = \frac{\Delta t}{n} = \text{small}$$

Position-update:

$$\vec{r}_f = \vec{r}_i + \vec{v}_{avg}\Delta t = \vec{r}_i + \frac{\vec{p}}{m\sqrt{1+\dfrac{p^2}{m^2c^2}}}\Delta t; \quad \Delta t = \text{large}$$

$$\vec{r}_f = \vec{r}_i + \vec{v}_f dt; \quad dt = \frac{\Delta t}{n} = \text{small}$$

Energy principle:

$$\Delta E = W = \Delta U_g + \Delta U_s + \Delta KE$$

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

Vectors

magnitude of a vector : $|\vec{a}| = \sqrt{a_x^2 + a_y^2 + a_z^2}$

writing a vector : $\vec{a} = \langle a_x, a_y, a_z \rangle = |\vec{a}|\hat{a} = a_x\hat{i} + a_y\hat{j} + a_z\hat{k}$

Useful Constants

$g = 9.8 \frac{m}{s^2}$

$G = 6.67 \times 10^{-11} \frac{Nm^2}{kg^2}$

$1e = 1.6 \times 10^{-19} C$

$k = \dfrac{1}{4\pi\varepsilon_o} = 9 \times 10^9 \frac{C^2}{Nm^2}$

$\varepsilon_o = 8.85 \times 10^{-12} \frac{Nm^2}{C^2}$

$1eV = 1.6 \times 10^{-19} J$

$\mu_o = 4\pi \times 10^{-7} \frac{Tm}{A}$

$c = 3 \times 10^8 \frac{m}{s}$

$h = 6.63 \times 10^{-34} Js$

$m_e = 9.11 \times 10^{-31} kg = \dfrac{0.511 MeV}{c^2}$

$m_p = 1.67 \times 10^{-27} kg = \dfrac{937.1 MeV}{c^2}$

$m_n = 1.69 \times 10^{-27} kg = \dfrac{948.3 MeV}{c^2}$

$1amu = 1.66 \times 10^{-27} kg = \dfrac{931.5 MeV}{c^2}$

$N_A = 6.02 \times 10^{23}$

$Ax^2 + Bx + C = 0 \rightarrow x = \dfrac{-B \pm \sqrt{B^2 - 4AC}}{2A}$