Name_________________________________

Physics 120 Quiz 4, April 29, 2011

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

1. Suppose that you have a wire with length L and stiffness k_{wire} this wire used to suspend a mass m from the ceiling and the wire stretches by an amount Δy. Now you cut this wire into two equal length pieces and you use these pieces to suspend the same mass m from the ceiling. Each piece of wire now stretches by an amount $\Delta y'$ where $\Delta y'$ is equal to

   a. Δy b. $\frac{\Delta y}{2}$ c. $\frac{\Delta y}{4}$ d. $4\Delta y$

2. Suppose that a *1000kg* mass is suspended from the lower end of a steel cable that is *10m* in length and has a square cross-section with area $16cm^2$. The upper end of the cable is attached to a helicopter that is flying parallel to the ground at a velocity $\vec{v} = \langle 80,0,0 \rangle \frac{m}{s}$. The helicopter and cable with attached mass is subject to a constant frictional force due to the air (directed opposite to the velocity of the helicopter) that causes the cable to be pushed backwards relative to the motion of the helicopter and the cable makes a 17^o angle with respect to the vertical when the helicopter is flying at this constant velocity.

   a. Applying the momentum principle, what is the magnitude of the tension force in the cable?

$$\vec{F}_{net} = \frac{d\vec{p}}{dt} = \langle -F_{air} + F_T \sin\theta, F_T \cos\theta - mg, 0 \rangle = \langle 0,0,0 \rangle N$$

$$y - dir: F_T \cos\theta - mg = 0 \rightarrow F_T = \frac{mg}{\cos\theta} = \frac{1000kg \times 9.8\frac{m}{s^2}}{\cos 17} = 10248N$$

   b. What is the magnitude of the resistive force due to the air?

$$x - dir: -F_{air} + F_T \sin\theta = 0 \rightarrow F_{air} = F_T \sin\theta = 10248N \times \sin 17 = 2996N$$

   c. If Young's modulus for steel is $2.0x10^{11} N/m^2$, what is the approximate change in length of the cable if the wire (and attached mass) were hanging vertically?

$$\frac{F}{A} = Y\frac{\Delta L}{L} \rightarrow \Delta L = \frac{mgL}{AY} = \frac{1000kg \times 9.8\frac{m}{s^2} \times 10m}{16cm^2 \times \left(\frac{1m}{100cm}\right)^2 \times 2 \times 10^{11}\frac{N}{m^2}} = 3.1 \times 10^{-4} m = 0.31mm$$

Useful formulas:

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

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

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

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

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

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

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

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

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

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:

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

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

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