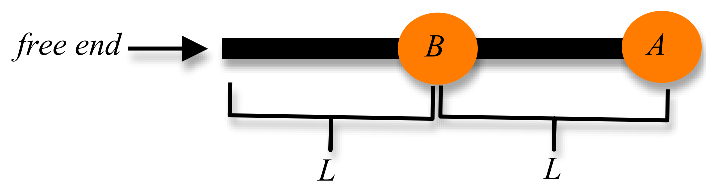
Name________________________________

Physics 110 Quiz #3, October 7, 2011

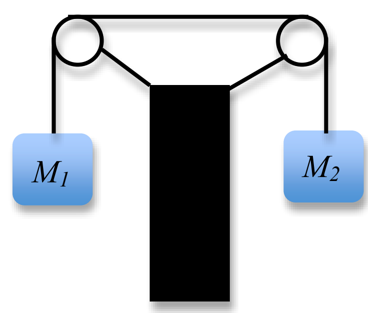
Please show all work, thoughts and/or reasoning in order to receive partial credit. The quiz is worth 10 points total.

1. Consider a massless rigid rod with two balls, *A* and *B* attached. Ball *A* is attached to one end of the rod, while ball *B* is attached to the center of the rod. Each half of the rod has length *L* and the balls have identical masses, *m*. When the free end of the rod is spun in a horizontal circle ball *A* has a constant speed of v_A while ball *B* has a constant speed of v_B. Comparing the tension forces in the left and right halves of the rod, we have



   a. the magnitude of the tension force in the left half of the rod is greater than the magnitude of the tension force in the right half of the rod.
   b. the magnitudes of the tension force in the left and right halves of the rod are equal.
   c. the magnitude of the tension force in the right half of the rod is greater than the magnitude of the tension force in the left half of the rod.
   d. no way of determining the tension forces in the rod.

2. Suppose that you are given the setup of blocks shown below. M_1 has a mass of *2kg* while M_2 has a mass of *3kg*.



   a. What is the magnitude of the acceleration of M_1?

   Assuming that M_1 rises and M_2 falls, we have

   Mass #1: $F_T - M_1 g = M_1 a$

   Mass #2: $F_T - M_2 g = -M_2 a$

   $$\therefore a = \left(\frac{M_2 - M_1}{M_1 + M_2}\right) g = \left(\frac{3-2}{3+2}\right) g = \frac{g}{5} = 1.96 \tfrac{m}{s^2}$$

   b. What is the magnitude of the tension force in the rope?

   $$F_T = M_2(g - a) = \frac{4M_2 g}{5} = \frac{4 \times 3kg \times 9.8 \tfrac{m}{s^2}}{5} = 23.5N$$

   or, alternatively $$F_T = M_1(g + a) = \frac{6M_1 g}{5} = \frac{6 \times 2kg \times 9.8 \tfrac{m}{s^2}}{5} = 23.5N$$

Useful formulas:

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

$$r_f = r_i + v_{ir}t + \tfrac{1}{2}a_r t^2$$

$$v_{fr} = v_{ir} + a_r t$$

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

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: $A = \tfrac{1}{2}bh$

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

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

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

Vectors

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

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

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

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

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

$$U_g = mgh$$

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

$$W_T = FdCos\theta = \Delta E_T$$

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

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

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

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

Heat

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

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

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

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

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

$$PV = Nk_BT$$

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

$$\Delta Q = mc\Delta T$$

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

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

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

Rotational Motion

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

$$\omega_f = \omega_i + \alpha t$$

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

$$\tau = I\alpha = rF$$

$$L = I\omega$$

$$L_f = L_i + \tau\Delta t$$

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

$$a_r = r\omega^2$$

Fluids

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

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

$$P_d = P_0 + \rho g d$$

$$F_B = \rho g V$$

$$A_1v_1 = A_2v_2$$

$$\rho_1 A_1 v_1 = \rho_2 A_2 v_2$$

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

Simple Harmonic Motion/Waves

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

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

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

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

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

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

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

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

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

$$I = 2\pi^2 f^2 \rho v A^2$$

Sound

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

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

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