PHYS 1211, Fall 2012

Test #3, version 1

October 30, 2012

2:00 pm– 3:15 pm

1. __________
2. __________
3. __________
4. __________

Total ________

Name __________________

ID __________________

NOTE: This test consists of one set of conceptual question and three problems. In working the problems, you must show all of the algebra and calculations and your reasoning clearly to receive credit. Be sure to include units in your solutions when required.

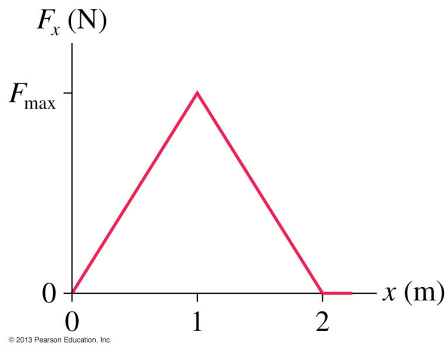
1. Conceptual questions (10 points, no calculations required). State whether the following statements are *True* or *False*.

A. For a car traveling on a straight, level road, the velocity at the top of one of its tires (with respect to the road) is twice the velocity of the car.

B. For an isolated mechanical system, the sum of the kinetic and potential energies remains constant as long as there are no non-conservative forces acting.

C. The work done by the normal force acting on an object depends on the displacement of the object.

2. A 10 kg particle moving along the x-axis experiences the force shown in the figure. The particle goes from v_x=1.0 m/s at x=0 to v_x=5.0 m/s at x=2 m. What is F_{max}? **(**30 points)



3. For a uniform rod of length L and mass M, its moment of inertia for rotation about its center of mass is $\frac{1}{12}ML^2$. If the rod is a uniform meter stick and is pivoted to rotate about a horizontal axis through the 25-cm mark, determine a) the moment of inertia of the stick about the pivot point and b) the magnitude of the initial angular acceleration, if the stick is released from rest in a horizontal position. (30 points)

4. Ball 1, with a mass of 200 g and traveling at 10 m/s, collides head-on with ball 2, which has a mass of 300 g and is initially at rest. What is the final velocity of each ball if the collision is (a) perfectly elastic? (b) perfectly inelastic? Assume the motion is in one dimension. (30 points)

Equations

$$\rho = M/V$$

$$\mathrm{v}_{xf} = \mathrm{v}_{xi} + a_x(t_f - t_i) \qquad \mathrm{v}_{yf} = \mathrm{v}_{yi} + a_y(t_f - t_i)$$

$$x_f = x_i + \tfrac{1}{2}(\mathrm{v}_{xi} + \mathrm{v}_{xf})(t_f - t_i) \qquad y_f = y_i + \tfrac{1}{2}(\mathrm{v}_{yi} + \mathrm{v}_{yf})(t_f - t_i)$$

$$x_f = x_i + \mathrm{v}_{xi}(t_f - t_i) + \tfrac{1}{2}a_x(t_f - t_i)^2 \qquad y_f = y_i + \mathrm{v}_{yi}(t_f - t_i) + \tfrac{1}{2}a_y(t_f - t_i)^2$$

$$\mathrm{v}_{xf}^2 = \mathrm{v}_{xi}^2 + 2a_x(x_f - x_i) \qquad \mathrm{v}_{yf}^2 = \mathrm{v}_{yi}^2 + 2a_y(y_f - y_i)$$

$$\cos\theta = x/h \qquad \sin\theta = y/h \qquad \tan\theta = y/x \qquad h = \sqrt{x^2 + y^2}$$

$$\Delta x = x_f - x_i \qquad \mathrm{v}_{x,avg} = \frac{x_f - x_i}{t_f - t_i} \qquad \mathbf{a}_{avg} = \frac{\mathbf{v}_f - \mathbf{v}_i}{t_f - t_i}$$

$$\mathrm{v}_x = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt} \qquad a_x = \lim_{\Delta t \to 0} \frac{\Delta \mathrm{v}_x}{\Delta t} = \frac{d\mathrm{v}_x}{dt}$$

$$az^2 + bz + c = 0 \qquad z = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$\Sigma\vec{F} = m\vec{a} \qquad |F_G| = \frac{Gm_1m_2}{r^2} \qquad F_g = mg$$

$$f_S^{\max} = \mu_S n \qquad f_k = \mu_k n$$

$$a_r = \mathrm{v}^2/r \qquad T = 2\pi r/\mathrm{v} = 2\pi r^{3/2}/\sqrt{GM}$$

$$s = r\theta \qquad \omega_{avg} = \frac{\theta_f - \theta_i}{t_f - t_i} \qquad \omega = \lim_{\Delta t \to 0} \frac{\Delta\theta}{\Delta t} = \frac{d\theta}{dt}$$

$$\alpha_{avg} = \frac{\omega_f - \omega_i}{t_f - t_i} \qquad \alpha = \lim_{\Delta t \to 0} \frac{\Delta\omega}{\Delta t} = \frac{d\omega}{dt} \qquad T = \frac{2\pi}{\omega}$$

$$\mathrm{v}_t = r\omega \qquad a_t = r\alpha \qquad \vec{\mathrm{v}}' = \vec{\mathrm{v}} - \vec{\mathrm{v}}_o \qquad \vec{\mathrm{r}}' = \vec{\mathrm{r}} - \vec{\mathrm{v}}_o t$$

$$\theta_f = \theta_i + \tfrac{1}{2}(\omega_i + \omega_f)(t_f - t_i)$$

$$\theta_f = \theta_i + \omega_i(t_f - t_i) + \tfrac{1}{2}\alpha(t_f - t_i)^2$$

$$\omega_f = \omega_i + \alpha(t_f - t_i)$$

$$\omega_f^2 = \omega_i^2 + 2\alpha(\theta_f - \theta_i)$$

$$g = 9.80\ \mathrm{m/s^2} = 32.2\ \mathrm{ft/s^2} \qquad G = 6.67\mathrm{x}10^{-11}\ \mathrm{Nm^2/kg^2}$$

$$\vec{p} = m\vec{v} \qquad \vec{J} = \vec{F}_{avg}\Delta t \qquad \vec{J} = \int_{t_i}^{t_f} \vec{F}dt = \vec{p}_f - \vec{p}_i$$

$$x_{\text{cm}} = \frac{\sum m_i x_i}{\sum m_i} \qquad \vec{v}_{\text{cm}} = \frac{\sum m_i \vec{v}_i}{\sum m_i} \qquad \sum \vec{F}_{\text{ext}} = \frac{d\vec{p}}{dt}$$

$$K = \tfrac{1}{2}mv^2 \qquad W = F\cos\phi\, s = K_f - K_i$$

$$W = \int_{s_i}^{s_f} \vec{F}\cdot d\vec{s} = -\Delta U \qquad \vec{A}\cdot\vec{B} = A_xB_x + A_yB_y + A_zB_z = AB\cos\phi$$

$$U_g = mgy \qquad E = K + U \qquad F_s = -kx \qquad F_x = -\frac{dU}{dx}$$

$$v_{1f} = \frac{m_1 - m_2}{m_1 + m_2} v_{1i} \qquad v_{2f} = \frac{2m_1}{m_1 + m_2} v_{1i}$$

$$P_{avg} = W/\Delta t \qquad P = dW/dt \qquad W_{NC} = E_f - E_i$$

$$U_s = \tfrac{1}{2}kx^2 \qquad P = \vec{F}\cdot\vec{v} \qquad \tau = rF\sin\phi \qquad \sum \tau = I\alpha$$

$$I = \sum m_i r_i^2 \qquad I = I_{\text{CM}} + MD^2$$

$$K_{\text{R}} = \tfrac{1}{2}I\omega^2 \qquad W_{\text{R}} = \tau\theta$$

Moments of inertia about axes through the center of mass:

$$I_{hoop} = MR^2 \qquad I_{disk} = \tfrac{1}{2}MR^2 \qquad I_{rod} = \tfrac{1}{12}ML^2$$

$$I_{hollow\ sphere} = \tfrac{2}{3}MR^2 \qquad I_{solid\ sphere} = \tfrac{2}{5}MR^2$$