Name____________________________________

Physics 120 Quiz #5, May 11, 2007

1. A ball whose mass is *0.1kg* falls vertically and hits the floor with a speed of *6m/s*, then rebounds upward with a speed of *5m/s*.

   a. What is the impulse (change in momentum) of the ball? (3)

   $$\vec{I} = \Delta\vec{p} = m\vec{v}_f - m\vec{v}_i = m\left(v_f - \left(-v_i\right)\right)\hat{j} = 0.1kg \times \left(6\tfrac{m}{s} + 5\tfrac{m}{s}\right)\hat{j} = 1.1\tfrac{kgm}{s}\,\hat{j}$$

   b. If the ball is in contact with the floor for *1ms* (*1x10*$^{-3}$*s*), what was the force exerted on the ball by the floor? (3)

   $$\vec{I} = \Delta\vec{p} = \vec{F}\Delta t \rightarrow \vec{F} = \frac{\Delta\vec{p}}{\Delta t} = \frac{\vec{I}}{\Delta t} = \frac{1.1\frac{kgm}{s}}{1\times10^{-3}s}\,\hat{j} = 1100N\hat{j}$$

   c. How much work was done on the ball by the floor? (2)

   $$W = \Delta KE = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2 = \tfrac{1}{2}\times 0.1kg \times \left(\left(5\tfrac{m}{s}\right)^2 - \left(-6\tfrac{m}{s}\right)^2\right) = -0.55J$$

   The ball loses energy and the floor gains the energy lost by the ball as heat.

2. Two objects are at rest on a frictionless surface. Object 1 has a greater mass than object 2. When a constant force is applied to object 1, it accelerates for a time interval Δt. The force is removed and applied to object 2. After object 2 has accelerated for the same time interval, Δt, which of the following statements is true?

   a. $p_1 > p_2$ (b.) $p_1 = p_2$. c. $p_1 < p_2$. d. Not enough information given.

Useful formulas:

Motion in the x, y or z-directions

$r_f = r_0 + v_{0r}t + \frac{1}{2}a_r t^2$

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

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

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

Vectors

$\text{magnitude of a vector} = \sqrt{v_x{}^2 + v^2{}_y}$

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

Useful Constants

$g = 9.8\,{}^{m}/_{s^2}$ $\quad G = 6.67\times10^{-11}\,{}^{Nm^2}/_{kg^2}$

$N_A = 6.02\times10^{23}\,{}^{atoms}/_{mole}$ $\quad k_B = 1.38\times10^{-23}\,{}^{J}/_{K}$

$\sigma = 5.67\times10^{-8}\,{}^{W}/_{m^2K^4}$ $\quad v_{sound} = 343\,{}^{m}/_{s}$ $\quad P_{air} = 1.013\times10^5\,N/m^2$

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

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

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

$U_g = mgh$

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

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

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

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

Rotational Motion

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

$\omega_f = \omega_i + \alpha t$

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

$\tau = I\alpha = rF$

$L = I\omega$

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

$a_r = r\omega^2$

Simple Harmonic Motion/Waves

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

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

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

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

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

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

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

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

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

$P = \frac{1}{2}\omega^2\mu vA^2$