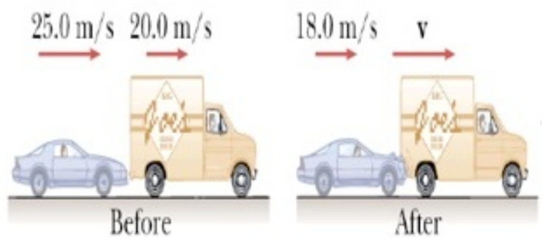
Name____
Physics 110 Quiz #5, May 14, 2010

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

1. A 1200kg car (traveling at *25m/s*) makes a rear-end collision with a 9000kg van (traveling in the same direction as the car and at a speed of *20m/s*). After the collision the car is found to be traveling at *18m/s* and the van at an unknown speed, but with both traveling in their original directions after the collision. The car and the van are not connected after the collision. The speed of the van after the collision and the collision itself are

   a. 20.9 m/s and elastic.
   b. 22.1 m/s and elastic.
   c. 20.9 m/s and inelastic.
   d. 22.1 m/s and inelastic.



2. The sun orbits the center of the galaxy at a distance of $2.37x10^{20}$ *m* with an average orbital speed of *228km/s*.

   a. Assuming that our galaxy, the Milky Way, is considered a solid disk with the sun seated at the outer edge of the galaxy (it's not by the way), what is the angular velocity of the of the galaxy?

$$\omega = \frac{v}{r} = \frac{228\times10^{3}\,\frac{m}{s}}{2.37\times10^{20}\,m} = 9.6\times10^{-16}\,\tfrac{rad}{s}$$

   b. Starting from the trajectory for the sun's motion about the center of the galaxy and assuming that the angular velocity is a constant, determine the number of earth years in a galactic year. A galactic year is the time it takes for the earth to make one complete orbit about the galactic center.

$$\theta_f = \theta_i + \omega_i t + \tfrac{1}{2}\alpha t^2 \rightarrow t = \frac{\theta_f - \theta_i}{\omega_i} = \frac{2\pi}{9.6\times10^{-16}\,s^{-1}} = 6.53\times10^{15}\,s$$

$$t_{galactic\ \ year} = 6.53\times10^{15}\,s\times\frac{1\ \ Earth\ \ year}{31.5\times10^{6}\,s} = 207\times10^{6}\,Earth\ \ yrs = 207M\ \ Eath\ \ yrs$$

Useful formulas:

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

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

$v_{fr} = v_{0r} + a_r t$

$v_{fr}^{\ 2} = v_{0r}^{\ 2} + 2a_r \Delta r$

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

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

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

Useful Constants

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

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

$\sigma = 5.67\times10^{-8} \, W/m^2K^4 \qquad v_{sound} = 343 \, m/s$

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

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

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

$U_g = mgh$

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

$W_T = FdCos\theta = \Delta E_T$

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

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

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

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

Heat

$T_C = \frac{5}{9}[T_F - 32]$

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

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

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

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

$PV = Nk_BT$

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

$\Delta Q = mc\Delta T$

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

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

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

Rotational Motion

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

$\omega_f = \omega_i + \alpha t$

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

$\tau = I\alpha = rF$

$L = I\omega$

$L_f = L_i + \tau\Delta t$

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

$a_r = r\omega^2$

Fluids

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

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

$P_d = P_0 + \rho g d$

$F_B = \rho g V$

$A_1 v_1 = A_2 v_2$

$\rho_1 A_1 v_1 = \rho_2 A_2 v_2$

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

Simple Harmonic Motion/Waves

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

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

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

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

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

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

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

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

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

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

Sound

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

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

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