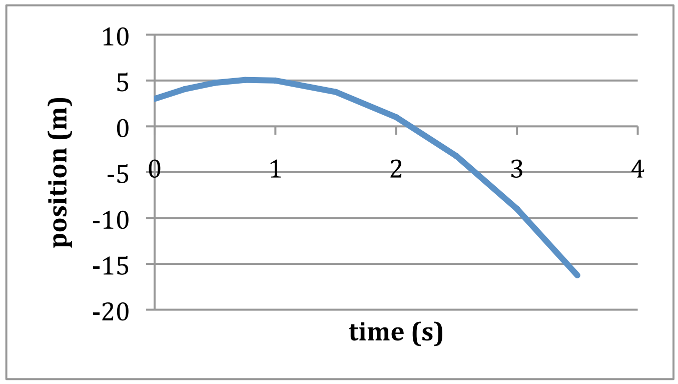
Name________________________________

Physics 110 Quiz #1, September 16, 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 the following position versus time graph for an object moving in one-dimension. The velocity of the object is best given as

   a. increasing linearly with time.
   b. decreasing linearly with time.
   c. constant in time.
   d. unable to be determined.



2. Suppose that you are driving down the road at a constant velocity v_{ix}.

   a. If you were driving at this constant rate and then you needed to apply the brakes and bring your car to rest. From the time you apply the brakes and your vehicle comes to rest, you cover a distance *d*. In terms of v_{ix} and *d*, derive an expression for the breaking time of your car? (Note, here we are ignoring any reaction time – this is purely bringing your car to rest.)

$$x_f = x_i + v_{ix}t + \tfrac{1}{2}a_x t^2 \rightarrow d = v_i t - \tfrac{1}{2}a_{Bx}t^2; \;\; \& \;\; v_{fx} = v_{ix} + a_x t \rightarrow 0 = v_i - a_{Bx}t \Rightarrow a_{Bx} = \frac{v_i}{t}$$

So, $d = v_i t - \tfrac{1}{2}a_{Bx}t^2 = v_i t - \tfrac{1}{2}v_i t = \dfrac{v_i t}{2}$

$$\therefore t = \frac{2d}{v_i}$$

   b. If you are driving with a velocity of $v_{ix} = 30m/s$ and you suddenly see a car *40m* ahead of you that has for some reason come to a complete stop. If you apply the brakes for *3.2s*, do you hit the car in front of you? If you do hit the car in front of you, what time would you have needed to bring your car to rest so that you did not hit the car?

$d = \dfrac{v_i t}{2} = \dfrac{30\,\tfrac{m}{s} \times 3.2s}{2} = 48m$, so Yes you do hit the car. To avoid the car you would have had to stop in a time $t = \dfrac{2d}{v_i} = \dfrac{2 \times 40m}{30\,\tfrac{m}{s}} = 2.7s$.

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

$a_r = \dfrac{v^2}{r}$

$F_r = ma_r = m\dfrac{v^2}{r}$

$v = \dfrac{2\pi r}{T}$

$F_G = G\dfrac{m_1 m_2}{r^2}$

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

Vectors

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

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

Useful Constants

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

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

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

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

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

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

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

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

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

$PV = Nk_BT$

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

$\Delta Q = mc\Delta T$

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

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

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

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

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

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

$P_d = P_0 + \rho gd$

$F_B = \rho gV$

$A_1v_1 = A_2v_2$

$\rho_1A_1v_1 = \rho_2A_2v_2$

$P_1 + \frac{1}{2}\rho v^2{}_1 + \rho gh_1 = P_2 + \frac{1}{2}\rho v^2{}_2 + \rho gh_2$

Simple Harmonic Motion/Waves

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

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

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

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

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

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

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

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

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

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

Sound