Name____

Physics 110 Quiz #1, September 20, 2013

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

I affirm that I have carried out my academic endeavors with full academic honesty.

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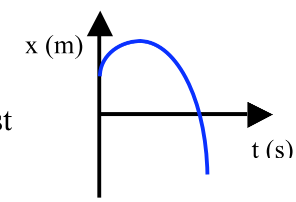
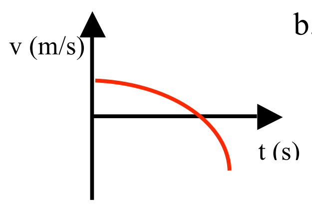
An object is launched vertically upwards from the edge of a cliff that is $42m$ high. The origin of the coordinate system is taken to be at the top of the cliff and vertically up is the positive y-direction. The ball is launched at a velocity of $7.7\frac{m}{s}$, $1.0m$ above the top of the cliff.

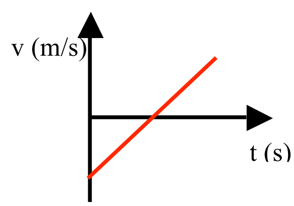
1. Suppose that the following position versus time graph were representative of the motion described on the right. The velocity versus time graph depicting the motion of the object would be best described by which of the following graphs below?



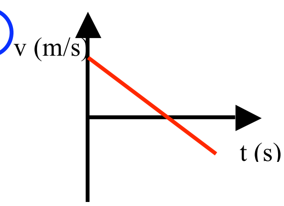
a.



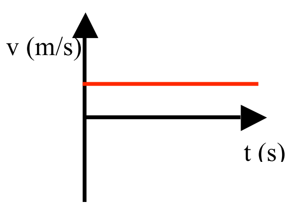
b.



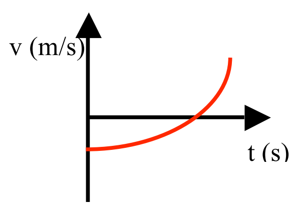
c.



d.



e.



2. How long does it take the object to reach its maximum height (above the cliff)?

$$v_{fy} = v_{iy} + a_y t \rightarrow 0 = 7.7\tfrac{m}{s} - 9.8\tfrac{m}{s^2}t \rightarrow t = \frac{7.7\frac{m}{s}}{9.8\frac{m}{s^2}} = 0.79s$$

3. What is the object's maximum height above the cliff?

$$y_f = y_i + v_{iy}t + \tfrac{1}{2}a_y t^2 = 1m + \left(7.7\tfrac{m}{s} \times 0.79s\right) - \tfrac{1}{2}\left(9.8\tfrac{m}{s^2}\right)\left(0.79s\right)^2 = 4.0m$$

4. What is the time of flight of the object from the time it's released until just before it impacts the ground below the cliff?

$$y_f = y_i + v_{iy}t + \tfrac{1}{2}a_y t^2 \rightarrow -42m = 1m + \left(7.7\tfrac{m}{s} \times t_{tof}\right) - \tfrac{1}{2}\left(9.8\tfrac{m}{s^2}\right)t_{tof}^2 \rightarrow t_{tof} = \begin{Bmatrix} 3.9s \\ -2.3s \end{Bmatrix}$$

5. What is the velocity of the object just before it strikes the ground below the cliff?

$$v_{fy} = v_{iy} + a_y t = 7.7\tfrac{m}{s} - 9.8\tfrac{m}{s^2}t_{tof} = 7.7\tfrac{m}{s} - 9.8\tfrac{m}{s^2} \times 3.9s = -30.5\tfrac{m}{s}$$

Useful formulas:

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

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

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

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

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

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

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

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

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

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

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

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

$$U_g = mgh$$

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

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

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

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

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

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

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

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

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

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

$$F_B = \rho g V$$

$$A_1v_1 = A_2v_2$$

$$\rho_1A_1v_1 = \rho_2A_2v_2$$

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

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

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

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

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