Equations

Wednesday, September 16, 2015 4:09 PM

PHYS I Test 1 Review

$$\Delta y = \left[\frac{v_{y_0} + v_y}{2}\right]t$$

$$\Delta x = \left[\frac{v_{x_0} + v_x}{2}\right]t$$

$$\Delta y = v_{y_0}\Delta t + \tfrac{1}{2}a_y t^2$$

$$\Delta x = v_{x_0} t + \tfrac{1}{2}a_x t^2$$

$$v_y = v_{y_0} + a_y t$$

$$v_x = v_{x_0} + a_x t$$

$$v_y^2 = v_{y_0}^2 + 2a_y \Delta y$$

$$v_x^2 = v_{x_0}^2 + 2a_x \Delta x$$

$$|\vec{A}| = \sqrt{A_x^2 + A_y^2}$$

$$g = 9.8 m/s^2$$

$$\sin\theta = \frac{A_y}{|\vec{A}|}$$

$$\cos\theta = \frac{A_x}{|\vec{A}|}$$

$$\tan\theta = \frac{A_y}{A_x}$$

$$A_y = |\vec{A}| \sin\theta$$

$$\theta = \tan^{-1}\left(\frac{A_y}{A_x}\right)$$

$$ax^2 + bx + c = 0$$

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

$$m \rightarrow 10^{-3}$$

$$k \rightarrow 10^{3}$$

$$1\,m = 3.28\,ft$$

Page 1

Wednesday, September 16, 2015 4:10 PM

TEST 1 Review

Name______________________________

Show all work in the spaces provided.

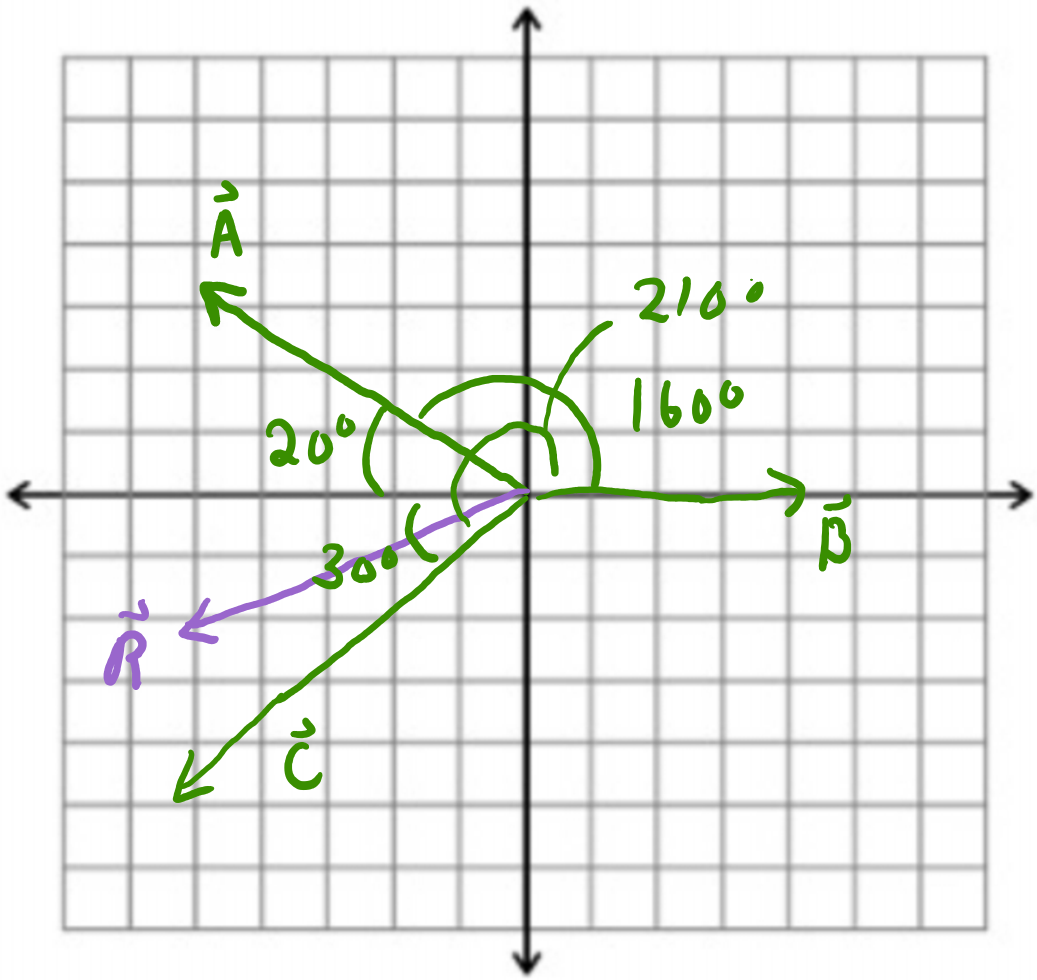
1) Let

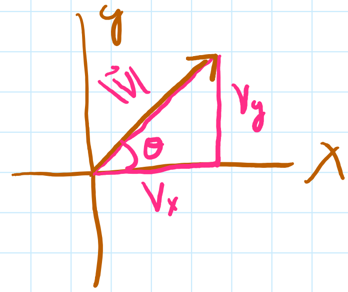
$$\left|\vec{A}\right| = 3.0\,m \text{ at } \theta_A = 160°$$

$$\left|\vec{B}\right| = 2.0\,m \text{ at } \theta_B = 0°$$

$$\left|\vec{C}\right| = 5.0\,m \text{ at } \theta_C = 210°$$

a) Draw the vectors on a coordinate system using the graph paper below. (5 points)





b) What are the x and y components of Vectors $\vec{A}, \vec{B}$ and $\vec{C}$? (6 points)

$A_x = |\vec{A}| \cos(160°)$

$A_x = (3m)\cos(160°)$

$A_x = -2.81m$

$A_y = |\vec{A}| \sin(160°)$

$A_y = (3m)\sin(160°)$

$A_y = 1.03m$

$B_x = 2m$

$B_y = 0$

$C_x = |\vec{C}| \cos(210°)$

$C_x = 5m \cos(210°)$

$C_x = -4.33m$

$C_y = |\vec{C}| \sin(210°)$

$C_y = (5m)\sin(210°)$

$C_y = -2.5m$

c) What is the sum of Vectors $\vec{A}, \vec{B}$ and $\vec{C}$ in terms of its magnitude and direction? (4 points)

$\vec{R} = \vec{A} + \vec{B} + \vec{C}$

$R_x = A_x + B_x + C_x$

$R_x = -2.81m + 2m - 4.33m$

$R_x = -5.14m$

$R_y = A_y + B_y + C_y$

$R_y = 1.03m + 0 - 2.5m$

$R_y = -1.47m$

$|\vec{R}| = \sqrt{R_x^2 + R_y^2}$

3

$|\vec{R}| = \sqrt{(-5.14m)^2 + (-1.47m)^2}$

$|\vec{R}| = 5.33m$

$\theta = \tan^{-1}\left(\frac{R_y}{R_x}\right)$

$\theta = \tan^{-1}\left(\frac{-1.47m}{-5.14m}\right)$

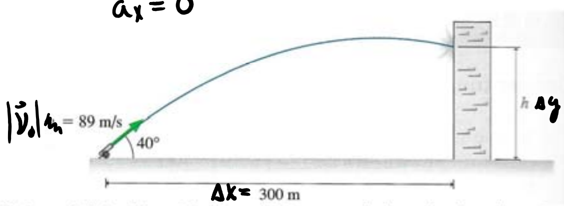
$\theta = 15.96° \approx 16°$ below (-) X axis

or

$196°$

$a_y = -9.8\,m/s^2$

$a_x = 0$



2) A cannonball aimed at $40°$ is fired at a wall $300m$ away on level ground as shown above. The initial speed of the cannonball is $|\vec{v}_0| = 89\,m/s$.

a) How long does it take the cannonball to hit the wall? (3 points)

$\Delta x = v_x t$

$t = \frac{\Delta x}{v_x} = \frac{300m}{68.2m/s} = 4.4s$

b) At what height does it hit the wall? (4 points)

$\Delta y = v_{y_0} t + \frac{1}{2} a_y t^2$

$\Delta y = (57.2m/s)(4.4s) + \frac{1}{2}(-9.8m/s^2)(4.4s)^2$

$\Delta y = 156.82m$

c) What is the speed and direction when it hits the wall? Is it on the way up or down? (4 points)

$v_x = 68.2m/s$

$v_y = v_{y_0} + a_y t$

$v_y = 57.2m/s + (-9.8m/s^2)(4.4s)$

$v_y = 14.08m/s$ on its way up!

4

$v_x = |\vec{v}_0| \cos(40°)$

$v_x = (89m/s)\cos(40°)$

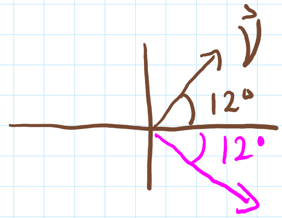
$v_x = 68.2m/s$

$v_{y_0} = |\vec{v}_0| \sin(40°)$

$v_{y_0} = (89m/s)\sin(40°)$

$v_{y_0} = 57.2\,m/s$

$\Delta y = v_y t + \frac{1}{2} a_y t^2$



$|\vec{v}| = \sqrt{v_x^2 + v_y^2}$

$|\vec{v}| = \sqrt{(68.2m/s)^2 + (14.08m/s)^2}$

$|\vec{v}| = 69.64m/s$ (speed)

$\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right)$

$\theta = \tan^{-1}\left(\frac{14.08m/s}{68.2m/s}\right)$

$\theta = 11.66° \approx 12°$

Page 4

Wednesday, September 16, 2015 4:10 PM

3) Chameleons catch insects with their tongues, which they can rapidly extend to great lengths. In a typical strike, the chameleon's tongue accelerates at a remarkable $250\,m/s^2$ for $20\,ms$, then travels at a constant speed for another $30\,ms$. During this total time of $50\,ms$, $\frac{1}{20}$ of a second, how far does the tongue reach? (12 pts)

(1)

$t_1 = 20\,ms = 20\times10^{-3}\,s$

$a_1 = 250\,m/s^2$

$v_0 = 0$

$\Delta x_1 = v_0 t + \frac{1}{2} a_1 t^2$

$\Delta x_1 = \frac{1}{2}(250\,m/s^2)(20\times10^{-3}\,s)^2$

$\Delta x_1 = .05\,m$

$v_1 = v_0 + a_1 t$

$v_1 = (250\,m/s^2)(20\times10^{-3}\,s)$

$v_1 = 5\,m/s$

(2)

$t_2 = 30\,ms = 30\times10^{-3}\,s$

$a_2 = 0$

$v_{2_0} = 5\,m/s$

$\Delta x_2 = v_{2_0} t_2$

$\Delta x_2 = (5\,m/s)(30\times10^{-3}\,s)$

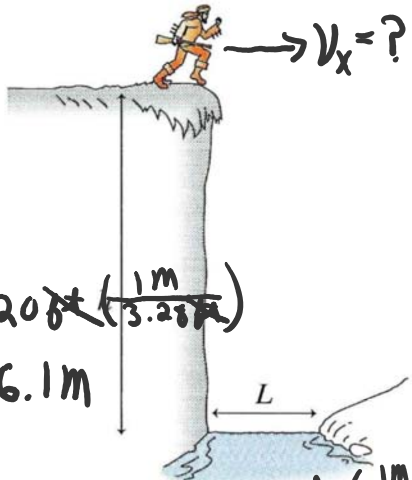
$\Delta x_2 = .15\,m$

$\Delta x_{tot} = \Delta x_1 + \Delta x_2 = .05\,m + .15\,m = .2\,m$

$v_{y_0} = 0$

$a_x = 0$

$a_y = -9.8\,m/s^2$



$\to v_x = ?$

4) In 1780, in what is now referred to as "Brady's Leap," Captain Sam Brady of the U.S. Continental Army escaped certain death from his enemies by running over the edge of the cliff above Ohio's Cuyahoga River, which is confined at that spot to a gorge. He landed safely on the far side of the river. It is reported that he leapt $22\,ft$ across while falling $20\,ft$.

a) What was Captain Brady's minimum speed he would need to make the leap? (9 points)

$\Delta y = -20\,ft\left(\frac{1\,m}{3.28\,ft}\right)$

$\Delta y = -6.1\,m$

$\Delta x = 22\,ft\left(\frac{1\,m}{3.28\,ft}\right)$

$\Delta x = 6.7\,m$

$\Delta y = \cancel{v_{y_0} t} + \frac{1}{2} a_y t^2$

$\Delta y = \frac{1}{2} a_y t^2$

$t^2 = \frac{2\Delta y}{a_y}$

$t = \sqrt{\frac{2\Delta y}{a_y}} = \sqrt{\frac{2(-6.1\,m)}{-9.8\,m/s^2}}$

$t = 1.12\,s$

$\Delta x = v_x t$

$v_x = \frac{\Delta x}{t} = \frac{6.7\,m}{1.12\,s} = 5.98\,m/s \approx 6\,m/s$

b) Is it reasonable that a person could make this leap? Use the fact that the world record for the $100\,m$ (Δx) dash is approximately $10\,s$ (t) to estimate the maximum speed such a runner would have. (3 points)

$v_x = \frac{\Delta x}{t} = \frac{100\,m}{10\,s} = 10\,m/s$