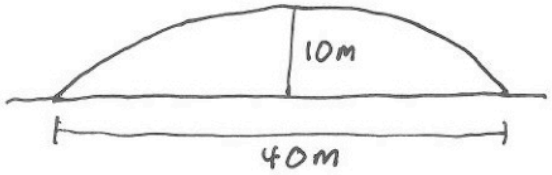
SMU Physics 1307 : Fall 2008

Quiz 1

Problem 1 : A ball is thrown and caught at the same height. If the total horizontal distance the object travels is 40 m, and the maximum vertical height above the throwing point is 10 m, find both components, V_{0x} and V_{0y}, of the initial velocity. Also find the total time of flight, t_f, of the ball.



for $y = 10\,m$: (t_m)

$V_y = V_{oy} - g t_m = 0 \qquad t_m = V_{oy}/g$

$y = V_{oy} t_m - \frac{1}{2} g t_m^2 = 10\,m$

$\frac{1}{2} V_{oy}^2 / g = 10\,m$

$V_{oy} = \sqrt{2g \cdot 10} = \sqrt{196} = 14\,m/s$

for $x = 10m$: (t_s)

$x = V_{ox} t_s = 40\,m$

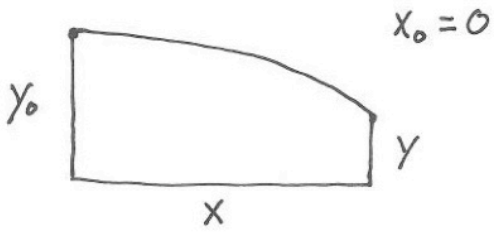
$y = V_{oy} t_s - \frac{1}{2} g t_s^2 = 0$

$t_s = 2 V_{oy}/g = 2.86\,s$

$x = 2 V_{ox} V_{oy}/g$

$V_{ox} = \frac{1}{2} g x / V_{oy} = 4.9 \cdot 40/14 = 14\,m/s$

Problem 2 : A baseball leaves a pitcher's hand parallel to the ground from a height of $y_0 = 2\,\text{m}$ and lands in the catcher's glove at a height of $y = 1\,\text{m}$ and horizontal distance from the release point $x = 20\,\text{m}$. Find both components, V_{0x} and V_{0y}, of the initial velocity of the ball. Find the y component, V_y, of the velocity of the ball when it reaches the catchers glove. Also find the time it takes, t_c, for the ball to reach the catchers glove.



$V_{0y} = 0$

$X = V_{0x} t_c = 20\,m$

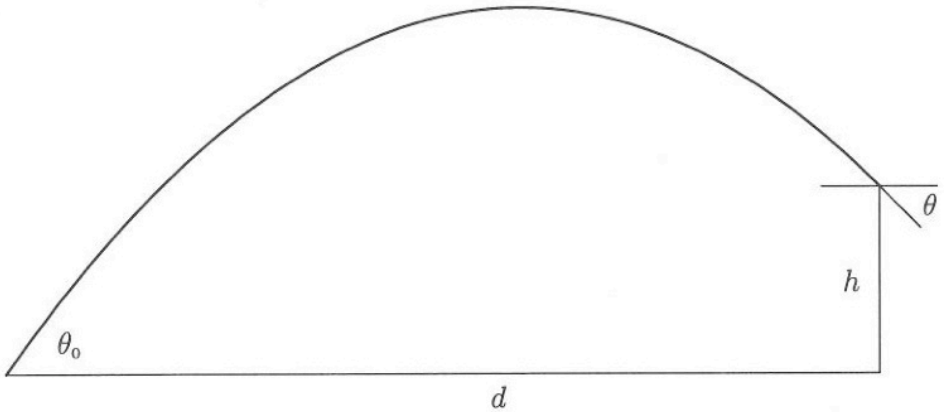
$y - y_0 = V_{0y} t_c - \frac{1}{2} g t_c^2 = -\frac{1}{2} g t_c^2 = -1\,m$

$t_c = (2 \cdot 1\,m/g)^{1/2} = 0.452\,s$

$V_{0x} = 20\,m/t_c = 44.3\,m/s$

$V_y = V_{0y} - g t_c = -g t_c = -4.43\,m/s$

Problem 3 : The figure below shows a golfball being hit from ground level at angle $\theta_0 = 55°$ into a cup which is an unknown distance h above, and a horizontal distance $d = 300\,\text{m}$ to right of, the point where the ball is struck. If the ball is to enter the cup at an angle $\theta = -45°$, what must be the magnitude, $|\vec{V}_0|$, of the initial velocity of the ball? What is the height h of the cup? How much time, t_c, does the ball take to reach the cup?



$X = V_{ox} t$

$y = V_{oy} t - \frac{1}{2} g t^2$

$V_y = V_{oy} - g t$

at t_c: $X = d = V_{ox} t_c = 300\,m$

$y = V_{oy} t_c - \frac{1}{2} g t_c^2 = h$

$V_y = V_{oy} - g t_c = V_x \tan(-45°)$

$= -V_{ox}$

since $V_{ox} = |\vec{V}_0| \cos\theta_0$

$V_{oy} = |\vec{V}_0| \sin\theta_0$

$\Rightarrow |\vec{V}_0| \cos\theta_0 \, t_c = 300\,m$

and, $|\vec{V}_0| \sin\theta_0 - g t_c = -|\vec{V}_0| \cos\theta_0$

or, $g t_c = |\vec{V}_0| (\cos\theta_0 + \sin\theta_0)$

so, $|\vec{V}_0|^2 \cos\theta_0 (\cos\theta_0 + \sin\theta_0) = g \cdot 300\,m$

$|\vec{V}_0| = 60.67\,m/s$

Thus, $t_c = |\vec{V}_0| (\cos\theta_0 + \sin\theta_0)/g$

$t_c = 8.62\,s$

$h = |\vec{V}_0| \sin\theta_0 \, t_c - \frac{1}{2} g t_c^2$

$h = 64.22\,m$