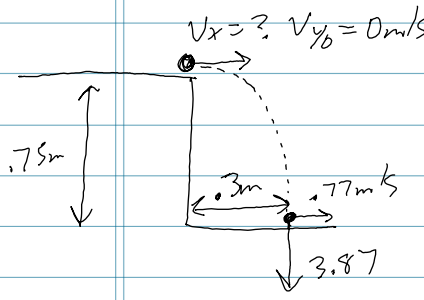
Projectile Problems

1) A 1 kg marble rolls off a table that is 0.75 m tall.
(a) What is the initial velocity of the marble if it travels 0.3m (range) before it hits the floor?
(b) What is the velocity of the ball the instant before it lands?



(a)

X	Y
$\Delta x = .3m$	$\Delta y = -.75m$
$V_x = ?$	$g = -10 m/s^2$
$t = .39s$	$V_{oy} = 0 m/s$
② $\Delta x = V_x t$	① $\Delta y = \frac{1}{2} g t^2 + V_{oy} t$
$.3 = V_x(.39)$	$-.75 = \frac{1}{2}(-10) t^2$
$V_x = .77 m/s$	$t^2 = .15$
	$t = .39s$

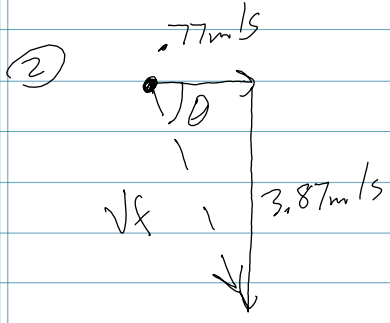
(b)

$V_{fy} = ?$

① $V_{fy}^2 = V_{oy}^2 + 2g\Delta y$

$(\pm V_{fy})^2 = 0^2 + 2(-10)(-.75)$

$V_{fy} = -3.87 m/s$

② 

$.77^2 + 3.87^2 = c^2$

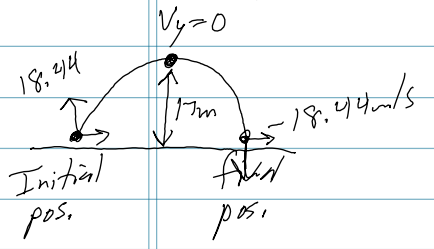
$c = V_f$

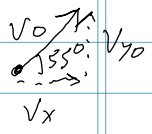
$c = V_f = 3.95 m/s$

$\tan^{-1}\left(\frac{3.87}{.77}\right) = \theta$

$\theta = 78.75°$ below the horizontal

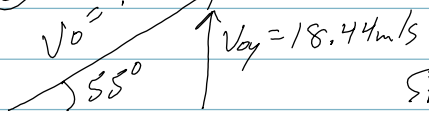
2) A football is kicked at an angle of 55° above the horizontal & reaches a max. height of 17m. (a) What is the initial velocity of the football the instant after it was kicked? (b) What is the range of the football? (c) What is the final velocity of the football?





x	y
	$\Delta y = +17m$
	$g = -10m/s^2$
	$V_{fy} = 0 m/s$
	$V_{oy} = ?$
	(1) $V_{fy}^2 = V_{oy}^2 + 2g\Delta y$
	$0^2 = V_{oy}^2 + 2(-10)(+17)$
	$V_{oy}^2 = 340$
	$V_{oy} = +18.44 m/s$

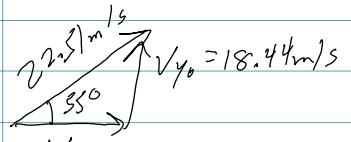
(2)



$\sin 55° = \frac{18.44}{V_0}$ $\quad V_0 = \frac{18.44}{\sin 55°}$

$V_0 =$ **22.5 m/s at 55° above hor.**

(B)



(1) $\cos 55° = \frac{V_x}{22.51}$

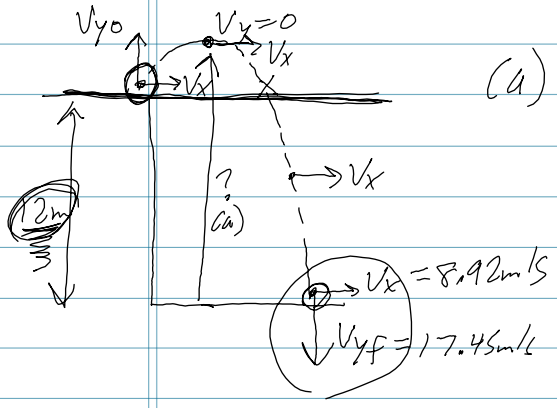
$V_x = 12.91 m/s$

x	y
$\Delta x = ?$	(2) $t = ?$
$V_x = 12.91 m/s$	$V_{oy} = 18.44 m/s$
(3) $t = 3.69s$	$g = -10 m/s^2$
$\Delta x = V_x t$	$V_{fy} = -18.44 m/s$
$\Delta x = 12.91(3.69)$	$V_{fy} = V_{oy} + gt$
$\Delta x = 47.64m$	$-18.44 = +18.44 - 10t$
	$t = 3.69s$

(C) $V_0 = V_f$ because $\Delta y = 0$

22.5 m/s at 55° below horizontal

3) A balloon is launched at 12 m/s at 42° above the horizontal from a height of 12m. (a) How high does the balloon get when measured from the ground? (b) What is the range of the balloon? (c) What is the balloon's velocity the instant before it lands?



(a)

x	y
$V_x = 8.92 m/s$	$V_{oy} = 8.03 m/s$
	$V_{fy} = 0 m/s$
	$g = -10 m/s^2$

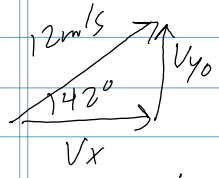
② $V_{fy}^2 = V_{oy}^2 + 2g\Delta y$

$0^2 = 8.03^2 + 2(-10)\Delta y$

$\Delta y = 3.22m$

$+ 12m$

$\boxed{15.22m}$

① 

$\cos 42^\circ = \frac{V_x}{12}$

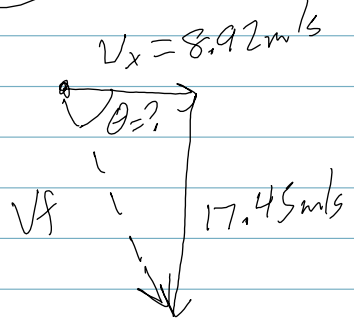
$V_x = 8.92 m/s$

$\sin 42^\circ = \frac{V_{yo}}{12}$

$V_{yo} = +8.03 m/s$

(b)

x	y
$\Delta x = ?$	$t = ?$
$V_x = 8.92 m/s$	$V_{fy} \neq 0$
③ $t = 2.55s$	① $V_{fy}^2 = V_{oy}^2 + 2g\Delta y$
$\Delta x = V_x t$	$(\pm V_{fy})^2 = 8.03^2 + 2(-10)(-12)$
$\Delta x = 8.92(2.55)$	$V_{fy} = -17.45 m/s$
$\boxed{\Delta x = 22.75m}$	② $V_{fy} = V_{oy} + gt$
	$-17.45 = +8.03 - 10t$
	$t = 2.55s$

(c) 

$8.92^2 + 17.45^2 = C^2$

$C = V_f$

$V_f = \boxed{19.6 m/s}$

$\tan^{-1}\left(\frac{17.45}{8.92}\right) = \theta$

$\theta = \boxed{62.93^\circ \text{ below the horizontal}}$