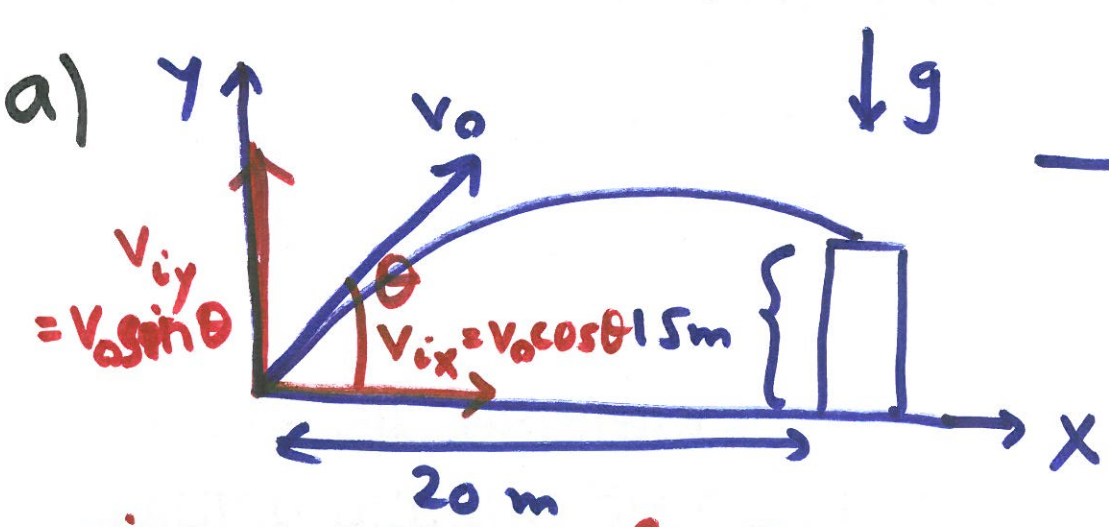
Whiteboard Problem 4.2

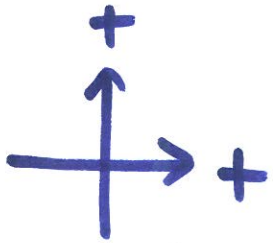
A batted ball is launched at 45^0 and just clears a fence 15 m higher than the launch point and 20 m away.

a) Find the launch speed and time required for the ball to reach the fence.

b) Is the ball on the way up or down when it clears the fence?

a)





HOR

$\Delta x = v_{ix}\,\Delta t$

$20 = (v_0 \cos 45)\Delta t$ — (i)

VERT

$\Delta y = v_{iy}\,\Delta t + \frac{1}{2} a_y (\Delta t)^2$

$15 = (v_0 \sin 45)\Delta t + \frac{1}{2}(-9.8)(\Delta t)^2$ — (ii)

(i) → Solve for v_0 from (i) & plonk into (ii)

(i) → $v_0 = \dfrac{20}{(\cos 45)\Delta t}$

$15 = \dfrac{20 \sin 45}{(\cos 45)\Delta t}\cdot \Delta t - \frac{1}{2}(9.8)(\Delta t)^2$

$15 = 20 - 4.9(\Delta t)^2 \Rightarrow \Delta t = \sqrt{5/4.9} = 1.01 \text{ sec}$

$v_0 = 28 \text{ m/s}$

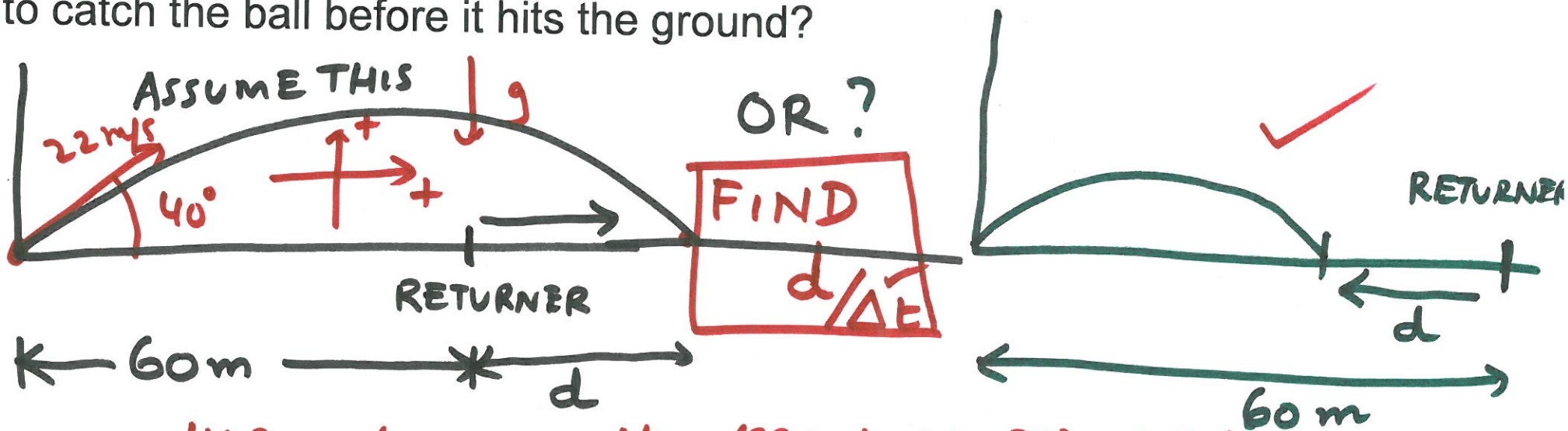
b) Find v_y @ $x = 20$, $y = 15$.

$v_y = v_0 \sin\theta + (-g)(\Delta t)$

$v_y = 28 \sin 45 - 9.8(1.01) > 0 \Rightarrow$ ON WAY UP!

Whiteboard Problem 4.3

A punter kicks a football such that it leaves his foot at a speed of 22 m/s at an angle of 40^0 with respect to the ground. The returner has positioned himself 60 m from the kicker. How fast (average speed) must the returner run to catch the ball before it hits the ground?



HOR $\Delta x = v_{ix}\Delta t = (22\cos 40)(2.89) = 48.6\text{ m} < 60\text{ m}$

VERT $\Delta y = v_{iy}\Delta t + \frac{1}{2}a_y(\Delta t)^2$

$0 = (22\sin 40)\Delta t + \frac{1}{2}(-9.8)(\Delta t)^2$

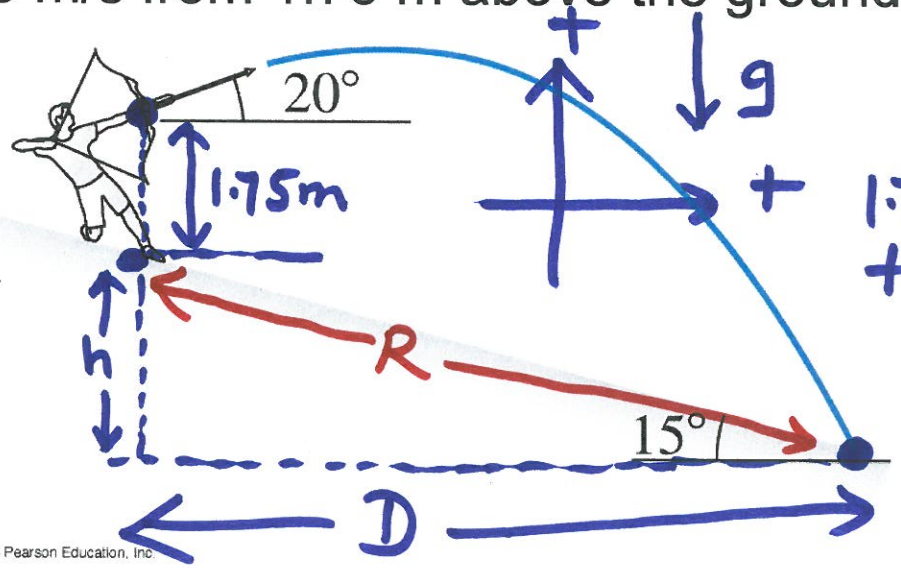
$\Rightarrow \boxed{\Delta t = 2.89\text{ sec}}$

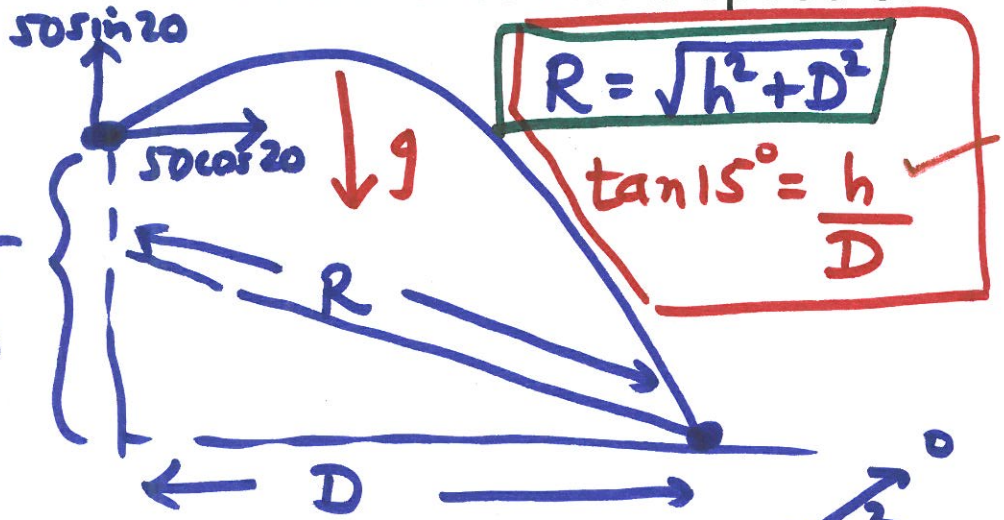
Speed: $\frac{60 - 48.6}{2.89}$

$= 3.9\text{ m/s}$ ←

Whiteboard Problem 4.4: Challenge problem 4.82

An archer standing on a 15^0 slope shoots an arrow 20^0 above the horizontal, as shown. How far down the slope does the arrow hit if it is shot with a speed of 50 m/s from 1.75 m above the ground?





$R = \sqrt{h^2 + D^2}$

$\tan 15^\circ = \frac{h}{D}$ ✓

HOR: $\Delta x = v_{ix}\Delta t + \frac{1}{2}a_x(\Delta t)^2$

$D = (50\cos 20)\Delta t$ — (i)

VERT: $\Delta y = v_{iy}\Delta t + \frac{1}{2}a_y(\Delta t)^2$

$-(h + 1.75) = (50\sin 20)\Delta t + \frac{1}{2}(-9.8)(\Delta t)^2$ — (ii)

$\rightarrow h = D\tan 15 = [(50\cos 20)\Delta t]\tan 15$

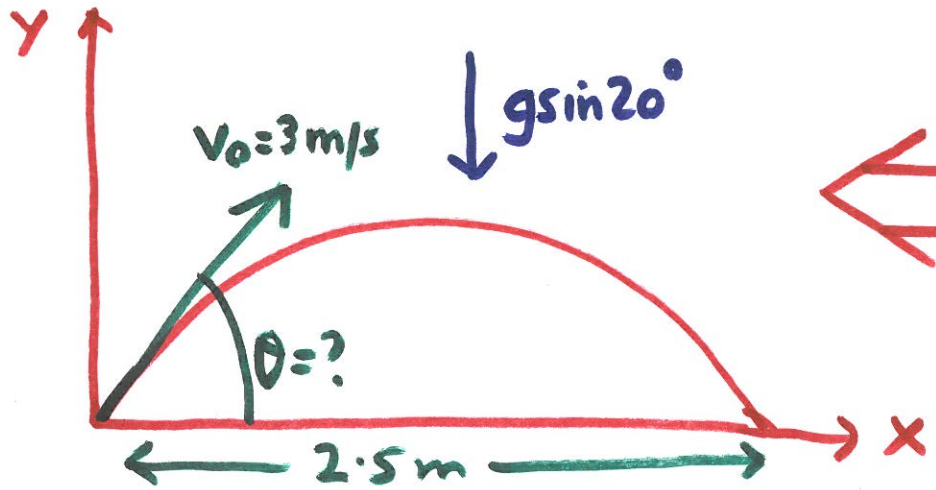
QUADRATIC EQN IN TIME 'Δt':

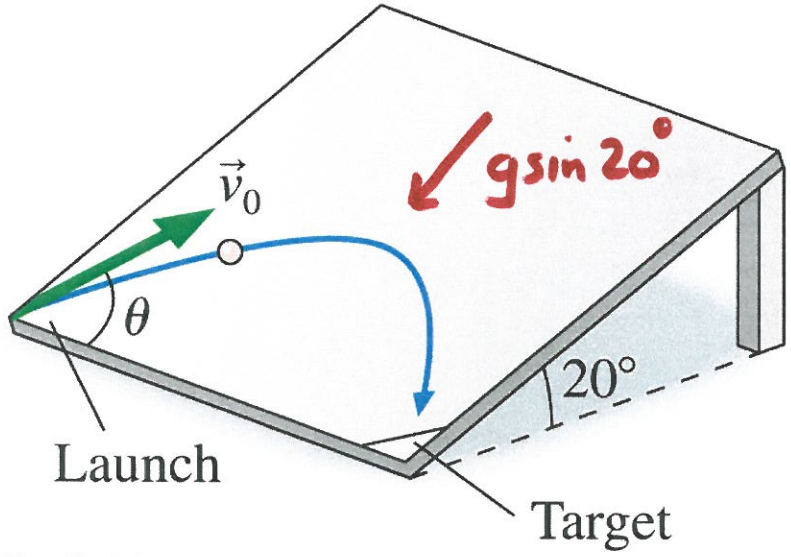
APPENDIX A3: $\Delta t = 6.11$ sec (ignore '−' root)

297 m

Discuss Challenge problem 4.~~73~~ 4.81

In one contest at the county fair, seen below, a spring-loaded plunger launches a ball at a speed of 3.0 m/s from one corner of a smooth, flat board that is tilted at a 20° angle. To win, you must make the ball hit a small target at the adjacent corner, 2.50m away. At what angle should you tilt the ball launcher?





CONVERTS TO A STANDARD PROJECTILE PROBLEM, EXCEPT W/ $a_y = g\sin 20^\circ \downarrow$ INSTEAD OF $a_y = g\downarrow$