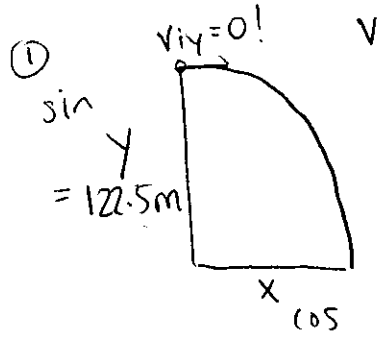
Projectile Motion Practic Problems KEY

① 

? is asking for horizontal displacement

eqn: $X = V_{ix}t$ But we don't know t!

B/C the object is projected horizontally, not @ an angle, the initial vertical velocity is $V_{iy}=0$

* use $y = V_{iy}t + \frac{1}{2}(-g)t^2$ to solve for t

I am making Y neg. b/c the object is being displaced downward.

$\Rightarrow -122.5m = \frac{1}{2}(-9.8\frac{m}{s^2})t^2$

$\frac{-122.5m}{-4.9\frac{m}{s^2}} = \frac{-4.9\frac{m}{s^2}t^2}{-4.9\frac{m}{s^2}}$

$\sqrt{t^2} = \sqrt{25s^2}$

$t = 5s.$

$X = V_{ix}t$

$X = 8 m/s \cos 0° (5s)$

$\boxed{X = 40m}$

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② $\theta = 30°$ $V_i = 49 m/s$; @ top of parabola, $V_{fy} = 0 m/s$

1st find time!

$V_{fy} = V_{iy} + (-g)t$ where $V_{fy} = 0 m/s$ & $V_{iy} = V_i \sin\theta$

$0\frac{m}{s} = 49\frac{m}{s}\sin 30° + (-9.8 m/s^2)t$

$\frac{-24.5\frac{m}{s}}{-9.8\frac{m}{s^2}} = \frac{-9.8\frac{m}{s^2}t}{-9.8\frac{m}{s^2}}$

$t = 2.5s$ now find y (vertical displacement @ the highest point)

$y = v_{iy}t + \frac{1}{2}(-g)t^2$

$y = 24.5 m/s(2.5s) + \frac{1}{2}(-9.8\frac{m}{s^2})(2.5s)^2$

$y = 61.25m + (-30.6m)$

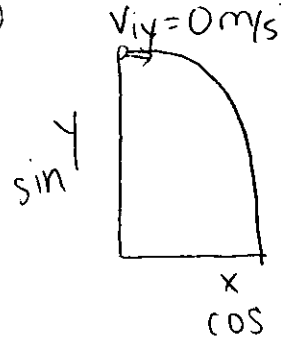
$\boxed{a)\ y = 30.65m}$

double time to find total time ⇓

b) $X = ?$ $X = V_{ix}t = v_i\cos\theta t = 49 m/s \cdot \cos 30° \cdot 5s$

$\boxed{X = 212.2m}$

③



$V = 20 m/s$
$t = 7s$

a) height of Cliff?

$y = V_{iy}t + \frac{1}{2}(-g)t^2$

$y = 0 + \frac{1}{2}\left(-9.8\frac{m}{s^2}\right)(7s)^2$

$y = -240m$. This tells us that the rock falls a distance of 240m down ∴ the height of the cliff is $\boxed{240m}$

b) $V_{fy} = V_{iy} + (-g)t$ so $V_{fy} = \left(-9.8\frac{m}{s^2}\right)(7s) = \boxed{-68.6\frac{m}{s}}$

($V_{iy} = 0$)

c) range = horizontal displacement, x

$x = V_{ix}t = 20\frac{m}{s}\cos 0°\,(7s) = \underline{140m}$

④ $V = 400 m/s$ $\theta = 35°$ $x = ?$ max altitude = max height (y)

$a = -9.8 m/s^2$

* @ max height $V_y = 0 m/s$
* V_x is constant

$x = V_{ix}t$ But we dont know t.

use $V_{fy} = V_{iy} + (-g)t$ to find t@ max height

$0 m/s = 400\frac{m}{s}\sin 35° + (-9.8)(t)$

$0\frac{m}{s} = 229.43\frac{m}{s} - 9.8t$

$-\frac{229.43\frac{m}{s}}{-9.8\,m/s^2} = \frac{-9.8t}{-9.8\frac{m}{s^2}}$

$t = 23s$ * @ max height!

$x = V_{ix}t = 400\frac{m}{s} \cdot \cos 35° \cdot 46s$

use t @ max height

$\boxed{x = 15{,}072m} \Rightarrow$ range

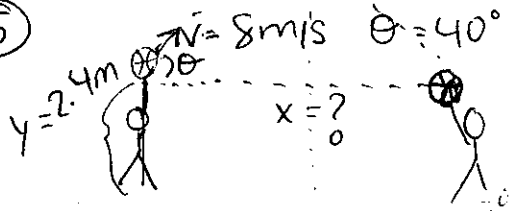
to find max height, use $y = V_{iy}t + \frac{1}{2}(-g)t^2$

$y = 400 m/s \cdot \sin 35°\,(23s) + \frac{1}{2}\left(-9.8\frac{m}{s^2}\right)(23s)^2$

$y = 5{,}276.9m - 2592.1m$ (2592.1m)

$\boxed{y = 2{,}684.8m}$

⑤



$x = v_{ix}t$ 1st find t

use $v_{fy} = v_{iy} + (-g)t$ to find t @ max height b/c we know that @ max height, $v_{fy} = 0 m/s$

$0 m/s = v_i \sin\theta + (-g)t$

$0 \frac{m}{s} = 8 m/s \sin 40° + (-9.8 m/s^2)t$

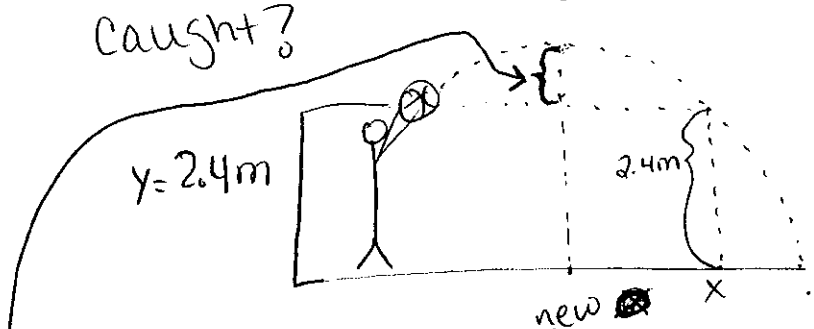
$0 \frac{m}{s} = 5.14 \frac{m}{s} + (-9.8 m/s^2)t$

$\frac{-5.14 \frac{m}{s}}{-9.8 m/s^2} = \frac{-9.8 m/s^2 t}{-9.8 m/s^2}$

$t = 0.52s$ @ max height ∴ t total = 1.04s

$X = v_{ix}t = 8 m/s \cos 40° (1.04s) = \boxed{6.37m}$

⑥ What would the range be if the ball was not caught?



$X = v_{ix}t$ 1st find t ... BUT now we can't find t w/out knowing ~~the~~ y. (from starting point) ∴ use t @ max height = 0.52s

$y = v_{iy}t + \frac{1}{2}(-g)t^2$

$y = \frac{8 m}{s} \sin 40° (0.52s) + \frac{1}{2}(-9.8 \frac{m}{s^2})(0.52s)^2$

$y = 2.67m - 1.32m$

$y = 1.35m$ so total $y = 2.4m + 1.35m = 3.75m$

use this new y to solve for t when ball is falling down

$y = -3.75m = 0t + \frac{1}{2}(-9.8 m/s^2)t^2$

$-3.75m = -4.9t^2$

$t^2 = 0.765$

$t = 0.87 + 0.52s$

* new total time ↓ 1.39s

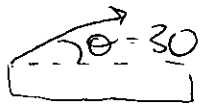
→ now find new x

$x = v_{ix}t$

$x = 8 m/s \cos 40° (1.39s)$

$\boxed{x = 8.5m}$

(7) ⇒ IS A BEAST! (seriously... this one is tough!)



$g = -9.8 m/s^2$

$x = 7.8m$

⇓ horizontal displacement

a) take off speed = ? = V_i

* Remember that b/c take off is at an ANGLE there is BOTH V_{iy} & V_{ix}

V_{iy} = vertical take off speed = $V_i \sin\theta$

V_{ix} = horizontal take off speed = $V_i \cos\theta$

So, what is the SAME in BOTH the vertical & horizontal components???

answer: TIME so figure out an equation for TIME for both vertical & horizontal which include V_i, set them equal to one another & solve for V_i.)

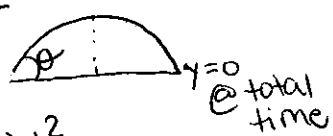
Horizontal w/ time

$x = V_{ix} t \Rightarrow t = \frac{x}{V_{ix}} = \frac{x}{V_i \cos\theta}$

so $\boxed{t = \frac{7.8m}{V_i \cos 30^\circ}}$

Vertical w/ time

* we know that at total time, $y = 0m$:



so use $y = V_{iy} t + \frac{1}{2}(-g)t^2$

$0 = V_i \sin 30^\circ t + (-4.9 \frac{m}{s^2}) t^2$

$-V_i \sin 30^\circ t = -4.9 \frac{m}{s^2} t^2$

$-V_i \sin 30^\circ = -4.9 \frac{m}{s^2} t$

$\frac{-V_i \sin 30^\circ}{-4.9 m/s^2} = \frac{-4.9 m/s^2 t}{-4.9 m/s^2}$

$\boxed{t = \frac{V_i \sin 30^\circ}{4.9 \frac{m}{s^2}}}$

Set these eqns equal to one another b/c time is the SAME.

$\frac{7.8m}{V_i \cos 30^\circ} = \frac{V_i \sin 30^\circ}{4.9 \frac{m}{s^2}}$

$4.9 m/s^2 \cdot 7.8m = \frac{V_i \sin 30^\circ (V_i \cos 30^\circ)}{4.9 m/s^2} \cdot 4.9 m/s^2$

$4.9 \frac{m}{s^2} \cdot 7.8m = V_i \sin 30^\circ (V_i \cos 30^\circ)$

$38.22 \frac{m^2}{s^2} = V_i^2 (0.5)(0.87)$

$\frac{38.22 m^2/s^2}{0.435} = \frac{V_i^2 (0.435)}{0.435}$

$\sqrt{V_i^2} = \sqrt{87.86 \frac{m^2}{s^2}}$

$\boxed{V_i = 9.37 m/s}$ ANSWER!!!

* This whole page is only part A. It is a BEAST! You will not have one this hard on the test! But it's good practice!