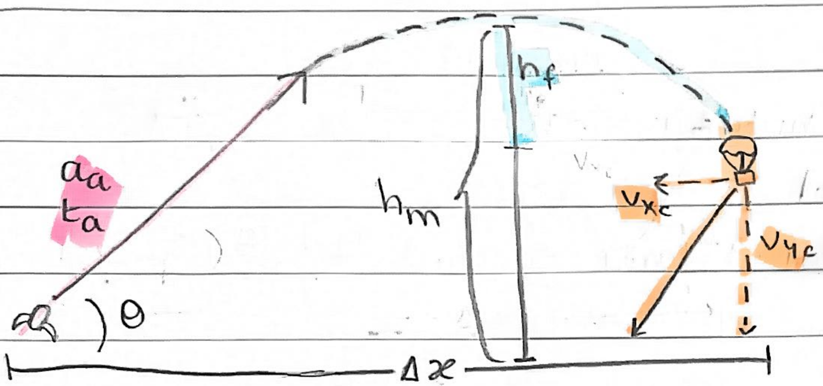
Multi-Step Rocket Problem 9/21/24

My approach:

I broke the problem into 3 parts: the acceleration phase, the projectile phase, and the parachute phase. I found the horizontal distance traveled over each interval and added them to get the final distance traveled.



$\theta = 48°$

$t_a = 7.9$ sec

$a_a = 5.9 \frac{m}{s^2}$

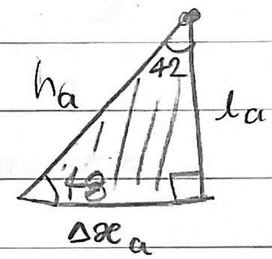
$h_f = 82$ m

$V_{yc} = 8 \frac{m}{s}$

$V_{xc} = 14 \frac{m}{s}$

Phase #1: the acceleration phase

1. solve for final velocity



$a_a = 5.9 \frac{m}{s^2}$
$t_a = 7.9$ sec
$v_0 = 0$

$v - v_0 = at$

$v = 5.9 \times 7.9$

$\boxed{v = 46.61 \frac{m}{s}}$

2. find side lengths of triangle to find the distance traveled and max height during acceleration phase

hypotenuse:

$v^2 = v_0^2 + 2a\Delta x$

$(46.61)^2 = 0^2 + 2(5.9)(\Delta x)$

$2172.49 = 11.8\Delta x$

$\Delta x = 184.11$ m

$\boxed{h_a = 184.11 m}$

distance traveled (Δx_a):

$\sin(42) = \frac{x}{184.11}$

$\sin(42) \cdot 184.11 = x$

$x = 123.19$

$\Delta x_a = 123.19$

height (l_a):

$(123.19)^2 + l_a^2 = (184.11)^2$

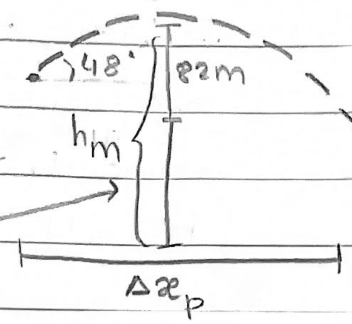
$l_a^2 = 18720.716$

$\boxed{l_a = 136.82 m}$

horizontal distance traveled during acceleration phase: 123.19 m

Phase #2: Projectile Phase

1. find max height of rocket



$V_0 = 46.61 \frac{m}{s}$

$V = 0$

$\theta = 48°$

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

$V^2 = V_0^2 + 2a\Delta x$

$0 = (46.61 \sin 48)^2 - 2(9.8)\Delta y$

$= 678.904 - 19.6\Delta y$

$\Delta y = 61.274m$

max height $= 136.82 + 61.274m = \boxed{198.034m}$

height of parachute $= 198.034 - 82 = \boxed{116.034\ m}$

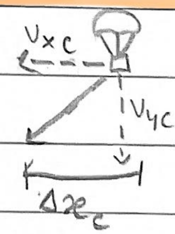
2. find horizontal distance traveled during projectile phase

horizontal	vertical
$\Delta x_p = V_x t$	$y = y_0 + V_{0y} t + \frac{1}{2} a t^2$
$\Delta x_p = (46.61 \cos 48) \times 7.63$	$116.034 = 136.82 + (46.61 \sin 48) t - 4.9t^2$
$\Delta x_p = 237.966m$	$0 = 20.786 + 34.64t - 4.9t^2$
	$t = 7.63$ sec

horizontal distance traveled during projectile phase: 237.966m

Phase #3: parachute phase

1. Find horizontal distance traveled during parachute phase



horizontal	vertical
$\Delta x_c = V_{x_c} t$	$y = y_0 + V_{0y} t + \frac{1}{2} a t^2$
$\Delta x_c = -14t$	$0 = 116.034 - 8t$
$\Delta x_c = -203.056m$	$t = 14.504$

$V_{x_c} = -14$

$a_c = 0$

$V_{0y_c} = -8$

$y_0 = 116$

Final distance traveled:

$\Delta x = \Delta x_a + \Delta x_p + \Delta x_c$

$= 123.19 + 237.966 - 203.056$

$\Delta x = 158.1\ m\ E$

Detailed Explantion:

Acceleration Phase

- first, I used the given information to final velocity of the acceleration phase. For this, I used the 'no x' equation.
- I used that value to find the max height of the acceleration phase as well as the total distance travelled. I used the 'no t' kinematic equation for that.
- last, I used right angle properties to find horizontal distance traveled.

Projectile Phase

- the final velocity from acceleration phase isthe intial velocity for projectile phase.
- I used that and the 'no t' kinematic equation to find the max height of the rocket
- I subtracted 82 from the max height to find the height at which the parachute was deployed.
- I used $\Delta x = V_x t$ and $y = y_0 + V_{0y} + \frac{1}{2}at^2$ to find the horizontal distance traveled and time ~~the pro~~ for the projectile phase.

Parachute phase:

- acceleration is $0 \frac{m}{s^2}$ because there is constant vertical speed
- vertical and horizontal speed are both negative.
- I used $\Delta x = V_x t$ and $y = y_0 + V_{0y} + \frac{1}{2}at^2$ to find horizontal distance traveled and duration of parachute phase

Finale:

- I found the sum of the horizontal distances from all 3 phases.