Multi-Step Rocket Problem

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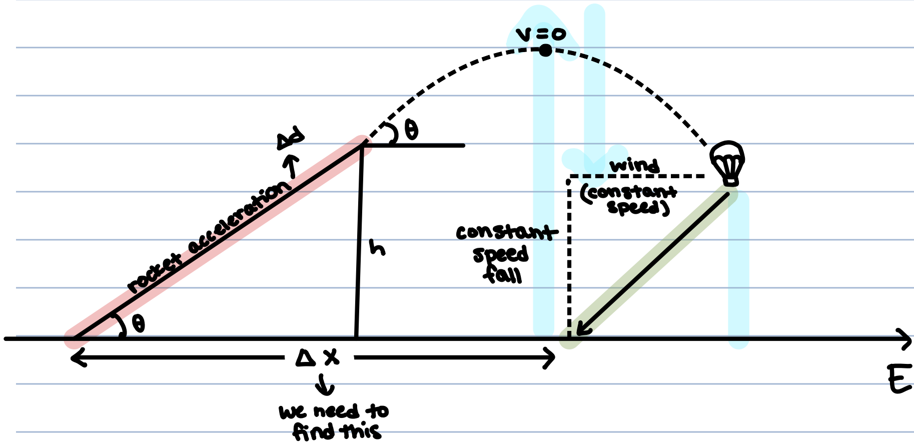


given:

- launch angle: 39°
- engine burn time: 7.3 sec
- Net a of rocket when engine burns: 6.4 m/s²
- vertical d of the rocket from the max height before the parachute opens: 58 m
- rocket w/ parachute constant vertical speed: 10.0 m/s
- wind & rocket w/ parachute constant horizontal speed: 13 m/s

STRATEGY:

STEP 1: In the first step, I solved for the rocket acceleration distance. Then I solved for h, & ΔX up till the projectile starts. I then found the final v for this rocket acceleration phase, which is the v_0 of the projectile phase.

STEP 2: In the second step, I found the max height, added it to h from previous step to find the total height. Then I subtracted the vertical d of the rocket before parachute opens, from the total height. Then find ΔX for the projectile.

STEP 3: In the third step, find the t that the parachute is descending, and then solve for ΔX.

FINAL PART: Added up ΔX for first 2 steps, & subtracted the ΔX from the third step from that sum.

(note, anything circled like ①, ②, etc. represents the order in which they were solved for that step)

STEP 1:

given: $a = 6.4\,m/s^2$

$v_0 = 0\,m/s$

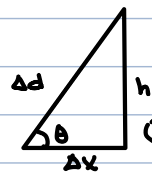
$t = 7.3\,sec$

$\theta = 39°$

Solve for Δd: $\Delta d = v_0 t + \frac{1}{2}at^2$

$\Delta d = 0(7.3) + \frac{1}{2}(6.4)(7.3)^2$

① $\boxed{\Delta d = 170.528\ m}$



$\sin\theta = \frac{h}{\Delta d}$

$\sin 39 \cdot 170.528 = h$

② $\boxed{h = 107.317\ m}$

ΔX: $\cos\theta = \frac{\Delta X}{\Delta d}$

$\cos 39 \cdot 170.528 = \Delta X$

③ $\boxed{\Delta X = 132.525}$

$v = v_0 + at$

$v = 0 + (6.4 \times 7.3)$

④ $\boxed{v = 46.72\ m/s}$

STEP 2:

max height (change in y): $v_y^2 = v_{0y}^2 + 2a\Delta Y$

$0 = (46.72 \sin 39)^2 + 2(-9.8)\Delta Y$

$0 = 864.469 - 19.6\Delta Y$

$\frac{-864.469}{-19.6} = \frac{-19.6\Delta Y}{-19.6}$

① $\boxed{\Delta Y = 44.106}$

total height = h + ΔY

= 107.317 + 44.106

② $\boxed{\text{total height} = 151.423\ m}$

(total height) − (vertical d of the rocket from the max before parachute) = 151.423 − 58

= $\boxed{93.423\ m}$ ③

h	v
$\Delta X = vt$	$Y = Y_0 + v_{0y}t - \frac{1}{2}gt^2$
$\Delta X = (46.72\cos 39)6.44063$	$93.423 = 107.317 + (46.72\sin 39)t - 4.9t^2$
⑤ $\boxed{\Delta X = 233.848}$ → ΔX of the projectile	$-4.9t^2 + (46.72\sin 39)t + 13.894 = 0$
	④ $t = 6.44063$ sec

STEP 3

h	v
$\Delta X = vt$	$Y = Y_0 + v_{0y}t - \frac{1}{2}at^2$ (a=0 because v is constant)
$\Delta X = 13 \cdot 9.3423$	$0 = 93.423 - 10t$
$\boxed{\Delta X = -121.4499\ m}$ ②	$-10t = -93.423$
	① $t = 9.3423$ sec

FINAL PART:

$(132.525\,m + 233.848\,m) - 121.4499$

(step 1, step 2, step 3)

$= \boxed{244.9231\ m\ east}$

final answer!