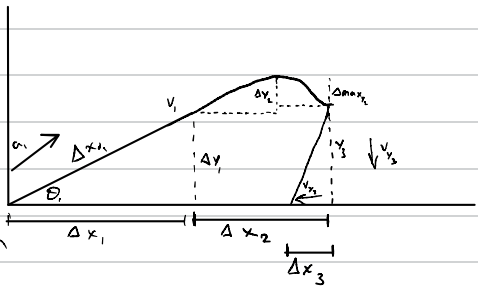
Multi-Step Rocket Problem

Givens / Variables



Launch Angle = $\theta = 34^0$ total $\Delta x = \Delta x_{final}$

Engine Burn Time = $t_1 = 7.9s$

Net Acceleration of rocket = $a_1 = 6.4 m/s^2$

Vertical distance travelled to max height from projectile = Δy_2

Vertical distance rocket falls from max height = $\Delta max_{y_2} = 82 m$

Rocket with parachute constant vertical speed = $V_{y_3} = 6 m/s$

Wind and Rocket with parachute horizontal speed = $V_{x_3} = 14 m/s$

diagonal distance travelled in air while accelerating = Δx_{d_1}

final velocity from acceleration = V_1

horizontal distance travelled by acceleration = Δx_1

Vertical distance travelled by acceleration = Δy_1

final height before parachute = y_3

horizontal distance travelled by parachute = Δx_3

Vertical velocity from the projectile = V_{y_2} horizontal velocity from projectile = V_{x_2}

projectile motion time = t_2

parachute time = t_3

Steps

1.) find final velocity from acceleration

2.) find diagonal distance travelled from V_1

3.) find Δx_1 and Δy_1 from Δx_{d_1}

4.) find V_{y_2} from V_1

5.) find Δy_2 from V_{y_2}

6.) find y_3 from Δy_2

7.) find t_2

8.) find Δx_2

9.) find t_3 using V_{y_3}

10.) find Δx_3

11.) find Δx_{final}

Step 1:

$V_1 = t_1 \cdot a_1$

$V_1 = 7.9 \cdot 6.4$

$V_1 = 50.56 m/s$

Step 2:

$\Delta x_{d_1} = \left(\frac{V_1}{2}\right) \cdot t_1$

$\Delta x_{d_1} = \frac{50.56}{2} \cdot 7.9$

$\Delta x_{d_1} = 199.712 m$

Step 3:

$\Delta y_1 = \Delta x_{d_1} \cdot \sin\theta$

$\Delta y_1 = 199.712 \cdot \sin 34$

$\Delta y_1 = 111.68 m$

$\Delta x_1 = \Delta x_{d_1} \cdot \cos\theta$

$\Delta x_1 = 199.712 \cdot \cos 34$

$\Delta x_1 = 165.57 m$

Step 4:

$V_{y_2} = V_1 \cdot \sin\theta$

$V_{y_2} = 50.56 \cdot \sin 34$

$V_{y_2} = 28.27 m/s$

Step 5:

$V^2 = V_{y_2}^2 + 2(-9.8)\Delta y_2$

$0 = 28.27^2 - 19.6\Delta y_2$

$\Delta y_2 = 40.78 m$

Step 6:

$Y_3 = (\Delta y_1 + \Delta y_2) - \Delta max_{y_2}$

$Y_3 = (111.68 + 40.78) - 82$

$Y_2 = 70.46 m$

Step 7:

$Y_3 = \Delta y_1 + V_{y_2} \cdot t_2 - 4.9 t_2^2$

$70.46 = 111.68 + 28.27 t_2 - 4.9 t_2^2$

$-4.9 t_2^2 + 28.27 t_2 + 41.22 = 0$

$t_2 = 6.98 s$

Step 8:

$\Delta x_2 = V_{x_2} \cdot t_2$

$\Delta x_2 = 50.56 \cos 34 \cdot 6.98$

$\Delta x_2 = 292.4 m$

Step 9:

$t_3 = \frac{Y_3}{V_{y_3}}$

$t_3 = \frac{70.46}{6}$

$t_3 = 11.74 s$

Step 10:

$\Delta x_3 = t_3 \cdot V_{x_3}$

$\Delta x_3 = 11.74 \cdot 14$

$\Delta x_3 = 164.41$

Step 11

$\Delta x_{Final} = \Delta x_1 + \Delta x_2 - \Delta x_3$

$\Delta x_{Final} = 165.57 + 292.4 - 164.41$

$\Delta x_{Final} = 293.6 m$ to East