Multi-Step Rocket Problem

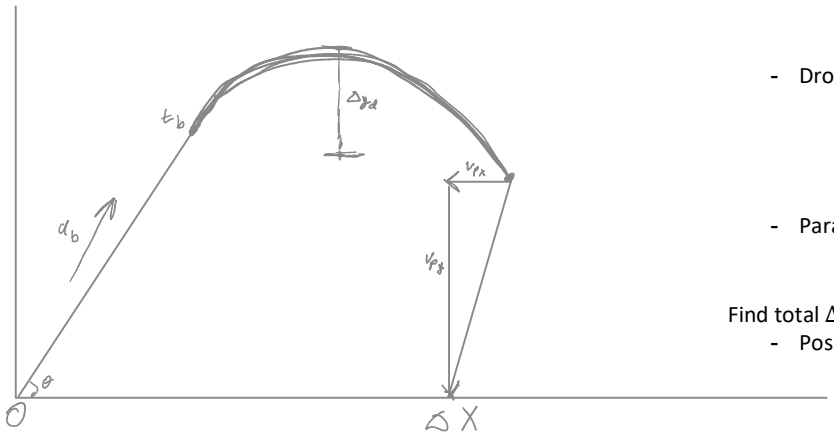
Tuesday, September 26, 2023 10:59 AM

3 stages - Δx and Δy used to keep running total

- Burn stage
  - Find v_{fx} and v_{fy} (no x equation)
    - Will become v_{0x} and v_{0y} next stage
  - Find Δx and Δy (no t equation)
- Drop stage
  - Find maximum height (no t equation)
  - Subtract given vertical distance for Δy_f
  - Find t taken to reach Δy_f (no v equation)
  - Find Δx (constant v equation)
- Parachute stage
  - Find t taken to reach $y = 0$
  - Find Δx (constant v equation)

Find total Δx (add all 3 Δx values)

- Positive is east, negative is west



$\theta = 38°$
$t_b = 7.5\ s$
$a_b = 7.9\ m/s^2$
$\Delta y_d = 78\ m$
$v_{py} = 9.0\ m/s$
$v_{px} = 16\ m/s$

Burn

x	y
$a_x = 7.9\cos\theta$	$a_y = 7.9\sin\theta$
$v_{0x} = 0$	$v_{0y} = 0$
$x_0 = 0$	$y_0 = 0$

$\theta = 38°$
$t = 7.5\ s$
$a = 7.9\ m/s^2$

$x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$
$x = 0 + 0 + \frac{1}{2}(7.9\cos 38)(7.5)^2$
$x = 175.0861393\ m$

$y = y_0 + v_{0y}t + \frac{1}{2}a_y t^2$
$y = 0 + 0 + \frac{1}{2}(7.9\sin 38)(7.5)^2$
$y = 136.7922404892\ m$

$v_{fx} = v_{0x} + a_x t$
$v_{fx} = 0 + (7.9\cos 38)(7.5)$
$v_{fx} = 46.68963715199\ m/s$

$v_{fy} = v_{0y} + a_y t$
$v_{fy} = 0 + (7.9\sin 38)(7.5)$
$v_{fy} = 36.47794241304 5\ m/s$

Drop

x	y
$a_x = 0$	$a_y = g = -9.8$
$v_{0x} = 46.6896$	$v_{0y} = 36.4779$
	$\Delta y_d = 78$

$\theta = 38°$

$v_y^2 = v_{0y}^2 + 2a_y\Delta y$
$0 = 36.4779^2 + 2(-9.8)\Delta y$
$\Delta y = 67.88994103412 97\ m$

$\Delta y_f = \Delta y - \Delta y_d$
$\Delta y_f = 67.8899 - 78$
$\Delta y_f = -10.11018965870 3\ m$
$(126.6920943902 2\ m)$

$y = y_0 + v_{0y}t + \frac{1}{2}a_y t^2$
$-10.1102 = 0 + 36.4779t + \frac{1}{2}(-9.8)t^2$
$t = 7.712021891387 6\ s$

$\Delta x = v_x t$
$\Delta x = (46.6896)(7.71202)$
$\Delta x = 360.0715038109 9\ m$
$(535.1576431279 9\ m)$

Parachute

x	y
$a_x = 0$	$a_y = 0$
$v_x = -16$	$v_y = -9$
$x_0 = 535.158$	$y_0 = 126.682$

$y = y_0 + v_{0y}t + \frac{1}{2}a_y t^2$
$0 = 126.682 - 9t + 0$
$t = 14.07578826 3558\ s$

$\Delta x = v_x t$
$\Delta x = (-16)(14.0758\ s)$
$\Delta x = -225.2126122 49 28\ m$

$309.9450308787 1\ m$

309.9 m east