Uber Rocket Problem

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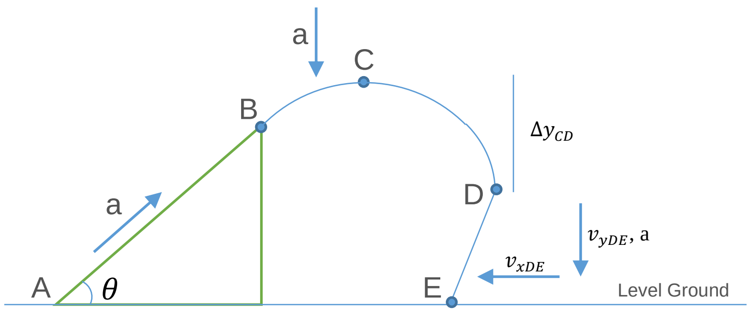


Description: One breezy afternoon Algebra Alex decides to launch Hamster Huey into the air using a model rocket. The rocket is launched over level ground, from rest, at a specified angle above the East horizontal. The rocket engine is designed to burn for specified time while producing a constant net acceleration for the rocket. Assume the rocket travels in a straight-line path while the engine burns. After the engine stops the rocket continues in projectile motion. A parachute opens after the rocket falls a specified distance from its maximum height. When the parachute opens the rocket instantly slows and descends at a constant vertical speed. A horizontal wind blows the rocket, with parachute, from the East to West. Assume the wind affects the rocket only during the parachute stage.

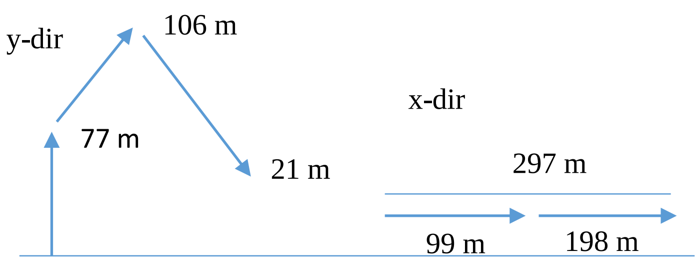
Givens:

Launch Angle	$38° \; N \; of \; E$
Engine Burn Time	$6.6 \; seconds$
Net Acceleration (AB)	$5.8 \; m/s^2$
Δy (CD)	$85 \; m$
Wind Speed	$-9 \; m/s$
Parachute Speed	$-13 \; m/s$

Stage 1 (AB): I componentized the acceleration vectors and used EQ3 to calculate the x and y displacements at B.

$\sin 38 = \frac{a_y}{5.8}$ $5.8 \sin 38 = a_y$ $\underline{a_y = 3.5708}$	$\cos 38 = \frac{a_x}{5.8}$ $5.8 \cos 38 = a_x$ $\underline{a_x = 4.5705}$
$y_B = \frac{1}{2}a_y t^2 + v_{Ay}t + y_A$ $y_B = \frac{1}{2}(3.5708)(6.6^2)$ $\underline{y_B = 77.773 \; meters}$	$x_B = \frac{1}{2}a_x t^2 + v_{Ax}t + x_A$ $x_B = \frac{1}{2}(4.5705)(6.6^2)$ $\underline{x_B = 99.545 \; meters}$

$v_{By} = a_y t + v_{Ay}$
$v_{By} = 3.5708(6.6)$
$\underline{v_{By} = 23.568 \; m/s}$



$v_{Bx} = a_x t + v_{Ax}$
$v_{Bx} = 4.5705(6.6)$
$\underline{v_{Bx} = 30.165 \; m/s}$

Stage 2 (BD): I calculated the maximum height of the rocket during its projectile motion phase and subtracted 85 to find y_D. Using that value, I calculated time and solved for x_D.

$$y_C = \frac{1}{2}a_y t^2 + v_{By}t + y_B$$
$$y_C = -4.9t^2 + 23.568t + 77.773, \; vertex$$
$$\frac{-b}{2a} = \frac{-23.568}{-9.8} = 2.4098 \; seconds$$
$$y_C = -4.9(2.4048)^2 + 23.568(2.4048) + 77.773$$
$$\underline{y_C = 106.11 \; meters} \qquad \underline{-85 = y_D = 21.111 \; m}$$

$$y_B = \frac{1}{2}a_y t^2 + V_{By}t + y_B$$
$$21.111 = -4.9t^2 + 23.568t + 77.773$$
$$0 = -4.9t^2 + 23.568t + 56.662, \; solve$$
$$t = \{-1.7601, 6.5698\}$$
$$\underline{t = 6.5698 \; seconds}$$

$$x_D = v_{Bx}t$$
$$x_D = 30.165(6.5698)$$
$$\underline{x_D = 198.18 \; meters}$$

$$\boxed{x_E = 267.3 \; meters}$$

Stage 3 (DE): The parachute gave the rocket an y-velocity of -9 m/s downwards and a x-velocity of -13 m/s eastwards. I calculated the time for the rocket to fall and solved for x_E.

$y_E = \frac{1}{2}a_y t^2 + v_{Dy}t + y_D$ $0 = 0 - 9t + 21.111$ $\underline{t = 2.3457}$	$X_E = v_{Dx} + x_D$ $x_E = -13(2.35) + 297.7$ $\underline{x_E = 267.23 \; meters}$