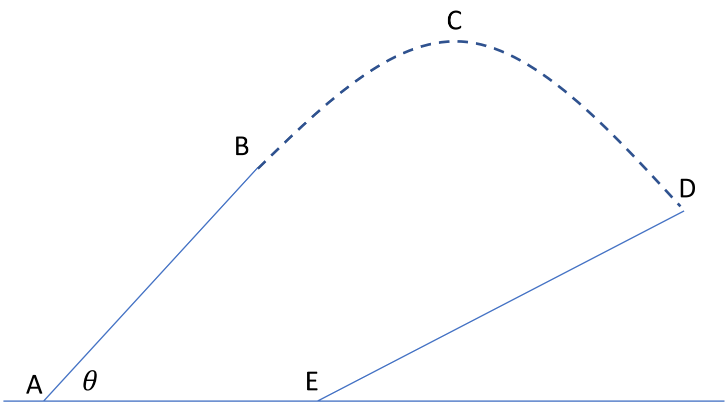
Justin Che 10/08/2021 Section S

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 vertical distance from its maximum height. When the parachute opens the rocket instantly changes speed and descends at a constant vertical speed. A horizontal wind blows the rocket, with parachute, from the East to West at the constant speed of the wind. Assume the wind affects the rocket only during the parachute stage.



Givens:

$\theta = 54^\circ$

$t_B = 6.1$ s

$a_A = 5.3$ m/s^2

$y_{C\text{-}D} = -61$ m

$v_{DX} = -19$ m/s

$v_{DY} = -10$ m/s

$x_A = 0$m

$v_A = 0$ m/s

$a = -9.8$ m/s^2

$y_A = 0$ m

$y_E = 0$ m

My strategy involved finding the x-displacement between two adjacent points and adding the values up at the end. Firstly, to find the x-displacement from A to B, I found the true distance from A to B (hypotenuse), and then used trig to find x-displacement. To find the x-displacement from points B to D, I found the height first at each individual point using EQ4/velocities. Using the height at each point, I used EQ3 to find time. After finding the time in between two points, the $v_{avg} = \frac{\Delta x}{\Delta t}$ equation could be used to find x-displacement, since time was just found and v_{avg} is constant from B to D. Finally, I used the equation $v_{avg} = \frac{\Delta x}{\Delta t}$ to find time and then x-displacement from points D to E. All the different x-displacements have been accounted for, so all that is needed is to add them up!

Step 1: From A to B:

$$x_f = \frac{1}{2}a\Delta t^2 + v_i\Delta t + x_i$$

$$d_{AB} = \frac{1}{2}a_A\Delta t_B^2 + v_A t_B + x_i$$

$$d_{AB} = \frac{1}{2}a_A\Delta t_B^2$$

$$d_{AB} = \frac{1}{2} * 5.3 * 6.1^2$$

$$\underline{d_{AB} = 98.6065\ m}$$

$$y_B = d_{AB} sin\theta$$

$$y_B = 98.6065 sin54$$

$$\underline{y_B = 79.7743\ m}$$

$$x_B = d_{AB} cos\theta$$

$$x_B = 98.6065 cos54$$

$$\underline{\Delta x_{AB} = 57.9594\ m}$$

$$v_f = a\Delta t + v_i$$

$$v_B = a_A t_B + v_A$$

$$v_B = 5.3 * 6.1$$

$$\underline{v_B = 32.33\ m/s}$$

$$v_{By} = v_B sin\theta$$

$$v_{By} = 32.33 sin54$$

$$\underline{v_{By} = 26.1555\ m/s}$$

$$v_{Bx} = v_B cos\theta$$

$$v_{Bx} = 32.33 cos54$$

$$\underline{v_{Bx} = 19.0\ m/s}$$

Step 2: From B to C:

$v_f^2 = v_i^2 + 2a\Delta x$

$v_f^2 = v_{By}^2 + 2a\Delta y_{BC}$

$0 = v_{By}^2 + 2a\Delta y_{BC}$

$\Delta y_{BC} = -\frac{v_{By}^2}{2a}$

$\Delta y_{BC} = -\frac{26.1555^2}{2*-9.6}$

$\Delta y_{BC} = -\frac{684.1}{-19.6}$

$\underline{\Delta y_{BC} = 34.9\ m}$

$y_C = \Delta y_{BC} + y_B$

$y_C = \Delta y_{BC} + y_B$

$y_C = 34.9 + 79.7743$

$\underline{y_C = 114.678}$

$x_f = \frac{1}{2}a\Delta t^2 + v_i\Delta t + x_i$

$y_C = \frac{1}{2}at_C^2 + v_{By}t_C + y_B$

$0 = \frac{1}{2}(-9.8)t_C^2 + 26.1555t_C + y_B - y_C$

$0 = -4.9t_C^2 + 26.1555t_C - 34.9,\ solver$

$\underline{t_C = 2.67s}$

$v_{avg} = \frac{\Delta x}{\Delta t}$

$v_{Bx} = \frac{\Delta x_{BC}}{t_C}$

$v_{Bx} * t_C = \Delta x_{BC}$

$\Delta x_{BC} = 19 * 2.67$

$\underline{\Delta x_{BC} = 50.74}$

Step 3: From C to D

$y_D = y_C + y_{C-D}$

$y_D = 114.678 - 61$

$\underline{y_D = 53.678}$

$x_f = \frac{1}{2}a\Delta t^2 + v_i\Delta t + x_i$

$y_D = \frac{1}{2}at_D^2 + v_{Cy}t_D + y_C$

$0 = \frac{1}{2}at_D^2 + y_C - y_D$

$y_D = -4.9t_D^2 + 61,\ solver$

~~$t_D = -3.59\ s$~~ or $\underline{t_D = 3.53\ s}$

$v_{avg} = \frac{\Delta x}{\Delta t}$

$v_{Bx} = \frac{\Delta x_{CD}}{t_D}$

$v_{Bx} * t_D = \Delta x_{CD}$

$\Delta x_{CD} = 19 * 3.53$

$\underline{\Delta x_{CD} = 67.05\ m}$

Step 4: From D to E:

$v_{avg} = \frac{\Delta x}{\Delta t}$

$v_{Dy} = \frac{\Delta y}{t_E}$

$v_{Dy} = \frac{y_E - y_D}{t_E}$

$t_E = \frac{y_E - y_D}{v_{Dy}}$

$t_E = \frac{0-53.678}{-10}$

$t_E = \frac{-53.678}{-10}$

$\underline{t_E = 5.3678\ s}$

$v_{avg} = \frac{\Delta x}{\Delta t}$

$v_{Dx} = \frac{\Delta x_{DE}}{t_E}$

$v_{Dx} = \frac{\Delta x_{DE}}{t_E}$

$v_{Dx} * t_E = \Delta x_{DE}$

$\Delta x_{DE} = -19 * 5.3678$

$\underline{\Delta x_{DE} = -101.988\ m}$

Final Step: Answer:

$\Delta x = \Delta x_{AB} + \Delta x_{BC} + \Delta x_{CD} + \Delta x_{DE}$

$\Delta x = 57.9594 + 50.74 + 67.05 + (-101.988)$

$\boxed{\Delta x = 73.76\ m}$