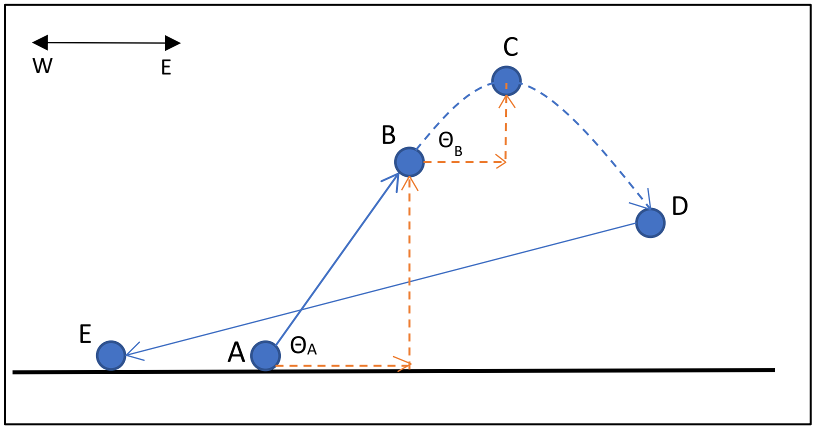
Name: Zoe Butzke Date: 10/5/2021 Section: S

Problem Statement:

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.

Question:

Calculate the x-displacement of where the rocket lands from the initial x-position



Givens:			**Variable:**
Launch Angle:	59	deg	Θ_A
Engine Burn Time:	8.6	sec	Δt_{AB}
Net Acceleration of rocket while engine burns:	4.4	m/s^2	a_{AB}
Vertical Distance rocket falls from max height before parachute opens:	65	m	Δy_{CD}
Rocket with parachute constant vertical speed:	7	m/s	$v_{DE\ y}$
Wind and rocket with parachute constant horizontal speed:	16	m/s	$v_{DE\ x}$

Steps Explanation:

1. Solve for the velocity at point B. This was done by utilizing the engine burn time, launch angle, and net acceleration while the engine burns.
2. Solve for the components of the velocity at B. This was done to simplify the next step.
3. Solve for the y-displacement the rocket from A to B.
4. Solve for the x-displacement the rocket from A to B.
5. Solve for the y-displacement between points B and C.
6. Solve for the time it takes the rocket to get from point B to C. This step is necessary in order to proceed with step 7.
7. Solve for the x-displacement between B and C.
8. Solve for the y-displacement of the rocket at D using the given distance that it drops from c.
9. Solve for the time it takes the rocket to go from point C to D. This step is necessary in order to proceed with step 10.
10. Solve for the x-displacement between C and D.
11. Solve for the total x-displacement of D. This was done by adding the x-displacements between each of the prior points.
12. Solve for the time it takes the rocket to go from point D to point E.
13. Solve for the x-displacement from D to E.
14. The final step was to solve for the x-displacement of the rocket from the initial position.

Name: Zoe Butzke Date: 10/5/2021 Section: S

Step 1:
Solve for v_B

$v_f = a\Delta t + v_i$
$v_B = a_{AB}\Delta t_{AB} + v_i$
$v_B = 4.4(8.6) + 0$
$\underline{v_B = 37.8400\ m/s}$

Step 2:
Solve for v_{Bx} and v_{By}

Note: $\theta_A = \theta_B$

$v_x = v * \cos(\theta)$
$v_{Bx} = v_B * \cos(\theta)$
$v_{Bx} = 37.84 * \cos(59)$
$\underline{v_{Bx} = 19.4890\ m/s}$

$v_y = v * \sin(\theta)$
$v_{By} = v_B * \sin(\theta)$
$v_{By} = 37.84 * \sin(59)$
$\underline{v_{By} = 32.4352\ m/s}$

Step 3:
Solve for Δy_{AB}

NOTE: $v_y = v * \sin(\theta)$
$\Delta x = \frac{1}{2}(v_f + v_i)\Delta t$
$\Delta y_{AB} = \frac{1}{2}(v_{By} + v_{Ay})\Delta t$
$\Delta y_{AB} = \frac{1}{2}(32.4352 + 0)8.6$
$\underline{\Delta y_{AB} = 139.471\ m}$

Step 4:
Solve for Δx_{AB}

NOTE: $v_x = v * \cos(\theta)$

$\Delta x = \frac{1}{2}(v_f + v_i)\Delta t$
$\Delta x_{AB} = \frac{1}{2}(v_{Bx} + v_{Ax})\Delta t$
$\Delta x_{AB} = \frac{1}{2}(19.4890 + 0)8.6$
$\underline{\Delta x_{AB} = 83.80327}$

Step 5:
Solve for Δy_{BC}

$v_f^2 = v_i^2 + 2a\Delta x$
$v_{Cy}^2 = v_{By}^2 + 2a_y\Delta y_{BC}$
$0^2 = 32.4352^2 + 2(-9.8)\Delta y_{BC}$
$0 = 1052.04 + (-19.6)\Delta y_{BC}$
$-1052.04 = (-19.6)\Delta y_{BC}$
$\underline{\Delta y_{BC} = 53.6756\ m}$

Step 6:
Solve for Δt_{BC}

$v_f = a\Delta t + v_i$
$v_{Cy} = g\Delta t_{BC} + v_{By}$
$0 = -9.8\Delta t_{BC} + 32.4352$
$-32.4352 = -9.8\Delta t_{BC}$
$\underline{\Delta t_{BC} = 3.30971\ s}$

Step 7:
Solve for Δx_{BC}

$v_{avg} = \frac{\Delta x}{\Delta t}$
$v_{Cx} = \frac{\Delta x_{BC}}{\Delta t_{bc}}$
$19.4890 = \frac{\Delta x_{BC}}{3.30971}$
$\underline{\Delta x_{BC} = 64.5030\ m}$

Step 8:
Solve for y_D

$\Delta y = y_f - y_i$
$y_f = \Delta y + y_i$
$y_D = y_C + \Delta y_{CD}$
$y_D = 193.147 + (-65)$
$\underline{y_D = 128.147\ m}$

Step 9:
Solve for Δt_{CD}

$x_f = \frac{1}{2}a\Delta t^2 + v_i\Delta t + x_i$
$y_D = \frac{1}{2}(a_y)\Delta t_{CD}{}^2 + v_{Cy}\Delta t_{CD} + y_C$
$128.147 = \frac{1}{2}(-9.8)\Delta t_{CD}^2 + 193.147$
$128.147 = (-4.9)\Delta t_{CD}^2 + 193.147$
$-65 = (-4.9)\Delta t_{CD}^2$
$t^2 = 13.2653$
$\Delta t_{CD} = -3.64216\ s \quad OR$
$\underline{\Delta t_{CD} = 3.64216\ s}$

Step 10:
Solve for Δx_{CD}

$v_{avg} = \frac{\Delta x}{\Delta t}$
$v_{Dx} = \frac{\Delta x_{CD}}{\Delta t_{CD}}$
$19.4890 = \frac{\Delta x_{CD}}{3.64216}$
$\underline{\Delta x_{CD} = 70.9821\ m}$

Step 11:
Solve for Δx_D

$\Delta x_D = \Delta x_{AB} + \Delta x_{BC} + \Delta x_{CD}$
$\Delta x_D = 83.80327 + 64.5030 + 70.9821$
$\underline{\Delta x_D = 219.288\ m}$

Step 12:
Solve for Δt_{DE}

$v_{avg} = \frac{\Delta x}{\Delta t}$
$v_{DEy} = \frac{\Delta y_{DE}}{\Delta t_{DE}}$
$7.00 = \frac{128.147}{\Delta t_{DE}}$
$\underline{\Delta t_{DE} = 18.3067\ s}$

Step 13:
Solve for Δx_{DE}

$v_{avg} = \frac{\Delta x}{\Delta t}$
$v_{DEx} = \frac{\Delta x_{DE}}{\Delta t_{DE}}$
$-16.0 = \frac{\Delta x_{DE}}{18.3067}$
$\underline{\Delta x_{DE} = -292.907\ m}$

Step 14:
Solve for Δx_E

$\Delta x_E = \Delta x_D + \Delta x_{DE}$
$\Delta x_E = 219.288 + (-292.907)$
$\Delta x_E = -73.619\ m$

FINAL ANSWER:
Δx_E = 73.62 meters west of A