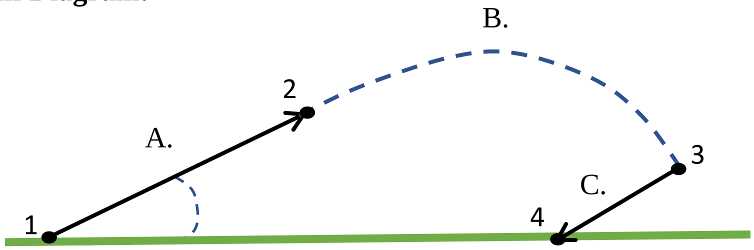
Garyth Page Violette
Section S

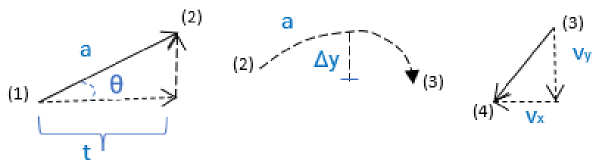
10/3/21

Über Problem - Hamster Huey and Algebra Alex

Problem: 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 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 rockets only during the parachute stage.

Full Diagram:





A.)

t = 8 sec

θ = 35 °

a = 4.9 m/s²

B.)

Δy = 75 m

a = -9.8 m/s²

C.)

v_y = 10 m/s

v_x = -15 m/s

Strategy:

I broke the problem up into three separate phases (A,B,C), which have separate coefficients for velocity, acceleration, etc... I also numerically labeled the positions where the values of the coefficients at those points affected the values of the coefficients in the kinematic equations of the following phases. I then determined the values in phase A for: Δx (hypotenuse), the actual Δx of A, and the velocity at point two using trigonometry and equations for constant acceleration. I used these values in the second phase, in addition to solving for Δy , to determine the v_i of x and y for the projectile equations of phase B. I then had to identify the maximum height (vertex) of phase B, by determining and substituting the amount of time it takes for the velocity to equal zero in the projectile motion of y[t]. I subtracted 75 from this height to determine the height of the rock at the start of phase C. I also had to determine the time it takes to get to this point by finding the Δx for the x[t] equation of this phase, and I summed it with the Δx of the previous stage. Then it was a matter of finding the theta below the horizon in phase C by using the inverse tangent of the given vertical and horizontal velocities. I used theta in an inverse tangent equation to determine the negative Δx of C knowing the initial height at point three. The sum of these values provided the final value for the total Δx.

A.)

$v_f = a\Delta t + v_i$

$v_f = (4.9)(8.3) + 0$

$v_2 = 40.67\ m/s$

$\Delta x = \frac{1}{2}\left(v_f + v_i\right)\Delta t$

$\Delta x = \frac{1}{2}(40.67 + 0)(8.3)$

$\Delta x = 168.78\ m$

$\Delta x_A = \Delta x(\cos(\theta))$

$\Delta x_A = 168.78(\cos(35))$

$\Delta x_A = 138.257\ m$

B.)

$v_{iy} = v_2(\sin(\theta))$

$v_{iy} = 40.67(\sin(35))$

$v_{iy} = 23.327\ m/s$

$y_i = \Delta x * hypotenuse * (\sin(\theta))$

$y_i = 168.78(\sin(35))$

$y_i = 96.808\ m$

$y[t] = \frac{1}{2}a_y(\Delta t)^2 + v_i(\Delta t) + y_i$

$\mathbf{y[t] = -4.9(\Delta t)^2 + 23.327(\Delta t) + 96.808}$

$v_{fy} = a_y\Delta t + v_{iy}$

$0 = -9.8(\Delta t) + 23.327$

$-23.327 = -9.8\Delta t$

$\Delta t = 2.3804\ s$

$y[2.3804] = -4.9(2.3804)^2 + 23.327(2.3804) + 96.808$

$y[2.3804] = 124.572\ m$

$y_3 = 124.572 - 75$

$y_3 = 49.572\ m$

$49.572 = -4.9(\Delta t)^2 + 23.327(\Delta t) + 96.808$

$*\ Solver\ t = -1.5319\ X\ or\ t = 6.2927\ s$

$x[t] = v_{ix}(\Delta t) + \Delta x_A$

$v_{ix} = v_2(\cos(\theta))$

$v_{ix} = 40.67(\cos(35))$

$v_{ix} = 33.315\ m/s$

$\mathbf{x[t] = 33.315(\Delta t) + 138.257}$

$x[6.29] = 33.315(6.29) + 138.257$

$\Delta x_{AB} = 347.896\ m$

C.)

$\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right)$

$\theta = \tan^{-1}\left(\frac{10}{15}\right)$

$\theta = 33.69°\ S\ of\ W$

$\theta = \tan^{-1}\left(\frac{y_3}{\Delta x_c}\right)$

$33.69 = \tan^{-1}\left(\frac{49.572}{\Delta x_c}\right)$

$\Delta x_c = 74.358\ m$

$tot\,\Delta x = \Delta x_{AB} - \Delta x_c$

$tot\,\Delta x = 347.896 - 74.358$

$tot\,\Delta x = 273.538\ m$

$\boxed{tot\Delta x = 273.5\ m}$

Hamster Huey will travel a total of **273.5** meters from his initial to final horizontal position.