20-P-KM-AF-004

Rectilinear Continous Motion: Beginner

Q:

You hang out with your friend and their dog. The dog is older and has a harder time seeing the ball so you have to roll the ball. Due to the grass, the acceleration acts as $a = (A - Bt)$ m/s². The initial velocity is $v = D$ m/s. Where does the ball stop and how long does it take the dog to get there if they move at C m/s.

A:

use $a = dv/dt$, , note $A = D \cdot {}^B/_2 - 1$

$\int dv = \int a\, dt$

$v_f - v_i = \int_0^t [A - Bt]\, dt$

$-v_i = [At - {}^{Bt^2}/_2]\Big|_0^t$

$-D = At - {}^{Bt^2}/_2$

$0 = -{}^{Bt^2}/_2 + At + D$

$v = -{}^{Bt^2}/_2 + At + D$

$t = D$

$v = ds/dt$

$\int_{s_i}^{s_f} ds = \int_0^t v\, dt$

$s_f - s_i = \int_0^t \left[-\frac{Bt^2}{2} + At + D\right] dt$

$s = \left[-\frac{Bt^3}{6} + \frac{At^2}{2} + Dt\right]\Big|_0^t$

$s = -Bt^3/6 + At^2/2 + Dt$

$s = -B\,{}^{D^3}/_6 + A\,{}^{D^2}/_2 + D^2$

$s = D^2\left[\frac{-BD}{6} + \frac{A}{2} + 1\right]$

$v = {}^s/_t \Rightarrow t = {}^s/_v$

$t = D^2\left[\frac{-BD}{2} + \frac{A}{2} + 1\right] / C$