Answer on Question #70329, Physics / Other

A jet touches down on a runway with a speed of 142.4mph. after 12.4s, the jet comes to a complete stop. Assuming constant acceleration of the jet. How far down the runway from where it touched down does the jet stand?

SOLUTION

Uniform acceleration is a type of motion in which the velocity of an object changes by an equal amount in every equal time period. There are simple formulas elating the displacement, initial and time-dependent velocities, and acceleration to the time elapsed:

$\vec{v}(t) = \vec{v_0} + \vec{a}t$, (1)

$v^2(t) = v_0^2(t) + 2\vec{a}(\vec{s}(t) - \vec{s_0})$, (2)

where t is the elapsed time,

$\vec{s_0}$ is the initial displacement from the origin,

$\vec{s}(t)$ is the displacement from the origin at time t,

$\vec{v_0}$ is the initial velocity, and

$\vec{a}$ is the uniform rate of acceleration.

Let us present a picture to imagine the task.

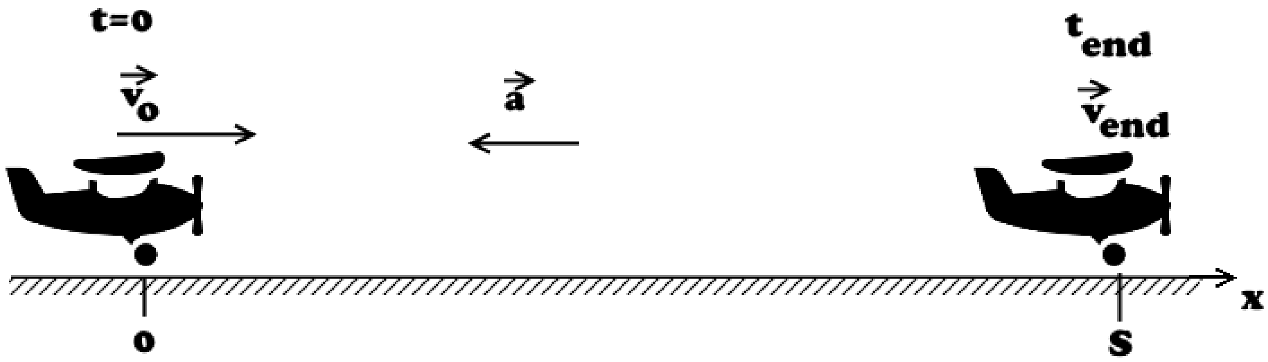

Fig. 1. Jet lending

A jet touches down on a runway with a speed of v_0=142.4 mph = (142.4/3600) mile/s ≈ 0.04 mile/s. Let us suppose that it is a time t=0, and the touch point has a displacement s_0=0. After t_{end}=12.4 s, the jet comes to a complete stop: v_{end}=0. Assuming constant acceleration of the jet, from the formula (1) we can find acceleration:

$\vec{a} = \frac{\vec{v}(t_{end}) - \vec{v_0}}{t_{end}}$, (3)

$$a = \frac{\left(0 - 0.04\frac{mile}{s}\right)}{12.4s} = -0.0032\frac{mile}{s^2}.$$

Appearing the minus means that acceleration decreases velocity. Extracting the displacement from the formula (2), we obtain a result:

$$s - s_0 = \frac{v_{end}^2 - v_0^2}{2a} = -\frac{\left(0.04\frac{mile}{s}\right)^2}{2\left(-0.0032\frac{mile}{s^2}\right)} = 0.25\,mile.$$

ANSWER: the jet stands 0.25 mile from the touched down point.

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