3.2 Motion With Constant Acceleration

STANDARDS
3.1 I can interpret and analyze the motion of an object moving with constant acceleration.

3.2 Motion with Constant Acceleration

Remember...

\[ t \cdot a_{AV} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i} \]

Constant-Acceleration Equation of Motion:
Velocity as a Function of Time

\[ v_x = v_{xo} + a_x t \]

\[ v_f = v_i + a t \]

Constant-Acceleration Equations of Motion

Position as a Function of Time

\[ x = x_o + v_{xo} t + \frac{1}{2} a_x t^2 \]

\[ x_f = x_o + v_o t + \frac{1}{2} a t^2 \]

Review

Average Acceleration

\[ a_{AV} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i} \]

Positive and Negative Acceleration

EXAMPLE: How Far?

An automobile starts at rest and speeds up at 3.5 m/s^2 after the traffic light turns green. How far will it have gone after 5.5 s?

\[ t = 5.5 \text{ s} \]
\[ a = 3.5 \text{ m/s}^2 \]

\[ v_i = 0 \]
\[ x_o = 0 \]

\[ \frac{x_f}{2} = \frac{4}{3} \cdot \frac{1}{2} \]

\[ x_f = \frac{53}{2} \text{ m} \]

EXAMPLE: How Fast?

A plane is being accelerated uniformly from rest at the rate of 5.0 m/s^2 for 3.5 s. What is its velocity after 3.5 s?

\[ a = 5.0 \text{ m/s}^2 \]
\[ t = 3.5 \text{ s} \]
\[ v_i = 0 \]

\[ v_f = 5 \text{ m/s} \]

\[ x_f = \frac{53}{2} \text{ m} \]
3.2 Motion With Constant Acceleration

Constant-Acceleration Equations of Motion

Velocity as a Function of Position

\[ v_x^2 = v_{x0}^2 + 2a(x-x_0) \]

\[ v_f^2 = v_0^2 + 2a(x_f-x_0) \]

Example

A drag racer starts from rest and accelerates at 7.40 m/s\(^2\). How fast is it moving after it has gone 20.0 m?

\[ v_f = \sqrt{2a(x_f-x_0)} \]

\[ v_f = \sqrt{2(7.40\text{ m/s}^2)(20.0\text{ m})} \]

\[ v_f = 17.2 \text{ m/s} \]

Driving At Night

A park ranger driving on a back country road suddenly sees a deer "frozen" in the headlights. The ranger, who is driving at 11.4 m/s, immediately applies the brakes and slows with an acceleration of 3.80 m/s\(^2\).

\[ x_0 = 0 \]
\[ v_0 = 11.4 \text{ m/s} \]
\[ a = -3.80 \text{ m/s}^2 \]
\[ v_f = ? \]
\[ x_f = ? \]

\[ \frac{v_f^2 - v_0^2}{2a} = x_f - x_0 \]

\[ \frac{v_f^2}{2a} - \frac{(11.4\text{ m/s})^2}{2(-3.80 \text{ m/s}^2)} = x_f \]

\[ x_f = 17 \text{ m} \]
Driving At Night

How much time is needed for the ranger's vehicle to stop?

\[ v_f = v_i + at \]