3.2 Motion with Constant Acceleration

STANDARDS

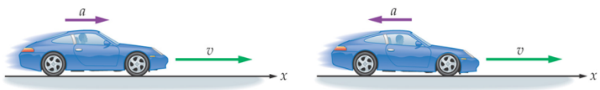
3.1 I can interpret and analyze the motion of an object moving with constant acceleration.

Review

Average Acceleration

$$\vec{a}_{av} = \frac{\Delta \vec{v}}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$$

Positive and Negative Acceleration



Remember...

$$t \cdot a_{av} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{\Delta t} \cdot t$$

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

$$v_x = v_{xo} + a_x t$$

$$V_f = V_o + at$$

EXAMPLE: How Fast?

A plane is being accelerated uniformly from rest at the rate of 5.0 m/s² for 8.5 s. What final velocity does it attain?

$a = 5.0\ m/s^2$
$t = 8.5\ s$
$V_o = 0$
$X_o = 0$
$V_f = ?$

$V_f = V_o + at$
$V_f = (5.0\ m/s^2)(8.5\ s)$
$V_f = 42\ m/s$

$\frac{m}{s^2} \cdot s$

$\frac{\frac{4}{3}}{2} = \frac{4}{3} \cdot \frac{1}{2}$

Constant-Acceleration Equations of Motion

Position as a Function of Time

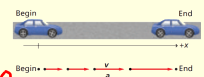
$$x = x_o + v_{xo} t + ½ a_x t^2$$

$$X_f = X_o + V_o t + \frac{1}{2} a t^2$$

EXAMPLE: How Far?

An automobile starts at rest and speeds up at 3.5 m/s² after the traffic light turns green. How far will it have gone after 5.5 s?

$t = 5.5\ s$
$a = 3.5\ m/s^2$
$V_o = 0$
$X_o = 0$
$X_f = ?$



$X_f = X_o + V_o t + \frac{1}{2} a t^2$
$X_f = \frac{1}{2} a t^2$
$X_f = \frac{1}{2}(3.5\ m/s^2)(5.5\ s)^2$
$X_f = 53\ m$

Constant-Acceleration Equations of Motion

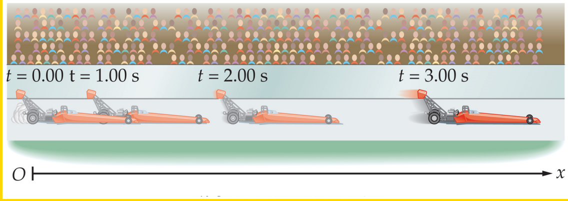
Velocity as a Function of Position

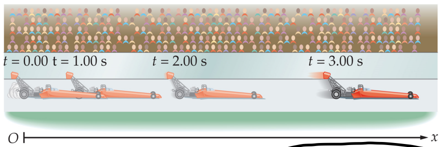
$$v_x^2 = v_{xo}^2 + 2a_x(x - x_o)$$

$$V_f^2 = V_o^2 + 2a(X_f - X_o)$$

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?





$X_o = 0$

$a = 7.40\ m/s^2$

$X_f = 20.0\ m$

$V_o = 0$

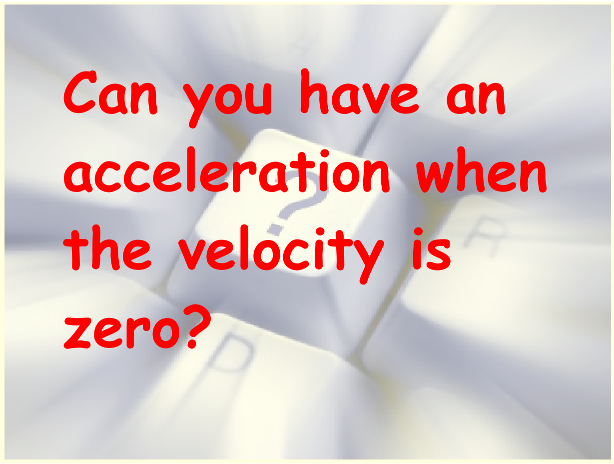
$V_f = ?$

$$\sqrt{V_f^2} = \sqrt{V_o^2 + 2a(X_f - X_o)}$$

$$V_f = \sqrt{2aX_f}$$

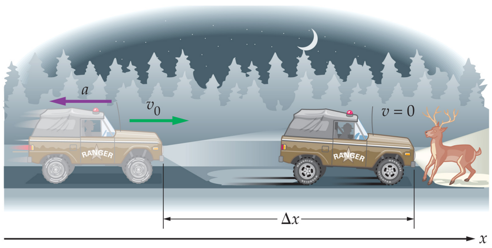
$$V_f = \sqrt{2(7.4\ m/s^2)(20\ m)}$$

$$V_f = 17.2\ m/s$$

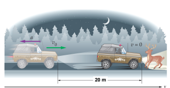


Driving At Night

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.



Driving At Night



If the deer is 20.0 m from the ranger's vehicle when the brakes are applied, will he hit the deer?

$X_o = 0$

$V_o = 11.4\ m/s$

$a = -3.80\ m/s^2$

$V_f = 0$

$X_f = ?$

$$V_f^2 = V_o^2 + 2a(X_f - X_o)$$

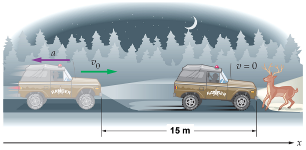
$$\frac{V_f^2 - V_o^2}{2a} = \frac{2a(X_f - X_o)}{2a}$$

$$X_o + \frac{V_f^2 - V_o^2}{2a} = X_f - X_o$$

$$\frac{-(11.4\ m/s)^2}{2(-3.80\ m/s^2)} = \frac{-(V_o^2)}{2a} = X_f$$

$$17.1\ m = X_f$$

Driving At Night



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

$V_f = V_o + at$