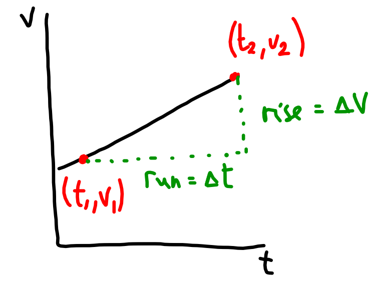
Acceleration

An object has acceleration if its speed and/or direction changes. (i.e. if the velocity changes). Acceleration is the rate of change of velocity.

Constant Acceleration



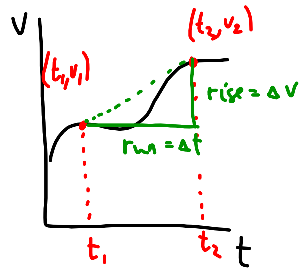
$$slope = \frac{rise}{run}$$

$$slope = \frac{\Delta v}{\Delta t}$$

But the slope on v-t graph is acceleration.

$$\vec{a} = \frac{\Delta \vec{v}}{\Delta t}$$

Non-Constant Acceleration

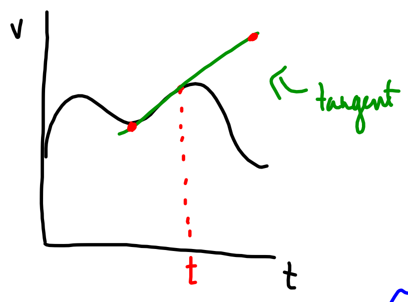


$$slope = \frac{rise}{run}$$

$$slope = \frac{\Delta v}{\Delta t}$$

$$\vec{a}_{ave} = \frac{\Delta \vec{v}}{\Delta t}$$

Average acceleration is the slope of the line connecting two points on a v-t graph

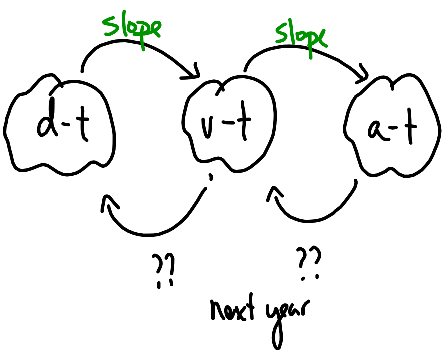


$$slope = \frac{rise}{run}$$

$$slope = \frac{\Delta v}{\Delta t}$$

$$\vec{a}_{inst} = \frac{\Delta \vec{v}}{\Delta t}$$

Instantaneous acceleration is the slope of the tangent at time, t



Acceleration

$$\vec{a} = \frac{\Delta \vec{V}}{\Delta t}$$

Where $\vec{a}$ is the acceleration ($m/s/s$ or m/s^2)

$\Delta \vec{V}$ is the change in velocity (m/s)

where $\Delta \vec{V} = \vec{V}_f - \vec{V}_i$

Δt is the time interval (s)

Example

A car enters a tunnel at 24 m/s and accelerates steadily at 2.0 m/s². At what speed does the car leave the tunnel 8.0 s later?

$V_i = 24\,m/s$

$V_f = ??$

$a = 2.0\,m/s^2$

$\Delta t = 8.0\,s$

$$a = \frac{\Delta V}{\Delta t}$$

$$a = \frac{V_f - V_i}{\Delta t}$$

$$a \Delta t = V_f - V_i$$

$$V_f = V_i + a\Delta t$$

$$V_f = 24\,m/s + (2.0\,m/s^2)(8.0\,s)$$

$$V_f = 24\,m/s + 16\,m/s$$

$$V_f = 40\,m/s$$

The car exits the tunnel with a speed of 40 m/s

Example

What is the average acceleration of a car that is going 15 m/s [E] and then 5.0 s later it is going 10 m/s [W]?

$\vec{V}_i = 15\,m/s\,[E] = +15\,m/s$

$\vec{V}_f = 10\,m/s\,[W] = -10\,m/s$

$\Delta t = 5.0\,s$

$$\vec{a} = \frac{\Delta \vec{V}}{\Delta t}$$

$$\vec{a} = \frac{\vec{V}_f - \vec{V}_i}{\Delta t}$$

$$\vec{a} = \frac{-10\,m/s - (+15\,m/s)}{5.0\,s}$$

$$\vec{a} = \frac{-25\,m/s}{5.0\,s}$$

$$\vec{a} = -5.0\,m/s^2$$

$$\vec{a} = 5.0\,m/s^2\,[W]$$

(note that the acceleration is in the opposite direction of the original motion)