Acceleration & Velocity-Time Graphs

Constant Acceleration (Uniform)

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

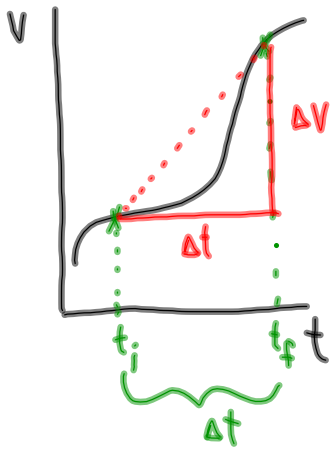
$\text{slope} = \frac{\Delta v}{\Delta t}$ $\left(\frac{\Delta y}{\Delta x} \rightarrow \frac{\Delta v}{\Delta t}\right)$

slope = acceleration

$\therefore a = \frac{\Delta v}{\Delta t}$ ← slope is constant since the graph is linear

acceleration is the rate of change in velocity

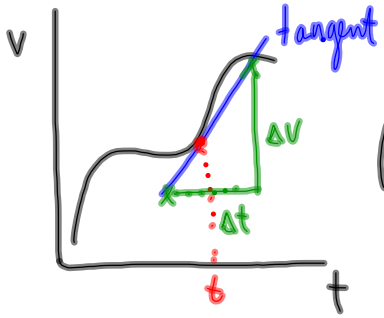
Non-Constant Acceleration (Non-Uniform)



$\text{Slope} = \frac{\Delta v}{\Delta t}$

$a_{ave} = \frac{\Delta v}{\Delta t}$

Average Acceleration is the slope between two points on the v-t graph.



$\text{Slope} = \frac{\Delta v}{\Delta t}$

$a_{inst} = \frac{\Delta v}{\Delta t}$

Instantaneous Acceleration is the slope of the tangent drawn at t.

✓ eyeball tangent

✗ use calculus ↑ later!

The Acceleration Equation

$\vec{a} = \frac{\Delta \vec{v}}{\Delta t}$ Where $\vec{a}$ is acceleration (m/s/s or m/s^2)

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

$(\Delta \vec{v} = \vec{v}_f - \vec{v}_i)$

Δt is the time interval (s)

Units: $\frac{m/s}{s}$

$\frac{m}{s} \div s$

$\frac{m}{s} \cdot \frac{1}{s}$

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

Example 1

A skier accelerates on her skis from $\vec{v}_i$ (6m/s [forward]) to ($\vec{v}_f$ 15m/s [forward]) in (Δt 1.5s). What is her average acceleration during this time? $a_{ave} = ?$

$\vec{v}_i = 6\ m/s\ [forward]$

$\vec{v}_f = 15\ m/s\ [forward]$

$\Delta t = 1.5\ s$

$\vec{a} = ??$

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

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

$\vec{a}_{ave} = \frac{+15\ m/s - (+6\ m/s)}{1.5\ s}$

$\vec{a}_{ave} = \frac{+9\ m/s}{1.5\ s}$

$\vec{a}_{ave} = +6\ m/s^2$

$\vec{a}_{ave} = 6\ m/s^2\ [forward]$

$\frac{m/s}{s} = m/s/s = m/s^2$

In 1 s, the skier's velocity changed by 6 m/s [forward]

6 m/s/s