# Acceleration & Velocity-Time Graphs


## Constant Acceleration (linear v-t graph)

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

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

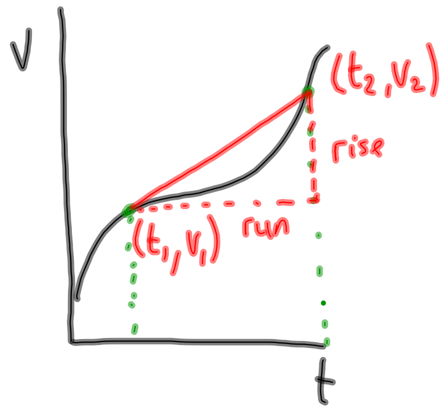
from INVS we know that

slope (v-t) = acceleration

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

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

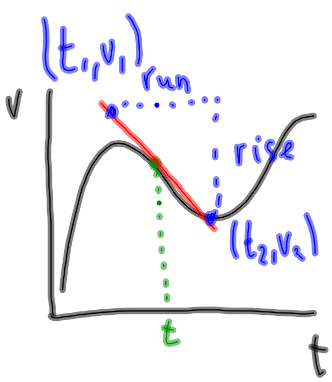
## Non-Constant Acceleration (non-uniform)




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

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

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




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

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

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

← find slope of tangent.

# Acceleration

Acceleration is a vector quantity unless it specifies to find the "magnitude". (size with no direction)

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

$$\vec{a} = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t}$$

## MP|77

$\vec{a} = 5.2 m/s^2$ [downhill]

$\Delta t = 8.5 s$

$\vec{v}_1 = 0$ (implied)

$\vec{v}_2 = ??$

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

$$\vec{a} = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t}$$

$$\vec{a}\Delta t = \vec{v}_2 - \vec{v}_1$$

$$\vec{v}_2 = \vec{v}_1 + \vec{a}\Delta t$$

$$\vec{v}_2 = \vec{v}_1 + \vec{a}\Delta t$$

$$\vec{v}_2 = 0 + (5.2 m/s^2 \text{ [downhill]})(8.5 s)$$

$$\vec{v}_2 \doteq 44 \frac{m}{s} \text{ [downhill]}$$

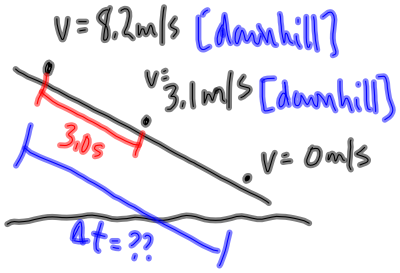
Think about what acc really means....

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

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

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

MP/78




Assume that the acceleration is constant

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

$\vec{a} = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t}$

$\vec{a} = \frac{3.1\,m/s\,[downhill] - 8.2\,m/s\,[dhill]}{3.0\,s}$

$\vec{a} = \frac{-5.1\,m/s\,[downhill]}{3.0\,s}$

$\frac{m}{s} \div s = \frac{m}{s} \cdot \frac{1}{s} = \frac{m}{s^2}$

$\vec{a} = -1.7\,m/s^2\,[downhill]$

Now we know the acceleration and we can find the time it takes to stop.

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

$\vec{a} = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t}$

$\vec{a}\Delta t = \vec{v}_2 - \vec{v}_1$

$\Delta t = \frac{\vec{v}_2 - \vec{v}_1}{\vec{a}}$

$\Delta t = \frac{0\,m/s - 8.2\,m/s\,[downhill]}{-1.7\,m/s^2\,[downhill]}$

$\Delta t = \frac{-8.2\,m/s\,[downhill]}{-1.7\,m/s^2\,[downhill]}$ ← must have the same direction.

$\Delta t \doteq 4.8\,s$

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

To Do: PP/80

Calculator Pad 1-15