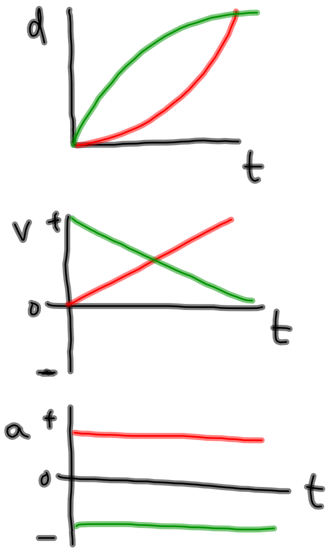
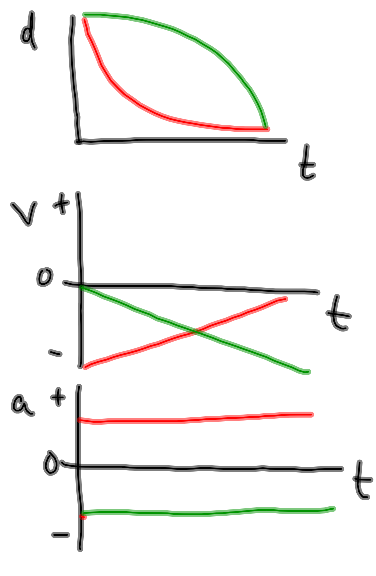
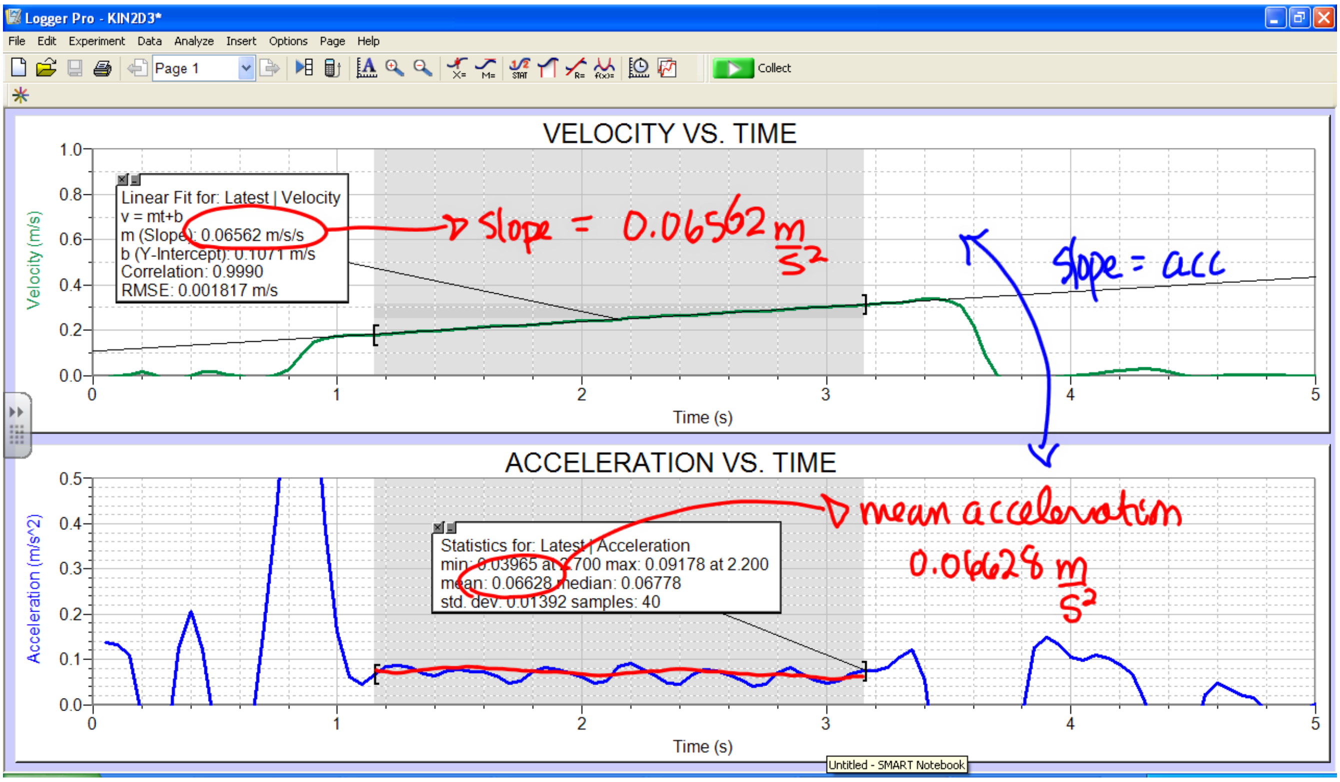
Position, Velocity + Acceleration Graphs



- Speeding up (+) steadily going away (+) => + acc
- Slowing down (−) steadily going away (+) => − acc



- slowing down (−) steadily, going towards (−). => + acc
- speeding up (+) steadily, going towards (−). => − acc


Logger Pro - KIN2D3*
File Edit Experiment Data Analyze Insert Options Page Help
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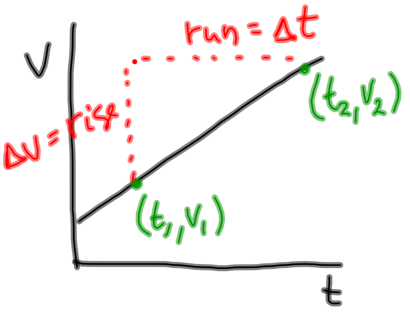
Collect
VELOCITY VS. TIME
Velocity (m/s)
Time (s)
Linear Fit for: Latest | Velocity
v = mt+b
m (Slope): 0.06562 m/s/s
b (Y-Intercept): 0.1071 m/s
Correlation: 0.9990
RMSE: 0.001817 m/s
slope = 0.06562 m/s²
slope = acc
ACCELERATION VS. TIME
Acceleration (m/s^2)
Statistics for: Latest | Acceleration
min: 0.03965 at 2.700 max: 0.09178 at 2.200
mean: 0.06628 median: 0.06778
std. dev: 0.01392 samples: 40
mean acceleration
0.06628 m/s²
Untitled - SMART Notebook

Acceleration

Consider an object moving with constant acceleration:



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

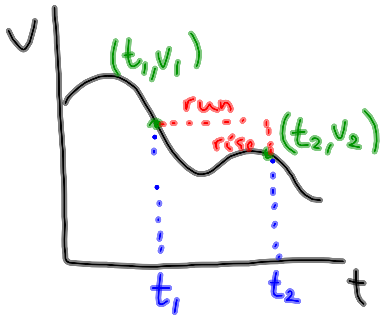
$$\text{slope} = \frac{\Delta v}{\Delta t}$$

from the previous graphs, we know that slope (v-t) is equal to acceleration

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

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

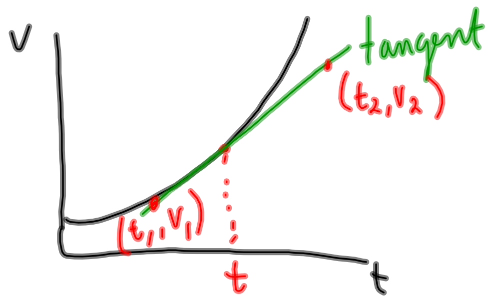
Non-Constant Acceleration



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

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

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



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

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

Instantaneous velocity is the slope of the tangent at time, t.

Using the Acceleration Equation

acceleration is a vector quantity:

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

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

solving for Δt

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

solve for v_2

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

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

solve for v_1

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

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

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

mp 177

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

$\Delta t = 8.5 s$

$\vec{v}_1 = 0$

$\vec{v}_2 = ?$

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

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

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

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

Δv

m/s/s

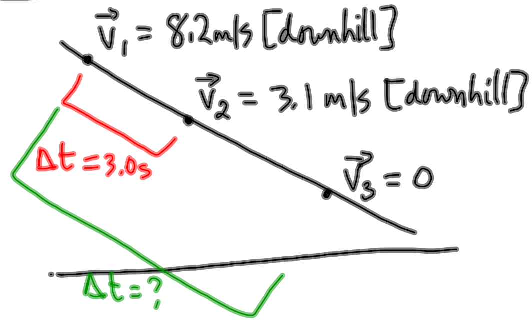
$$\vec{v}_2 = 0 + (5.2 \frac{m}{s^2} \text{[downhill]})(8.5 s)$$

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

Units:

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

The velocity of the boulder will be $44 \frac{m}{s}$ [downhill] mp|78



Find the time to stop: $v_2 = 0$

$\vec{v}_1 = 8.2$ m/s [downhill]

$a = -1.7 \frac{m}{s^2}$ [downhill]

$\Delta t = ?$

$\vec{v}_2 = 0$

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

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

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

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

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

$$\Delta t \doteq 4.8\ s$$

It took 4.8s for the skier to stop.

Find the acceleration during the first 3.0s after the fall.

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

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

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

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

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

or $\vec{a} = 1.7\frac{m}{s^2}$ [uphill]

TO DO

① PP|80

② Calculator Pad