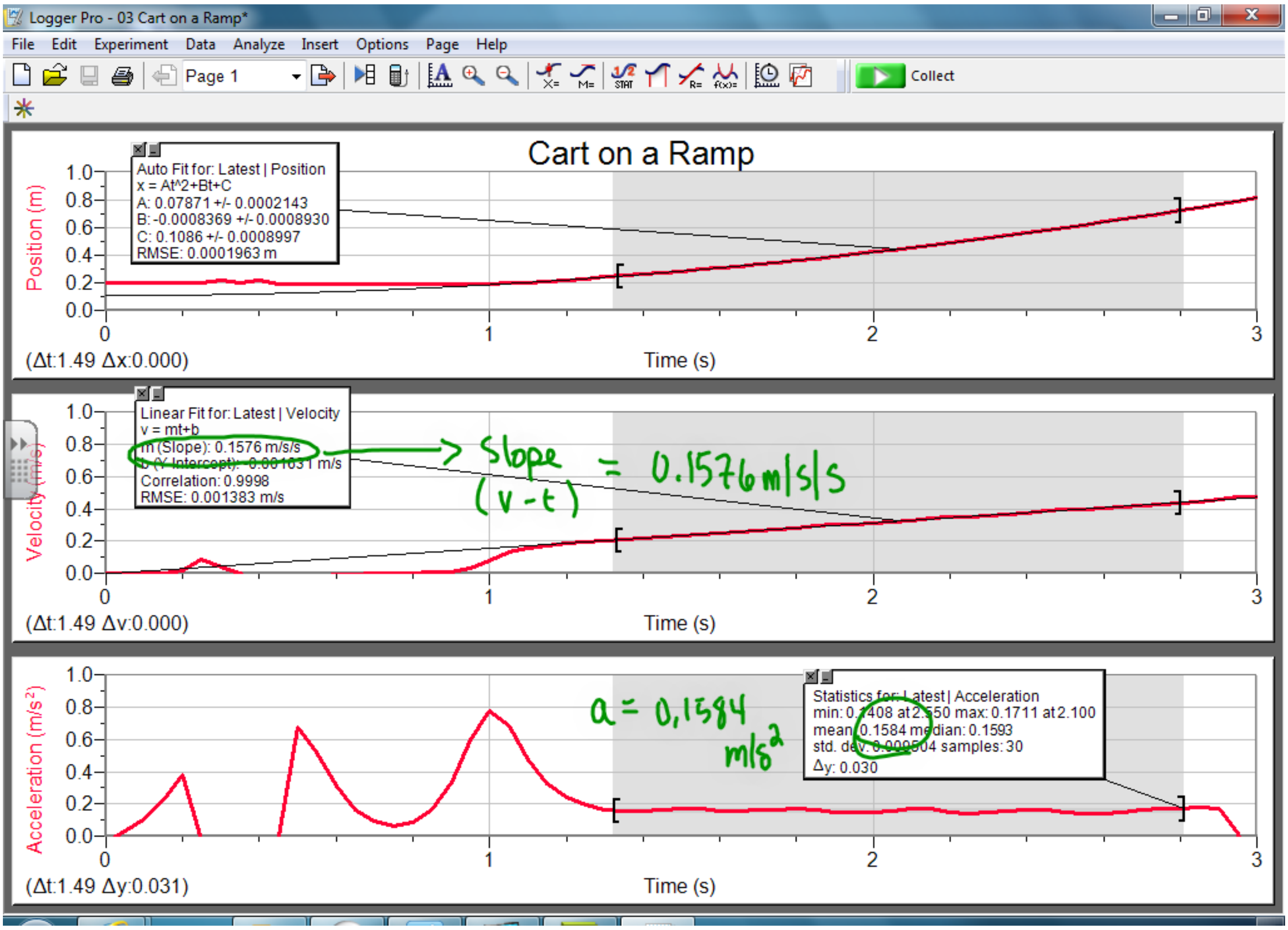
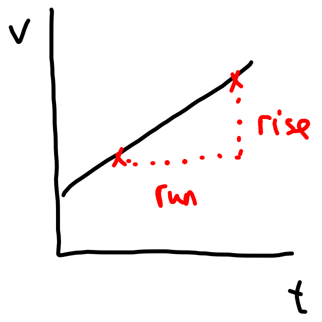

Logger Pro - 03 Cart on a Ramp*
File Edit Experiment Data Analyze Insert Options Page Help
Page 1
Collect
Cart on a Ramp
Auto Fit for: Latest | Position
x = At^2+Bt+C
A: 0.07871 +/- 0.0002143
B: -0.0008369 +/- 0.0008930
C: 0.1086 +/- 0.0008997
RMSE: 0.0001963 m
Position (m)
(Δt:1.49 Δx:0.000)
Time (s)
Linear Fit for: Latest | Velocity
v = mt+b
m (Slope): 0.1576 m/s/s
b (Y-Intercept): -0.001031 m/s
Correlation: 0.9998
RMSE: 0.001383 m/s
Slope (v-t) = 0.1576 m/s/s
Velocity (m/s)
(Δt:1.49 Δv:0.000)
Time (s)
a = 0,1584 m/s²
Statistics for: Latest | Acceleration
min: 0.1408 at 2.550 max: 0.1711 at 2.100
mean: 0.1584 median: 0.1593
std. dev: 0.009504 samples: 30
Δy: 0.030
Acceleration (m/s²)
(Δt:1.49 Δy:0.031)
Time (s)

# Acceleration and Velocity-Time Graphs

## Constant Acceleration




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

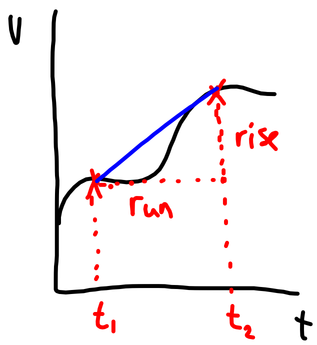
$$\text{slope} = \frac{\Delta v}{\Delta t}$$

Slope (v-t) = acceleration (from the DEMO)

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

The slope is constant since the v-t graph is linear.

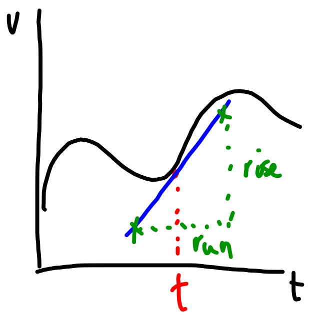
## Non-Constant Acceleration




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

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

Average acceleration is the slope of the line joining the two points.




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

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

Instantaneous acceleration is the slope of the tangent drawn at time t.

* Eyeball tangent!
Use Calculus .... not yet
Use technology .... graphing calculator/Logger Pro

## The acceleration equation

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

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

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

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

$\Delta t$ is the time interval (s)

## Example 1

A skier accelerates on her skis from 6 m/s [forward] to 15 m/s [forward] in 1.5 s. What is her acceleration during this time?

$\vec{v}_i$ $\vec{v}_f$ $\Delta t$

G

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

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

$\Delta t = 1.5$ s

R

$\vec{a} = ?$

A

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

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

S

$$\vec{a} = \frac{15\text{ m/s [forward]} - 6\text{ m/s [forward]}}{1.5\text{ s}}$$

$$\vec{a} = \frac{9\text{ m/s [forward]}}{1.5\text{ s}}$$

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

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

(m/s/s)

P The acceleration of the skier is 6 m/s$^2$ [forward]

## Example 2

A skateboarder rolls down a hill with an average acceleration ($\vec{a}$) of (+)0.40m/s² downhill. He is on the hill for 4.8s ($\Delta t$) and was going (+) 10.1m/s downhill ($\vec{v}_f$) at the bottom of the hill. What was his velocity at the start?

$\vec{v}_i = ?$

$$\vec{v}_f = +10.1\,m/s$$
$$\Delta t = 4.8\,s$$
$$\vec{a} = +0.40\,m/s^2$$
$$\vec{v}_i = ?$$

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

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

$$\vec{a}\Delta t = \vec{v}_f - \vec{v}_i$$
$$\vec{v}_i + \vec{a}\Delta t = \vec{v}_f$$
$$\vec{v}_i = \vec{v}_f - \vec{a}\Delta t$$

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

$$\vec{v}_i = +10.1\,m/s - (+0.40\,m/s^2)(4.8\,s)$$
$$\vec{v}_i = +10.1\,m/s - 1.92\,m/s$$
$$\vec{v}_i = +8.2\,m/s$$

↑ downhill

The skateboarder was going +8.2m/s at the top of the hill.

## Example 3

$\vec{a} = 9.81\, m/s^2$ [down]

neglecting air resistance.

$\vec{v}_i = 0$

A ball is dropped and falls until it reaches a velocity of 29.8 m/s [down]. How long was it falling?

$\vec{v}_f$ $\Delta t$

$\vec{v}_i = 0$

$\vec{v}_f = 29.8\, m/s$ [down]

$\vec{a} = 9.81\, m/s^2$ [down]

$\Delta t = ?$

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

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

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

$$\Delta t = \frac{29.8\, m/s\,[\text{down}] - 0}{9.81\, m/s^2\,[\text{down}]}$$

$$\Delta t = 3.04\, s$$

UNITS:

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

$$= s$$

The ball was falling for 3.04 s.

# Acceleration

$$a = \frac{\Delta v}{\Delta t} \quad \text{where: } \Delta v = v_f - v_i$$

$$a = \frac{v_f - v_i}{\Delta t}$$

To solve for $v_f$ or $v_i$ =>

$$a\Delta t = v_f - v_i$$

$v_f$

$$\boxed{v_f = v_i + a\Delta t}$$

$v_i$

$$v_i + a\Delta t = v_f$$

$$\boxed{v_i = v_f - a\Delta t}$$

$$a\Delta t = v_f - v_i$$

$$\boxed{\Delta t = \frac{v_f - v_i}{a}}$$