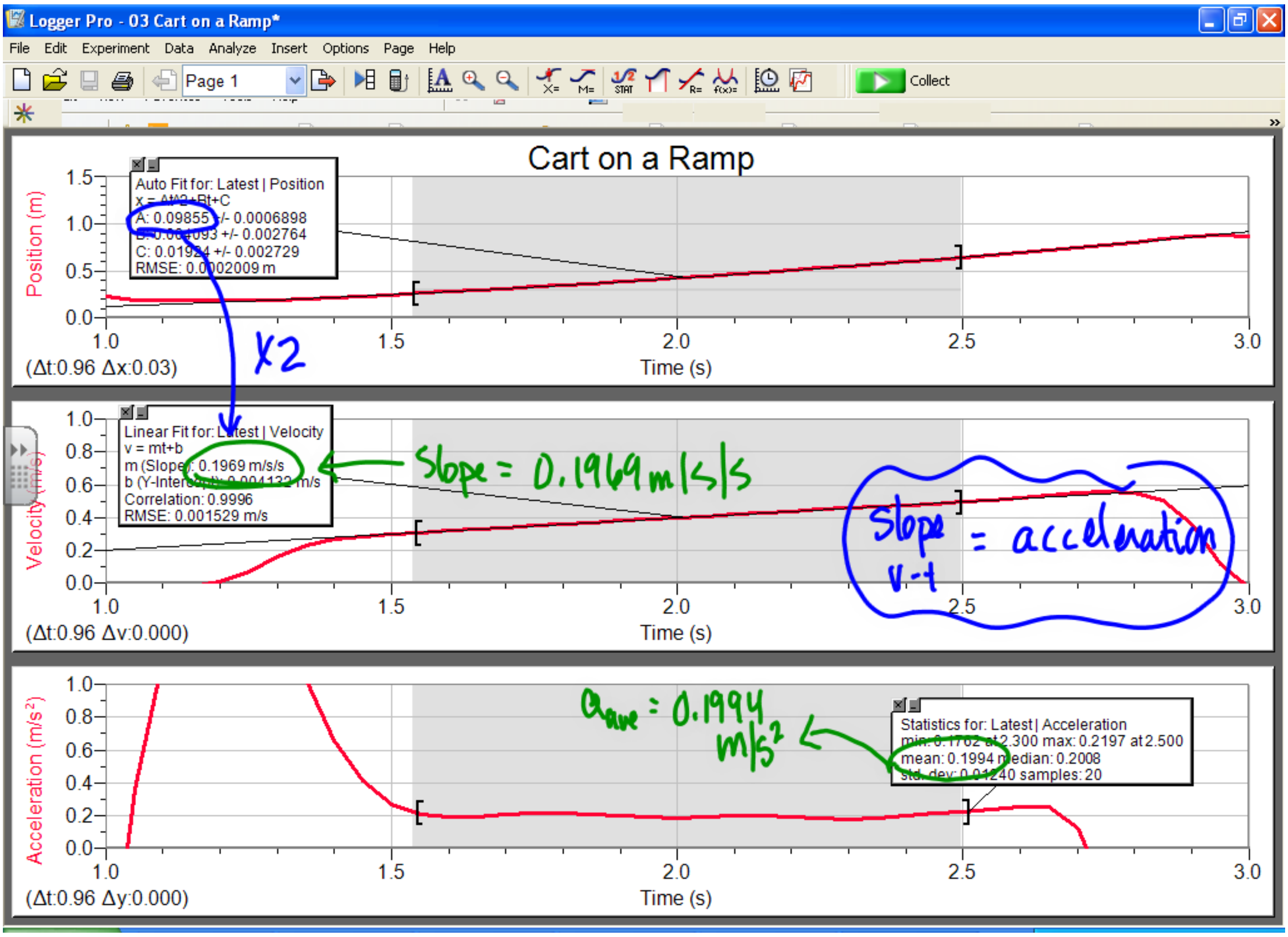
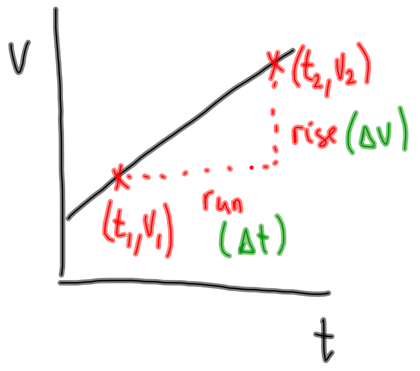

Logger Pro - 03 Cart on a Ramp*
File Edit Experiment Data Analyze Insert Options Page Help
Page 1
Collect
Cart on a Ramp
Auto Fit for: Latest | Position
x = At^2+Bt+C
A: 0.09855 +/- 0.0006898
C: 0.01924 +/- 0.002729
RMSE: 0.0002009 m
Position (m)
(Δt:0.96 Δx:0.03)
Time (s)
x2
Linear Fit for: Latest | Velocity
v = mt+b
m (Slope): 0.1969 m/s/s
Correlation: 0.9996
RMSE: 0.001529 m/s
Slope = 0.1969 m/s/s
slope v-t = acceleration
Velocity (m/s)
(Δt:0.96 Δv:0.000)
Time (s)
a_ave = 0.1994 m/s²
Statistics for: Latest | Acceleration
mean: 0.1994 median: 0.2008
Acceleration (m/s²)
(Δt:0.96 Δy:0.000)
Time (s)

Acceleration & Velocity-Time Graphs

Constant Acceleration



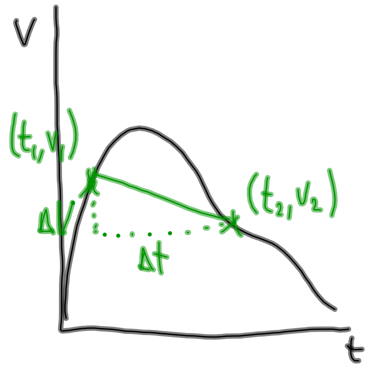
$$\text{slope} = \frac{\text{rise}}{\text{run}}$$

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

slope = acceleration (from previous demo + Galileo lab)

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

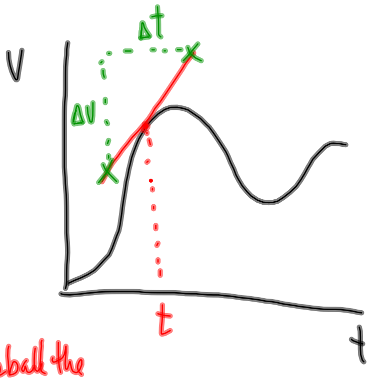
Non-Constant Acceleration



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

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

Average acceleration is the slope of the line joining 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 time, t.

Eyeball the tangent or use Calculus or Logger Pro.

d-t →(slope) v-t →(slope) a-t

The Acceleration Equation

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

where $\Delta \vec{v}$ is the change in velocity (m/s)
$(\Delta \vec{v} = \vec{v}_f - \vec{v}_i)$

Δt is the time interval for the velocity change to occur (s)

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

Example 1

A skier accelerates on her skis from 6m/s [forward] ($\vec{v}_i$) to 15m/s [forward] ($\vec{v}_f$) in 1.5s (Δt). What is her acceleration during this time? ($a = ?$) ms^{-2}

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

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

Δt = 1.5s

a = ?

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

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

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

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

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

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

The acceleration of the skier was 6m/s²

UNITS: $\frac{m/s}{s} = \frac{m}{s} \div s$

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

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

Example 2

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

$\vec{a} = +0.40 \text{ m/s}^2$

$\Delta t = 4.8 \text{ s}$

$\vec{v}_f = +10.1 \text{ m/s}$

$\vec{v}_i = ?$

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

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

$$\vec{a}\Delta t = \vec{v}_f - \vec{v}_i \quad (+v_i \text{ both sides})$$

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

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

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

$$\vec{v}_i = +10.1 \frac{m}{s} - \left(+0.40 \frac{m}{s^2}\right)(4.8 s)$$

$$\vec{v}_i = +10.1 \frac{m}{s} - 1.92 \frac{m}{s}$$

$$\vec{v}_i = +8.18 \frac{m}{s}$$

$$\vec{v}_i \doteq +8.2 \frac{m}{s}$$

or $8.2 \frac{m}{s}$ [downhill]

The skateboarder's initial velocity was $+8.2 \frac{m}{s}$

Example 3

A ball is dropped ($\vec{v}_i = 0$) and falls (implies $\vec{a} = 9.81\frac{m}{s^2}$ [down]) until it reaches a velocity of $29.8\frac{m}{s}$ [down] ($\vec{v}_f$). How long (Δt) was it falling?

$\vec{v}_i = 0$

$\vec{a} = 9.81\frac{m}{s^2}$ [down] $= -9.81\,m/s^2$ (− = down)

$\vec{v}_f = 29.8\frac{m}{s}$ [down] $= -29.8\frac{m}{s}$

$\Delta t = ?$

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

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

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

$$\Delta t = \frac{(\vec{v}_f - \vec{v}_i)}{\vec{a}} \quad (\vec{v}_i = 0)$$

$$\Delta t = \frac{-29.8\frac{m}{s}}{-9.81\frac{m}{s^2}}$$

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

UNITS

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

The ball was falling for 3.04 s.