Physics 113 - Sept. 4, 2012

Note Title 9/4/2012

- A few hard copies of syllabus available up front
- Note that P.S. 1, Lect 1 slides/audio posted on class website
- If you have a technical issue and request help or report problem ... Give me some information
- Lab Statistics lecture Friday 3:30 (here)
- No workshops this week ... begin Next Mon.
- BlackBoard now available (but not yet used for P113)

Last Time

- organization of course

  Questions ??

- A bit about
  - human perspective
  - Scales in our universe
  - Nature of science

What is Time?

1 dimensional Motion → Kinematics

Kinematic variables → 4 variables

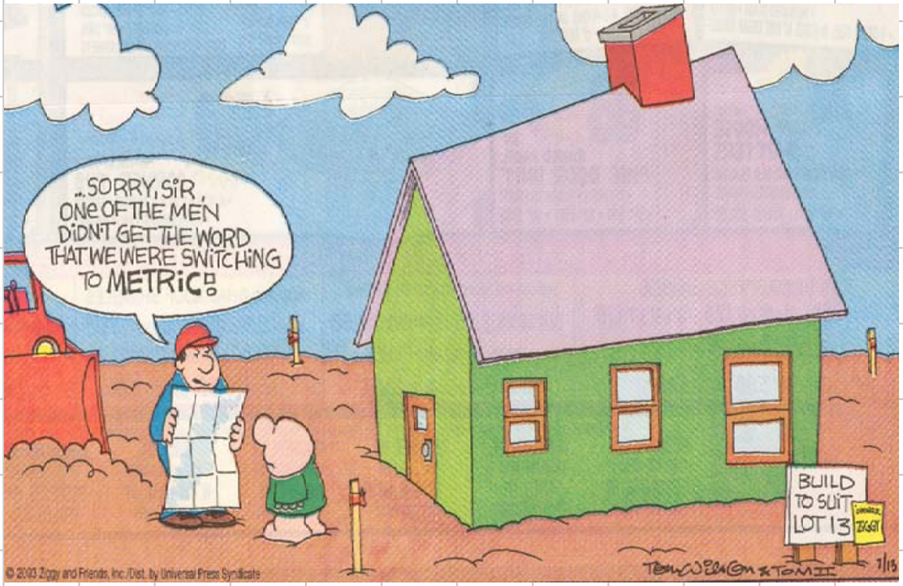
2 of them are:

Position symbolized by x or y or z or s

units → meters or cm
or feet, yards ...

Time Symbolized by t

in Seconds



Two Teams, Two Measures Equaled One Lost Spacecraft

By ANDREW POLLACK

LOS ANGELES, Sept. 30 — Simple confusion over whether measurements were metric or not led to the loss of a $125 million spacecraft last week as it approached Mars, the National Aeronautics and Space Administration said today.

An internal review team at NASA's Jet Propulsion Laboratory said in a preliminary conclusion that engineers at Lockheed Martin Corporation, which had built the spacecraft, specified certain measurements about the spacecraft's thrust in pounds, an English unit, but that NASA scientists thought the information was in the metric measurement of newtons.

The resulting miscalculation, undetected for months as the craft was designed, built and launched, meant the craft, the Mars Climate Orbiter, was off course by about 60 miles as it approached Mars.

"This is going to be the cautionary tale that is going to be embedded into introductions to the metric system in elementary school and high school and college physics till the end of time," said John Pike, director of space policy at the Federation of American Scientists in Washington.

Lockheed's reaction was equally blunt.

"The reaction is disbelief," said Noel Hinners, vice president for flight systems at Lockheed Martin Astronautics in Denver, Colo. "It can't be something that simple that could cause this to happen."

The finding was a major embarrassment for NASA, which said it was investigating how such a basic error could have gone through a mission's checks and balances.

"The real issue is not that the data was wrong," said Edward C. Stone, the director of the Jet Propulsion Laboratory in Pasadena, Calif., which was in charge of the mission. "The real issue is that our process

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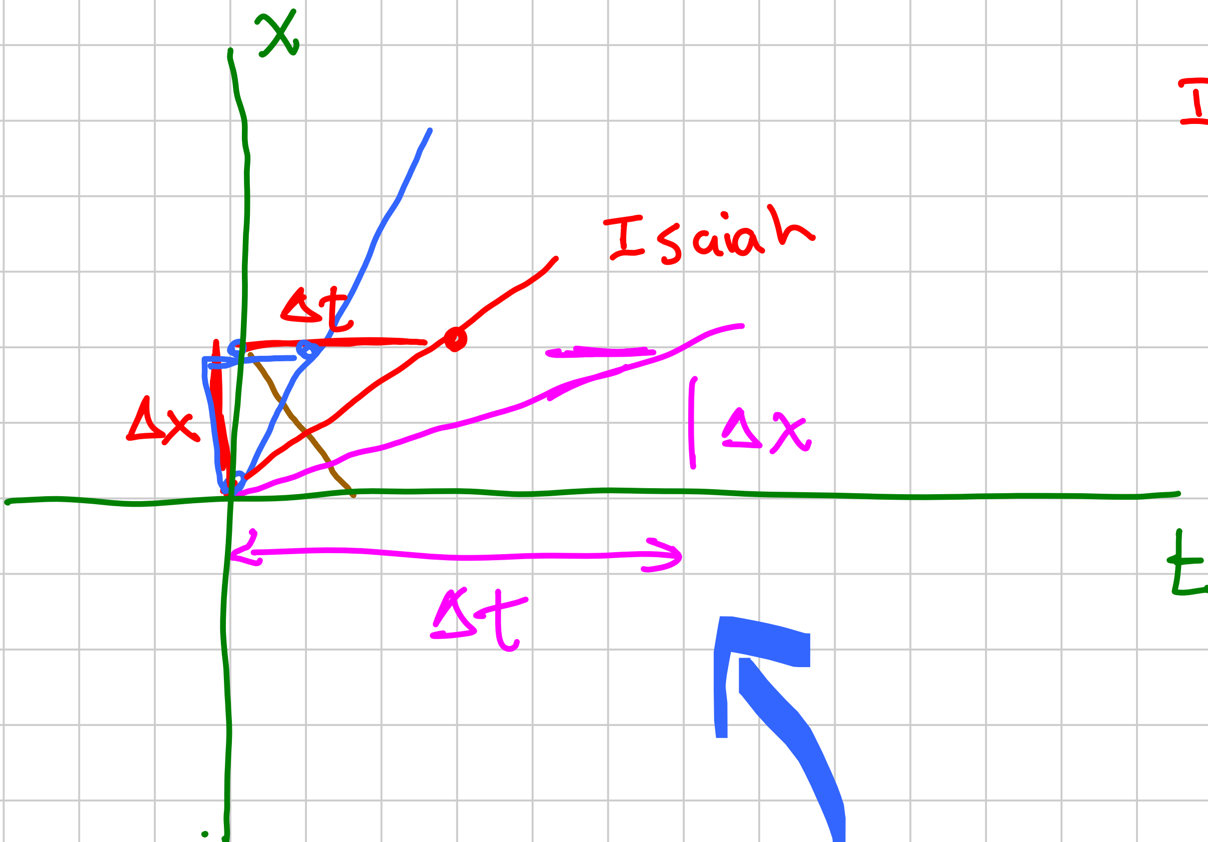
1 dimensional Motion

Kinematics

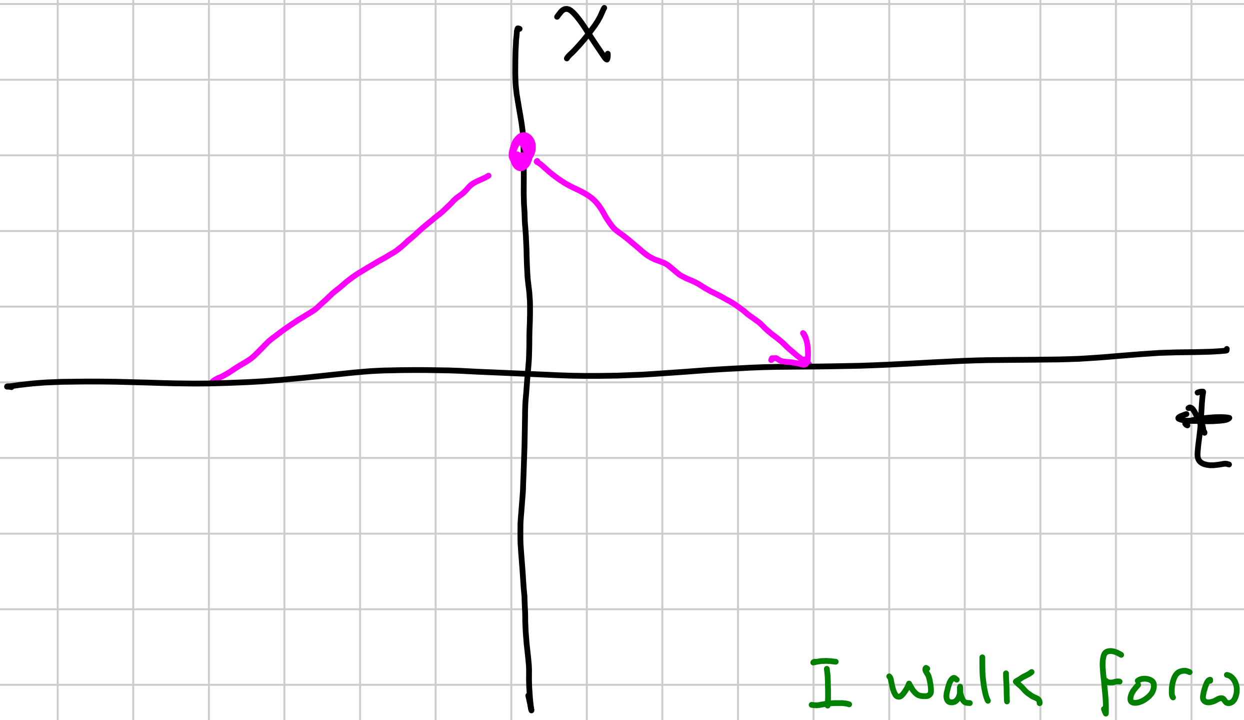


I use "Δ" to signify a finite difference or step or change

For example,

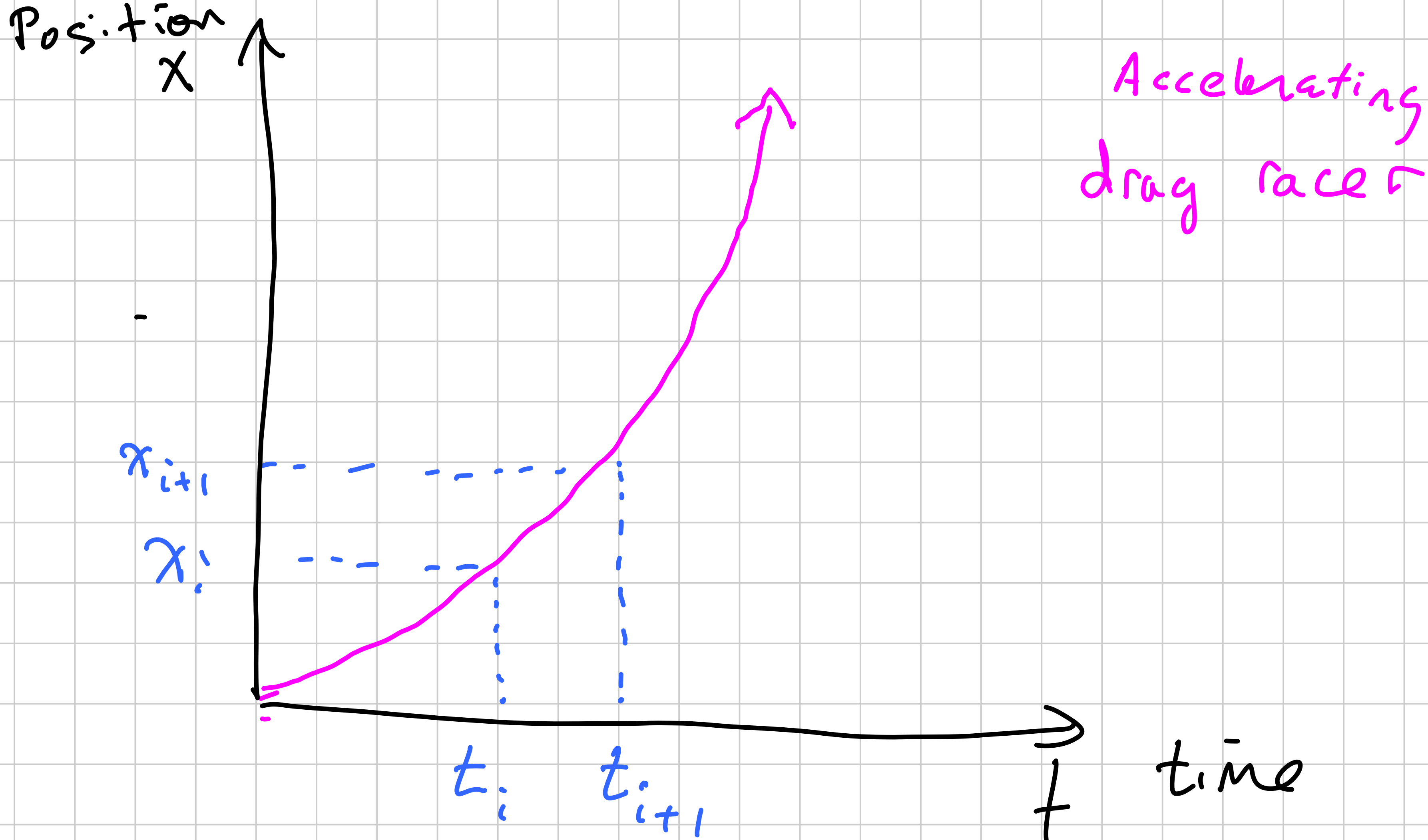
$\Delta = t_{i+1} - t_i$

3 students walking at different speeds



I walk forward at const speed
Then stop momentarily
and walk backward at
the same speed.

Arbitrarily define "zero"
of time to be when I
am at turnaround point



Average Speed $= \dfrac{\text{displacement}}{\text{time}} = \dfrac{x_{i+1} - x_i}{t_{i+1} - t_i} = \left|\dfrac{\Delta x}{\Delta t}\right|$

Average velocity — but includes direction

Units of Speed → $\frac{\text{distance}}{\text{time}}$

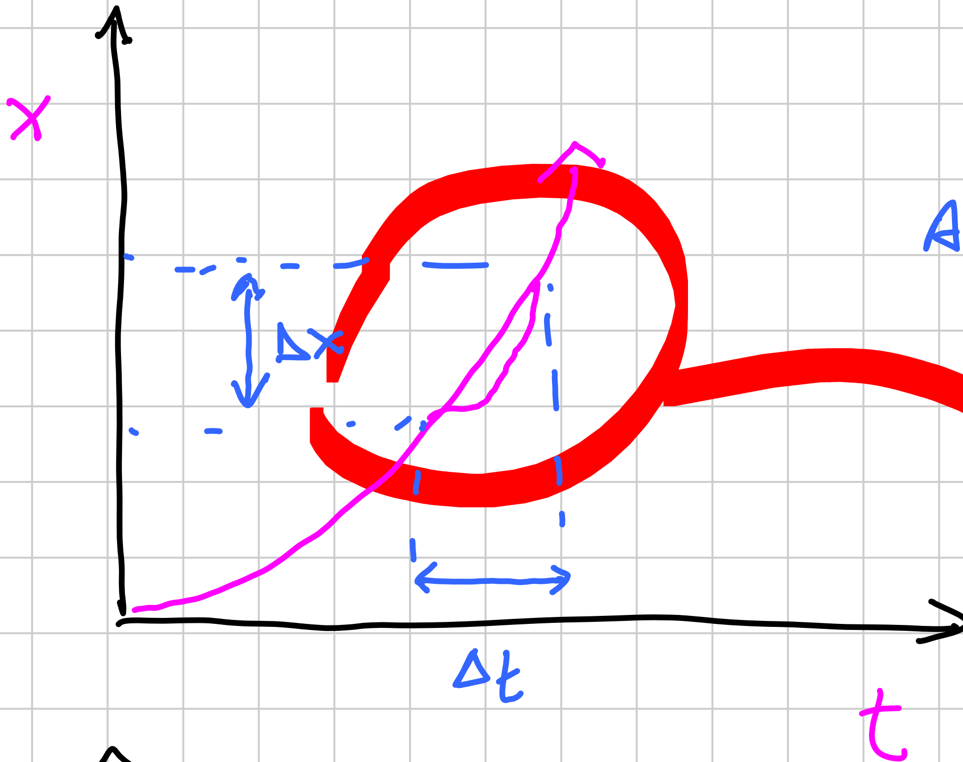
MKS → Meters, Kilograms, second

m/s = meters/second

Velocity is made up of (Magnitude)(direction)

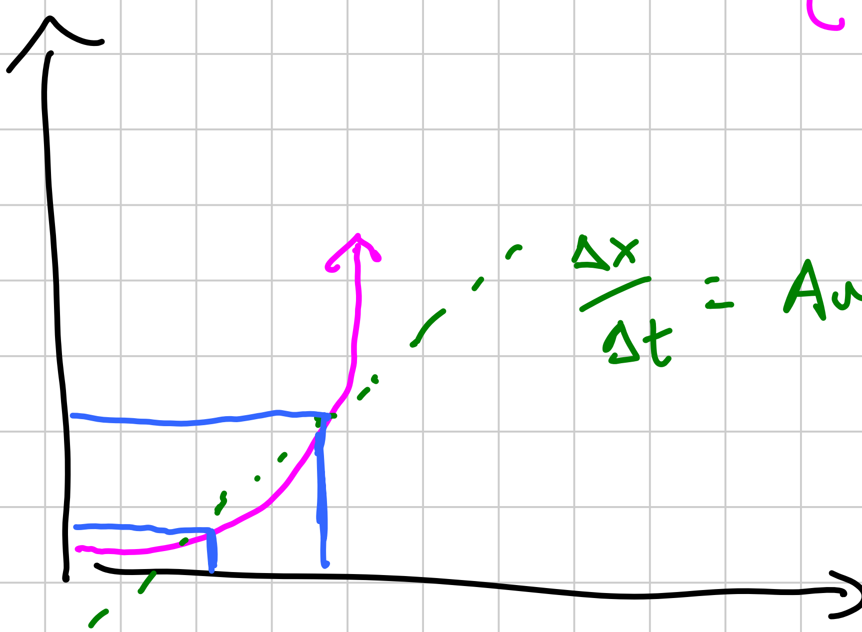
Magnitude = speed

Speed has only a Magnitude

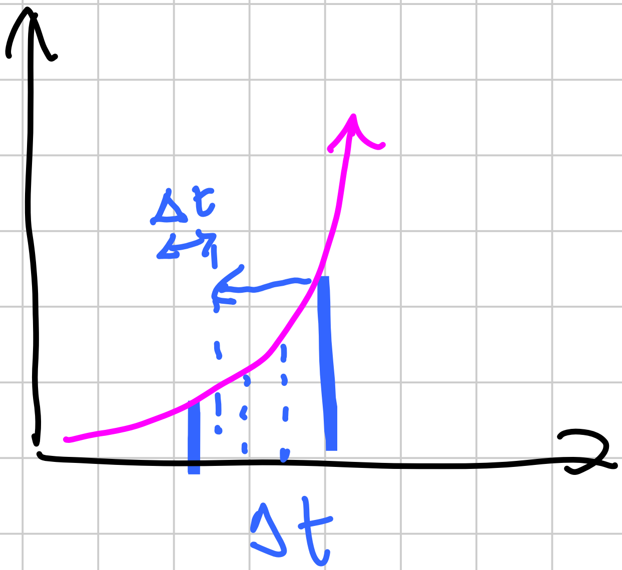


Ave Speed $= \frac{\Delta x}{\Delta t}$

Anything could happen over the interval between endpoints used for Ave. Speed calculation



$\frac{\Delta x}{\Delta t}$ = Ave Speed



$$\lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$$

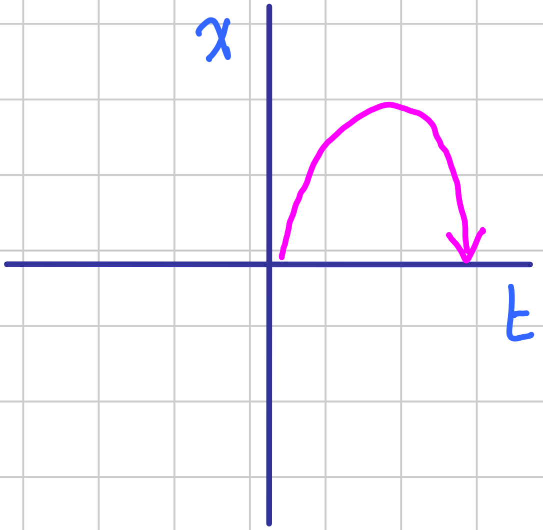
derivative

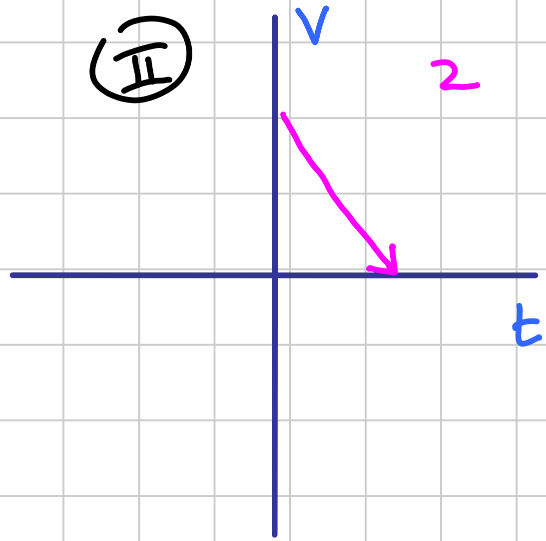
≡ instantaneous speed

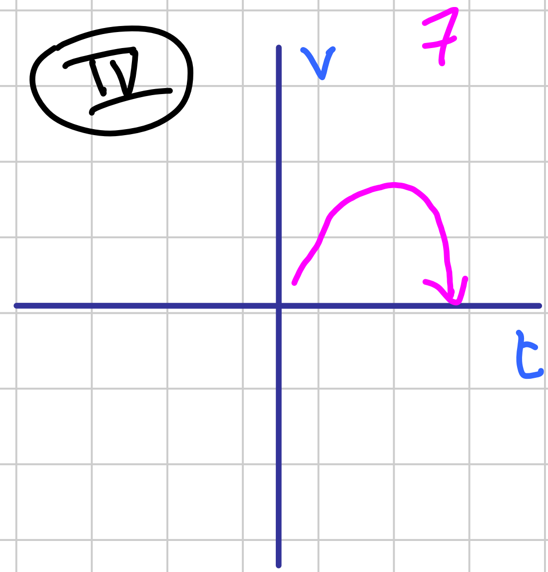
w/ direction → instantaneous velocity

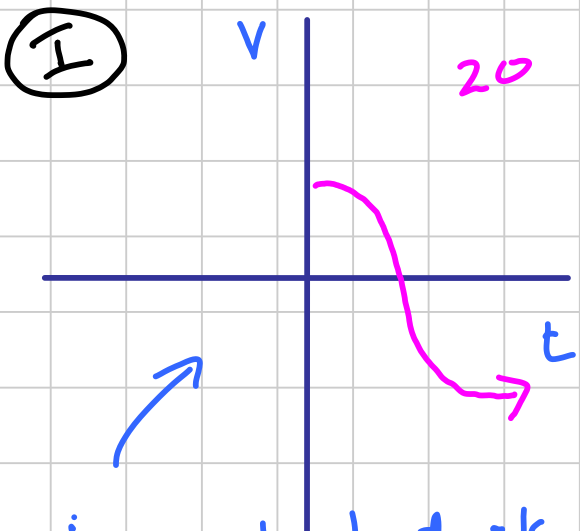
Average speed or velocity determined over finite interval of time. For changing speed or velocity it is an imperfect measure of what is happening at a specific time. So work in limit of infinitesimally small $\Delta t \longrightarrow dt$, then Average $\longrightarrow$ instantaneous

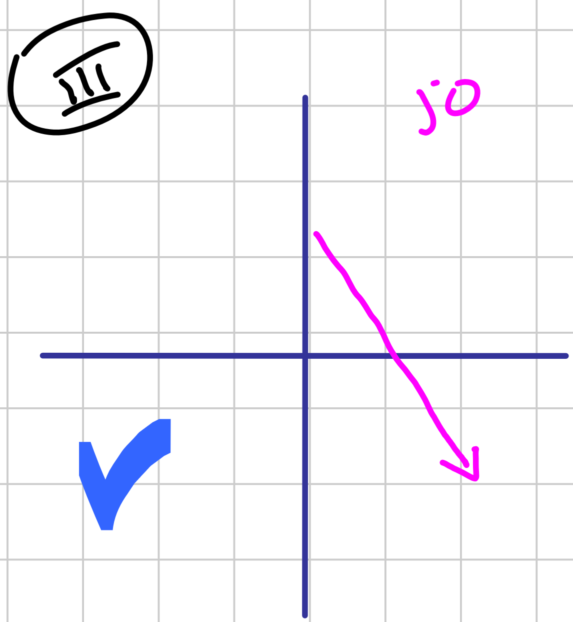
Given x-t motion/graph, what is the most appropriate v-t graph?

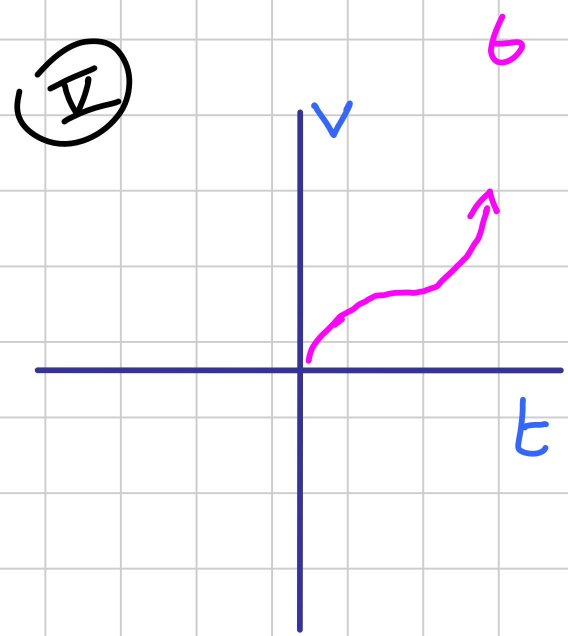




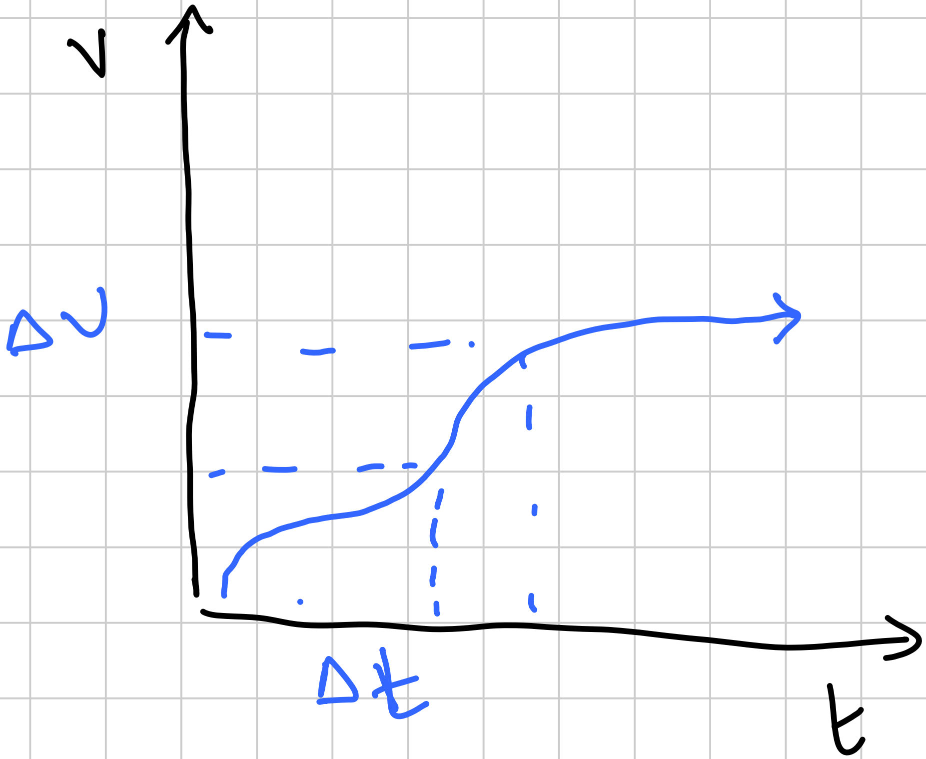








incorrect but ok
for what we have covered so far



$\frac{\Delta v}{\Delta t}$ = Average Acceleration

$$\lim_{\Delta t \to 0} \frac{\Delta v}{\Delta t} = \frac{dv}{dt}$$

= instantaneous Acceleration

$= a(t)$

a is function of time

units $\frac{dist}{time^2} \rightarrow m/s^2$

Accel. is slope of the V-t graph

Kinematic Variables

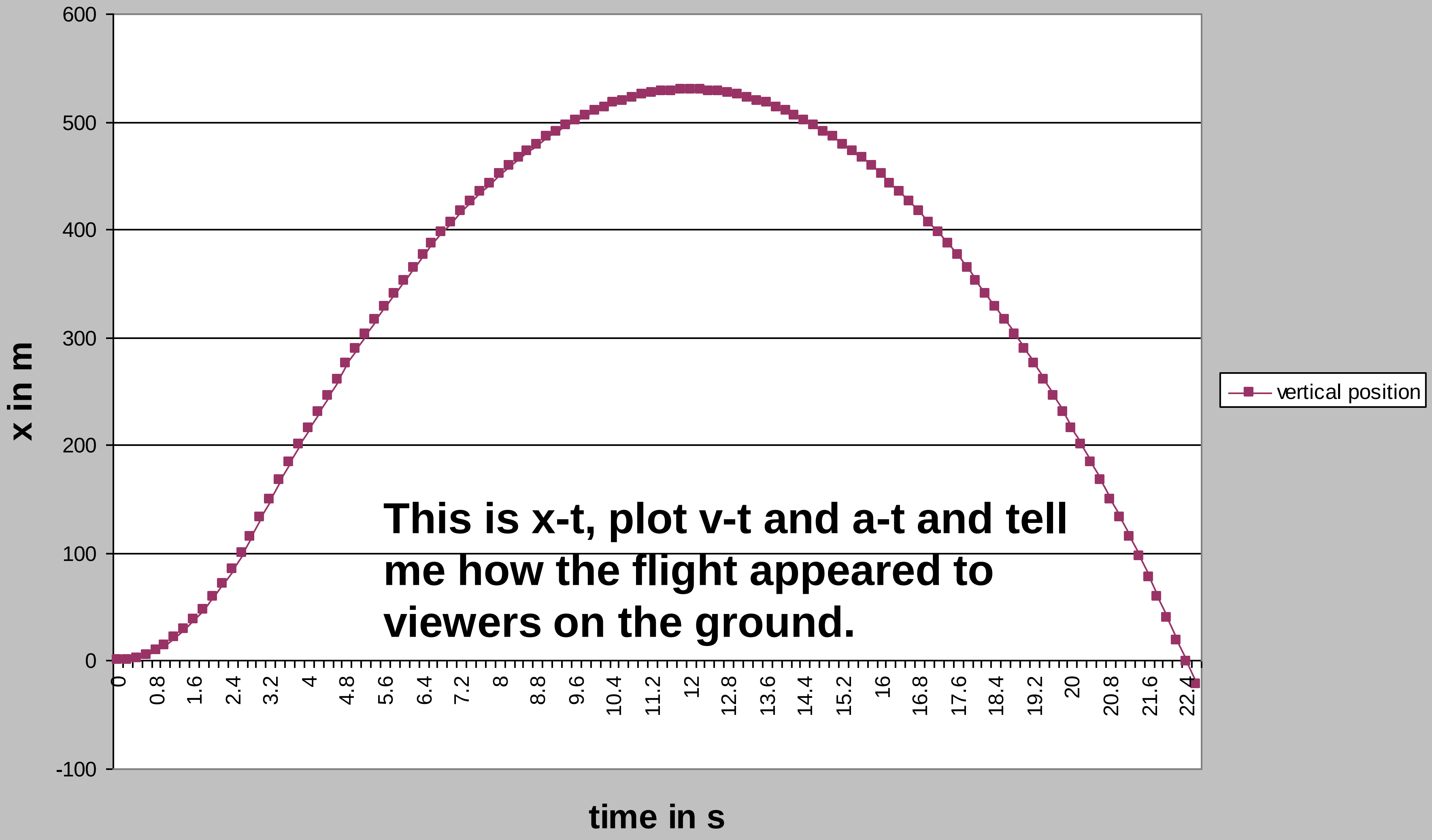
		MKS	cgs	English
x	position	m	cm	feet
v	velocity	m/s	cm/s	$feet/s$
a	acceleration	m/s^2	cm/s^2	$feet/s^2$
t	time	s	s	s

units are important !

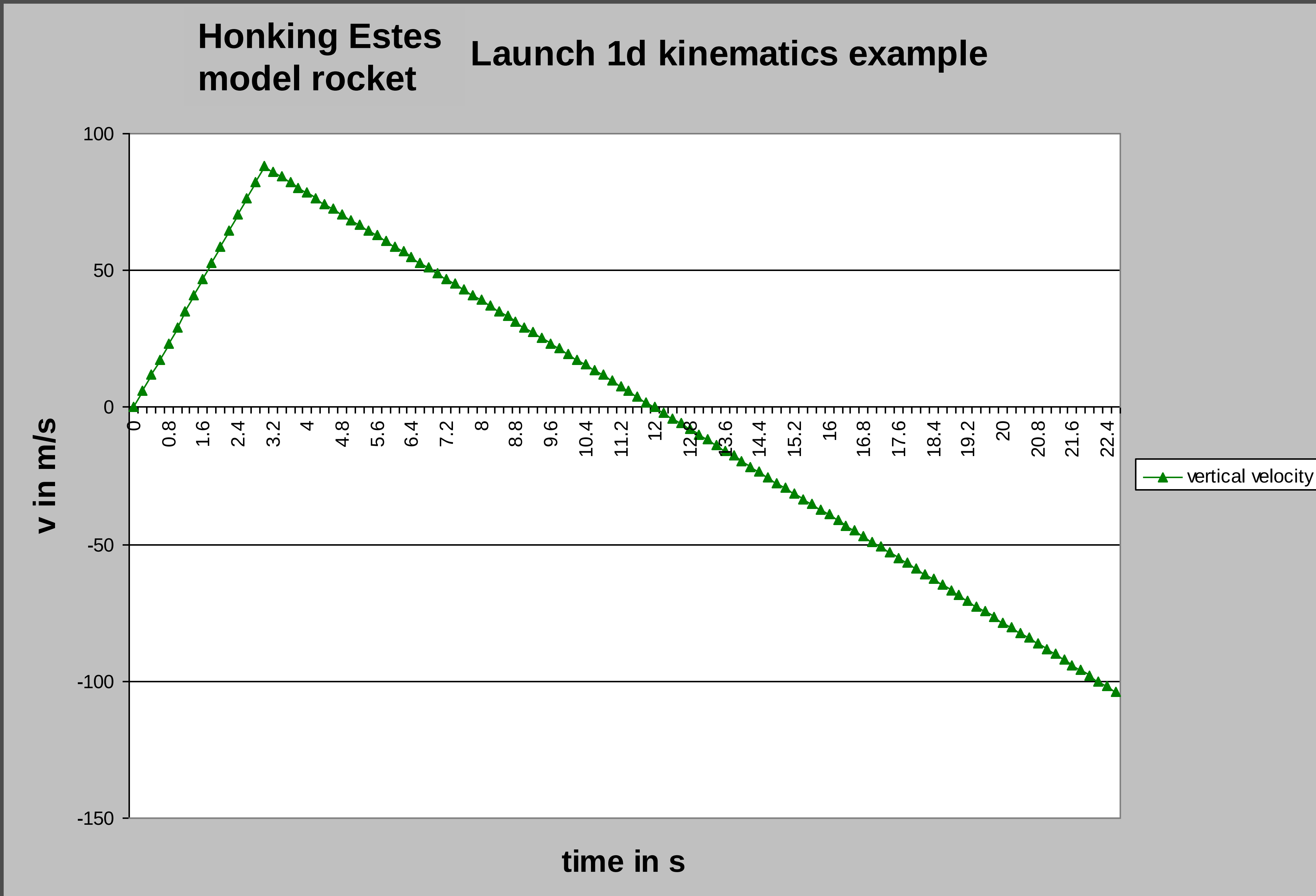
You finally graduate and make the big bucks … what do you do?

Well … duh! You go out and buy the biggest honking Estes model rocket you can find!

Honking Estes model rocket Launch 1d kinematics example



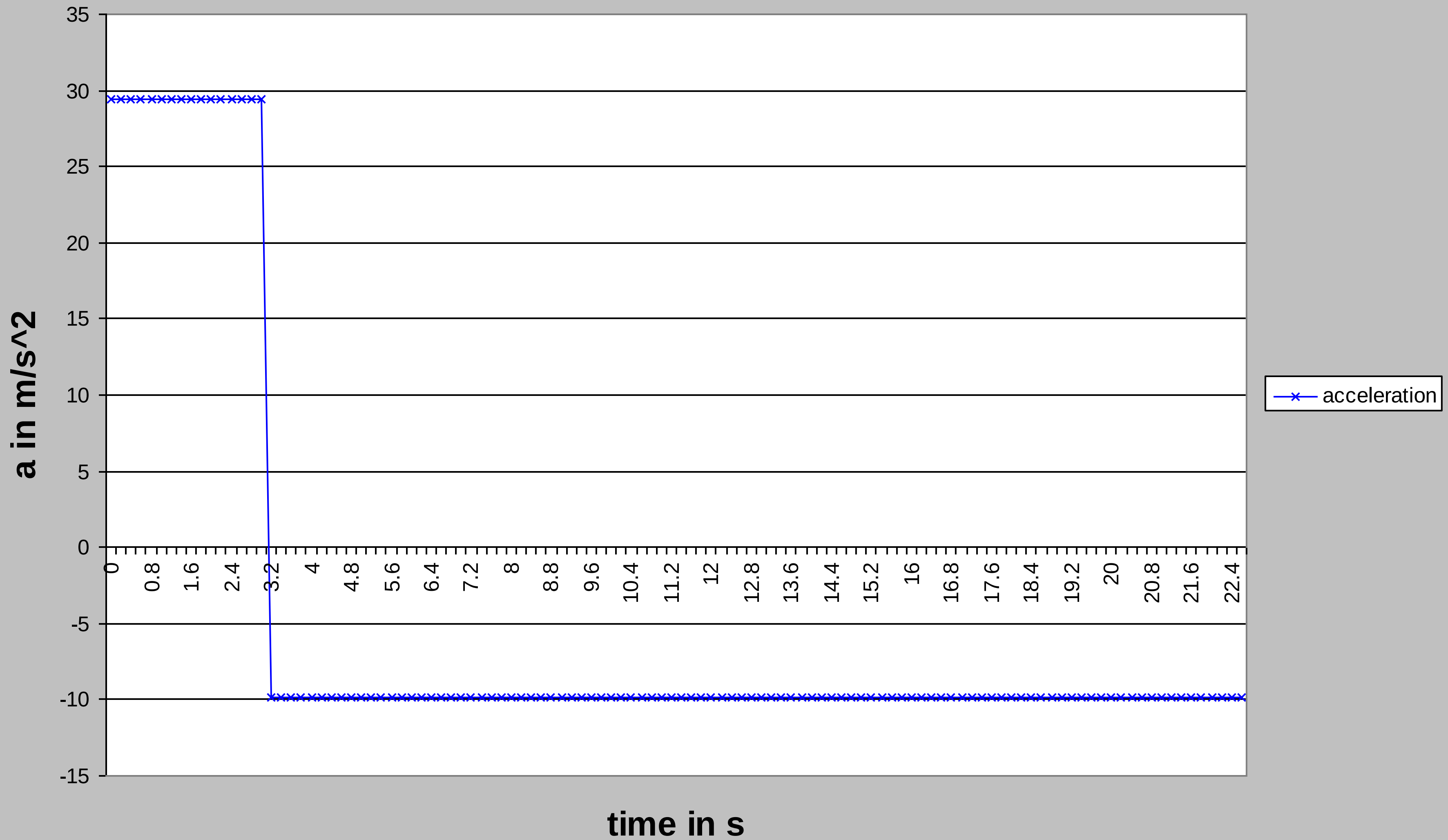
This is x-t, plot v-t and a-t and tell me how the flight appeared to viewers on the ground.

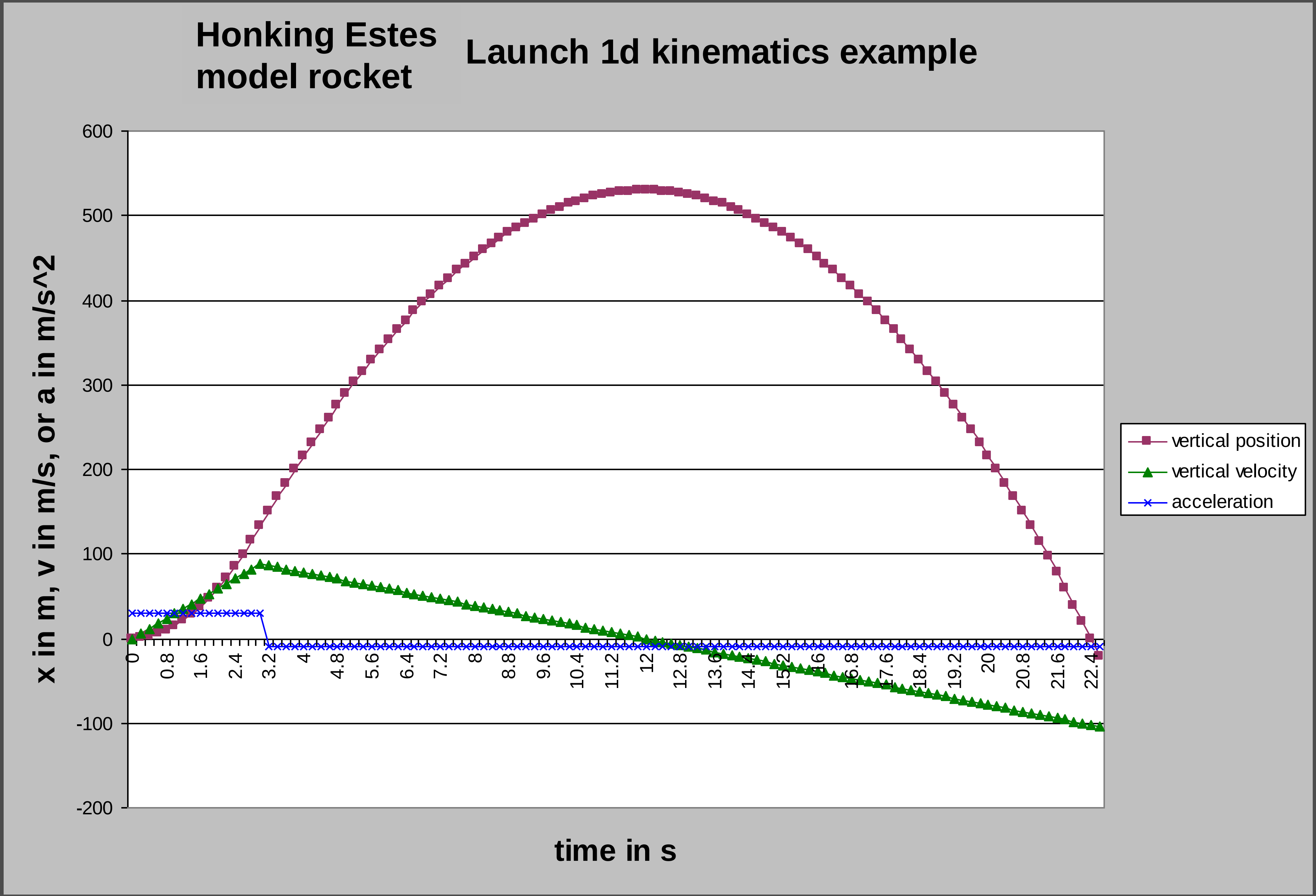


Honking Estes model rocket
Launch 1d kinematics example
100
50
0
-50
-100
-150
v in m/s
0
0.8
1.6
2.4
3.2
4
4.8
5.6
6.4
7.2
8
8.8
9.6
10.4
11.2
12
12.8
13.6
14.4
15.2
16
16.8
17.6
18.4
19.2
20
20.8
21.6
22.4
time in s
vertical velocity

Honking Estes model rocket

Launch 1d kinematics example





Honking Estes model rocket
Launch 1d kinematics example
x in m, v in m/s, or a in m/s^2
time in s
vertical position
vertical velocity
acceleration
600
500
400
300
200
100
0
-100
-200
0
0.8
1.6
2.4
3.2
4
4.8
5.6
6.4
7.2
8
8.8
9.6
10.4
11.2
12
12.8
13.6
14.4
15.2
16
16.8
17.6
18.4
19.2
20
20.8
21.6
22.4