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, 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 Hinnen, vice president for flight systems at Lockheed Martin Aeronautics 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 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...

Continued on Page A16
1 dimensional Motion

Kinematics

I use \( \Delta \) to signify a finite difference or step of change. For example,

\[
\Delta = t_{i+1} - t_i
\]

3 students walking at different speeds
I walk forward at constant 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: \[ \text{displacement} \over \text{time} = \frac{X_{i+1} - X_i}{t_{i+1} - t_i} = \left| \frac{\Delta X}{\Delta t} \right| \]

Average velocity but includes direction
Units of speed

\[
\text{m/s} = \frac{\text{meters}}{\text{second}}
\]

Velocity is made up of

\( (\text{Magnitude}) \times (\text{direction}) \)

\( \vec{S} \)

Speed has only a magnitude

MKS

\( \text{Seconds} \)

\( \text{Meters} \)

\( \text{Kilograms} \)
Ave Speed = \frac{\Delta x}{\Delta t}

Anything could happen over the interval between end points used for Ave Speed calculation.
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 $\Delta t \rightarrow 0$, than average $\rightarrow$ instantaneous speed.
Given \( x-t \) motion/graph, what is the most appropriate \( v-t \) graph?

1. Incorrect but ok for what we have covered so far
2. \( v \)
3. \( 20 \)
4. Correct
\[ \frac{\Delta v}{\Delta t} = \text{Average Acceleration} \]

\[ \lim_{\Delta t \to 0} \frac{\Delta v}{\Delta t} = \frac{dv}{dt} = \text{Instantaneous Acceleration} \]

\[ a(t) \]

Acceleration is the slope of the \( V - t \) graph.

Units: \( \frac{\text{m}}{\text{s}^2} \)

\( \frac{\text{dist}}{\text{time}} \)
Kinematic Variables

\[ x \text{ position} \quad \left[ \begin{array}{c} \text{MKS} \\ \text{m} \\ \text{cm} \end{array} \right] \quad \left[ \begin{array}{c} \text{English} \\ \text{Feet} \end{array} \right] \]

\[ v \text{ velocity} \quad \left[ \begin{array}{c} \text{m/s} \\ \text{cm/s} \end{array} \right] \quad \left[ \begin{array}{c} \text{feet/s} \end{array} \right] \]

\[ a \text{ acceleration} \quad \left[ \begin{array}{c} \text{m/s}^2 \\ \text{cm/s}^2 \end{array} \right] \quad \left[ \begin{array}{c} \text{feet/s}^2 \end{array} \right] \]

\[ t \text{ time} \quad \text{s} \]

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!
Shuttle Launch 1d kinematics example

Honking Estes model rocket

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

time in s
v in m/s

vertical velocity
Honking Estes model rocket

Launch 1d kinematics example

<table>
<thead>
<tr>
<th>time in s</th>
<th>x in m, v in m/s, or a in m/s^2</th>
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<tbody>
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Graph showing:
- **vertical position**
- **vertical velocity**
- **acceleration**