Chapter 1. Introduction

Math Review: Powers and exponents
Prefixes for units
Conversion of units
Dimensional analysis

Today...

Chapter 2. Motion in 1-dimension

Position and displacement
Speed and velocity
Motion with a constant velocity

Chapter 2. Motion in 1-dimension

Why do we study motion?

A lot of things move!

Simplest kind of motions
→ Motion along a straight line
(i.e., 1-dimensional motion)
**Position**

What is motion?

*Change of position over time*

How to represent position along a straight line:

**define:** \( x = 0 \) some position (Origin)
positive direction for \( x \)
length unit, e.g., meter

Position of ball: \( x = +3 \, \text{m} \)

**Displacement**

Displacement: Change in position

\( x_2 = -2 \, \text{m} \hspace{1cm} x_1 = +3 \, \text{m} \)

\((\text{Displacement}) = \Delta x = x_2 - x_1\)

\(\Delta x = -2\text{m} - (+3\text{m}) = -5 \, \text{m}\)

+ or - sign represents direction

Length unit, e.g., meter
**Average velocity, $v_{\text{avg}}$**

\[
(Average\ velocity\ between\ time\ t_1\ and\ t_2) = v_{\text{avg}} = \frac{x(t_2) - x(t_1)}{t_2 - t_1} = \frac{x_2 - x_1}{t_2 - t_1} = \frac{\Delta x}{\Delta t} = \frac{(\text{Displacement})}{(\text{Time change})}
\]

Unit: [Length]/[Time], e.g., m/s

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**Average speed, $s_{\text{avg}}$**

\[
(Average\ speed\ between\ time\ t_1\ and\ t_2) = s_{\text{avg}} = \frac{(\text{Total distance})}{(\text{Time change})}
\]

Distance does not care about direction, unlike displacement

Distance & $s_{\text{avg}}$: always positive, no direction

In general, Distance $\neq$ Displacement

Average speed $\neq$ Average velocity
Example:
Displacement, distance, average velocity, average speed

X=0 km \hspace{1cm} x=50 \ km
\hspace{1cm} \ t=0 \ min

Example:
Displacement, distance, average velocity, average speed

X=0 km \hspace{1cm} x=50 \ km
\hspace{1cm} \ t=50 \ min
Example:
Displacement, distance, average velocity, average speed

\[ X=0 \text{ km} \quad x = 50 \text{ km} \]
\[ t = 50 \text{ min} \]

Example:
Displacement, distance, average velocity, average speed

Between \( t_1=0 \) and \( t_2=100 \text{ min} \),
find displacement, distance, average velocity, average speed

\[ X=20 \text{ km} \quad x = 50 \text{ km} \]
\[ t = 100 \text{ min} \]
Math review: Slope of a line

See notes

Active figure on Position vs time curve
**Graphical interpretation of average velocity**

\[ \text{Average velocity between time } t_1 \text{ and } t_2 = v_{\text{avg}} = \frac{\Delta x}{\Delta t} = \frac{x_2 - x_1}{t_2 - t_1} \]

→ Slope of the green line joining \((t_1, x_1), (t_2, x_2)\) in \(x\) vs. \(t\) plot

**Instantaneous velocity, or velocity**

\[ \text{Instantaneous velocity, or simply, velocity} = \text{Average velocity between } t \text{ and } t + \Delta t, \]

where \(\Delta t\) is tiny (or, \(\Delta t \rightarrow 0\) limit)

→ Slope of tangential line at \(t\) for \(x\) vs. \(t\) curve

→ How fast at a given time \(t\)
Motion with a constant velocity, \( v \)

\[ x(t) \text{ vs. } t: \]

\[ v = v_{\text{avg}} = \frac{x(t) - x_0}{t - 0} \rightarrow x(t) - x_0 = v \times t \rightarrow x = x_0 + v \times t \]

**Instantaneous Speed, or Speed**

(Instantaneous Speed) = (magnitude of instantaneous velocity)

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**iClicker Quiz**

Average velocity between 20 s and 30 s is

(a) positive

(b) zero

(c) negative
iClicker Quiz

Instantaneous velocity at 30 s is

(a) positive  
(b) zero  
(c) negative

iClicker Quiz

Velocity at 10 s is

(a) positive  
(b) zero  
(c) negative
Announcement

HW #1: Introduction (Due 1 am central time, 2/2, Monday).
HW #2: Motion in 1-d (Due 1 am central time, 2/9, Monday).

If you have a difficulty with HW website, see me after class.

Common Exam 1 : Feb 13th, Friday