Chapter 2 Motion in One Dimension

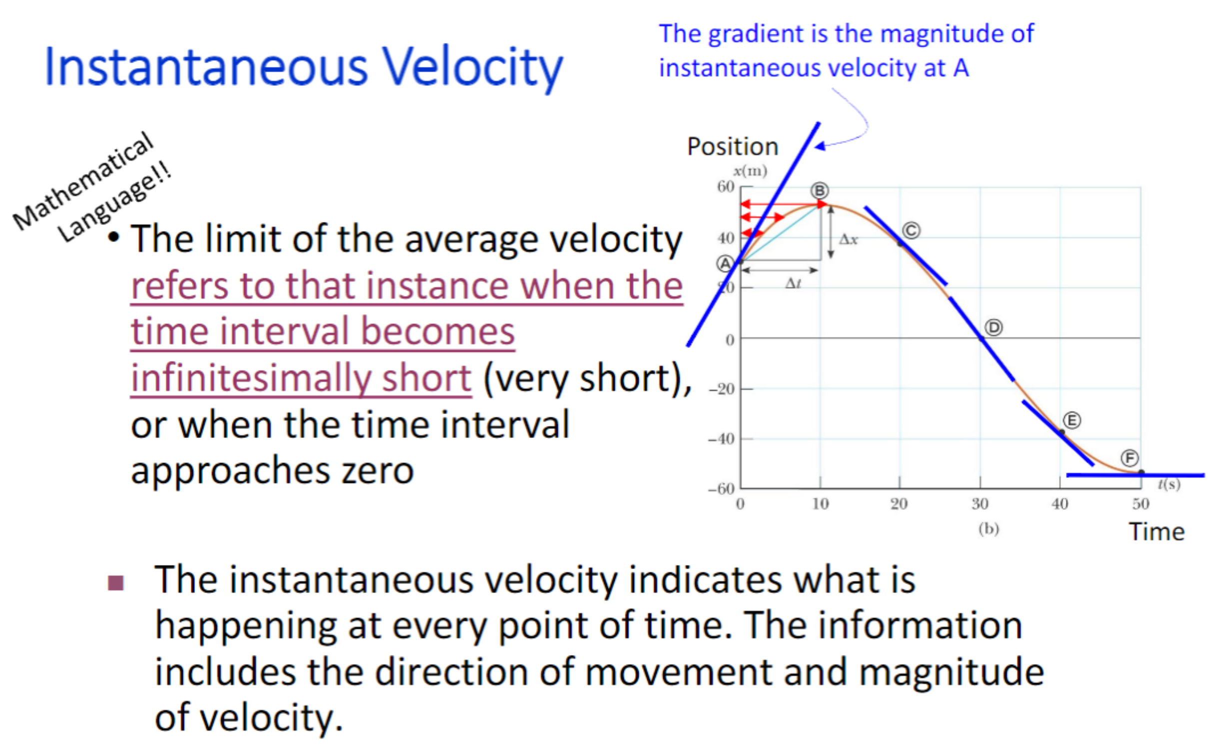
Kinematics

- Describes a motion, without the agent that moved it
- Will use the particle model, where a particle is a point-like object. It has mass but the size is very small.

Position

- Defined in terms of a **frame of reference**
  - In one dimension (x-axis or y-axis)
  - Origin must be well defined
- The object's position is its location with respect to the frame of reference
- The frame can be moving or stationary

Position-Time Graph



Displacement

- Change in position during some time interval
  - $\Delta x = x_f - x_i$
  - SI Units is meters (m).
- Displacement does not mean distance

Vector and Scalars

- Vector has:
  - Magnitude
  - Direction
  - Use + and - signs to indicate directions
- Scalars has:
  - Magnitude
  - Always +ve numerical value

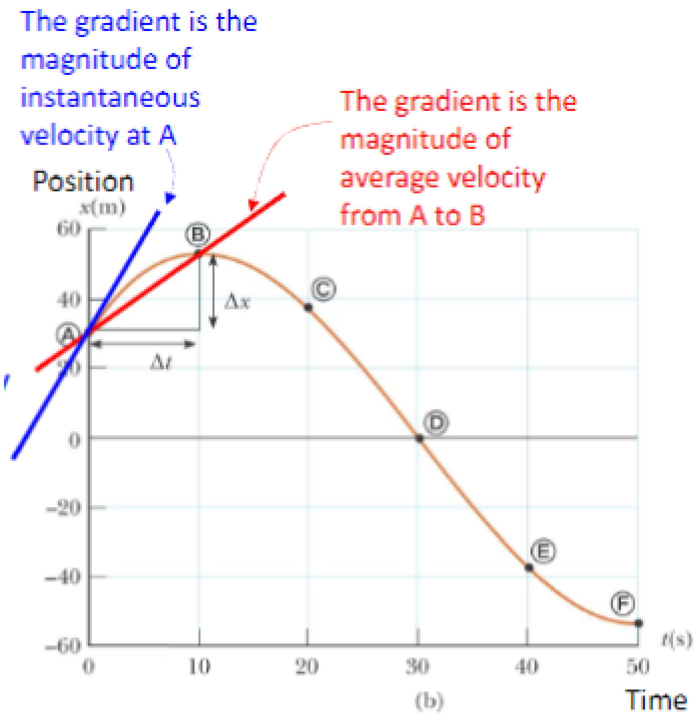
Velocity

- Vector quantity
- SI Unit is m/s

Average Velocity

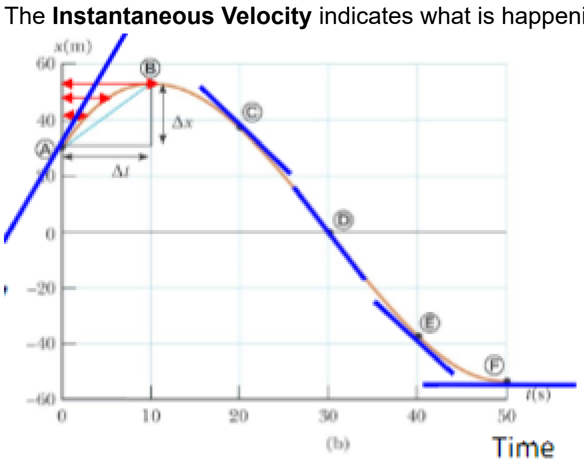
The **Average Velocity** is the rate with respect to time at which the displacement occurs

$$v_{average} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{\Delta t}$$



Instantaneous Velocity

The **Instantaneous Velocity** indicates what is happening at every point of time.



Average Speed

- Scalar quantity
- SI Unit m/s

$$\frac{d_T}{t_T}$$

- Average speed does not necessarily mean the magnitude of the average velocity.

Acceleration

SI Unit is m/s^2

Average Acceleration

Rate of change of the velocity

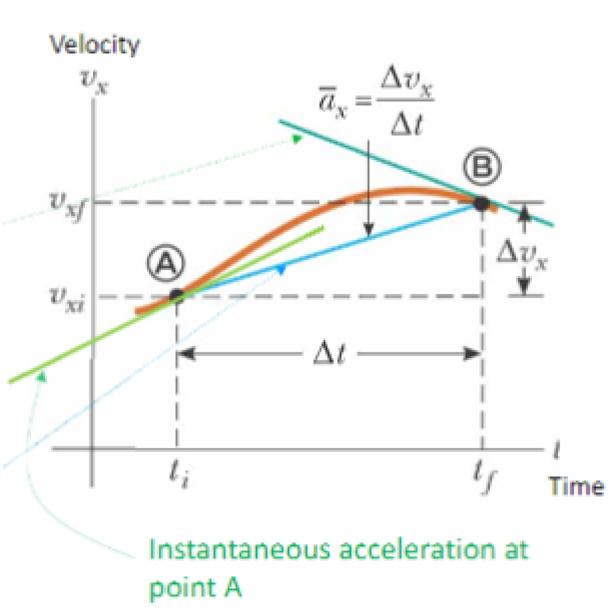
$$a_{average} = \frac{\Delta v_x}{\Delta t} = \frac{v_{xf} - v_{xi}}{\Delta t}$$

Instantaneous Acceleration

The magnitude for **instantaneous acceleration** is the limit of the magnitude for average acceleration as the Δt approaches 0, which is the value of the constant when Δt tends to 0.

Graph

velocity vs time graph



The slope of the tangent in is the magnitude for acceleration
Blue line is the average acceleration from A to B

Kinematic Equations

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Only for one dimensional motion with constant acceleration
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Equation (Physics notation)	Equation (Alternative notation)	Information Given by Equation
$v_{xf} = v_{xi} + a_x t$	$v = u + at$	Velocity as a function of time
$x_f = x_i + \frac{1}{2}(v_{xi} + v_{xf})t$	$s = s_0 + \frac{1}{2}(u + v)t$	Position as a function of velocity and time
$x_f = x_i + v_{xi}t + \frac{1}{2}a_x t^2$	$s = s_0 + ut + \frac{1}{2}at^2$	Position as a function of time
$v_{xf}^2 = v_{xi}^2 + 2a_x(x_f - x_i)$	$v^2 = u^2 + 2a(s - s_0)$	Velocity as a function of position

where,
u: initial velocity
v: final velocity
s_0: initial position
s: final position
a: acceleration

Freely Falling Objects

A **freely falling object** is any object moving freely under the influence of gravity ***alone***
Does not depend upon the initial motion:

- Dropped (released from rest) $v_i = 0$
- Thrown downward $v_i \neq 0$
- Thrown upward $v_i \neq 0$

Acceleration of Freely Falling Object

The acceleration is **directed downward**, regardless of the initial motion and position.

$$g = a = 9.80\,m/s^2$$

This is the average gravitational acceleration at the Earth's surface, if the $\uparrow altitude$ then $\downarrow g$
Free fall motion is constantly accelerated motion in one dimension
Let $upwards \rightarrow +ve$ and $downwards \rightarrow -ve$, so the $a = -g = 9.80\,m/s^2$