

Kinematics and One Dimensional Motion

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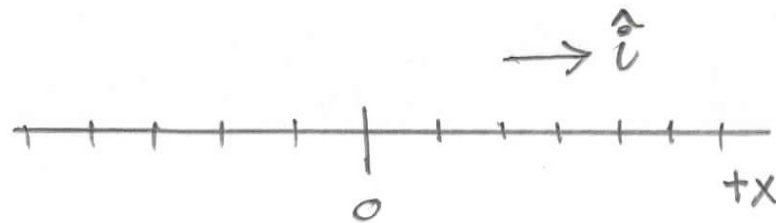
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Kinematics

- *Kinema* means movement
- Mathematical description of motion
- Position
- Displacement
- Velocity
- Acceleration

Coordinate System in One Dimension

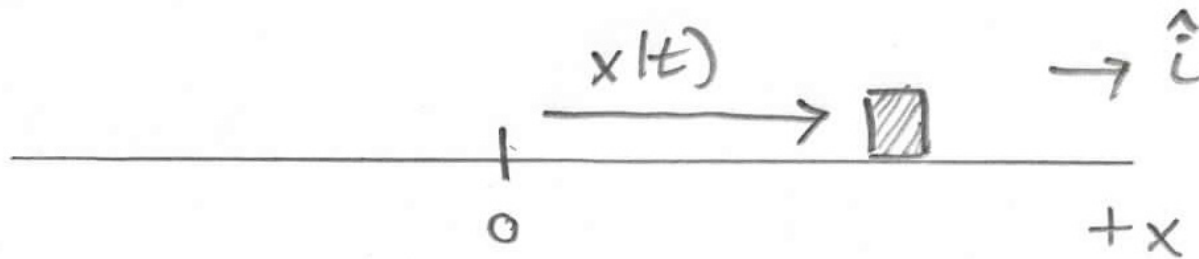
- Choice of origin
- Choice of coordinate axis
- Choice of positive direction for the axis
- Choice of unit vectors at each point in space



Position

- Vector from origin to body

$$\vec{\mathbf{X}}(t) = x(t)\hat{\mathbf{i}}$$



Displacement

- change in position coordinate of the object between the times t_1 and t_2

$$\Delta\vec{\mathbf{x}} \equiv (x(t_2) - x(t_1))\hat{\mathbf{i}} \equiv \Delta x(t)\hat{\mathbf{i}}$$

Average Velocity

- component of the average velocity, $\overline{v_x}$,
is the displacement Δx divided
by the time interval Δt

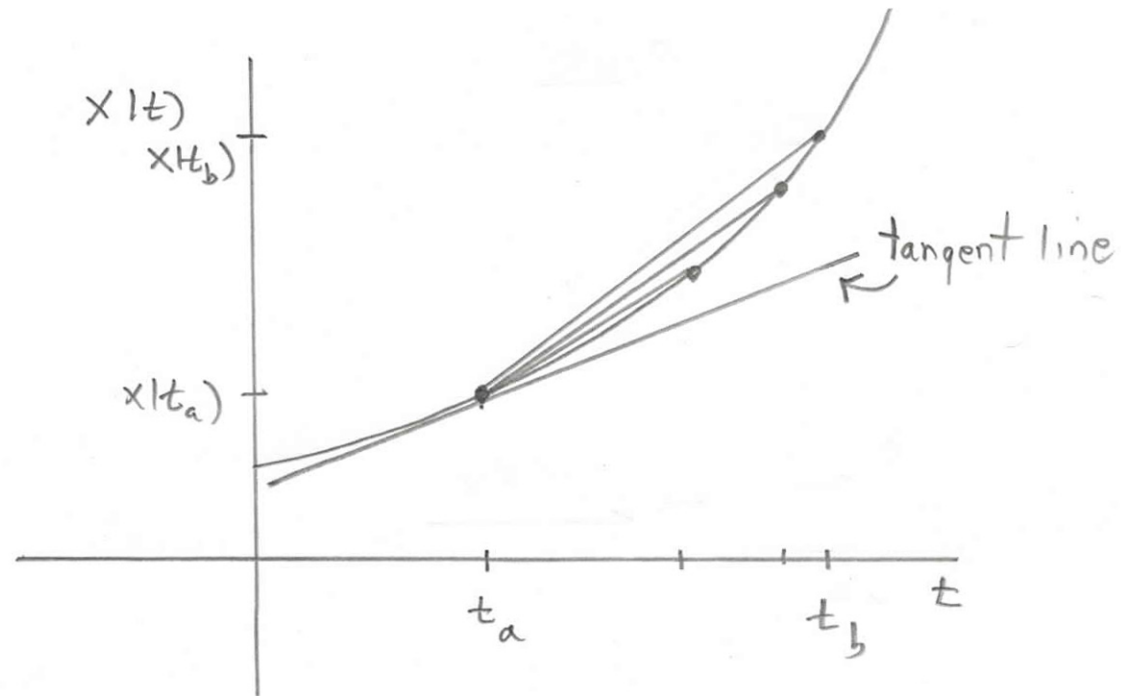
$$\overline{\vec{v}}(t) \equiv \frac{\Delta x}{\Delta t} \hat{\mathbf{i}} = \overline{v_x}(t) \hat{\mathbf{i}}$$

Instantaneous velocity

- For time interval Δt , we calculate the average velocity. As $\Delta t \rightarrow 0$, we generate a sequence of average velocities. The limiting value of this sequence is defined to be the x-component of the instantaneous velocity at the time t .

$$v_x(t) \equiv \lim_{\Delta t \rightarrow 0} \overline{v_x} = \lim_{\Delta t \rightarrow 0} \frac{\Delta x}{\Delta t} = \lim_{\Delta t \rightarrow 0} \frac{x(t + \Delta t) - x(t)}{\Delta t} \equiv \frac{dx}{dt}$$

Instantaneous velocity



Average Acceleration

- Change in velocity divided by the time interval

$$\vec{\mathbf{a}} = \overline{a_x} \hat{\mathbf{i}} \equiv \frac{\Delta v_x}{\Delta t} \hat{\mathbf{i}} = \frac{(v_{x,2} - v_{x,1})}{\Delta t} \hat{\mathbf{i}} = \frac{\Delta v_x}{\Delta t} \hat{\mathbf{i}}$$

Instantaneous acceleration

- For time interval Δt , we calculate the average acceleration. As $\Delta t \rightarrow 0$, we generate a sequence of average accelerations. The limiting value of this sequence is defined to be the x-component of the instantaneous velocity at the time t .

$$\vec{\mathbf{a}}(t) = a_x(t)\hat{\mathbf{i}} \equiv \lim_{\Delta t \rightarrow 0} \overline{a_x}\hat{\mathbf{i}} = \lim_{\Delta t \rightarrow 0} \frac{\Delta v}{\Delta t}\hat{\mathbf{i}} = \lim_{\Delta t \rightarrow 0} \frac{v(t + \Delta t) - v(t)}{\Delta t}\hat{\mathbf{i}} \equiv \frac{dv}{dt}\hat{\mathbf{i}}$$

Instantaneous Acceleration

