

## Mathematical representation

Position  $[L] \equiv \vec{r} = \langle x, y, z \rangle$

Displacement  $[L] \equiv \Delta \vec{r} = \vec{r}_f - \vec{r}_i$   
 $= \langle x_f - x_i, y_f - y_i, z_f - z_i \rangle$

Distance  $[L] \equiv |\vec{r}| = \sqrt{x^2 + y^2 + z^2}$

Velocity  $\frac{[L]}{[T]} \equiv \vec{v} = \langle v_x, v_y, v_z \rangle$

Change in velocity  $\frac{[L]}{[T]} \equiv \Delta \vec{v} = \vec{v}_f - \vec{v}_i$   
 $= \langle v_{fx} - v_{ix}, v_{fy} - v_{iy}, v_{fz} - v_{iz} \rangle$

Speed  $\frac{[L]}{[T]} \equiv |\vec{v}| = \sqrt{v_x^2 + v_y^2 + v_z^2}$

Average velocity  $\frac{[L]}{[T]} \equiv \vec{v} = \frac{\Delta \vec{r}}{\Delta t}$   
 $= \left\langle \frac{x_f - x_i}{\Delta t}, \frac{y_f - y_i}{\Delta t}, \frac{z_f - z_i}{\Delta t} \right\rangle$

Acceleration  $\frac{[L]}{[T]^2} \equiv \vec{a} = \langle a_x, a_y, a_z \rangle$

Magnitude of acceleration  $\frac{[L]}{[T]^2} \equiv |\vec{a}| = \sqrt{a_x^2 + a_y^2 + a_z^2}$

average acceleration  $\frac{[L]}{[T]^2} \equiv \vec{a} = \frac{\Delta \vec{v}}{\Delta t}$   
 $= \left\langle \frac{v_{fx} - v_{ix}}{\Delta t}, \frac{v_{fy} - v_{iy}}{\Delta t}, \frac{v_{fz} - v_{iz}}{\Delta t} \right\rangle$

KINEMATIC EQUATIONS

**\* CONSTANT**

Vector form (3 equations each)  
 Example:

$$\vec{r}_f = \vec{r}_i + \vec{v}_i \Delta t + \frac{1}{2} \vec{a} \Delta t^2$$

$$\vec{v}_f = \vec{v}_i + \vec{a} \Delta t$$

$$v_{fx}^2 = v_{ix}^2 + 2 a_x \Delta x$$

$$x_f = x_i + v_{ix} \Delta t + \frac{1}{2} a_x \Delta t^2$$

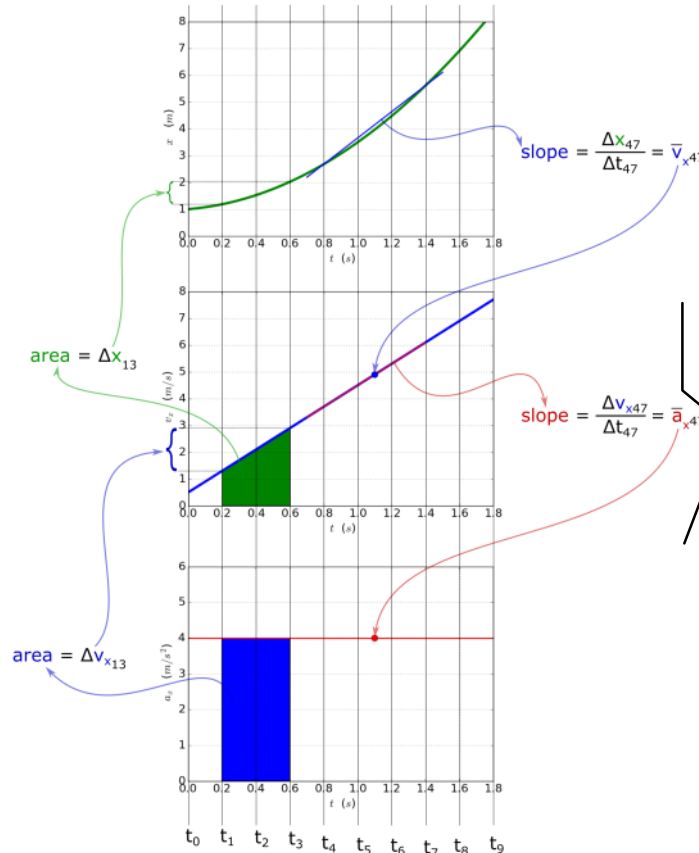
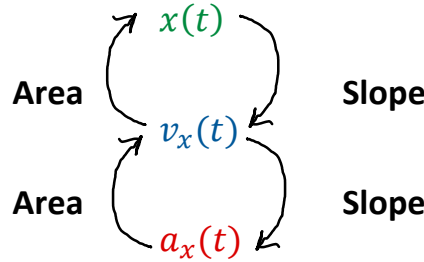
$$v_{fx} = v_{ix} + a_x \Delta t$$

$$v_{fx}^2 = v_{ix}^2 + 2 a_x \Delta x$$

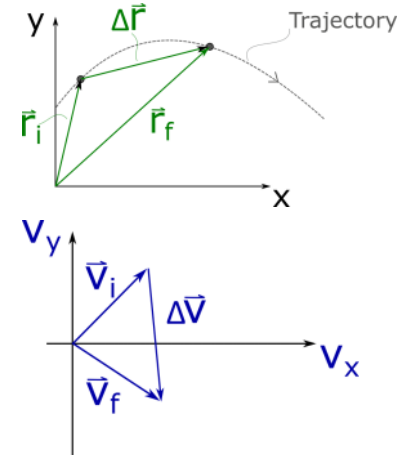
## KINEMATICS

\* [Dimensions]  $\xrightarrow{\text{SI units}}$   $[L] \rightarrow m$   
 $[M] \rightarrow kg$   
 $[T] \rightarrow s$

## Graphical representation



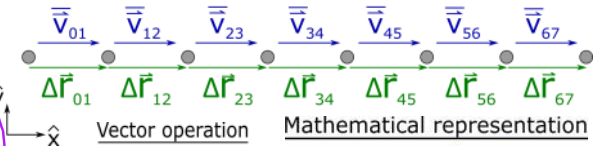
## Physical representation



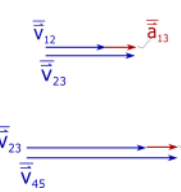
## Motion diagrams

\* Position updated with dots on a spatial plane (e.g. x vs y) at equal time intervals.

### Physical representation



### Vector operation

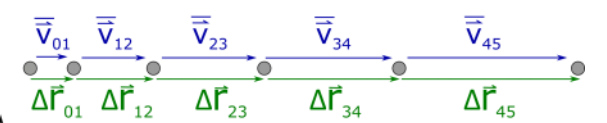


### Mathematical representation

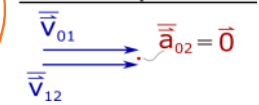
$$\bar{a}_{13} = \frac{\Delta \vec{v}}{\Delta t} = \frac{\vec{v}_{12} - \vec{v}_{23}}{\Delta t_{12}}$$

Average time is the same as the time between two successive locations since motion diagrams are updated at equal time intervals.

### Physical representation



### Vector operation



### Mathematical representation

$$\bar{a}_{02} = \frac{\Delta \vec{v}}{\Delta t} = \frac{\vec{v}_{01} - \vec{v}_{12}}{\Delta t_{01}}$$

Average time is the same as the time between two successive locations since motion diagrams are updated at equal time intervals.

CONSTANT ACCELERATION EXAMPLE

CONSTANT VELOCITY EXAMPLE