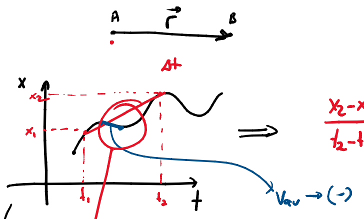
Lecture4

3 Ekim 2019 Perşembe 09:34

> Motion along a straight line



$$\frac{x_2 - x_1}{t_2 - t_1} = \frac{\Delta x}{\Delta t} = V_{av} \ (+)$$

average velocity

$$\lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt} = \dot{x} = v \sim \text{instantaneous velocity}$$

time derivative

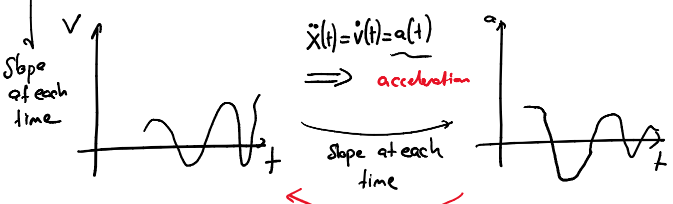
$\frac{dx}{dt}$ $\quad$ $\dot{x}(t) = v(t)$

time derivative

Slope of each time

$$\ddot{x}(t) = \dot{v}(t) = a(t)$$

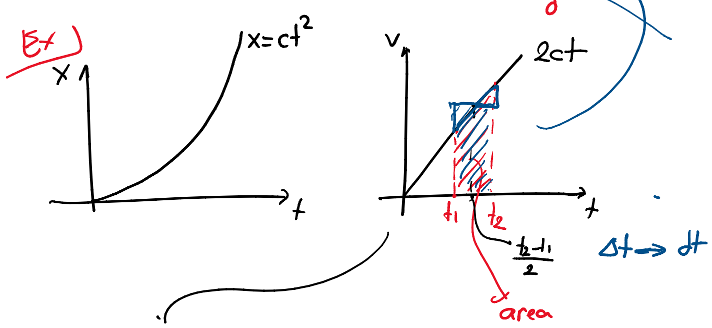
$\Longrightarrow$ acceleration



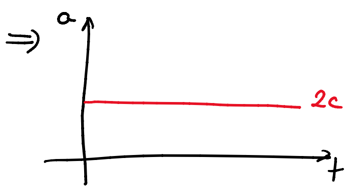
$$v(t) = v(0) + \int_0^t a(t')\,dt'$$

$$x(t) = x(0) + \int_0^t v(t')\,dt'$$

Ex)



$\Rightarrow$



$$x(t) = x(0) + v(0)t + \frac{1}{2}at^2$$

Constant acceleration

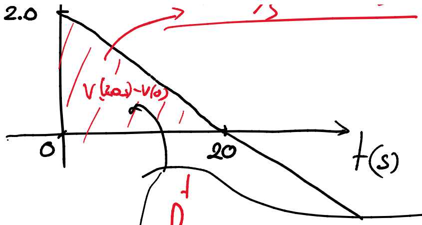
Ex) Variable acceleration

$a(t) = 2.0\,m/s^2 - (0.10\,m/s^3) \cdot t$, $v(0) = 10\,m/s$ $\quad x(0) = 0\,m$

$v(t) = ?$

$x(t) = ?$

$x(t) = ?$



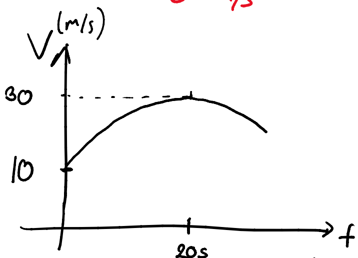
$$v(t) = v(0) + \int_0^t a(t')\,dt'$$

$$= 10\ m/s + \int_0^t \left[2.0\ m/s^2 - (0.10\ m/s^3)t'\right]dt'$$

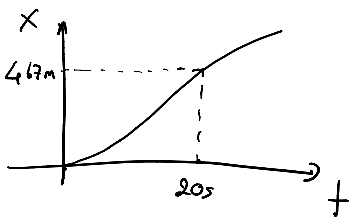
$$v(t) = 10\ m/s + 2.0\ m/s^2\, t - (0.10\ m/s^3)\frac{t^2}{2}$$

$$v(20) = 10\ m/s + 40\ m/s - 20\ m/s$$

$$= 30\ m/s$$



$$x(t) = x(0) + \int_0^t v(t')\,dt' = (10\ m/s)t + (1.0\ m/s^2)t^2 - \left(\frac{0.10}{6}\ m/s^3\right)t^3$$



Chapter 3 – Motion in two or three dimensions

> we will use vectors

$$\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$$ displacement vector

$$\vec{v} = \frac{d\vec{r}}{dt} = \dot{\vec{r}} = \frac{dx}{dt}\hat{i} + \frac{dy}{dt}\hat{j} + \frac{dz}{dt}\hat{k} = v_x\hat{i} + v_y\hat{j} + v_z\hat{k}$$ velocity

$$\vec{a} = \frac{d\vec{v}}{dt} = \ddot{\vec{r}} = \frac{d^2x}{dt^2}\hat{i} + \frac{d^2y}{dt^2}\hat{j} + \frac{d^2z}{dt^2}\hat{k} = a_x\hat{i} + a_y\hat{j} + a_z\hat{k}$$ acceleration

Speed → $|\vec{v}| = \sqrt{v_x^2 + v_y^2 + v_z^2}$

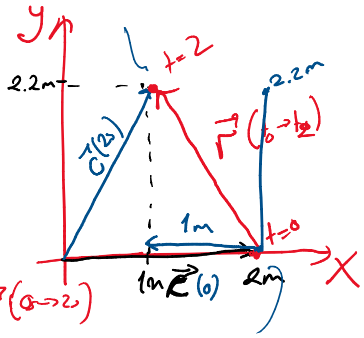
it's the magnitude of the velocity vector

Ex) $x(t) = 2.0\,m - (0.25\ m/s^2)t^2$ → What is the average velocity in 2 seconds?

$(\ldots)\ (0.025\ m/s)\,t^3$

$x(t) = 2.0\,m - (0.25\,m/s^2)\,t^2$ velocity in 2 seconds?

$y(t) = (1.0\,m/s)\,t + (0.025\,m/s^3)\,t^3$



$x(0) = 2.0\,m$ | $x(2s) = 1\,m$

$y(0) = 0$ | $y(2s) = 2.2\,m$

$\vec{c}(2s) - \vec{c}(0) = \vec{r}(0 \to 2s)$

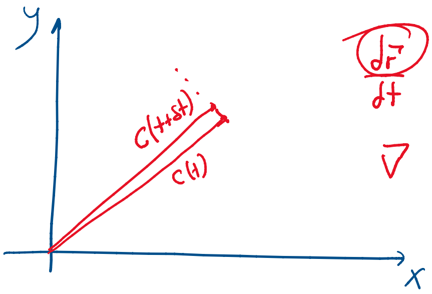
$\vec{c}(2s) = 1.0\,m\,\hat{i} + 2.2\,m\,\hat{j}$

$\vec{c}(0s) = 2.0\,m\,\hat{i}$

$\vec{r} = (-1.0\,m)\,\hat{i} + 2.2\,m\,\hat{j}$

$$\vec{V}_{av} = \frac{\vec{r}}{\Delta t} = -0.5\,m/s\,\hat{i} + 1.1\,m/s\,\hat{j}$$

⇒ Instantaneous velocity



$$\frac{d\vec{r}}{dt} = \frac{dx}{dt}\hat{i} + \frac{dy}{dt}\hat{j}$$

$$\vec{V} = -0.50\,m/s^2\,t\,\hat{i} + \left(1.0\,m/s + 0.075\,m/s^3\,t^2\right)\hat{j}$$

$\frac{dx}{dt}$ $\qquad$ $\frac{dy}{dt}$

$$\vec{a} = \frac{d\vec{V}}{dt} =$$