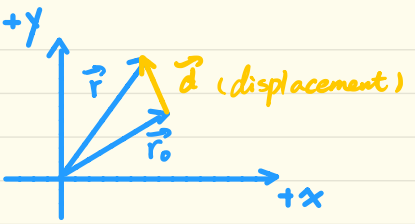
Lecture 3

1/14

Position vector, $\vec{r}$

$(\vec{r}_i, \vec{r}_f)$

$(\vec{r}_0, \vec{r})$



$\vec{r}_0 + \vec{d} = \vec{r}$

$\vec{d} = \vec{r} - \vec{r}_0$

$= \Delta\vec{r}$

r_0: position at 0 & period of time

Average velocity

$$\vec{V}_{avg} = \frac{\vec{r} - \vec{r}_0}{\Delta t} \quad \left(\frac{m}{s}\right)$$

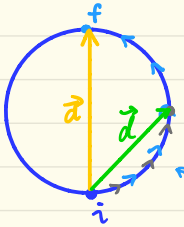
$\vec{r} = (5, 0, 0)$ $\quad \Delta t = 3$

$\vec{r}_0 = (2, 0, 0)$ $\quad \vec{V}_{avg} = \frac{(3, 0, 0)}{3} = (1, 0, 0)$

define instantaneous → **Velocity**

$$\vec{V} = \lim_{\Delta t \to 0} \frac{\vec{r} - \vec{r}_0}{\Delta t} = \frac{d\vec{r}}{dt}$$

Uniform Circular Motion



full circle:

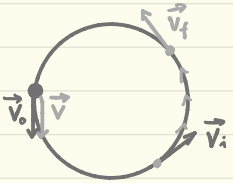
$\vec{r} - \vec{r}_i = 0$

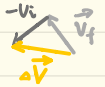
$\vec{V}_{avg} = 0$

half circle:

$\vec{d}$ = displacement

quarter circle: $\vec{d}$





$$\vec{a}_{avg} = \frac{\vec{V} - \vec{V}_0}{\Delta t}$$

define instantaneous → **Acceleration**

$$\vec{a} = \lim_{\Delta t \to 0} \frac{\Delta\vec{V}}{\Delta t} = \frac{d\vec{V}}{dt}$$

1-D motion with constant acceleration

a_x = constant

$$a_x = \frac{dV_x}{dt}$$

$$\int_{V_{0x}}^{V_x} dV'_x = \int_0^t a_x\, dt'$$

$$V_x = V_{0x} + a_x t$$

$$V_x = \frac{dx}{dt} = V_{0x} + a_x \cdot t$$

$$\int_{x_0}^{x} dx' = \int_0^t (V_{0x} + a_x t')\, dt'$$

$$x = x_0 + V_{0x} t + \frac{1}{2} a_x t^2$$

$$V_x^2 = V_{0x}^2 + 2 a_x (x - x_0)$$

Free Fall

- neglect air resistance
- acceleration is downward at a rate of $g = 9.8\ m/s^2$ (# on exam, $g = 10\ m/s^2$)

$a_y = -10$

rock released from rest 20 m above ground,

(a) time t to hit ground?

(b) speed V at impact?

Strategy

① pic, axis, i, f

② list $y_0 = 20$ $y = 0$ $V_{0y} = 0$ $V_y =$ $a_y = -10$ $t =$

③ choose equation / plug in $y = y_0 + V_{0y} t + \frac{1}{2} a_y t^2$

$t^2 = 4$ $t = 2$ sec $0 = 20 + 0 + \frac{1}{2}(-10)\, t^2$