General Physics I
Classnotes

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1 Kinematics in 2-D

Let:

$$\begin{aligned}\vec{r} &= \text{position} \\ &= x\hat{i} + y\hat{j} \qquad\qquad \vec{r_i} = x_i\hat{i} + y_i\hat{j} = \text{initial} \\ \vec{r_f} &= x_f\hat{i} + y_f\hat{j} = \text{final}\end{aligned}$$

$$\begin{aligned}\Delta\vec{r} &= \vec{r_f} - \vec{r_i} \\ &= (x_f\hat{i} + y_f\hat{j}) - (x_i\hat{i} + y_i\hat{j}) \\ &= (x_f - x_i)\hat{i} + (y_f - y_i)\hat{j} \\ &= \Delta x\hat{i} + \Delta y\hat{j}\end{aligned}$$

$$\begin{aligned}\vec{\bar{v}} &= \text{average velocity} \\ &= \frac{\text{displacement}}{\text{time}} \\ &= \frac{\Delta\vec{r}}{\Delta t} \\ &= \frac{\Delta x\hat{i} + \Delta y\hat{j}}{\Delta t} \\ &= \frac{\Delta x}{\Delta t}\hat{i} + \frac{\Delta y}{\Delta t}\hat{j} \\ &= \vec{\bar{v}}_x\hat{i} + \vec{\bar{v}}_y\hat{j}\end{aligned}$$

$$\begin{aligned}
\vec{v} &= \text{instantaneous velocity} \\
&= \frac{d\vec{r}}{dt} \\
&= \frac{d}{dt}\left(x\hat{i} + y\hat{j}\right) \\
&= \frac{dx}{dt}\hat{i} + \frac{dy}{dt}\hat{j} \\
&= \vec{v_x}\hat{i} + \vec{v_y}\hat{j}
\end{aligned}$$

$$\begin{aligned}
\vec{\vec{a}} &= \text{average acceleration} \\
&= \frac{\Delta\vec{v}}{\Delta t} \\
&= \frac{\Delta\left(v_x\hat{i} + v_y\hat{j}\right)}{\Delta t} \\
&= \frac{\Delta v_x}{\Delta t}\hat{i} + \frac{\Delta v_y}{\Delta t}\hat{j} \\
&= \vec{\vec{a}_x}\hat{i} + \vec{\vec{a}_y}\hat{j}
\end{aligned}$$

$$\begin{aligned}
\vec{a} &= \text{instantaneous acceleration} \\
&= \frac{d\vec{v}}{dt} \\
&= \frac{d}{dt}\left(v_x\hat{i} + v_y\hat{j}\right) \\
&= \frac{dv_x}{dt}\hat{i} + \frac{dv_y}{dt}\hat{j} \\
&= \vec{a_x}\hat{i} + \vec{a_y}\hat{j}
\end{aligned}$$

2 Projectiles

$v_x = \text{constant}$

$a_x = 0 \qquad\qquad a_y = -g$

(1-D) iff $a =$ constant

$$(1) \qquad v = v_0 + at$$

$$(2) \qquad x = x_0 + v_0 t + \frac{1}{2} a t^2$$

$$(3) \qquad x = x_0 + \frac{1}{2} (v_0 + v) t$$

$$(4) \qquad 2a (x - x_0) = v^2 - v_0^2$$

iff $\vec{a} =$ constant

$$(1x) \qquad v_x = v_{0_x} + a_x t$$

$$(1y) \qquad v_y = v_{0_y} + a_y t$$

$$(2x) \qquad x = x_0 + v_{0_x} t + \frac{1}{2} a_x t^2$$

$$(2y) \qquad y = y_0 + v_{0_y} t + \frac{1}{2} a_y t^2$$