

# 继续极坐标部分.

Variables :  $\vec{r}$ ,  $\vec{v}$ ,  $\vec{a}$ ,  $t$

Components of vectors :

$$\vec{v} = \frac{d\vec{r}}{dt}$$

$v_x, v_y, v_z$

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

$a_x, a_y, a_z$

分量对应相加

数学基础 :  $\hat{x} \cdot \hat{y} = \hat{y} \cdot \hat{z} = \hat{z} \cdot \hat{x} = 0$



$$\vec{r} = \int \vec{v}(t) dt \quad \text{indefinite}$$

$$\vec{v} = \int \vec{a}(t) dt$$

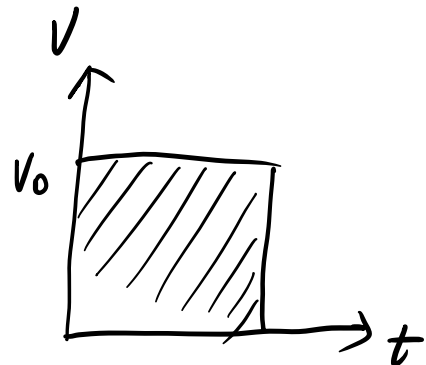
定积分 : 给定初始条件

e.g. 1d, 匀速

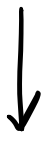
$$v = v_0$$

$$r = v_0 t + r_0$$

$$a = 0$$



匀变速 : 自由落体



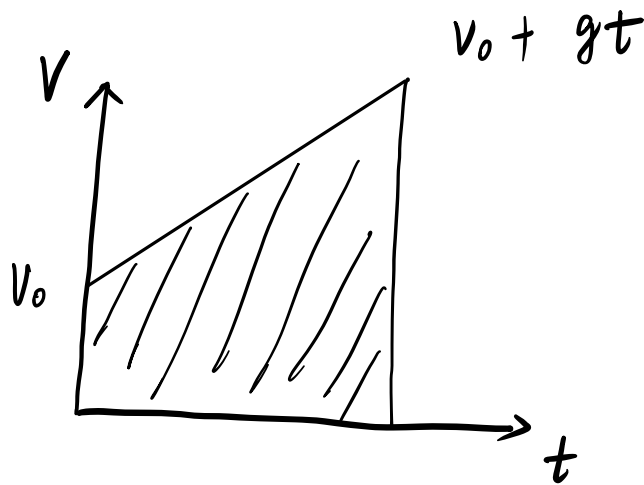
free fall

$$v_0, r_0, g, t \quad (t_0 = 0)$$

$$r(t) = ?$$

$$v(t) = v_0 + gt$$

$$\int_0^t v(t) dt = v_0 t + \frac{1}{2} gt^2$$



$$S = \int_0^t v(t) dt = \frac{1}{2} (v_0 + v_0 + gt) t$$

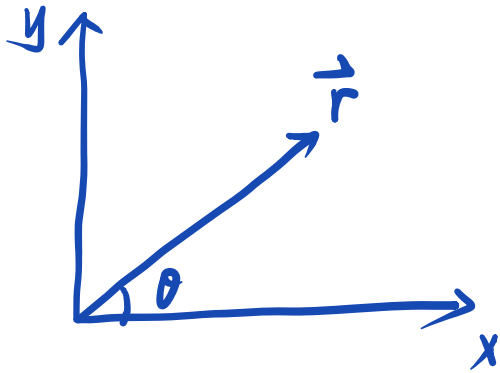
$$= v_0 t + \frac{1}{2} gt^2$$

$$= \frac{[(v_0 + gt)^2 - v_0^2]}{2g}$$

请大家回顾 = 维极坐标  $(r, \theta)$ , 自己  
通过代数 (几何) 的方式推导

$$\frac{d\hat{r}}{dt} = \frac{d\theta}{dt} \hat{\theta}$$

$$\frac{d\hat{\theta}}{dt} = -\frac{d\theta}{dt} \hat{r}$$



$$\begin{aligned}\vec{r} &= (x, y) \\ &= (r \cos \theta, r \sin \theta)\end{aligned}$$

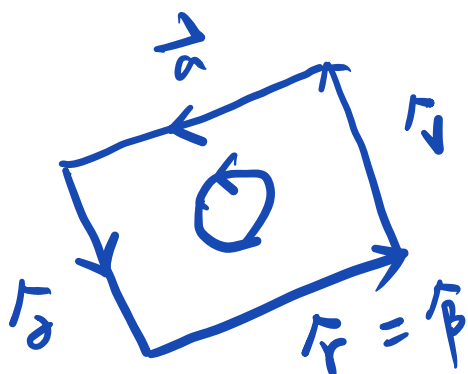
$$\vec{v} = \frac{d\vec{r}}{dt} = \omega r (-\sin \theta, \cos \theta)$$

$$\vec{a} = \frac{d\vec{v}}{dt} = \omega^2 r (-\cos \theta, -\sin \theta)$$

$$\vec{\alpha} \equiv \frac{d\vec{a}}{dt} = \omega^3 r (\sin \theta, -\cos \theta)$$

$$\vec{\beta} \equiv \frac{d\vec{\alpha}}{dt} = \omega^4 r (\cos \theta, \sin \theta)$$

用时间的一次导数连接



4次一循环

$$e^{i\theta} = \cos\theta + i\sin\theta$$

$$e^{i\frac{\pi}{2}} = \cos\frac{\pi}{2} + i\sin\frac{\pi}{2} = i$$

$$i^2 = -1, \quad i^4 = 1$$

$i^4 = 1$  , 四次一循环