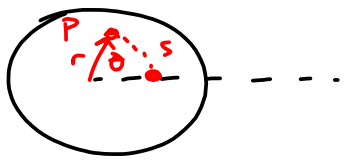
More Rotation



$s \rightarrow$ arc length
$r \rightarrow$ radius
$\theta \rightarrow$ angle between positions 1 and 2

$$s = r\theta$$

$$\theta\,(\text{rad}) = \frac{\pi}{180^\circ}\,\theta\,(\text{deg})$$

$$\Delta\theta \equiv \theta_f - \theta_i$$

$$\omega_{avg} \equiv \frac{\Delta\theta}{\Delta t}$$

instantaneous $\quad \omega = \dfrac{d\theta}{dt}$

$$\alpha_{avg} \equiv \frac{\Delta\omega}{\Delta t}$$

instantaneous $\quad \alpha = \dfrac{d\omega}{dt}$ ← "full" derivative

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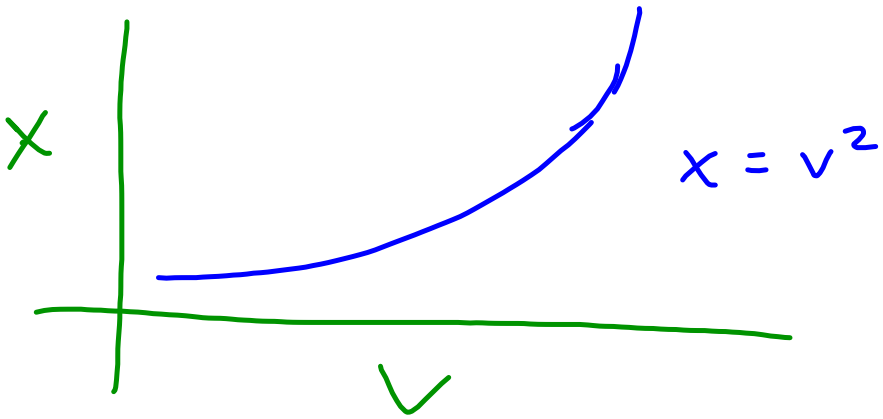
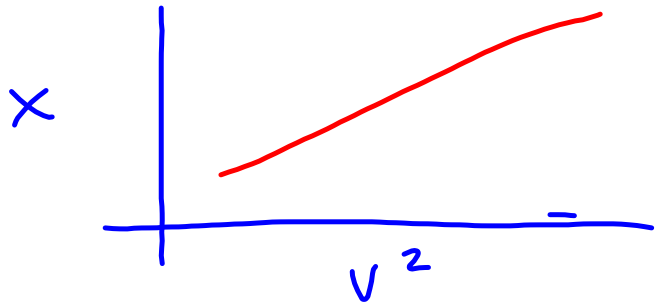
$$\frac{\partial f(x,y,z)}{\partial t} = \left(\frac{\partial f_x}{\partial t}\right)\left(\frac{\partial f_y}{\partial t}\right)\left(\frac{\partial f_z}{\partial t}\right)^*$$

* may not be correct

$$\frac{\partial f_x}{\partial t} = 2xy^3z^4 \qquad \frac{\partial f_y}{\partial t} = 3x^2y^2z^4$$

$$f(x,y,z) = x^2y^3z^4 \qquad \frac{\partial f_z}{\partial t} = 4x^2y^3z^3$$





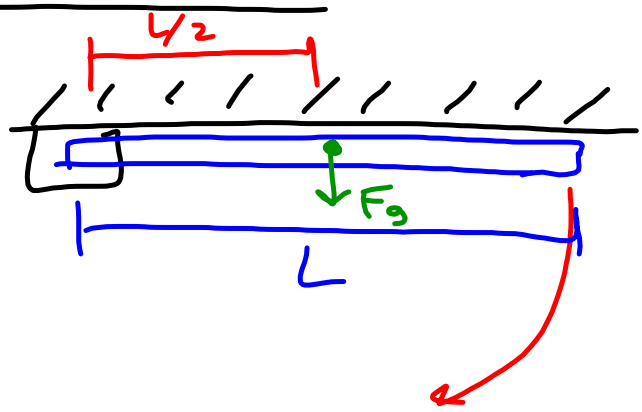
$$\text{slope} = \frac{\Delta x}{\Delta v^2} = 2a$$

$$\Delta x = 2a\,\Delta v^2$$

Relationship between angular and translational

- $\bar{v} = r\bar{\omega}$
- $\bar{a} = r\bar{\alpha}$
- $a_c = \frac{v^2}{r} = r\omega^2$

Example 10.4



$$\sum \tau_{ext} = I\alpha$$

$$\alpha = \frac{\sum \tau_{ext}}{I}$$

$\tau = rF\sin\theta$
$= \left(\frac{L}{2}\right)(F_g)$
$= \left(\frac{L}{2}\right)(Ma_g)$

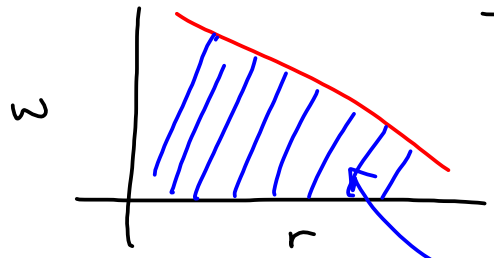
$$= \frac{\frac{L}{2} M a_g}{\frac{1}{3} M L^2}$$

$$= \frac{3}{2}\frac{a_g}{L}$$

tangential acceleration

$$a_t = L\alpha$$
$$= L\left(\frac{3}{2}\frac{a_g}{L}\right)$$
$$= \frac{3}{2}a_g$$

Rotation Lab



If data of r and ω

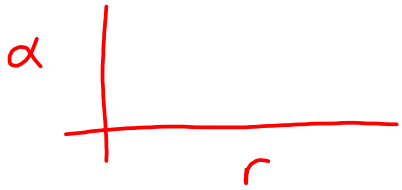
$v = r\omega$

area (missing a $\frac{1}{2}$?)

$\omega = v\left(\frac{1}{r}\right)$

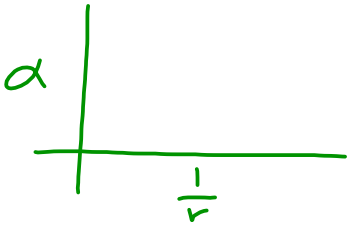
use the slope

equation: $a_t = r\alpha$



find area (?)

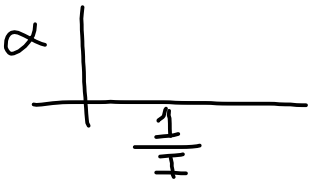
$\alpha = \left(\frac{1}{r}\right) a_t$



look at slope

using $\tau = I\alpha$

$\alpha = \left(\frac{1}{I}\right)\tau$



slope = τ