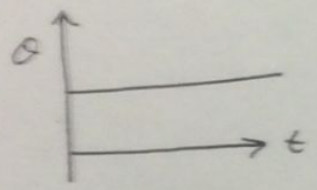
Translational v. Rotational Motion

Translational motion: the motion of the center of mass of an object.

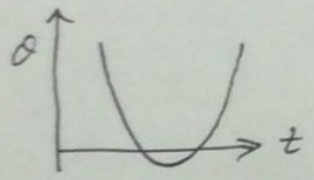
Rotational motion: how an object rotates about an axis.

Translational:		Rotational:		
x		θ	angular position (rad.)	
$\Delta x = x_f - x_i$		$\Delta\theta$	angular displacement (rad.)	
$\bar{v} = \frac{\Delta x}{t}$		ω	angular velocity ($\frac{rad}{s}$)	$\bar{\omega} = \frac{\Delta\theta}{\Delta t}$ slope of θ
$\bar{a} = \frac{\Delta v}{\Delta t}$		α	angular acceleration	$\bar{\alpha} = \frac{\Delta\omega}{\Delta t}$ slope of ω
t		t	time (seconds)	

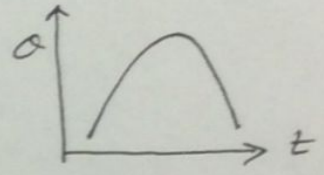


ω : constant

$\alpha = 0$



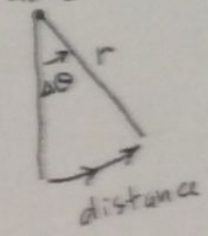
α = positive



α = negative

If rolling without slipping OR rotating about a fixed axis:

$\Rightarrow$ Rotational motion and translational motion are related.



distance $= r \cdot \Delta\theta$

speed $= r \cdot \omega$

$a = \frac{\Delta(\text{speed})}{\Delta t} = \frac{\Delta(r\omega)}{\Delta t} = r \cdot \left(\frac{\Delta\omega}{\Delta t}\right) = r \cdot \alpha$

$a_{Tangential} = r \cdot \alpha$

$a_c = \frac{v^2}{r} = \frac{(r\omega)^2}{r} = r\omega^2$

Translational Dynamics

If $F_{net} = 0$, rest $\Rightarrow$ stays at rest.
motion $\Rightarrow$ stays in motion

$\Sigma F = m \cdot a$

Newton's Laws

1

2

3

For every force, equal and opposite force.

Rotational Dynamics

If $\tau_{net} = 0$, no rotation $\Rightarrow$ no rotation
rotating $\Rightarrow$ stays rotating

$\Sigma \tau = I\alpha$

I: rotational inertia or moment of inertia

For every torque, there is an equal and opposite torque.