Translational vs. Rotational Motion

Nomenclature

Δs: displacement (m), v: velocity(m/s), a: acceleration (m/s^2), Δt: duration (s), r: radius or radial distance from the axis of rotation (m), F: force (N), m: mass (kg), p: linear momentum (kg·m/s), P: power (W)

Δθ: angular displacement (rad), ω: angular velocity (rad/s), α: angular acceleration (rad/s^2), τ: torque (Nm), L: angular momentum ($kg{\cdot}m^2/s$), I: moment of inertia ($kg{\cdot}m^2$), T: period (s)

Subscripts

i: initial, f: final, t: tangential, r: radial, K: kinetic

Translational Kinematic Equations (constant a)	Rotational Kinematic Equations (constant α)
$\Delta s = v_i\,\Delta t + \frac{1}{2} a\,(\Delta t)^2$	$\Delta\theta = \omega_i\,\Delta t + \frac{1}{2}\alpha\,(\Delta t)^2$
$v_f = v_i + a\,\Delta t$	$\omega_f = \omega_i + \alpha\,\Delta t$
$v_f^2 = v_i^2 + 2\,a\,\Delta s$	$\omega_f^2 = \omega_i^2 + 2\,\alpha\,\Delta\theta$

Translational (instantaneous motion)	Rotational (instantaneous motion)	Relationship
$a\,ds = v\,dv$	$\alpha\,d\theta = \omega\,d\omega$	$\Delta s = r\ \Delta\theta$
$\vec{v} = \frac{d\vec{s}}{dt}$	$\vec{\omega} = \frac{d\vec{\theta}}{dt}$	$v_t = r\ \omega$
$\vec{a} = \frac{d\vec{v}}{dt}$	$\vec{\alpha} = \frac{d\vec{\omega}}{dt}$	$a_t = r\ \alpha$ $a_r = \frac{v_t^2}{r} = \omega^2 r$
$\vec{F} = m\vec{a}$	$\vec{\tau} = I\vec{\alpha}$	$\vec{\tau} = \vec{r} \times \vec{F}$
$\vec{p} = m\vec{v}$	$\vec{L} = I\vec{\omega}$	$\vec{L} = \vec{r} \times \vec{p}$

Simple Harmonic Motion

$$T = \frac{2\pi r}{v} = \frac{2\pi}{\omega}$$

Work, Energy, and Power

$W = \int \vec{F} \cdot d\vec{s}$	$W = \int \vec{\tau} \cdot d\vec{\theta}$
$E_K = \frac{1}{2} m v^2$	$E_K = \frac{1}{2} I \omega^2$
$P = Fv$	$P = \tau\omega$

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