Rigid-Body Kinetics

Mechanical Engineering

The two equations that govern a body which both moves and spins.

Force drives the centre of mass; moment about that centre drives the spin.

$$\Sigma F = m\,a_G \cdot \Sigma M_G = I_G\,\alpha$$

Wheel rolling, no slip — $a = \alpha\,r$

Kinematic constraint.

Rod pinned at O — $\Sigma M_O = I_O\,\alpha$

I_O is about the pin.

$I_G = 2$, $\alpha = 5$ rad/s² — Moment = 10 N·m

Units N·m.

THE COMMON MISTAKE

× **Using I about the centroid for a pinned body**

✓ **Shift it: $I_O = I_G + md^2$**

The parallel axis term is often larger than I_G itself. For a uniform rod pinned at one end it triples the value.

Assumes a rigid body in plane motion. A flexible member needs vibration analysis instead.