

MAIN POINTS

Center of Mass Equation for Rotational Motion

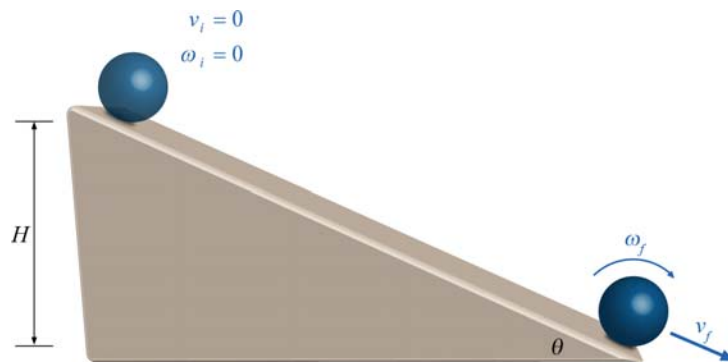
Integrating the rotational dynamics equation, we determined that the change in the rotational kinetic energy is equal to the integral of the torque over the angular displacement.

$$\int_{\theta_i}^{\theta_f} \tau_{Net} d\theta = \Delta \left(\frac{1}{2} I_{CM} \omega^2 \right)$$

Translation + Rotation: Rolling Without Slipping

The total kinetic energy of an object is equal to the sum of the translational kinetic energy of the center of mass and the rotational motion about the center of mass.

$$K_{Total} = \frac{1}{2} M v_{CM}^2 + \frac{1}{2} I_{CM} \omega^2$$



Applying the center-of-mass equation and its rotational analog, we determined that the change in the total kinetic energy of a solid ball rolling without slipping down the ramp is equal to the work done by gravity.

$$\Delta \left(\frac{1}{2} M v_{CM}^2 \right) + \Delta \left(\frac{1}{2} I_{CM} \omega^2 \right) = W_{gravity}$$

Applying Newton's second law and the rotational dynamics equation, we determined the acceleration of a solid ball down the ramp.

$$a_{CM} = \frac{5}{7} g \sin \theta$$