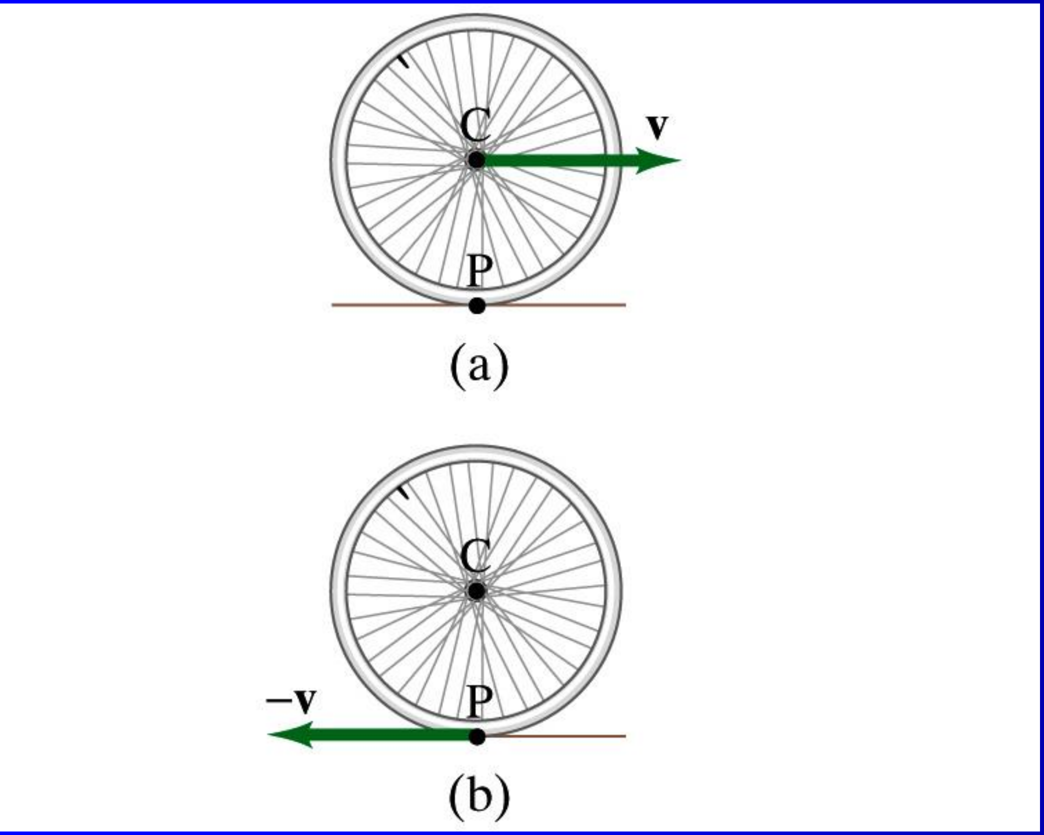
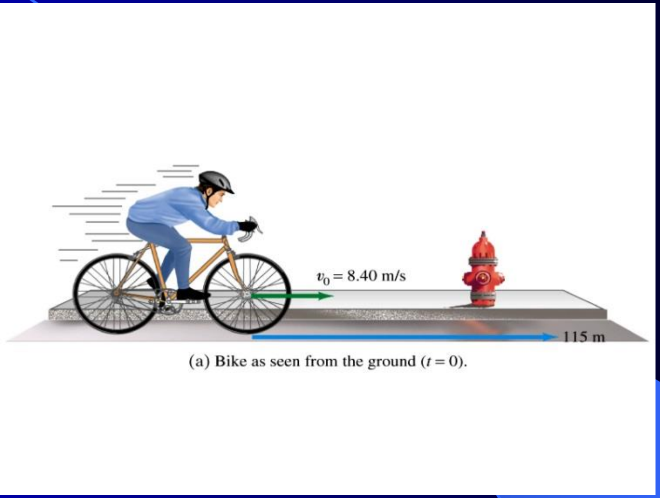
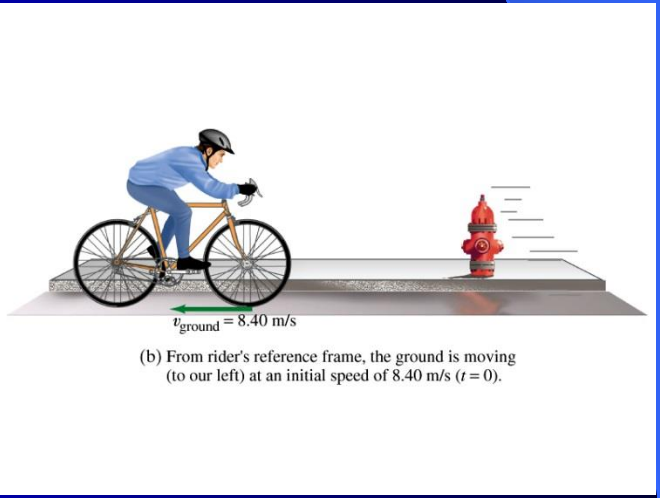
Rolling Motion







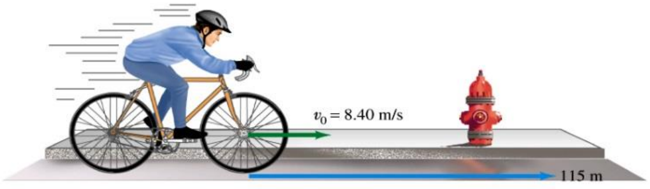
Rolling Motion

- Given: v_0, x to stop, R
- a) ω_0 = ? $\omega_0 = v_0/R$
- b) Revolutions to stop?

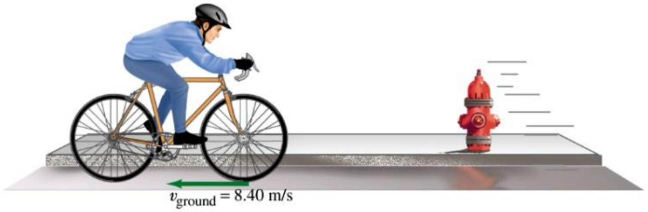
  $x/2\pi r$
- c) Angular Acceleration?

  $\alpha = \omega^2 - \omega_0^2 / 2\theta$
- d) Time to stop

  $t = \omega - \omega_0 / \alpha$

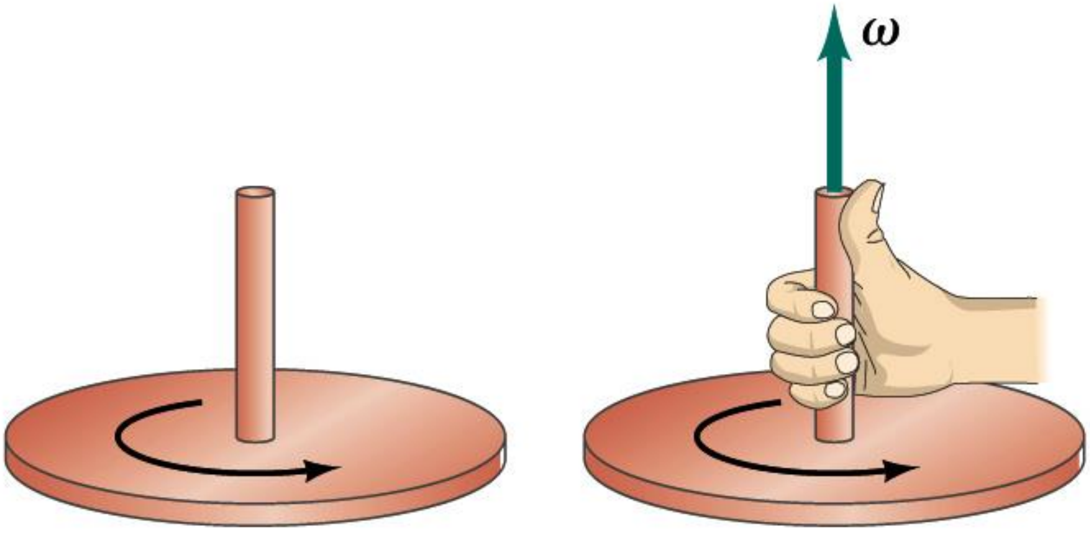


(a) Bike as seen from the ground ($t = 0$).



(b) From rider's reference frame, the ground is moving (to our left) at an initial speed of 8.40 m/s ($t = 0$).

Vector, Right Hand Rule



(a) (b)

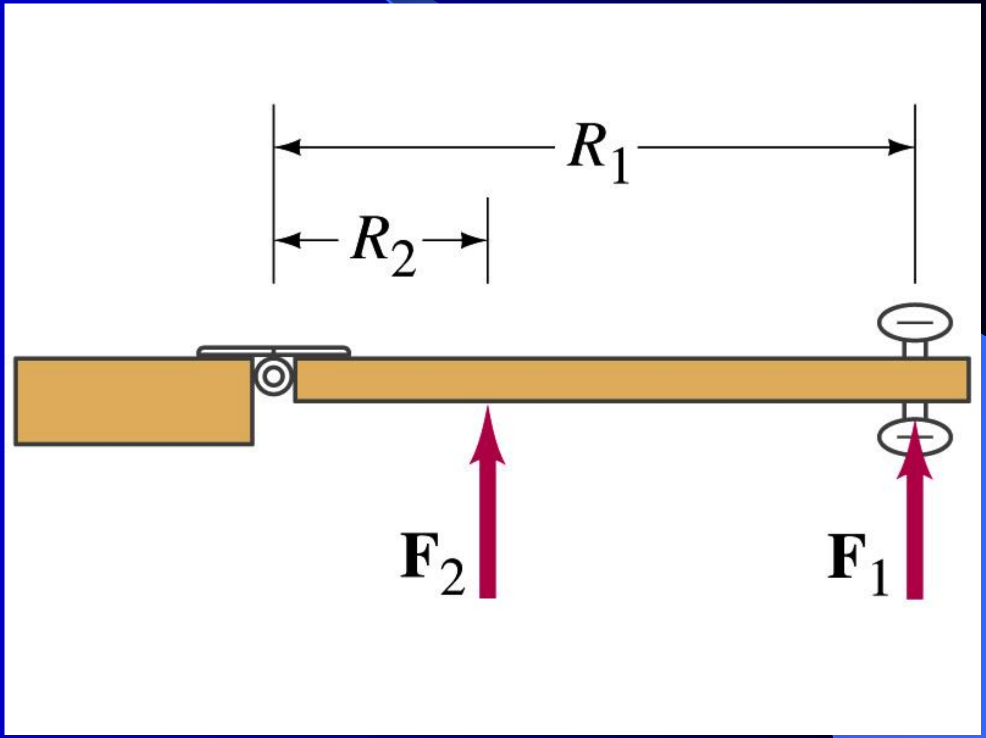
FIGURE 10–11 (a) Rotating wheel. (b) Right-hand rule for obtaining direction of $\boldsymbol{\omega}$.

Right-hand rule

Torque vs. Force

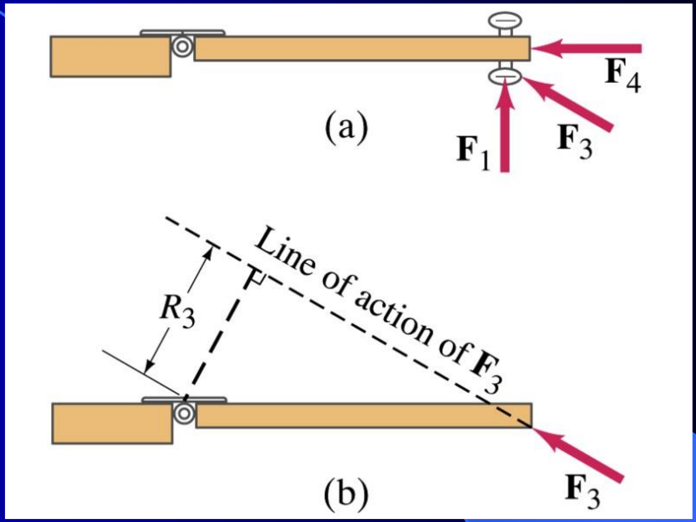
- Torque: rot. Force
- Remember: $a \propto F$
- $\alpha \propto ?$

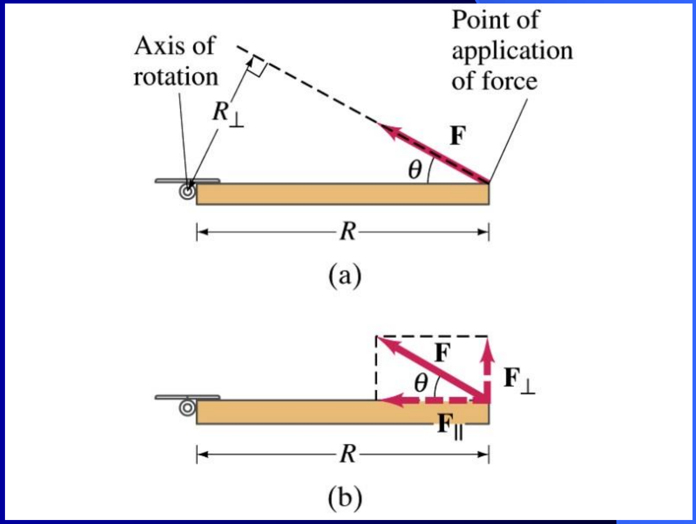
- $\alpha \propto F$
- $\alpha \propto R_\perp$
- $\alpha \propto \tau = R_\perp F$



Torque – More general

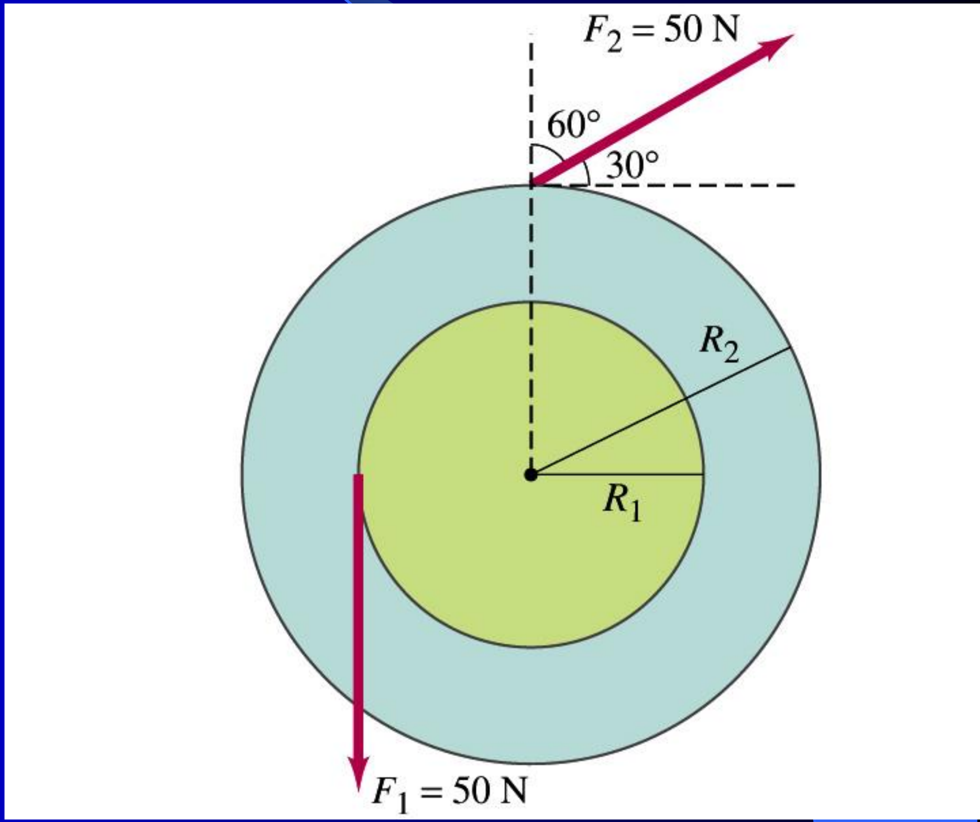
- $\tau = R_\perp F$
- $\tau = R F_\perp$
- $\boldsymbol{\tau = R F \sin\theta}$





Torque – More general

- +: counterclockwise
- Two Torques, opposite
- $\tau = R_1 F_1 - R_2 F_2 \sin 60°$



Rotational Dynamics

- $\alpha \propto \Sigma\tau$ $a \propto \Sigma F$
- $a = 1/m\ \Sigma F$
- What plays the role of mass in rotation?
- $F = ma = mR\alpha$
- $\tau = R\ F = mR^2\alpha$
- Rotational inertia: mR^2
- $\Sigma\tau_i = (\Sigma m_i R_i^2)\ \alpha$
- $I = \Sigma m_i R_i^2$
- $\Sigma\tau = I\ \alpha$
- $(\Sigma\tau)_{CM} = I_{CM}\ \alpha_{CM}$