**12.30. Model:** The rocket attached to the end of a rigid rod is a rotating rigid body. Assume the rocket is small compared to 60 cm.

**Visualize:** Please refer to Figure EX12.30.

**Solve:** We can determine the rocket's angular acceleration from the relationship $\tau = I\alpha$. The torque $\tau$ can be found from the thrust ($F$) using $\tau = Fr\sin\phi$. The moment of inertia ($I$) can be calculated from equations given in Table 12.2. Specifically, $I = I_{\text{rod about one end}} + I_{\text{rocket}}$ becomes

$$\frac{1}{3}M_{\text{rod}}L^2 + ML^2 = \frac{1}{3}(0.100\text{ kg})(0.60\text{ m})^2 + (0.200\text{ kg})(0.60\text{ m})^2$$

$$= 0.012\text{ kg m}^2 + 0.072\text{ kg m}^2 = 0.0840\text{ kg m}^2$$

$$\Rightarrow \alpha = \frac{\tau}{I} = \frac{Fr\sin\phi}{I} = \frac{(4.0\text{ N})(0.60\text{ m})\sin(45°)}{0.0840\text{ kg m}^2} = 20\text{ rads/s}^2$$

**Assess:** The rocket will accelerate counterclockwise since $\alpha$ is positive.