13.80. Model: Model the merry-go-round as a rigid disk rotating on frictionless bearings about an axle in the center and John as a particle. For the (merry-go-round + John) system, no external torques act as John jumps on the merry-go-round. Angular momentum is thus conserved.

Visualize: The initial angular momentum is the sum of the angular momentum of the merry-go-round and the angular momentum of John. The final angular momentum as John jumps on the merry-go-round is equal to \( I_{\text{final}} \omega_{\text{final}} \).

Solve: John’s initial angular momentum is that of a particle: \( L_j = m_j v_j R \sin \beta = m_j v_j R \). The angle \( \beta = 0 \) since John runs tangent to the disk. The conservation of angular momentum equation \( L_i = L_f \) is

\[
I_{\text{final}} \omega_{\text{final}} = I_{\text{disk}} + L_j = \left( \frac{1}{2} MR^2 \right) \omega_i + m_j v_j R
\]

\[
= \left( \frac{1}{2} \right) (250 \text{ kg})(1.5 \text{ m})^2 (20 \text{ rpm}) \left( \frac{2\pi}{60} \text{ rad} / \text{rpm} \right) + (30 \text{ kg})(5.0 \text{ m/s})(1.5 \text{ m}) = 814 \text{ kg m}^2 / \text{s}
\]

\[
\Rightarrow \omega_{\text{final}} = \frac{814 \text{ kg m}^2 / \text{s}}{I_{\text{final}}}
\]

\[
I_{\text{final}} = I_{\text{disk}} + I_j = \frac{1}{2} MR^2 + m_j R^2 = \frac{1}{2} (250 \text{ kg})(1.5 \text{ m})^2 + (30 \text{ kg})(1.5 \text{ m})^2 = 349 \text{ kg m}^2
\]

\[
\omega_{\text{final}} = \frac{814 \text{ kg m}^2 / \text{s}}{349 \text{ kg m}^2} = 2.33 \text{ rad/s} = 22.3 \text{ rpm}
\]