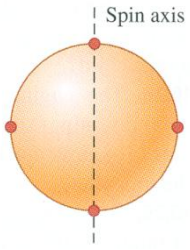
10.8. A uniform 8.40-kg spherical shell, 50.0 cm in diameter has four small 2.00-kg masses attached to its outer surface and equally spaced around it. This combination is spinning about an axis running through the center of the sphere and two of the small masses (see figure). What friction torque is needed to reduce its angular speed from 75.0 rpm to 50.0 rpm in 30.0 s?



Identify: Use a constant acceleration equation to calculate α_z and then apply $\sum \tau_z = I\alpha_z$.

Set Up: $I = \frac{2}{3}MR^2 + 2mR^2$, where $M = 8.40$ kg, $m = 2.00$ kg, so $I = 0.600\ \text{kg}\cdot\text{m}^2$.
$\omega_{0z} = 75.0\ \text{rpm} = 7.854\ \text{rad/s};\ \omega_z = 50.0\ \text{rpm} = 5.236\ \text{rad/s};\ t = 30.0\ \text{s}$.

Execute: $\omega_z = \omega_{0_z} + \alpha_z t$ gives $\alpha_z = -0.08726\ \text{rad/s}^2$. $\tau_z = I\alpha_z = -0.0524\ \text{N}\cdot\text{m}$

Evaluate: The torque is negative because its direction is opposite to the direction of rotation, which must be the case for the speed to decrease.