PHY 221 — Ch. 9 — Cutnell & Johnson — Sharma

(30) $\Sigma \tau = I\alpha \Rightarrow 2TR = I\alpha$

$2(720\,N)(1.2\,m) = (650\,kg\,m^2)\alpha$

Hence $\alpha = \dfrac{2 \times 720 \times 1.2\,Nm}{650\,kg\,m^2} = 2.66\,rad/s^2$

$\theta = \omega_0 t + \frac{1}{2}\alpha t^2 = (1.1\,rad/s)(3\,s) + \frac{1}{2}\left(2.66\,\frac{rad}{s^2}\right)(3.0\,s)^2$

$= 15\,rad = \frac{15}{2\pi}\,rev = 2.4\,rev$

(44) → (50) Energy Conservation $\Rightarrow mgh + \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 = \frac{1}{2}I\omega_0^2 + \frac{1}{2}mv_0^2$

For rolling (No slip) $\omega = \frac{v}{R}$ and $\omega_0 = \frac{v_0}{R}$

$mgh + \frac{1}{2}mv^2 + \frac{1}{2}\left(\frac{2}{5}mR^2\right)\frac{v^2}{R^2} = \frac{1}{2}\left(\frac{2}{5}mR^2\right)\frac{v_0^2}{R^2} + \frac{1}{2}mv_0^2$

$mgh + \left(\frac{1}{2} + \frac{1}{5}\right)mv^2 = \left(\frac{1}{5} + \frac{1}{2}\right)mv_0^2$

$mgh + \frac{7}{10}mv^2 = \frac{7}{10}mv_0^2$

$\Rightarrow \frac{7}{10}\cancel{m}v^2 = \frac{7}{10}\cancel{m}v_0^2 - \cancel{m}gh \Rightarrow v^2 = v_0^2 - \frac{10}{7}gh$

$v = \sqrt{v_0^2 - \frac{10}{7}gh} = \sqrt{(3.5)^2 - \frac{10}{7}(9.8)(0.760)} = \sqrt{1.61}$

$= 1.27\,m/s$

(50) → (57) Ang mom conservation $\Rightarrow I\omega = I_0\omega_0 \Rightarrow \frac{\omega}{\omega_0} = \frac{I_0}{I}$

Now $I_0 = I_s + 500\,(mR^2) = 3.00 \times 10^9\,kg\,m^2 + 500\,[70.0\,kg \times (82.5\,m)^2]$

$= (3.00 \times 10^9 + 2.38 \times 10^8)\,kg\,m^2 = 3.24 \times 10^9\,kg\,m^2$

and after people have moved to the center

$I = I_s = 3.00 \times 10^9\,kg\,m^2$

Hence $\frac{\omega}{\omega_0} = \frac{I_0}{I} = \frac{3.24}{3.00} = 1.08$

Percentage increase $= \dfrac{1.08\,\omega_0 - \omega_0}{\omega_0} \times 100 = 8\%$