

53. We use  $\tau = Fr = I\alpha$ , where  $\alpha$  satisfies  $\theta = \frac{1}{2}\alpha t^2$  (Eq. 11-13). Here  $\theta = 90^\circ = \frac{\pi}{2}$  rad and  $t = 30$  s. The force needed is consequently

$$F = \frac{I\alpha}{r} = \frac{I(2\theta/t^2)}{r} = \frac{(8.7 \times 10^4)(2(\pi/2)/30^2)}{2.4} = 1.3 \times 10^2 \text{ N} .$$