

Chapter 10Problem 48

$$\omega_0 = 0$$

$$\omega_f = 100,000 \frac{\text{rev}}{\text{min}} \left(\frac{2\pi \text{ rad}}{1 \text{ rev}} \right) \left(\frac{1 \text{ min}}{60 \text{ s}} \right) = 10,470 \text{ rad/s}$$

$$\Delta t = 2.00 \text{ min} \left(\frac{60 \text{ s}}{1 \text{ min}} \right) = 120 \text{ s}$$

a) What is the average angular acceleration?

$$\alpha = \frac{\Delta \omega}{\Delta t} = \frac{10,470 \text{ rad/s} - 0}{120 \text{ s}} = \boxed{87.3 \text{ rad/s}^2}$$

b) What is the tangential acceleration at 9.50 cm?

$$a_t = \alpha \cdot r = (87.3 \frac{\text{rad}}{\text{s}^2}) (0.0950 \text{ m}) = \boxed{8.29 \text{ m/s}^2}$$

c) What is the centripetal acceleration at full speed?

$$v_t = \omega \cdot r \text{ and } a_c = \frac{v_t^2}{r} = \frac{(\omega \cdot r)^2}{r} = \omega^2 \cdot r$$

$$a_c = (10,470 \text{ rad/s})^2 \cdot (0.0950 \text{ m}) = \boxed{10,410 \text{ m/s}^2}$$

convert to g's

$$(10,410 \text{ m/s}^2) \left(\frac{1 \text{ g}}{9.8 \text{ m/s}^2} \right) = \boxed{1,060 \text{ g's}}$$

d) What is the total distance traveled as ~~it~~ it is spinning up.

$$\omega_f^2 - \omega_0^2 = 2\alpha\Delta\theta \quad \Delta\theta = \frac{\omega_f^2 - \omega_0^2}{2\alpha} = \frac{(10,470 \text{ rad/s})^2 - (0)^2}{2(87.3 \text{ rad/s}^2)}$$

$$\Delta\theta = 627,800 \text{ rad}$$

~~$$s = \theta \cdot r$$~~

$$s = (627,800 \text{ rad})(0.0950 \text{ m})$$

$$\boxed{s = 59,600 \text{ m}}$$