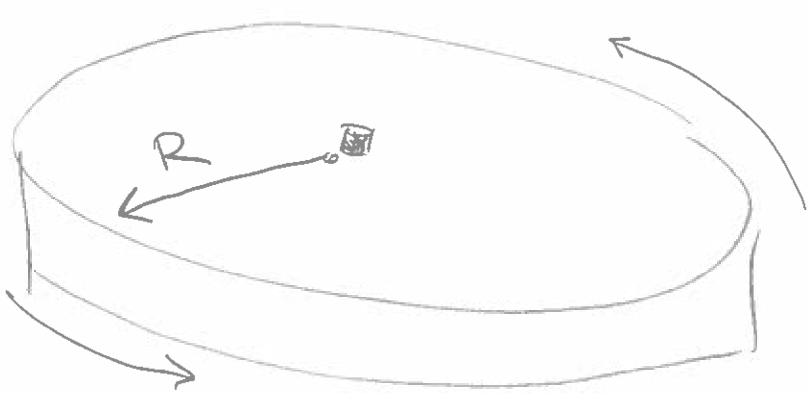


Joe makes a flywheel out of a disk of

radius $R = 0.30$ m

mass $M = 31$ kg

It spins at

$\omega_i = 193$ RPM

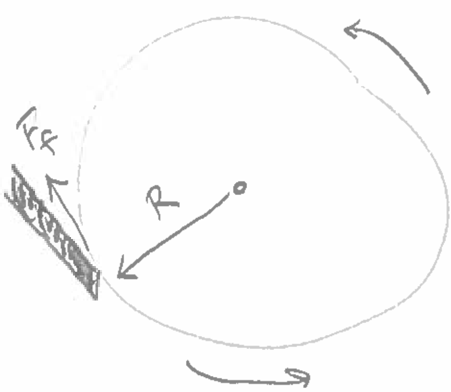
$= 20.21$ rad/s

The initial KE of the wheel is

$$KE_i = \frac{1}{2} I \omega^2 = \frac{1}{2}\left(\frac{1}{2}MR^2\right)\left(\omega_i^2\right) = \frac{1}{2}\left(1.395\ \mathrm{kg\cdot m^2}\right)\left(20.21\ \tfrac{\mathrm{rad}}{\mathrm{s}}\right)^2$$

$$= 284.9\ \mathrm{J}$$

top view



Joe presses a stick against the wheel, with

normal force $F_N = 38$ N

coeff of fric $\mu_K = 0.15$

The friction force

$$F_f = \mu_K F_N = 5.7\ \mathrm{N}$$

acts normal to the radius, so it produces a torque

$$\vec{\tau} = |R|\,|F_f| \sin 90^\circ \ \underline{\text{into}}\ \text{page}$$

$$= 1.71\ \mathrm{N\cdot m}\ \underline{\text{into}}$$

Joe applies his brake for exactly $t = 3\,s$. During this time,

$$\vec{\alpha} = \frac{\vec{\tau}}{I} = \frac{1.71\ N\cdot m \text{ into}}{1.395\ kg\cdot m^2} = 1.23\ \frac{rad}{s^2} \ \underline{\text{into}} \text{ page}$$

Note that initial angular velocity is <u>out</u> of page, so the angular displacement of the wheel during this time is

$$\theta_f - \theta_i = \omega_i t + \frac{1}{2}\alpha t^2$$

$$= \left(20.21\ \frac{rad}{s}\right)(3\,s) + \frac{1}{2}\left(-1.23\ \frac{rad}{s^2}\right)(3\,s)^2$$

$$= 55.1\ rad\ \underline{\text{out}} \text{ of page}$$

The torque is constant in size and direction, so work done by torque is

$$\text{Work} = \int \vec{\tau}\cdot d\vec{\theta} = \int |\tau||d\theta| \cos 180°$$

$$= \int |\tau||d\theta|(-1)$$

$$= (-1)(1.71\ N\cdot m)\int d\theta$$

But we know the total angular displacement is

$$\int d\theta = 55.1\ rad$$

$$\rightarrow \text{Work} = (-1)(1.71\ N\cdot m)(55.1\ rad) = -94.2\ J$$