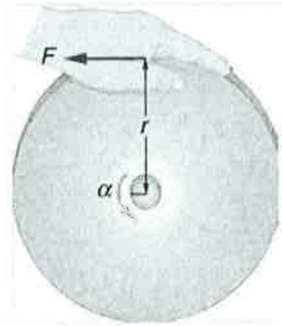
Name: Key

Notes - 10.4 Rotational Kinetic Energy: Work and Energy Revisited

1. What is the kinetic energy of a rotating object? $K = \frac{1}{2} I \omega^2 \leftrightarrow \frac{1}{2} m v^2$

2. A person spins a large grindstone with a radius of 0.320m by placing her hand on its edge and exerting a force of 200N through a rotation of 1.00 rad (57.3°). The rotational inertia I of a disk/cylinder is $I = \frac{1}{2}MR^2$.



A. How much work is done? [Remember the comparison of translational and rotation terms and equations: W = Fd <--> W = τθ]

$$W = \tau\theta = RF\theta = (0.320\,m)(200\,N)(1.00\,rad) = \boxed{64.0\,J}$$

B. What is the final angular velocity if the grindstone has a mass of 85.0 kg? [Remember to use the rotational analog of $v^2 = v_0^2 + 2ad$. Also, $a = \frac{F}{m} \leftrightarrow \alpha = \frac{\tau}{I}$.]

$$\omega^2 = \omega_0^2 + 2\alpha\theta \Rightarrow \omega = \sqrt{\omega_0^2 + 2\frac{\tau}{I}\theta}$$

$$\omega = \sqrt{0^2 + 2\frac{(0.320\,m)(200\,N)}{\frac{1}{2}(85.0\,kg)(0.320\,m)^2}(1.00\,rad)} = \boxed{5.42\,\frac{rad}{s}}$$

C. What is the final rotational kinetic energy? (It should equal the work.)

$$K = \frac{1}{2}I\omega^2 = \frac{1}{2}\left(\frac{1}{2}(85.0\,kg)(0.320\,m)^2\right)\left(5.42\,\frac{rad}{s}\right)^2 = \boxed{64.0\,J}$$

$W = \Delta K$

3. Calculate the final speed of a solid cylinder that rolls down a 2.00-m-high incline. The cylinder starts from rest, has a mass of 0.750 kg, and has a radius of 4.00 cm.

$$K_i + U_i = K_f + U_f$$

$$0 + mgh = \frac{1}{2}I\omega^2 + \frac{1}{2}mv^2 + 0$$

$$= \frac{1}{2}\left(\frac{1}{2}mR^2\right)\left(\frac{v}{R}\right)^2 + \frac{1}{2}mv^2 = \frac{1}{4}mv^2 + \frac{1}{2}mv^2$$

$$mgh = \frac{3}{4}mv^2 \Rightarrow v = \sqrt{\frac{4}{3}gh} = \sqrt{\frac{4}{3}\left(9.80\,\frac{m}{s^2}\right)(2.00\,m)}$$

$$= \boxed{5.11\,\frac{m}{s}}$$