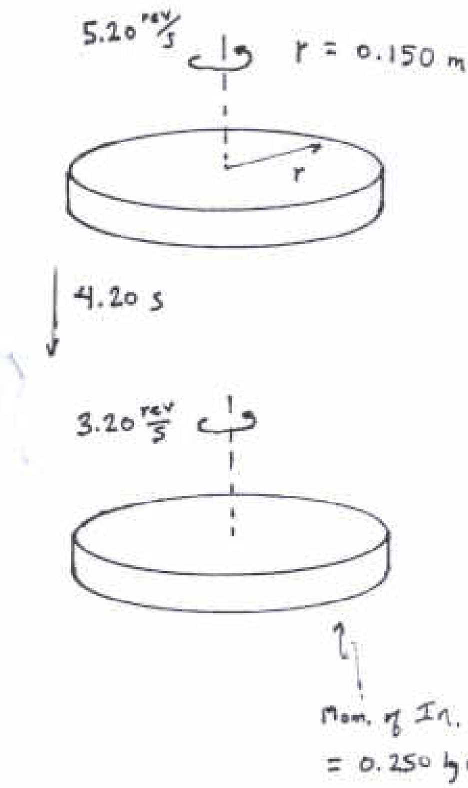
Name____________________________

Phys 2110, Section 5
Quiz #4 — Fall 2001



1. A wheel of radius 0.150 m and moment of inertia 0.250 kg·m^2 turns on a frictionless axle at a rate of 5.20$\frac{\text{rev}}{\text{s}}$. It is slowed to 3.20$\frac{\text{rev}}{\text{s}}$ in 4.20 s by a constant external torque.

a) Find the angular acceleration of the wheel.

Constant torque, so α is constant, and then:

$$\alpha = \frac{\Delta\omega}{\Delta t} = \frac{3.20\,\frac{\text{rev}}{\text{s}} - 5.20\,\frac{\text{rev}}{\text{s}}}{(4.20\,\text{s})} = -0.476\,\frac{\text{rev}}{\text{s}^2}\left(\frac{2\pi\ \text{rad}}{1\ \text{rev}}\right)$$

$$= \boxed{-2.99\ \text{rad/s}^2}$$

b) Find the tangential acceleration of a point on the rim of the wheel.

$$a_T = \alpha r = (-2.99\,\text{rad/s}^2)(0.150\ \text{m})$$

$$= \boxed{-0.449\ \text{m/s}^2}$$

c) Find the torque which acts on the wheel.

$$\tau_{\text{net}} = I\alpha = (0.250\ \text{kg m}^2)(-2.99\,\text{rad/s}^2) = \boxed{-0.748\ \text{N·m}}$$

d) How many revolutions did the wheel make as it was slowing down? Kinematic eqn for θ can also be used w/ units of revolutions:

$$\theta - \theta_0 = \tfrac{1}{2}(\omega_0 + \omega)t = \tfrac{1}{2}\left(5.20\,\tfrac{\text{rev}}{\text{s}} + 3.20\,\tfrac{\text{rev}}{\text{s}}\right)(4.20\,\text{s})$$

$$= \boxed{17.6\ \text{rev}}$$

e) What was the work done in slowing the wheel?

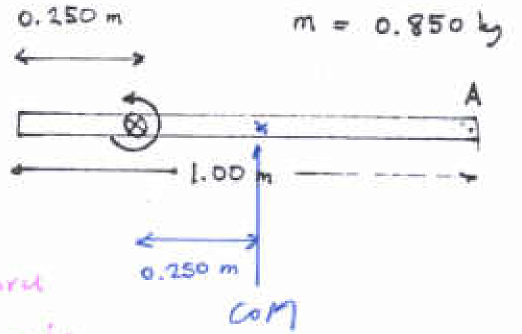
$$W = \Delta K = \tfrac{1}{2}I\omega_f^2 - \tfrac{1}{2}I\omega_i^2 = \tfrac{1}{2}I(\omega_f^2 - \omega_i^2)$$

$$\omega_f = (3.20\,\tfrac{\text{rev}}{\text{s}})(2\pi/\text{rev}) = 20.1\,\tfrac{\text{rad}}{\text{s}}$$

$$\omega_i = (5.20\,\tfrac{\text{rev}}{\text{s}})(2\pi/\text{rev}) = 32.7\,\tfrac{\text{rad}}{\text{s}}$$

$$W = \tfrac{1}{2}(0.250\ \text{kg m}^2)\left([20.1/\text{s}]^2 - [32.7/\text{s}]^2\right) = \boxed{-82.9\ \text{J}}$$

2. A thin uniform rod of mass 0.850 kg and length 1.00 m rotates about an axis which is perpendicular to its length and passes through a point 0.250 m from one end.



a) Find the moment of inertia of the rod for rotation about this axis.

The given axis is displaced from one passing thru the com by 0.250 m. We can apply the parallel axis theorem:

$$I = I_{com} + Mh^2 = \frac{1}{12}ML^2 + Mh^2 = M\left(\frac{1}{12}L^2 + h^2\right)$$

$$= (0.850\ \text{kg})\left(\frac{1}{12}(1.00\ \text{m})^2 + (0.250\ \text{m})^2\right) = \boxed{0.124\ \text{kg m}^2}$$

w/ $L = 1.00$ m, $h = 0.250$ m

b) If the rod turns at a rate of 15.5 rad/s, what is the centripetal (radial) acceleration of point A (the far end) of the rod?

Point A is a distance (0.750 m) from the axis, so

$$a_c = \omega^2 r = (15.5\ \tfrac{\text{rad}}{\text{s}})^2(0.750\ \text{m}) = \boxed{180\ \tfrac{\text{m}}{\text{s}^2}}$$

You must show all your work and include the right units with your answers!

$g = 9.8\,\frac{\text{m}}{\text{s}^2}$ $f_k = \mu_k N$ $W = Fs\cos\phi$

$K = \frac{1}{2}mv^2$ $U_{\text{grav}} = mgy$ $U_{\text{spring}} = \frac{1}{2}kx^2$ $\Delta E = W_{\text{fric}}$

$\omega = \omega_0 + \alpha t$ $\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$ $\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$ $\theta = \theta_0 + \frac{1}{2}(\omega_0 + \omega)t$

2π rad = 1 rev = 360 deg $v = r\omega$ $a_c = \frac{v^2}{r} = \omega^2 r$ $a_T = \alpha r$ $I = I_{\text{com}} + Mh^2$

$K = \frac{1}{2}I\omega^2$ $I_{\text{rod, ctr}} = \frac{1}{12}ML^2$ $I_{\text{rod, end}} = \frac{1}{3}ML^2$ $I_{\text{cyl}} = \frac{1}{2}MR^2$ $I_{\text{sph, solid}} = \frac{2}{5}MR^2$

$\tau = rF\sin\phi$ $\tau = I\alpha$ $W = \tau\theta$ $W_{\text{net}} = \Delta K$ $P = \tau\omega$