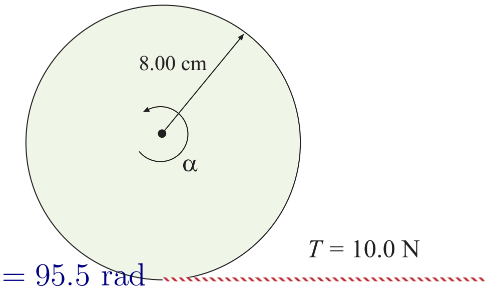
Name ______________________

Apr. 18, 2007

Quiz #4 — Spring 2007

Phys 2110 – Sec 2

1. A cord is wrapped around the rim of a *non-uniform* cylinder of radius 8.0 cm. The cord is pulled so that it has a constant tension of 10.0 N. Starting from rest, the disk makes 15.2 revolutions in 10.0 s.



a) What was the final angular velocity of the disk?

We have

$$\Delta\theta = (15.2 \text{ rev})(2\pi \text{ rad}/1 \text{ rev}) = 95.5 \text{ rad}$$

and we can use $\Delta\theta = \frac{1}{2}(\omega_0 + \omega)\Delta t$:

$$\Delta\theta = \frac{1}{2}(\omega_0 + \omega)\Delta t = \frac{1}{2}(0 + \omega)(10.0 \text{ s}) = 95.5 \text{ rad}$$

Solve for ω, get:

$$\omega = 19.1 \frac{\text{rad}}{\text{s}}$$

b) What was the angular acceleration of the disk?

$$\alpha = \frac{\Delta\omega}{\Delta t} = \frac{(19.1 \frac{\text{rad}}{\text{s}})}{(10.0 \text{ s})} = 1.91 \frac{\text{rad}}{\text{s}^2}$$

c) What was the magnitude of the torque exerted on the disk?

The string exerts a force at the edge of the wheel, perpendicular to the line joining the application point to the axis. This gives:

$$\tau = rF = (0.080 \text{ m})(10.0 \text{ N}) = 0.800 \, \text{N} \cdot \text{m}$$

d) What is the moment of inertia of the disk?

Use $\tau = I\alpha$, then

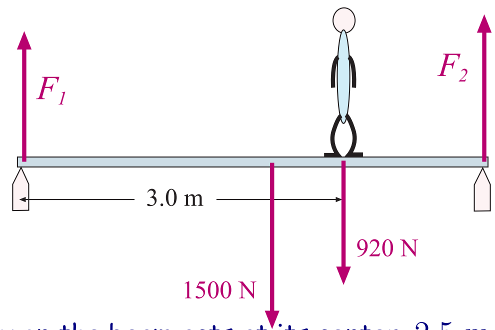
$$I = \tau/\alpha = \frac{(0.800 \, \text{N} \cdot \text{m})}{(1.91 \frac{\text{rad}}{\text{s}^2})} = 0.419 \, \text{kg} \cdot \text{m}^2$$

e) What was the final kinetic energy of the disk?

$$K = \frac{1}{2} I \omega^2 = \frac{1}{2}(0.419 \, \text{kg} \cdot \text{m}^2)(19.1 \frac{\text{rad}}{\text{s}})^2 = 76.4 \text{ J}$$

2. A uniform beam of length 5.00 m has a mass of 1500 N; it is supported on its two ends (the supports exert only *upward* forces). A man with a weight of 920 N stands on the beam 3.00 m from the left end.

Find the forces exerted by the left and right supports.



The forces acting on the beam have been added to the figure. We want to solve for F_1 and F_2. (The force of gravity on the beam acts at its center, $2.5\ \mathrm{m}$ from either end.)

The total force on the beam is zero, which gives:

$$F_1 + F_2 - 1500\ \mathrm{N} - 920\ \mathrm{N} = 0$$

The total torque on the beam is zero; it is convenient to choose the left end of the beam as the location of the axis. This gives:

$$-(1500\ \mathrm{N})(2.5\ \mathrm{m}) - (920\ \mathrm{N})(3.0\ \mathrm{m}) + F_2(5.0\ \mathrm{m}) = 0$$

Solve for F_2, get $F_2 = 1302\ \mathrm{N}$. Put this result into the first equation and get

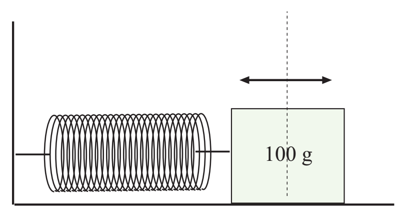
$$F_1 = 2420\ \mathrm{N} - F_2 = 1118\ \mathrm{N}$$

So the forces are

$$F_1 = 1120\ \mathrm{N}\,, \qquad F_2 = 1300\ \mathrm{N}$$

3. A 100 g mass oscillates on the end of an ideal spring while sliding on a frictionless horizontal surface. It is found that the mass makes 36 oscillations in 10.0 s.

What is the force constant of the spring?



The frequency of the oscillations is $36/(10.0\ \mathrm{s}) = 3.6\ \mathrm{Hz}$. Use the formula for the frequency of mass/spring oscillations,

$$f = \frac{\omega}{2\pi} = \frac{1}{2\pi}\sqrt{\frac{k}{m}} \qquad \Longrightarrow \qquad f^2 = \frac{1}{4\pi^2}\left(\frac{k}{m}\right) \qquad \Longrightarrow \qquad k = 4\pi^2 f^2 m$$

Plug in:

$$k = 4\pi^2(3.6\ \mathrm{s}^{-1})^2(0.100\ \mathrm{kg}) = 51.2\ \tfrac{\mathrm{N}}{\mathrm{m}}$$

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

$$\omega_f = \omega_i + \alpha\Delta t \qquad \theta_f = \theta_i + \omega_i\Delta t + \tfrac{1}{2}\alpha(\Delta t)^2 \qquad \omega_f^2 = \omega_i^2 + 2\alpha\Delta\theta \qquad \Delta\theta = \tfrac{1}{2}(\omega_0 + \omega)t$$

$$v_t = r\omega \qquad a_t = r\alpha \qquad \tau = |rF\sin\theta| \qquad \tau = I\alpha \qquad K = \tfrac{1}{2}I\omega^2 \qquad I = \sum_i m_i r_i^2$$

$$I_{\text{cyl}} = \tfrac{1}{2}MR^2 \qquad I_{\text{rod, ctr}} = \tfrac{1}{12}ML^2 \qquad I_{\text{rod, end}} = \tfrac{1}{3}ML^2 \qquad I_{\text{sph, sol}} = \tfrac{2}{5}MR^2 \qquad I_{\text{sph, sh}} = \tfrac{2}{3}MR^2$$

$$\text{Statics:} \quad \sum \mathbf{F} = 0 \qquad \sum \tau = 0 \qquad f = \frac{1}{T} = \frac{\omega}{2\pi} \qquad \omega = \sqrt{\frac{k}{m}} \qquad \omega = \sqrt{\frac{g}{L}}$$