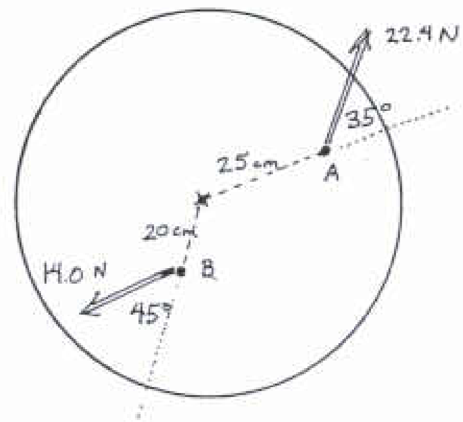
Name________________________________

Phys 121
Quiz #5

1. A uniform disk of mass 2.40 kg and radius 32.0 cm rotates freely about an axis through its center. A force of magnitude 22.4 N is applied to the disk at point A, which is 25.0 cm from the disk's center. The force is directed at an angle of 35.0° with the line joining the center and A (and is in the plane of the disk). Another force of magnitude 14.0 N is applied to the disk at point B, which is 20.0 cm from the center; this force makes an angle of 45.0° with the line joining the center and B. The geometry is *as shown in this figure*.



a) What is the net torque on the disk?

Torque from force at A is (note: gives ccwise rot'n):

$\tau_A = +(0.250\,\mathrm{m})(22.4\,\mathrm{N})(\sin 35°) = 3.21\ \mathrm{N\cdot m}$

Torque from force at B is (note: gives c-wise rot'n):

$\tau_B = -(0.200\,\mathrm{m})(14.0\,\mathrm{N})(\sin 45°) = 1.98\ \mathrm{N\cdot m}$

$\tau_{net} = \tau_A + \tau_B$

$= \boxed{1.23\ \mathrm{N\cdot m}}$

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

$I = I_{\text{unif. disk}} = \frac{1}{2}MR^2 = \frac{1}{2}(2.40\,\mathrm{kg})(0.320\,\mathrm{m})^2 = \boxed{0.123\ \mathrm{kg/m^2}}$

c) What is the angular acceleration of the disk?

$\tau_{net} = I\alpha \Rightarrow \alpha = \frac{\tau_{net}}{I} = \frac{1.23\ \mathrm{N\cdot m}}{0.123\ \mathrm{kg\cdot m^2}} = 10.0\ \mathrm{s^{-1}}$

or $\boxed{10.0\ \mathrm{rad/s^2}}$

2. What is the length of a simple pendulum which has a period of 7.04 s?

$T = 7.04\,s \Rightarrow f = 0.142\ s^{-1}$

$f = \frac{1}{2\pi}\sqrt{\frac{g}{L}} \rightarrow f^2 = \frac{1}{4\pi^2}\frac{g}{L} \rightarrow L = \frac{g}{4\pi^2 f^2}$

$$L = \frac{(9.80\ m/s^2)}{4\pi^2\ (0.142\ s^{-1})^2} = \boxed{12.3\ m}$$

3. A string has length 1.2 m and is maintained at a tension of 76.6 N. When a disturbance of frequency 312 Hz is applied to one end, the standing wave pattern shown here is produced.

a) What is speed of (transverse) waves on this string?

For this mode, $L = 3\frac{\lambda}{2} \Rightarrow \lambda = \frac{2}{3}L = \frac{2}{3}(1.20\,m) = 0.800\ m$

$$v = \lambda f = (0.800\,m)(312\ s^{-1}) = \boxed{250\ \frac{m}{s}}$$

b) What is the linear mass density (mass per length) of the string?

If $\mu = \frac{m}{L}$ then $v = \sqrt{\frac{F}{\mu}} \rightarrow v^2 = \frac{F}{\mu} \rightarrow \mu = \frac{F}{v^2}$

$$\mu = \frac{(76.6\ N)}{(250\ \frac{m}{s})^2} = \boxed{1.23\times10^{-3}\ \frac{kg}{m}}$$

You must show all your work!

$\tau = rF\sin\phi \qquad \tau = I\alpha \qquad$ Stat. Eq.: $\sum \mathbf{F} = 0$ and $\sum \tau = 0$

$I = \sum mr^2 \qquad I_{\text{disk}} = \frac{1}{2}MR^2 \qquad I_{\text{sol. sph.}} = \frac{2}{5}MR^2 \qquad I_{\text{rod, middle}} = \frac{1}{12}ML^2$

$\text{KE}_{\text{rot}} = \frac{1}{2}I\omega^2 \qquad \text{KE}_{\text{roll}} = \frac{1}{2}I\omega^2 + \frac{1}{2}mv_{\text{CM}}^2 \qquad L = I\omega$

$f = \frac{1}{T} \qquad \omega = 2\pi f \qquad f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} \qquad f = \frac{1}{2\pi}\sqrt{\frac{g}{L}} \qquad v_{max} = A\omega \qquad a_{max} = A\omega^2$

$\lambda f = v \qquad v = \sqrt{\frac{F}{(m/L)}}$