Name: ______________________

You may answer the questions in the space provided here, or if you prefer, on your own notebook paper.

Multiple choice

1. [1 point] A fictitious force is one that is
   - ● Seen in a non-inertial frame, not seen in an inertial frame.
   - ○ Seen in an inertial frame, not seen in a non-inertial frame.
   - ○ Seen in both inertial and non-inertial frames.
   - ○ Never seen.

2. [1 point] What is easiest way to make a Ferris wheel safer?
   - ○ Make it go faster.
   - ○ Increase the radius. ← This would work but very hard + expensive, but I'll accept it.
   - ● Make it go slower.
   - ○ None of these would work.

3. [1 point] Conservation of angular momentum says that
   - ○ The angular momentum of a rotating object never changes.
   - ○ The angular momentum of a rotating object changes by moving the mass.
   - ○ The angular momentum of a rotating object constantly changes.
   - ● The angular momentum of a rotating object only changes if an external torque is applied.

Short Problems

$$F_{\text{cent}} = m\frac{v^2}{R}$$
$$a_c = \frac{v^2}{R}$$
$$f_s \leq \mu_s F_N$$
$$f_k = \mu_k F_N$$
$$\sum \tau_{\text{net}} = I\alpha$$
$$K_r = \frac{1}{2}I\omega^2 \quad , \quad K_{linear} = \frac{1}{2}mv^2$$
$$L = I\omega$$

Please go on to the next page...

1. $\boxed{\text{3 points}}$ Indiana Jones (no relation) has a mass of 85.0 kg and crosses a river by swinging across a vine. The vine is 10 meters long and assume he's at the very end of it. His speed at the very bottom of the swing is 8.00 m/s. The vine has a breaking strength of 1000 N, which he is unaware of. In the river are a large gang of hungry aligators. Will the aligators continue to be hungry, or will the vine be strong enough to carry Dr. Jones across the river?

See solutions to Quiz I

2. $\boxed{\text{2 points}}$ A yo-yo de-spin is used to reduce the spin of a satellite without having to use extra fuel. Some final stages of satellite launches involves spinning the satellite very fast as this makes propelling it in a straight line easier (like a rotating top which doesn't fall as long as its spinning fast enough due to angular momentum conservation).

Two yo-yo like devices on the left and right side of the craft are released. These masses are held by a very long wire that is initially wrapped around the "yo-yo" but unwinds upon release.

Describe the physics of what happens to the satellite as the yo-yos unwind. Will the satellite spin faster, slower, or stay the same?

The moment of Inertia for the satellite will increase as the yo-yos unfold since moment of inertia is proportional to radius.

$I_1 \omega_1 = I_2 \omega_2$

implies that

$\omega_2 = \frac{I_1}{I_2} \omega_1$

So $\omega_2 < \omega_1$ if Moment of Inertia increases, satellite's spin slows down

2. $\boxed{\text{5 points}}$ A star rotates with a period of 30 days about an axis through its center. The period is the time interval required for a point on the star's equator to make one complete revolution around the axis of rotation. After the star undergoes a supernova explosion, the stellar core radius shrinks from $1.0 \times 10^4 km$ to 3.0 km. Find the period of rotation of the neutron star. (*Hint: ω is rotations per second, the star rotates once every 30 days, convert.*)

$T = 30$ day $\quad I = \frac{2}{5}MR^2$

$\omega = \frac{1}{30}$

$I_1\omega_1 = I_2\omega_2$

$\cancel{\frac{2}{5}}\cancel{M}(1.0\times10^4\text{ km})^2\left(\frac{1}{30}\frac{1}{\text{day}}\right) = \cancel{\frac{2}{5}}\cancel{M}(3\text{ km})^2(\omega_2)$

$\omega_2 = \left(\frac{1.0\times10^4}{3}\right)^2\left(\frac{1}{30}\right)$

$= 370000 \frac{1}{\text{days}}$

OR $\left(\frac{1}{370000}\right)\text{days}\left(\frac{24\text{ hr}}{\text{day}}\right)\left(\frac{3600\text{ s}}{\text{hr}}\right)$

$= 0.23$ seconds

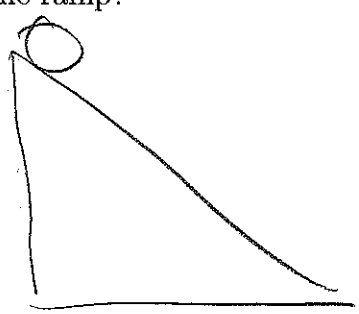
More than 4 rotations per second!

$\left(4.2867 \frac{\text{rev}}{\text{s}}\right)$

Longer Problems

$$
\begin{aligned}
F_{\text{cent}} &= m\frac{v^2}{R} \\
a_c &= \frac{v^2}{R} \\
f_s &\le \mu_s F_N \\
f_k &= \mu_k F_N \\
\sum \tau_{\text{net}} &= I\alpha \\
K_r = \frac{1}{2}I\omega^2 \quad &, \quad K_{linear} = \frac{1}{2}mv^2 \\
L &= I\omega \\
U_g &= mgh
\end{aligned}
$$

1. $\boxed{\text{5 points}}$ A solid sphere ($I = \frac{2}{5}MR^2$) with radius 0.2 m and mass 4 kg rolls down a ramp that is 2 m tall. Using energy conservation, how fast is it going at the bottom of the ramp?



$$mgh_i + \frac{1}{2}mv_i^2 + \frac{1}{2}I\omega_i^2 = mgh_f + \frac{1}{2}mv_f^2 + \frac{1}{2}I\omega_f^2$$

$v = \omega R \rightarrow \omega = v/R$, so

$$K = \frac{1}{2}mv^2 + \frac{1}{2}I\frac{v^2}{R^2} = \frac{1}{2}mv^2 + \frac{1}{2}\frac{2}{5}MR^2\frac{v^2}{R^2}$$

$$= \frac{1}{2}Mv^2 + \frac{1}{5}Mv^2$$

$$= \frac{7}{10}mv^2 \longrightarrow$$

$$\cancel{M}g(2\,m) = \frac{7}{10}\cancel{m}v^2$$

$$\sqrt{\frac{(9.8)(2)(10)}{7}} = v = 5.3\ m/s$$