Name: _____

PHYS 2211 – Exam 3
April 2, 2008

*Please solve all six problems below. You must **show all your work** to get full credit. You may use a calculator and a 3" x 5" index card for reference. A cell phone may not be used as a calculator. Exam duration: 55 min.*

1. An astronaut is being tested in a centrifuge. The centrifuge has a radius of 12 m and, in starting, rotates according to $\theta = 0.30t^2$, where t is in seconds and θ is in radians.

(a) When t = 9.0 s, what is the magnitude of the astronaut's rotational velocity (in rad/s)? $\left[5.4\ {}^{rad}/_{s}\right]$

(b) When t = 9.0 s, what is the magnitude of the astronaut's translational velocity (in m/s)? $\left[65\ {}^{m}/_{s}\right]$

(c) When t = 9.0 s, what is the magnitude of the astronaut's tangential acceleration (in m/s^2)? $\left[7.2\ {}^{m}/_{s^2}\right]$

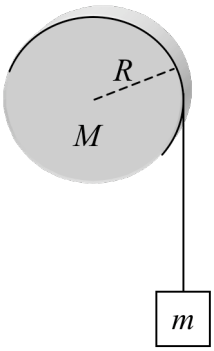
(d) When t = 9.0 s, what is the magnitude of the astronaut's radial acceleration (in m/s^2)? $\left[350\ {}^{m}/_{s^2}\right]$

2. A 3.0 kg particle with velocity $\vec{v} = (5.0\ {}^{m}/_{s})\hat{i} - (6.0\ {}^{m}/_{s})\hat{j}$ is at x = 3.0 m, y = 8.0 m. It pulled by a 7.0 N force in the negative x direction.

(a) What is the rotational momentum (magnitude and direction) of the particle about the origin? $\left[-174\hat{k}\ kg\bullet{}^{m^2}/_{s}\right]$

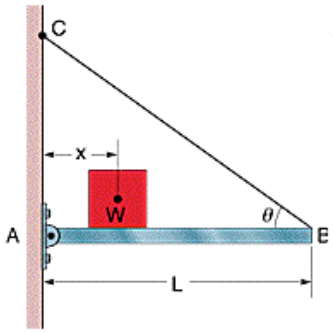
(b) What torque (about the origin) acts on the particle? $\left[-56\hat{k}\ N\bullet m\right]$

3. A pulley of mass $M = 0.240$ kg and radius $R = 0.12$ m is fixed at its center so that it can rotate about an axis through its center. The rotational inertia of the pulley is $I = \frac{1}{2}MR^2$. A light rope is passed around the pulley and attached to a hanging mass $m = 0.050$ kg. Find the speed of the block after it has descended 0.50 m starting from rest. $\left[1.7\,{}^{m}/_{s}\right]$



4. A diver can change his rotational inertia by drawing his arms and legs close to his body in the "tuck" position. After he leaves the diving board (with some unknown rotational velocity), he pulls himself into a ball as closely as possible and makes 2.00 complete rotations in 1.33 s. If his rotational inertia decreases by a factor of 3.00 when he goes from the "straight" to the "tuck" position, what was his rotational velocity when he left the diving board? $\left[3.15\,{}^{rad}/_{s}\right]$

5. In the figure on the right, suppose the length L of the uniform bar is 3.7 m and its weight is 217 N. Also, let W = 294 N and θ = 30°. The wire can withstand a maximum tension of 500 N.



(a) What is the maximum possible distance x before the wire breaks? $[1.78m]$

(b) W is now placed at this maximum x. What is the horizontal component of the force exerted on the bar by the pin at A? $[433N]$

(c) What is the vertical component of the force exerted on the bar by the pin at A? $[261N]$

6. The orbit of Halley's Comet around the Sun is a long thin ellipse. At its aphelion (point farthest from the Sun), the comet is 5.2×10^{12} m from the Sun and moves with a speed of 11.0 km/s.

(a) What is the comet's speed at its perihelion (closest approach to the Sun) where its distance from the Sun is 8.9×10^{10} m? $[55\ {}^{km}/_{s}]$

(b) By what factor does the force on the comet due to the Sun change when the comet moves from the farthest point (aphelion) to the closest point (perihelion)? $[3400]$

Astronomical data: $G = 6.67 \times 10^{-11}$ N•m^2/kg^2, mass of Sun = 1.987×10^{30} kg, mean radius of Sun = 6.96×10^{8} m, mass of Halley's Comet = 2.2×10^{14} kg, mean radius of Halley's Comet = 6 km.