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Test 3
05/13/2005
Ch. 9-12

Useful number(s): Gravitational Constant: $G=6.6726\times10^{-11}\ N\cdot m^2/kg^2$

1) (25 points) You are designing a compact disc (CD) player. The diameter of a CD is 120mm and has a mass of 55 grams. (Assume the CD is a solid cylinder $I=M R^2/2$, and the axle on which it rotates is frictionless and massless.)
   a) What is the moment of inertia of the CD?
   b) If the CD spins at an angular speed of 30,000 rpm, find the angular momentum of the CD.
   c) Find the constant angular acceleration needed to stop the CD in one revolution.
   d) How long does it take to stop the CD?
   e) How much constant torque is needed to stop the CD?
   f) Find the average rate of change of the angular momentum $\Delta L/\Delta t$?
   g) The torque to stop the CD is applied by a frictional brake ($\mu=0.77$) near the hub of the CD at radius of 20mm. What is the magnitude of the constant normal force needed to stop the CD?
   h) How much work is done stopping the CD?
   i) How much power is needed?

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2) (25 points) Your 75 kg friend is standing 0.5m from the center of a merry-go-round (a large rotating solid cylinder mounted on a frictionless shaft) with moment of inertia of I=895 kg·m^2 and radius 2.4m initially rotating at 10.8 rpm.
   a) If your friend moves to the outer edge what will be the new angular velocity? (Assume the person is a point mass.)
   b) What is the total kinetic energy ***before*** and ***after*** the move?
   c) Next your friend jumps off the merry-go-round in such a way that his tangential velocity with respect to the ground is zero. What is the new angular velocity?
   d) What is the total kinetic energy at this point?

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3) (25 points) The mass of the moon is 7.35×10^{22} kg and radius of 1.74×10^{6} m.
   a) What speed is needed to launch a 1kg projectile 1000km above the surface?
   b) How much energy is needed to launch the 1kg?
   c) What speed is needed to launch a 100kg projectile 1000km above the surface?
   d) How much energy is needed to launch the 100kg projectile?
   e) What speed is needed for the 100kg projectile to just escape the moon's gravity?

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4) (25 points) A 90 kg man is standing on a rung 8m up a 30 kg, 12 m ladder that makes a 75-degree angle with the ground and is resting on a frictionless vertical wall.
   a) What is the minimum friction coefficient needed between the ladder and the ground such that the ladder will not slip?
   b) Using the friction found in part a, how high could the man climb if the ladder were at a 45-degree angle?
   c) If a second 75kg man stood on the bottom rung (0.3m from the bottom), how high could the 90kg man climb?