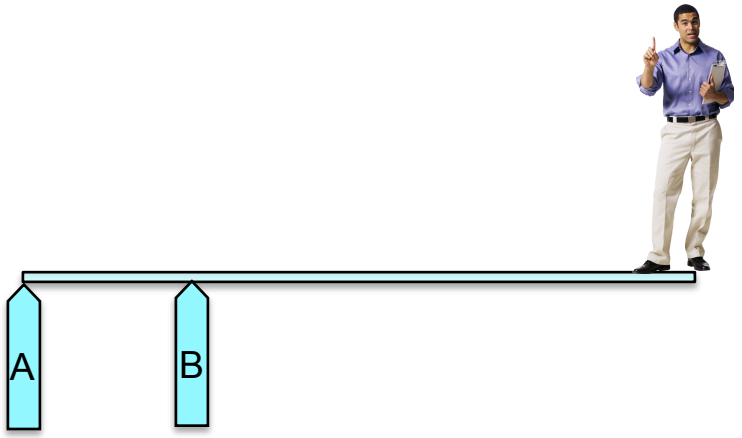
Problem Set #9 due beginning of class, Monday, Nov 24. 100 pts. total

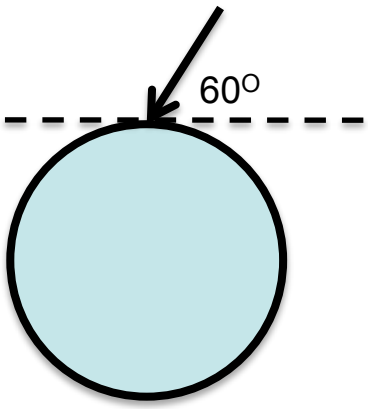
2 pts extra credit per extra person in the group – up to 8 points possible!

3 pts extra credit if you don't use a calculator: if so, write and sign a statement at the top of the problem set: "I [your name] did not use a calculator for any part of this problem set."



#1 An 80 kg man stands at the end of a 10 m diving board as shown. The pilons are 3 meters apart. Please find the reactive forces at pts A and B if:

a) the board is massless
b) the board has a mass of 100 kg.



#2 A child's carousel has a mass of 100 kg and a diameter of 3 meters. Assume that the mass is uniformly distributed over the circular area and is rotating at 1 radian per second. One kid, a 40 kg point mass, runs as fast as she can (5 m/s), jumps onto and grabs the edge of the carousel as shown. Please find the following:

a) the final angular velocity of the child and carousel if the carosel is initially rotating clockwise as viewed at right.
b) the final angular velocity of the child and carousel if the carosel is initially rotating anti-clockwise as viewed at right.
c) was kinetic energy conserved in this process? How do you know?

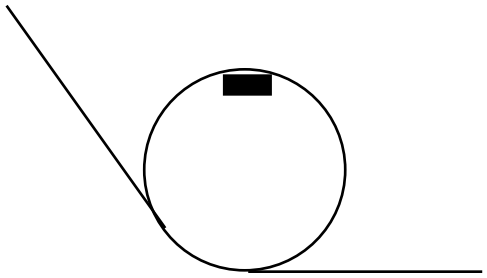
#3 Remember the flywheel from the first problem in PS #7?, now it has a hub on either side, rolling down two rails inclined at 30° as shown at right. The flywheel is a 3 kg flat disk of uniform thickness and has a radius of 30 cm. The hub is of radius = 10 cm. The flywheel starts from rest and rolls without slipping along 4 m of rail.

a) What is the loss of potential energy?
b) Find the final velocity and rotational velocity. *hint: you have two unknowns and only one equation! Poop! Ah, but there is a relationship between the speed of the disk and how fast it is spinning. Is this a helpful relationship?*
c) Use the above to find the average velocity, the time taken, and the angular and linear acceleration.
d) Use the above to find the torque on the wheel, and therefore find the frictional force that must have been applied by the rails.
e) Now that you know the frictional force on the wheel, and the force of gravity, can you find the acceleration the wheel should have and see if it matches your value for (c) above?

#4 Take a bicycle wheel and spin it very fast, then support the horizontal axel only at one end (some distance "x" from the center of the wheel's hub, letting the other side "fall".

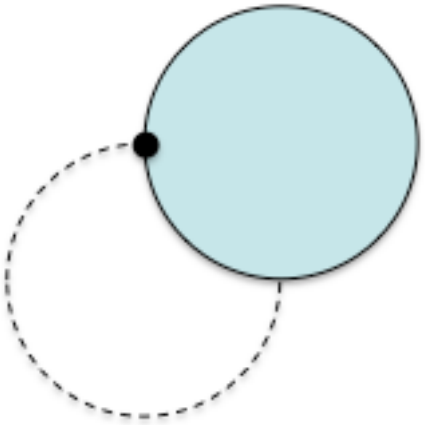
a) Draw a good picture and explain what is happening. Be sure to indicate in the picture the direction of omega of the wheel, and the angular momentum of the wheel… as well as the direction of the torque on the wheel due to gravity… as well as the direction of precession. Yes, please label all of these vectors with the correct direction. This is what students often have difficulty with. You may want to put in more than one picture to get everything labeled correctly.
b) If I spin the wheel in the other direction at the same omega how would this change the precession of the wheel? *Explain why according to the physics model we've been using?*
c) If I spin the wheel with a larger omega how would this change the precession of the wheel? *Explain why according to the physics model we've been using.*
d) If I hold the wheel on my finger closer to the wheel itself how would this change the precession of the wheel? *Explain why according to the physics model we've been using.*
e) If instead of a wheel with all the mass at the rim, it was a disk of uniform density, how would this change the precession of the wheel? *Explain why according to the physics model we've been using.*

#5 You go on a R = 10 m, loop-de-loop ride at the carnival, but you have to choose how high to start the cart. Say you have a mass of 70 kg, like your instructor and you are sitting on a scale that reads in kg.



a) If you start from a vertical height of 40 m, what does the scale under you read as you are at the top of the loop? What does it read at the bottom of the loop as you enter the loop? Is this a good ride for pregnant women? How does it feel as you round the bottom of the loop?
b) What would happen if you decide to start the cart at the same height as the top of the loop? Why would this happen?
c) Please find the minimum vertical height, above the ground that you must start the ride.
d) Repeat part a if instead of a frictionless cart, the object is a <u>*hollow*</u> sphere that is rolling without slipping

#6 A disk of uniform mass and radius, R is secured to a wall with a frictionless pivot that allows rotation as shown at right. It is started in the higher position where the center of the circle is at the same height as the pivot and allowed to drop and swing. When the disk is at the bottom of the swing (dotted line), please find:



a) Omega, the angular velocity of the disk about the pivot.
b) The angular momentum of the disk about the pivot.
c) The force that the pivot is providing to the disk. Include direction.