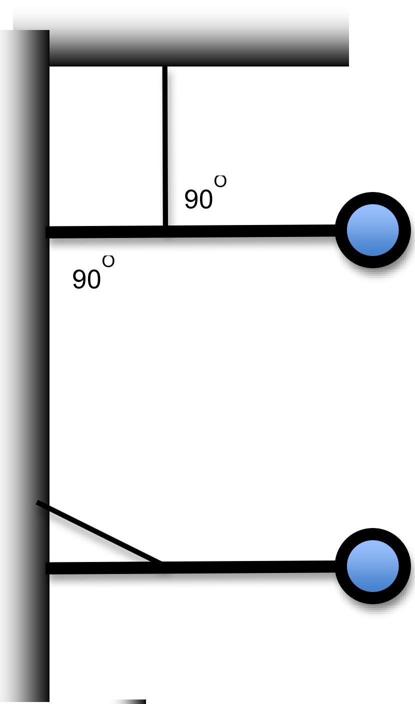
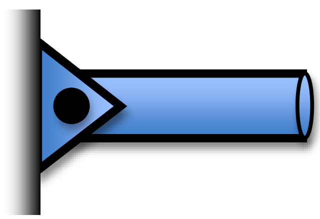
Problem Set #8 due beginning of class, Monday, March 7





#1 A 30 kg sphere is suspended in front of a store as a sign. It is at the end of a 1.5 m bar and a cable is connected just 50 cm along the bar from the store front as shown. *Read 9.1 - 9.4 in your text to learn how to do this.* Where the bar meets the wall there is a pivot, as illustrated at bottom, so the bar is free to rotate about this point, but not move translationally

a) We want to find the tension in the cable (right, top), what concept of physics is used here? State which of the 4 concepts and if it's linear or rotational, and state why you know it.

b) Label all the forces on the bar.

c) Which point do you use as the center for calculating torques? Why do you use this point?

d) Find the tension in the cable.

e) Find the force supplied to the bar by the store front. – indicate direction.

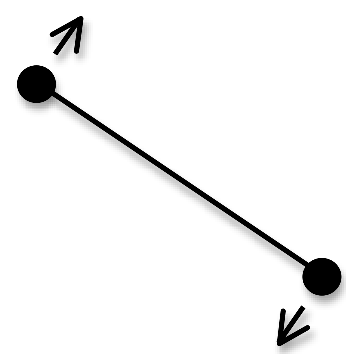
f) If the mass of the bar was 100 kg as well, what would be the tension then? This mass can be treated as being a point mass at the center of mass of the bar. *Section 9.4 of your text demonstrates how to use center of mass (they call center of gravity, CG).*

g) What would happen if we moved the cable's connection point on the bar closer and closer to the store front? How do you know?

h) * (harder problem) How about if instead of being vertical, the line made a 30 degree angle with the bar as shown in the middle? What would this do to the tension in the string *and the force supplied by the wall*? How do you know?

i) For each of the problems, f, g, and h. How would you check your work? You would add all the forces and make sure they = zero, and then pick a different rotation point, such as the center of the hanging mass and make sure all the torques about *this point* = zero! Please do this for the three problems given (f, g, and h).

#2 You see two equal masses tied together with a string spinning in space at constant angular speed, w_o, when a motor at the center pulls them both inward such that the final diameter of their paths is 1/3 the original diameter, or, d => <u>1/3</u> d_O. This is kind of like the ice skater pulling in her arms.



a) What causes this change? Are there outside forces? What should be conserved? What does this say about energy, momentum, forces, and kinematics?

b) What happens with the moment of inertia with this change?, I => ___ I_O,

<u>Let's say we conserve angular momentum.</u> Put in a "1" L => ___ L_O,

c) Now find the new rotational velocity, ω => ___ ω_O,

<u>Let's say we conserve rotational kinetic energy.</u> KE =>___ KE_O

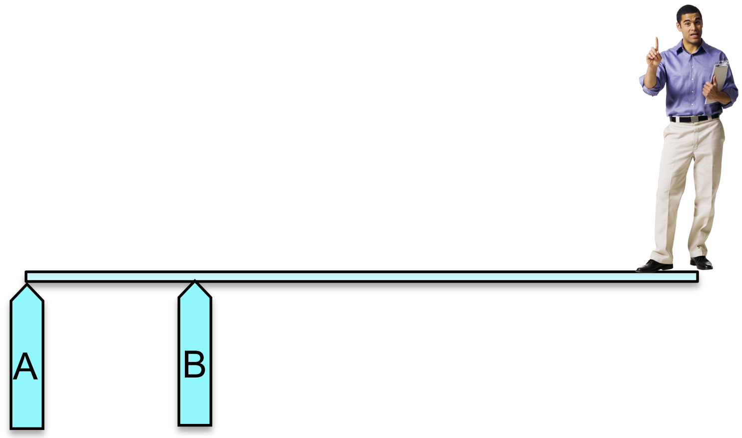
d) Now find the new rotational velocity, ω => ___ ω_O,

e) OK, now we have a problem. Hopefully, you have shown that in this change, either angular momentum or rotational energy is conserved, ***but not both***. Which one isn't conserved? Where did the extra energy (or angular momentum) come (or go)? Who do you trust?

h) * (more difficult problem) During this transition, by what factor would the tension in the string change? T=> ___ T_O. I heard many students say "Tension in a string doesn't depend upon the length of the string, so the tension doesn't change when radius changes." But wait! When we change the distance between the two masses *other* things change that *may* effect the tension. What *does* affect tension? How do we know there's tension in this string? What does this force depend on? What does this tension force do?

#3 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.

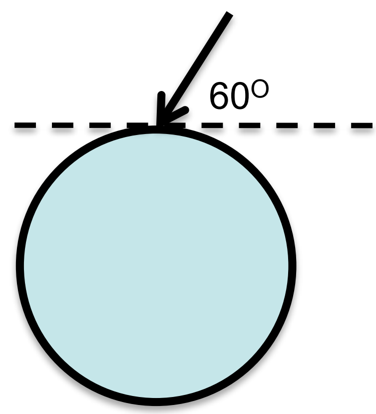


#4 A child's carousel has a mass of 100 kg and a diameter of 3 meters, and is spinning clockwise as viewed from above at 1.5 revolutions per second. Assume that the mass is uniformly distributed over the circular area. Two kids, 30 kg point masses, each are dropped from rest simultaneously on opposite sides of the carousel, 1 meter from the center.

a) Find the moment of inertia of the carousel and the moment of inertia of the two children.
b) Find the initial angular velocity, ω_o, please include direction using the right hand rule.
c) What happens to the rotation rate of the carousel after the kids are dropped onto the surface? Why is this? Please identify the appropriate physics concept in your answer.
d) Please find the final angular velocity, ω_f.
e) Please find the initial and final kinetic energy of the carousel + children system before and after the stationary kids were dropped onto the carousel's surface. Was kinetic energy conserved? If not where did it go, and how?

#5 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 at rest. 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) What is the final angular velocity?
b) If the carousel instead of being at rest, was slowly rotating into the paper (clockwise), would the collision increase, decrease, or not affect the rotation rate? How do you know?
c) was kinetic energy conserved in this process? How do you know?
d) If collision was in outer space, how would this change the result?



#6 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.*