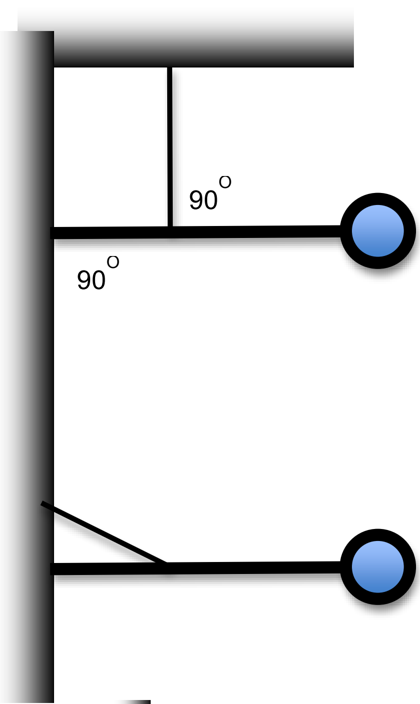
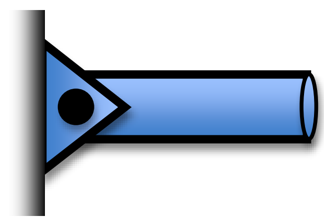
Problem Set #8 due beginning of class, Monday, March 9



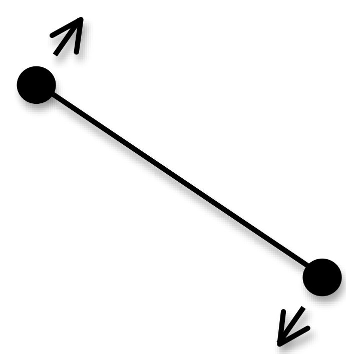
#1 A 30 kg sphere is suspended in front of a store as a sign. It is at the end of a 1.5 m bar and a cable is connected just 50 cm along the bar from the store front as shown. *Read 9.1 - 9.4 in your text to learn how to do this.* Where the bar meets the wall there is a pivot, as illustrated at bottom, 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, what would be the tension in the cable 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 cable makes a 30 degree angle with the (massless) bar as shown in the middle? Please find the tension in this cable *and the force supplied by the wall.*



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, ω_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, $d \Rightarrow \underline{1/3}\ d_O$. Is this like the ice skater pulling in her arms?



a) What causes this change? Are there outside forces? What should be conserved?
b) What happens with the moment of inertia with this change?, $I \Rightarrow$ ___ I_O,

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

c) Now find the new rotational velocity, $\omega \Rightarrow$ ___ ω_O,

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

d) Now find the new rotational velocity, $\omega \Rightarrow$ ___ ω_O,
e) OK, now we have a problem. Hopefully, you have shown that in this change, either angular momentum or rotational energy could be 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? $T \Rightarrow$ ___ 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 (tension) force depend on? What does this force do?