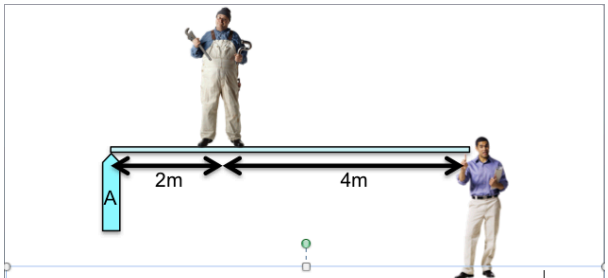
Problem Set #5 due beginning of class, Tuesday, Nov. 1. Remember to start each question with a description of what concept is central to your strategy and *why*. Don't forget your 4 lenses

1. Please do exercise 2 in 4.5 angular momentum
2. Please do exercise 5 in 5.0 Centripetal Acceleration.
3. Please do Exercise 2 in 5.2 Inverse Square Relationship
4. Please do Exercise 1 in 5.2 Inverse Square Relationship
5. There are two planets with centers 10^6 m apart: Planet A, and Planet B. The radius of Planet A is twice that of planet B, or $r_A=2r_B$. Both planets are made of the same rocks, and therefore have the same density. There are no other objects, so we are only looking at the force of gravity acting between the two planets. *Provide reasons for your answers before showing the work, before showing the answer.*
   a) What is the ratio of the masses of the planets? $m_A=\_\_m_B$.
   b) What is the ratio of the gravitational force attracting each of the two planets? $F_A=\_\_F_B$. *hint, there's just a single attractive gravitational force acting between the two planets.*
   c) What is the ratio of the acceleration of each planet due to gravitational acceleration? $a_A=\_\_a_B$.
   d) I want to put myself between the two planets so that there is no force acting on me. That is, the force of gravity from each planet should be equal and opposite. What should be the ratio of these distances (from the center of the planets)? $x_A=\_\_x_B$
   e) Find x_A (my distance from the center of planet A) in meters in the above question.
   f) Starting from rest, I let the planets fall together. When they hit, what is the ratio of the two speeds? $v_A=\_\_v_B$ be careful to identify which of the 4 concepts is at play here, what must be the same for them? Please identify a lens you use.
   g) For question g above, can you calculate where they will hit each other? Is it half way between where the two plants' original positions or not?

6. Do Exercise 2 in 5.3 Loop the Loop, circular motion in the vertical plane.
7. You balance your friend on a plank as shown at Right.
8. 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, $d \Rightarrow \underline{1/3}\ d_O$. This is kind of like the ice skater pulling in her arms.
   a) This happens in outer space…. And we wonder what causes this change and if there are any outside forces: What should be conserved? Consider each of the 4 lenses when you answer this question.
   b) What happens with the moment of inertia with this change?, $I \Rightarrow$ ___ I_O,



I support a 70 kg Friend on a massless plank
a) What is the lens? How do you start?
b) What is the torque about A from the worker?
c) What is the force on my finger?
d) What is the force that support A is providing?

<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> Put in a "1" $KE \Rightarrow$___ KE_O

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

e) In such a change can we conserve *both* angular momentum as well as kinetic energy? If not, which one is for sure conserved… who do you trust and where did the extra energy (or angular momentum) come (or go)?

f) 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? What kind of problem is this?

9. 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?