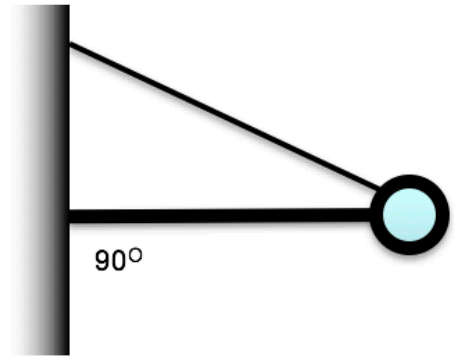
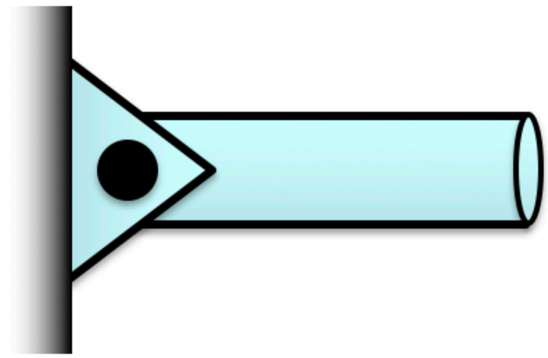
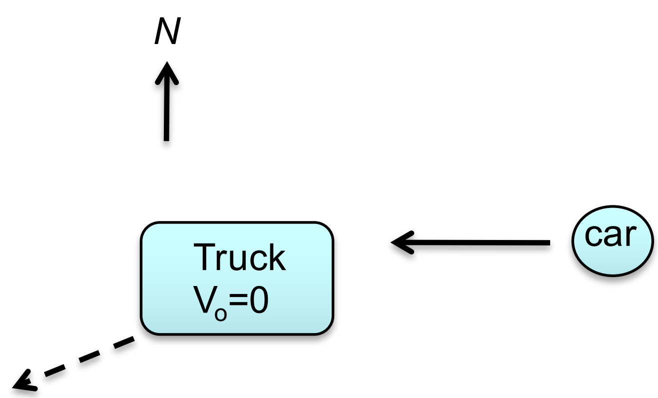
PS#8 Due Tuesday Nov. 29 in class. Remember to start each question with a description of the lens and method.

1) A 100 kg sphere is hung in front of a store (as an advertisement for ball bearings) using a bar and a cable as shown at right. The linkage between the bar and wall is a freely rotating hinge (shown below) so that without the cable, the ball would swing downward with no friction. <u>**BUT**</u>, the cable keeps it hanging there.
   a) Is the tension in the cable more, less, or equal to the force of gravity on the ball? How do you know?
   b) Is the force on the bar a compressional or tension force, or is there no force on the bar? How do you know?
   c) Estimate the tension on the cable.
   d) Estimate the force the bar puts on the hinge at the store front (include direction).



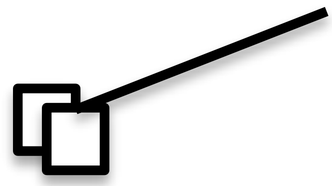


2. On a surface of frictionless ice, a 1000 kg car driving 30 m/s westward collides with a 4000 kg truck at rest. The truck subsequently takes off at 10 m/s in the direction indicated. North is indicated
   a) Without using a calculator, please determine as best you can the subsequent velocity of the car.
   b) Was mechanical energy conserved in this collision? Estimate the change in mechanical energy.



3. In a classic physics problem, a car is stuck in the mud, so you tie a rope to a tree on the other side of the road as tight as you can and then push the rope – do you pull it along the rope, or push it perpendicular? Would it be a good idea to slack line on it? If you were slack lining on it, would it be a good idea to jump on it?

4. You are watching the fuzzy dice from the rear view mirror. As you take off, it makes an angle as shown at right.

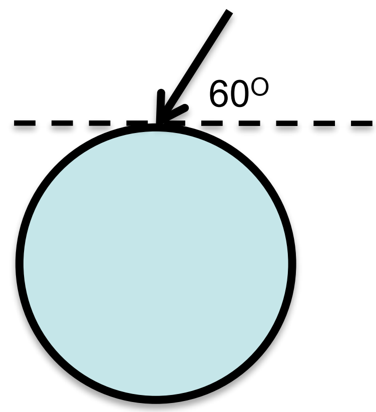


a) Estimate the acceleration of the car.

b) Then you are playing tetherball with friends. You have a 2 kg ball at the end of a 2m string. You hit the ball in a circle and as it goes around, it makes the same angle you see the fuzzy dice made. Estimate the speed of the tetherball *and* the tension on the string. You'll need to estimate the radius of the ball's circular trajectory around the pole.

c) How is part b) like the F-22 in the conical pendulum video?

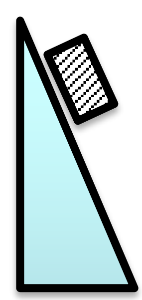
5. A child's carousel has a mass of 100 kg and a diameter of 3 meters. Assume that the mass is uniformly distributed over the circular area and is at rest. One kid, a 40 kg point mass, runs as fast as she can (5 m/s), jumps onto and grabs the edge of the carousel as shown. Please find the following:



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? If so, why can you be sure? If not, please calculate the kinetic energy lost in the collision.
d) Did we conserve linear momentum of the girl? Where did the linear momentum go?
e) If the carousel's rotation bearing were not mounted in the ground… if it were instead floating on a lake or in outer space, what would the final velocity of the carousel and girl system be after the collision? In which direction?

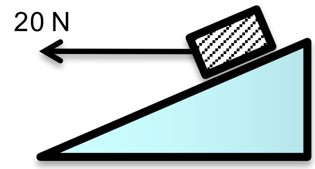
6. In doing a roundhouse kick (where the kicker spins about a vertical axis), explain with proper physics reasoning how the kicker should move her arms at the moment she kicks, and why this works.

7. At right, you have an inclined plane. Make your drawing as realistic as possible, so you can solve the problem without measuring the angles. If you want to, you may assume the mass of the block is 10 kg, but if you allow it to be m_o you may find that mass doesn't matter (and if it does you could just put the mass in at the end.

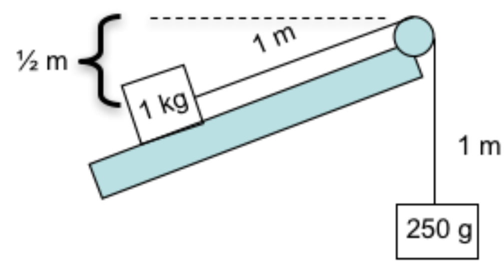


a) If the block is frictionless, calculate the anticipated acceleration.
b) If the block slides down with an acceleration of 1 m/s^2, estimate the coefficient of friction.
c) If you doubled the mass to $2m_o$, what would change (and how), and what would stay the same?

8. At right, you see that I pull a 5 kg mass down a 2 m long incline with a 20 N, horizontal force. With good communication and without a calculator or angle measuring, please calculate:
   a) For a frictionless surface, please calculate the acceleration of the block, and the normal force of the surface on the block.
   b) For a frictionless surface, please calculate the total work I do, and the block's final speed.
   c) If the coefficient of friction is 0.25, please calculate the acceleration of the block.
   d) If the coefficient of friction is 0.25, please calculate the amount of heat produced (in Joules), and please calculate the final speed of the block.
   e) If I double mass now like I did in question 1, would the acceleration of the block remain the same? What makes this different from the above problem?



9. In problem set #3, we were able to solve for the acceleration by using the energy lens:
   - Let the mass fall and find the change in potential energy which turns into kinetic energy of the two masses.
   - Notice that in order for the potential energy to decrease, the system must fall to the left.
   - Conserving energy, we can find the final velocity of the system
   - Kinematics provides the average velocity of the system
   - Kinematics provides the time it takes the system to fall.
   - We can find the acceleration from its kinematic definition: the rate of change of velocity.



However, now I'd like you to find the acceleration using dynamics in one line: $a_S = \frac{\sum \vec{F}_S}{m_S}$. The challenge is getting all the forces on the system. What is the effect of F_g on the 1 kg block? What is the direction of acceleration of the 1 kg block? What should we do with F_g?