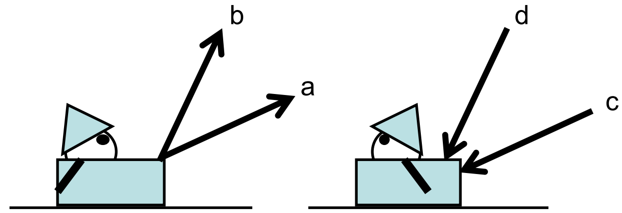
Problem Set #4 due beginning of class, Monday Oct 19. Remember to start each questions with a description of what concept is central to your strategy and *why*. Don't forget your 4 lenses

1. MT #1. Hand in a perfect copy of your midterm, with your original MT stapled to it. If you got a question completely correct on MT#1, you don't need to do that problem again. If you got part of the question wrong, or left out a lens analysis, please do a thorough job on the question.

2. My daughter is sledding (total mass = 20 kg), and I am applying a force of 120 N to her sled. I have 4 different options (pushing and pulling at two different angles) and I try all of them.



   a) For each scenario, estimate both the acceleration of the sled and the normal force between the sled and the frictionless snow.
   b) Now, please rank the different force scenarios in order of least acceleration to greatest acceleration. If some accelerations are the same, please indicate that.
   c) Now, let's say that the coefficient of friction of the snow is *actually* 0.2. How does this change things? Please rank again the different force scenarios in order of least acceleration to greatest acceleration.
   d) Have you ever pushed a lawn mower (or watched someone do it)… you are using force scenario d, pushing along the handle. When you run into some thick grass the "coefficient of friction" might be high enough to stop you cold. What scenario can you change to, and why does this work?

3. Consider pushing the sled above in scenario "c" on the 0.2 frictional snow for a total of four meters, please find the amount of work I do, the amount of heat produced and the final speed of the sled. Carefully lay out your lens discussion.

4. Consider throwing a rock from the edge of a 60 m high cliff at a speed of 30 m/s in the direction indicated by force vector "b" above.
   a) Please make a drawing showing the rock at each second until it hits the ground. You may not use a calculator, as we are making simple approximations here. For each second elapsed, estimate where the rock is and its velocity. Draw the velocity vector at that point.
   b) Use an energy lens to judge if your final speed is reasonably close to what you would expect.

5. On a surface of frictionless ice, a 1000 kg car driving 20 m/s eastward collides and sticks to a 5000 kg truck driving 15 m/s northward. The vehicles stick together and slide off:
   a) Please draw and indicate the final velocity of the vehicles.
   b) Please calculate the amount of energy turned to heat in the collision.

6. 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?