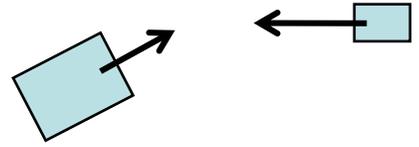1. I am pushing a toy choo choo train made of two blocks up a wall as shown. The 1 kg block is hanging on a string from the 2 kg block. There is a coefficient of friction of 0.2 between the wall and the bock. I push with a 50 N force on a pole making a 30° angle with the vertical.

   a) If I the block moves 2 meters vertically (up or down), how much work do I do? What Lens do you use for this? I get 87 J

   b) Find the acceleration of the blocks while I am pushing. What lens do you do for this? Can you set the problem up well? Do you need a drawing? I get about 2.8 m/s²

   c) Find the tension in the string joining the blocks while I am pushing. What lens do you do for this? I get about 13 N.

2 kg

1 kg
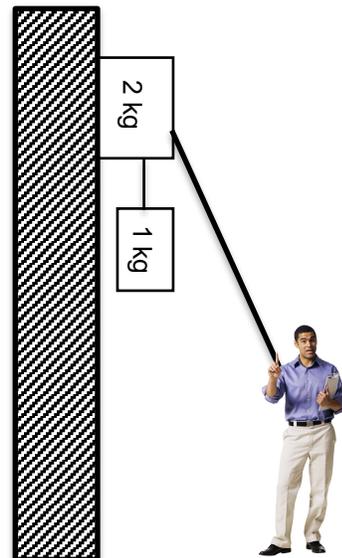
2. You are riding a bicycle and bank into a steep turn (of radius 30 m) making an angle with the horizontal of 40 degrees, as shown at right.
   a)   About what is your mass? This is not a calculation, just write down the (estimated) mass of your body. Mine is about 70 kg
   b)   About what is your speed as you go around the turn? It is very important here to identify a lens and follow the protocol well. I get a speed of about 19 m/s.
   c)   About what is the force that the bike frame is putting on your body? I get about 1100 N, for my body.
        Many folks forgot about the protocol… what is the direction of the acceleration? Where does this force come from? Can we make a good FBD? Can we make a good "vector sum of the forces" diagram?
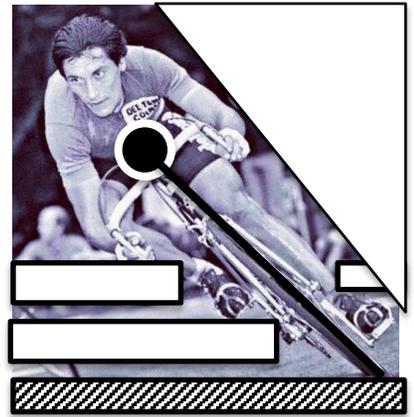
3. You are involved in a nasty collision on slippery ice, shown from above at right. Your 2000 kg car is headed Northeast at 20 m/s, making a 30° angle with the east-west direction, and you hit a 1000 kg car going due west at 35 m/s. The cars stick together.
   a) Find the velocity with which they move off, include direction.
      Which lens do you use for this? I get a final answer of about 6.7 m/s due north.

   b) If the collision lasted for about 0.05s, please find the average force exerted on the little car by my car. Include approximate direction. I get a force of about 7 x 10⁵ N in a direction that is almost directly East, but a little North. The angle the force makes with the east-west is about 11°. Momentum is a vector! A lot of people realized this for the first part, but didn't use 2-D vectors correctly in part b)

c) Two planets, A and B are orbiting in perfect circles about a massive star (smiling at right). B has twice the mass and is orbiting at twice the radius as A: $M_B = \underline{2}$ M_A; $R_B = \underline{2}\,R_A$

This problem was a train wreck. I should have started with a question asking what the ratio of forces on these planets was… But the conceptual flaw was that students forgot that acceleration is caused by forces. We don't know what the speeds of these planets are at first, but we can certainly find the ratio of the gravitational forces… it just boils down to the inverse square law. And the mass of the planet has no effect on the acceleration of that planet… drop two different sized masses and watch them accelerate at the same rate.

a) How does the acceleration of planet B compare to the acceleration of planet A?

$a_B = \underline{\ 0.25\ }\ a_A$ ***Please support your answer with clear math reasoning***

b) How does the speed of planet B compare to the speed of planet A?

$v_B = \underline{\ \sim 0.71\ }\ v_A$ ***Please support your answer with clear math reasoning***