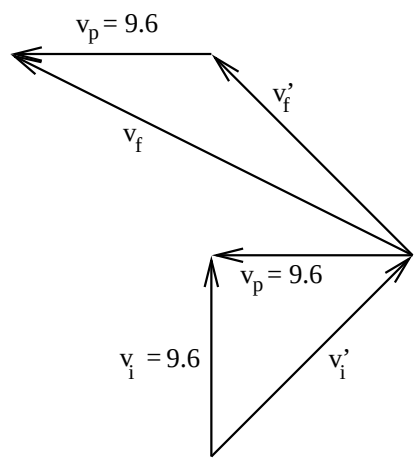
PHYSICS 5I
Homework 7
Due in class, Wednesday December 2.

FINAL EXAM: Wednesday December 9, 4:00–6:00 pm in ISB 231.

1. A spacecraft approaches the planet Saturn. The planet has a speed $v_p = 9.6$ km/s in the x-direction and the spacecraft has the same speed $v_i = 9.6$ km/s (to keep the math a bit simpler) but in the y direction. After passing the planet the space craft is moving at a different angle and a different speed. Let us assume that in the rest frame of the center of mass (which is the same, to within negligible error, as the rest frame of the planet) the direction of the spacecraft is changed by 90°, i.e. the angle between v_i' and v_f' is 90°, see the figure. (Note that this angle depends on how close the spacecraft passes to the planet.)



v_i' and v_f' are velocities in the rest frame of the center of mass
The angle between v_i' and v_f' is 90 degrees

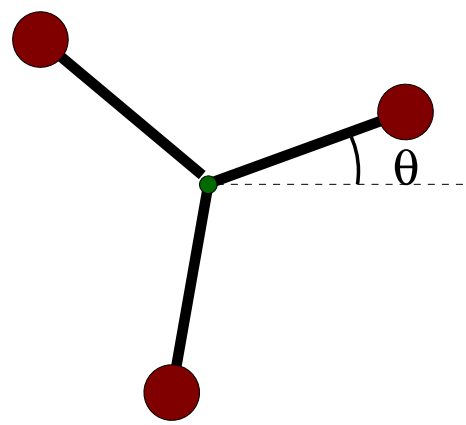
Find the speed of the spacecraft, v_f, after it has passed Saturn.

Note: Questions continue on the other side.

2. Consider the "heavier on one side seduction" in the perpetual motion handout

   `http://www.lhup.edu/ dsimanek/museum/physgal.htm`

   with three masses making equal angles with each other, as shown in the figure below. Show that, despite there being more mass on one side the net torque (due to gravity) is exactly zero for *any* orientation of the device.
   Note: You will need that $\cos(\theta \pm 2\pi/3) = \cos(\theta)\cos(2\pi/3) \mp \sin(\theta)\sin(2\pi/3)$.



3. Consider the "more weight on one side distraction" in the handout on perpetual motion machines. Naively one would expect that the chain will turn continously because there is more mass to the left of the top point (the apex) than to the right which seems to imply that there is a next torque pulling the chain down on the left.

   Explain in a few sentences the fallacy in this argument.