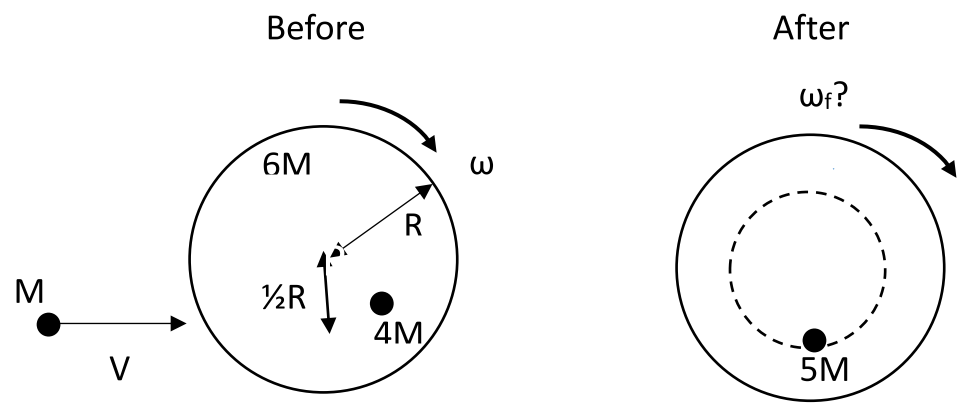
Physics 1135: Homework for Recitation #21: Angular Momentum

1. A star of radius of 6×10^8m that rotates about itself once every 40 days collapses into a very dense neutron star of radius 15km. How many times per second does the neutron star rotate? Assume we can model the star as a uniform solid sphere.

(A neutron star rotating that rapidly would be emitting beams of electromagnetic radiation and would be called a pulsar.)

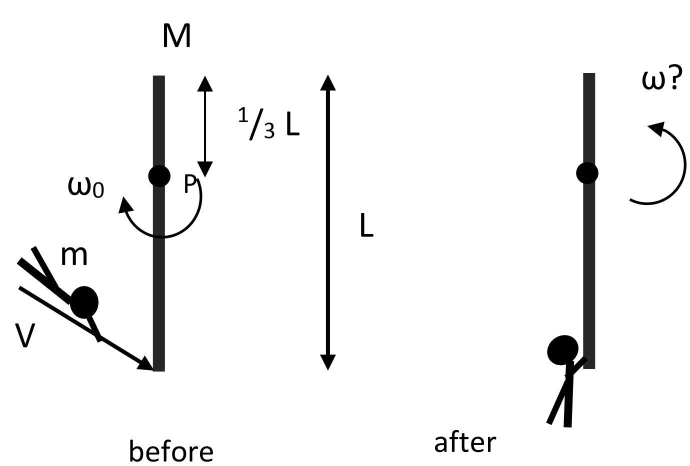
2. Tauriel the elf of mass $4M$ is standing half-way between center and edge of a large horizontal uniform disc of mass $6M$ and radius R that is rotating clockwise with angular speed ω around a frictionless axis that is through its center. At the same time, a rock of mass M that was thrown by foul creatures is flying with speed V along the straight path that is shown in the figure (dashed line).



Tauriel catches the rock head-on just as it reaches the point half-way between the center and edge of the disc. Since she is very slender, you may treat her as a point mass.

Determine the angular velocity of the system just after Tauriel has caught, and is holding, the rock.

3. In a goblin infested cave, a wooden beam of length L and mass M can rotate freely about pivot **P**, which is located a distance ⅓L from its upper end. It swings down and attains angular speed ω_o when it is at a vertical position, as shown in the figure. At this very moment, Thorin, of mass m, who is fleeing from goblins and is moving with speed V in a direction that makes an angle θ with the horizontal, catches, and clings to, the lower end of the beam. Thorin can be treated as a point mass.



a) Derive an expression for the moment of inertia of the **beam** about point P, in terms of system parameters.

b) Derive an expression for the angular velocity of the beam right after Thorin firmly clings to it, in terms of system parameters.

4. A uniform disk of mass $10M$ and radius $3R$ can rotate freely around its fixed center like a merry-go-round. A smaller uniform disk of mass M and radius R lies on top of the larger disk, concentric with it. Initially both disks rotate together with angular velocity ω.

Then a small disturbance causes the smaller disk to slide outward until its edge rests against the edge of the larger disk. The disks rotate together without further sliding.
Derive an expression for the final angular speed of the disks, in terms of system parameters.