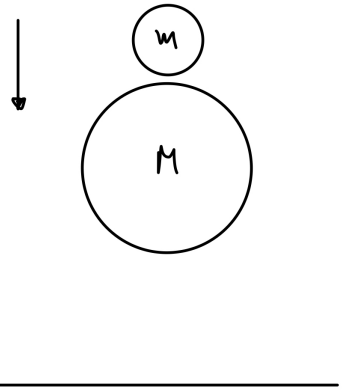
Problem set 5 (due April 3)

1. (2.5pts) A $45kg$ woman stands up in a $60kg$ canoe $5m$ long. She walks from a point $1m$ from one end to a point $1m$ from the other end. If you ignore resistance to motion of the canoe in the water, how far does the canoe move during this process?
2. (2.5pts) Consider $2 \to 2$ scattering between objects of identical mass. Let one of the initial objects be at rest. What are the possible values of the scattering angle?
3. Consider a small ball of mass m on top of a large ball of mass M. You can assume the balls are separated vertically an infinitesimal distance and drop them (in the absence of air resistance). The balls hit the ground at a speed v.

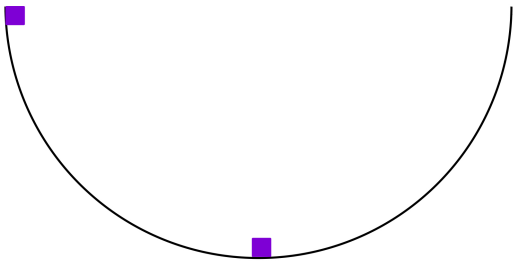


(a) (1pt) Compute the speed of the balls after bouncing off the ground assuming all collisions are elastic

(b) (1pt) Compute the ratio between the height reached by the smaller and the larger ball in the limit that $M \gg m$. Does the result fit with your experience (if not, you can go outside and try it out!)

(c) (0.5pt) Compute the first correction to the result obtained above in the limit where m/M is small

4. Two identical masses are released from rest in a smooth and frictionless hemispherical bowl of radius R as shown in the figure below.



(2pt) If the masses stick together when they collide, how high above the bottom of the bowl will they go after colliding?

(0.5pt) Compare the initial and final gravitational potential energies and explain the result.