Homework 06

Problem 1 (2 points):

Two bodies with masses m_1 and m_2 are bounded by the gravitational potential, i.e. moving along elliptical trajectory. Prove that the ratio of the semimajor axis to the semiminor axis is the same for both trajectories

Problem 2 (4 points):

Consider two billiard balls with the same mass hitting each other. Initially one of them is at rest. Using energy and momentum conservation laws show that in the laboratory reference frame both balls will move at 90 degrees to each other after collision. A quite elegant proof of it will be shown from the center of mass point of view (the CM frame and classical mechanics must be useful for something), your job is to do it via "brute" force without moving to the center of mass reference frame.

Assume that the collision is elastic and that balls do not rotate.

Problem 3 (4 points):

Solve problem 14.27. I.e. show that $\theta_{lab} = \theta_{CM}/2$ for two particles of the same mass.

Problem 4 (4 points):

Now do the problem 14.24. I.e. express the differential cross section in the lab reference frame.

Additionally, make a plot of differential cross section in the lab reference frame as a function of θ_{lab}.

Problem 5 (6 points):

Now calculate and plot the differential cross section in the lab reference frame (i.e. as a function of $\theta_{1_{lab}}$), for two colliding balls of different mass. The final expression is too cumbersome to show, so make a plot. Normalize the differential cross section to the one at the CM reference frame. Two balls have the same radius R but different masses: $m_1 = 10m_2$. The lighter ball with the mass m_2 is initially at rest. Pay attention: not all $\theta_{1_{lab}}$ are possible

If you need hints, see example 14.7 from the textbook. Note that in the example the λ is different.