5. Magnetic Billiard (9 points) — *Jaan Kalda.*

Consider two absolutely elastic dielectric balls of radius r and mass m one of which carries isotropically distributed charge $-q$, and the other — $+q$. There is so strong homogeneous magnetic field B, parallel to the axis z, that electrostatic interaction of the two charges can be neglected; neglect also gravity and friction forces. The first ball (negatively charged) moves with speed v and collides with the second ball which had been resting at the origin. The collision is central, and immediately before the impact, the velocity of the first ball was parallel to the x-axis.

i) *(1 point)* What is the speed of the second ball immediately after the collision?

ii) *(2 points)* Sketch the trajectories of the centres of the both balls during the subsequent motion.

iii) *(3 points)* What is the average velocity (magnitude and direction) of the balls during their subsequent motion?

iv) *(3 points)* Consider the same situation as before, except that the there are three differences in the assumptions: the both balls have now identical positive charge $+q$; electrostatic repulsion between the balls is no longer negligible; the collision is not necessarily central (but the balls move still at the same value of z so that the collision will not induce any motion in the direction of the z-axis). Let P_i denote the point where the surfaces of the two balls are in contact during the i-th collision. What is the maximal distance between P_i and P_j (maximize over all the values $i, j = 1, \ldots \infty$, and over all the impact parameters of the collisions for fixed values of B, m, and q)?