8. Connected charges (8 points) — *Jaan Kalda.*

In the region $0 < x < L$, there is an electric field $\vec{E} = E_0\hat{x}$, where $\hat{x}$ denotes the unit vector parallel to the x-axis. Two small balls, each of mass m and carrying charge q ($qE_0 > 0$) are connected with a weightless non-stretchable string of length l. Initially, at the moment of time $t = 0$, the string is taut, the velocity of the both balls is $\vec{v} = v_0\hat{x}$, one of the balls, the ball A, is at $x = 0$ while the other ball, the ball B is at $x < 0$. The electric field created by the balls can be neglected, and it can be assumed that v_0 is very small (much smaller than $\sqrt{ELq/m}$).

i) *(2 points)*Consider the case when the string is parallel to the x-axis, and $l = L$ Sketch the dependence of the velocity of the both balls as a function of time. Will the balls collide? If yes then when?

ii) *(2 points)* Now, at $t = 0$, the string forms an angle of $45°$ with the x-axis, $l = 1.2291L$. By this string length, at the moment $t = T$ when the ball A reaches $x = L$, the string is parallel to the x-axis. Find T.

iii) *(2 points)* Under the assumptions of the previous task, what is the speed of the ball A at the moment $t = T$?

iv) *(2 points)* Now, at $t = 0$, the string forms a very small angle ϕ with the x-axis. Similarly to the previous two tasks, at the moment $t = T'$ when the ball A reaches $x = L$, the string is parallel to the x-axis. Find the string length l assuming that $l > L$. *The answer to this point should contain only L and numerical constants.*