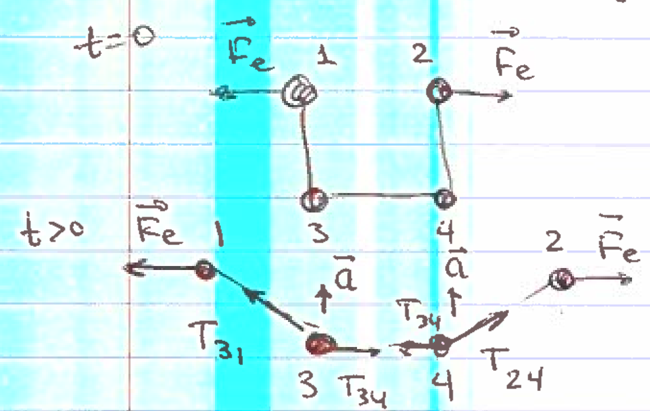
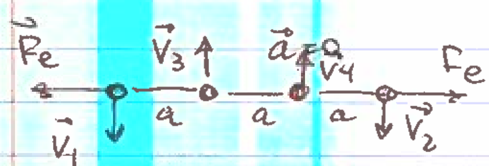
Written assignment #5 solutions

Q1. Once the string is cut, the charged balls will start moving away.



The electric repulsive force will always be horisontal, but tension will start to push balls 3 & 4 up

Because of the symmetry, balls 3 & 4 will be accelerating vertically up to a moment when all 4 balls form one horisontal line



That is when the speed is maximal, since after that the charge balls will ~~start~~ continue moving down, slowing down balls 3 & 4, until they reform the square, and the full cycle is repeated.

Energy conservation $U_{ini} = \frac{kq^2}{a}$ $K_{ini} = 0$

Final: $U_{fin} = \frac{kq^2}{(3a)}$ $K_{fin} = 4 \cdot \frac{mv^2}{2}$

$$\frac{kq^2}{a} = \frac{kq^2}{3a} + 2 \cdot mv^2$$

$$\frac{2kq^2}{3a} = 2mv^2 \Rightarrow v = \sqrt{\frac{kq^2}{3ma}}$$

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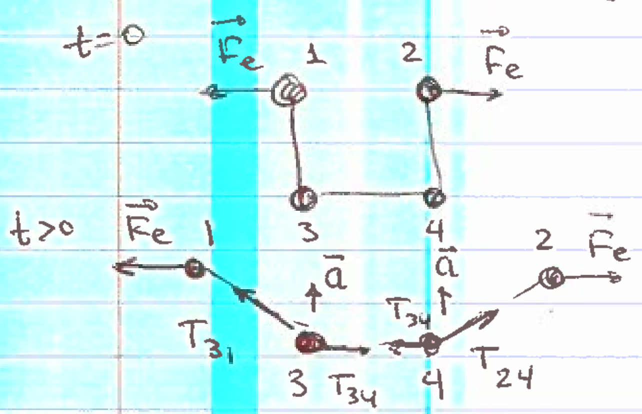

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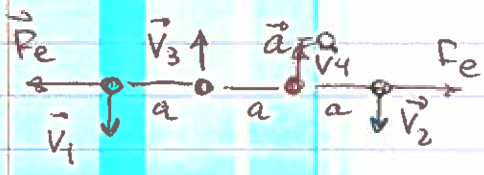

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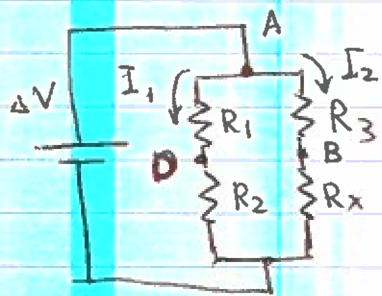
Q 4



$$I_1 (R_1+R_2) = I_2 (R_3+R_x)$$

$$V_a - I_1 R_1 = V_D$$

$$V_A - I_2 R_3 = V_B$$

if $V_B = V_D$

$$I_1 R_1 = I_2 R_3$$

$$\frac{R_1}{R_1+R_2} = \frac{R_3}{R_3+R_x}$$

$$R_x = \frac{R_3}{R_1}(R_1+R_2) - R_3 = \frac{R_3 R_2}{R_1}$$