An electron starts from one plate of a charged closely spaced (vertical) parallel plate arrangement with a velocity of 1.94*10^4 m/s to the right. Its speed on reaching the other plate, 2.15 cm away is 4.34*10^4 m/s. If the plates are square with an edge of 24.4 cm, determine the charge on each.

Distance between the plates is much smaller than the geometrical size of plates. Thus we can assume that the electrical field between the plates is uniform. Electron gets energy from electric field and increases its speed:

$$\Delta W = Ue^-$$

where ΔW – kinetic energy change, U – potential difference between plates, e^- - electron's charge.

$$\Delta W = \frac{Mv^2}{2} - \frac{Mv_0^2}{2}$$

$$\frac{Mv^2}{2} - \frac{Mv_0^2}{2} = Ue^- \rightarrow U = \frac{M}{2e^-}(v^2 - v_0^2)$$

$$U = \frac{1}{2 * 1.76 * 10^{11} C/kg}((4.34 * 10^4 m/s)^2 - (1.94 * 10^4 m/s)^2) = 4.28 * 10^{-3} V$$

Electron will increase its speed when the first plate is negative and the second plate is positive charged. Assuming that the plates have the same charge magnitude, electric field between plates:

$$E = E_1 + E_2 = 2E_1$$

Electric field of one plate:

$$E_1 = \frac{\sigma}{2\varepsilon_0}$$

The total field between two plates:

$$E = \frac{\sigma}{\varepsilon_0}$$

where σ – surface charge density.

From the other hand:

$$E = \frac{U}{d}$$

where d – distance between plates.

$$\frac{\sigma}{\varepsilon_0} = \frac{U}{d}$$

$$\frac{q}{S} = \frac{U\varepsilon_0}{d}$$

$$q = \frac{US\varepsilon_0}{d} = \frac{Ua^2\varepsilon_0}{d}$$

$$q = \frac{4.28 * 10^{-3} V * (0.244m)^2 * 8.85 * 10^{-12} F/m}{0.0215m} = 1.05 * 10^{-13} C$$

Answer: $q_1 = -1.05 * 10^{-13} C$, $q_2 = 1.05 * 10^{-13} C$