23. An electron is released from rest at the negative plate of a parallel plate capacitor. The charge per unit area on each plate is σ = 1.8 x 10^{-7} C/m^2, and the plate separation is 1.5 x 10^{-2} m. How fast is the electron moving just before it reaches the positive plate?

$$v_f^2 = v_0^2 + 2ax = 2ax$$

$$a = \frac{F}{m} = \frac{qE}{m}$$

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

$$v_f^2 = 2ax = 2\frac{qE}{m}x = 2\frac{q}{m}\frac{\sigma}{\varepsilon_0}x$$

$$v_f = \sqrt{2\left(\frac{q}{m}\right)\left(\frac{\sigma}{\varepsilon_0}\right)x}$$

$$v_f = \sqrt{2\left(\frac{1.6\ x\ 10^{-19}C}{9.11\ x\ 10^{-31}kg}\right)\left(\frac{1.8\ x\ 10^{-7}\ {}^{C}/_{m^2}}{8.85\ x\ 10^{-12}\ {}^{C^2}/_{(Nm^2)}}\right)(1.5\ x\ 10^{-2}m)}$$

$$v_f = \sqrt{2\left(1.756\ x\ 10^{11}\ {}^{C}/_{kg}\right)\left(2.034\ x\ 10^{4}\ {}^{N}/_{C}\right)(1.5\ x\ 10^{-2}m)}$$

$$v_f = \sqrt{1.072\ x\ 10^{14}\ {}^{m^2}/_{s^2}} = 1.035\ x\ 10^{7}\ {}^{m}/_{s}$$

$$\boxed{v_f = 1.0\ x\ 10^{7}\ {}^{m}/_{s}}$$