31. The charge on the metal plate, which is negative, exerts a force of repulsion on the electron and stops it. First find an expression for the acceleration of the electron, then use kinematics to find the stopping distance. We take the initial direction of motion of the electron to be positive. Then, the electric field is given by $E = \sigma/\varepsilon_0$, where σ is the surface charge density on the plate. The force on the electron is $F = -eE = -e\sigma/\varepsilon_0$ and the acceleration is

$$a = \frac{F}{m} = -\frac{e\sigma}{\varepsilon_0 m}$$

where m is the mass of the electron. The force is constant, so we use constant acceleration kinematics. If v_0 is the initial velocity of the electron, v is the final velocity, and x is the distance traveled between the initial and final positions, then $v^2 - v_0^2 = 2ax$. Set $v = 0$ and replace a with $-e\sigma/\varepsilon_0 m$, then solve for x. We find

$$x = -\frac{v_0^2}{2a} = \frac{\varepsilon_0 m v_0^2}{2e\sigma} \ .$$

Now $\frac{1}{2}mv_0^2$ is the initial kinetic energy K_0, so

$$x = \frac{\varepsilon_0 K_0}{e\sigma} \ .$$

We convert the given value of K_0 to Joules. Since $1.00\,\text{eV} = 1.60 \times 10^{-19}\,\text{J}$, $100\,\text{eV} = 1.60 \times 10^{-17}\,\text{J}$. Thus,

$$x = \frac{(8.85 \times 10^{-12}\,\text{C}^2/\text{N}\cdot\text{m}^2)(1.60 \times 10^{-17}\,\text{J})}{(1.60 \times 10^{-19}\,\text{C})(2.0 \times 10^{-6}\,\text{C/m}^2)} = 4.4 \times 10^{-4}\ \text{m} \ .$$