

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 $\sigma = 1.8 \times 10^{-7} \text{ C/m}^2$, and the plate separation is $1.5 \times 10^{-2} \text{ m}$. How fast is the electron moving just before it reaches the positive plate?

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

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

$$E = \frac{\sigma}{\epsilon_0}$$

$$v_f^2 = 2ax = 2 \frac{qE}{m} x = 2 \frac{q}{m} \frac{\sigma}{\epsilon_0} x$$

$$v_f = \sqrt{2 \left(\frac{q}{m} \right) \left(\frac{\sigma}{\epsilon_0} \right) x}$$

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

$$v_f = \sqrt{2 (1.756 \times 10^{11} \text{ C/kg}) (2.034 \times 10^4 \text{ N/C}) (1.5 \times 10^{-2} \text{ m})}$$

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

$v_f = 1.0 \times 10^7 \text{ m/s}$

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This page last updated on January 7, 2021