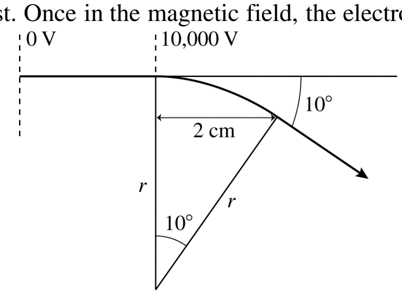
32.63. Model: Energy is conserved as the electron moves between the two electrodes. Assume the electron starts from rest. Once in the magnetic field, the electron moves along a circular arc.

Visualize:



The electron is deflected by 10° after moving along a circular arc of angular width 10°.

Solve: Energy is conserved as the electron moves from the 0 V electrode to the 10,000 V electrode. The potential energy is $U = qV$ with $q = -e$, so

$$K_f + U_f = K_i + U_i \Rightarrow \tfrac{1}{2}mv^2 - eV = 0 + 0$$

$$v = \sqrt{\frac{2eV}{m}} = \sqrt{\frac{2(1.60\times10^{-19}\ \text{C})(10{,}000\ \text{V})}{9.11\times10^{-31}\ \text{kg}}} = 5.93\times10^{7}\ \text{m/s}$$

The radius of cyclotron motion in a magnetic field is $r = mv/eB$. From the figure we see that the radius of the circular arc is $r = (2.0\ \text{cm})/\sin 10°$. Thus

$$B = \frac{mv}{er} = \frac{(9.11\times10^{-31}\ \text{kg})(5.93\times10^{7}\ \text{m/s})}{(1.60\times10^{-19}\ \text{C})(0.02\ \text{m})/\sin10°} = 2.9\times10^{-3}\ \text{T}$$