5. (a) The textbook uses "geomagnetic north" to refer to Earth's magnetic pole lying in the northern hemisphere. Thus, the electrons are traveling northward. The vertical component of the magnetic field is downward. The right-hand rule indicates that $\vec{v} \times \vec{B}$ is to the west, but since the electron is negatively charged (and $\vec{F} = q\vec{v} \times \vec{B}$), the magnetic force on it is to the east.

(b) We combine $F = m_e a$ with $F = evB \sin\phi$. Here, $B \sin\phi$ represents the downward component of Earth's field (given in the problem). Thus, $a = evB/m_e$. Now, the electron speed can be found from its kinetic energy. Since $K = \frac{1}{2}mv^2$,

$$v = \sqrt{\frac{2K}{m_e}} = \sqrt{\frac{2(12.0 \times 10^3\,\text{eV})(1.60 \times 10^{-19}\ \text{J/eV})}{9.11 \times 10^{-31}\,\text{kg}}} = 6.49 \times 10^7\ \text{m/s} .$$

Therefore,

$$a = \frac{evB}{m_e} = \frac{(1.60 \times 10^{-19}\,\text{C})(6.49 \times 10^7\,\text{m/s})(55.0 \times 10^{-6}\,\text{T})}{9.11 \times 10^{-31}\,\text{kg}} = 6.27 \times 10^{14}\ \text{m/s}^2 .$$

(c) We ignore any vertical deflection of the beam which might arise due to the horizontal component of Earth's field. Technically, then, the electron should follow a circular arc. However, the deflection is so small that many of the technicalities of circular geometry may be ignored, and a calculation along the lines of projectile motion analysis (see Chapter 4) provides an adequate approximation:

$$\Delta x = vt \quad \Longrightarrow \quad t = \frac{\Delta x}{v} = \frac{0.200\,\text{m}}{6.49 \times 10^7\,\text{m/s}}$$

which yields a time of $t = 3.08 \times 10^{-9}$ s. Then, with our y axis oriented eastward,

$$\Delta y = \frac{1}{2}at^2 = \frac{1}{2}\left(6.27 \times 10^{14}\right)\left(3.08 \times 10^{-9}\right)^2 = 0.00298\ \text{m} .$$