3. (a) The force on the electron is

\[ \vec{F}_B = q \vec{v} \times \vec{B} = q \left( v_i \hat{i} + v_j \hat{j} \right) \times \left( B_i \hat{i} + B_j \hat{j} \right) = q \left( B_j v_i - B_i v_j \right) \hat{k} \]

\[ = \left( -1.6 \times 10^{-19} \text{ C} \right) \left[ \left( 2.0 \times 10^6 \text{ m/s} \right) \left( -0.15 \text{ T} \right) - \left( 3.0 \times 10^6 \text{ m/s} \right) \left( 0.030 \text{ T} \right) \right] \]

\[ = \left( 6.2 \times 10^{-14} \text{ N} \right) \hat{k}. \]

Thus, the magnitude of \( \vec{F}_B \) is \( 6.2 \times 10^{14} \text{ N} \), and \( \vec{F}_B \) points in the positive \( z \) direction.

(b) This amounts to repeating the above computation with a change in the sign in the charge. Thus, \( \vec{F}_B \) has the same magnitude but points in the negative \( z \) direction, namely, \( \vec{F}_B = -\left( 6.2 \times 10^{-14} \text{ N} \right) \hat{k}. \)

4. (a) We use Eq. 28-3:

\[ F_B = |q| vB \sin \phi = (+3.2 \times 10^{-19} \text{ C}) (550 \text{ m/s}) (0.045 \text{ T}) (\sin 52^\circ) = 6.2 \times 10^{-18} \text{ N}. \]

(b) The acceleration is

\[ a = F_B/m = (6.2 \times 10^{-18} \text{ N}) / (6.6 \times 10^{-27} \text{ kg}) = 9.5 \times 10^8 \text{ m/s}^2. \]

(c) Since it is perpendicular to \( \vec{v}, \vec{F}_B \) does not do any work on the particle. Thus from the work-energy theorem both the kinetic energy and the speed of the particle remain unchanged.

11. Since the total force given by \( \vec{F} = e \left( \vec{E} + \vec{v} \times \vec{B} \right) \) vanishes, the electric field \( \vec{E} \) must be perpendicular to both the particle velocity \( \vec{v} \) and the magnetic field \( \vec{B} \). The magnetic field is perpendicular to the velocity, so \( \vec{v} \times \vec{B} \) has magnitude \( vB \) and the magnitude of the electric field is given by \( E = vB \). Since the particle has charge \( e \) and is accelerated through a potential difference \( V \), \( mv^2 / 2 = eV \) and \( v = \sqrt{2eV/m} \). Thus,

\[ E = \frac{2eV}{m} = (1.2 \text{ T}) \sqrt{\frac{2 \left( 1.60 \times 10^{-19} \text{ C} \right) \left( 10 \times 10^3 \text{ V} \right)}{(9.99 \times 10^{-27} \text{ kg})}} = 6.8 \times 10^5 \text{ V/m}. \]