3. (a) The force on the electron is

$$\vec{F}_B = q\vec{v}\times\vec{B} = q\left(v_x\hat{\text{i}} + v_y\hat{\text{j}}\right)\times\left(B_x\hat{\text{i}} + B_y\vec{j}\right) = q\left(v_xB_y - v_yB_x\right)\hat{\text{k}}$$
$$= \left(-1.6\times10^{-19}\,\text{C}\right)\left[\left(2.0\times10^{6}\text{ m/s}\right)\left(-0.15\text{ T}\right) - \left(3.0\times10^{6}\text{ m/s}\right)\left(0.030\text{ T}\right)\right]$$
$$= \left(6.2\times10^{-14}\text{ N}\right)\hat{\text{k}}.$$

Thus, the magnitude of $\vec{F}_B$ is 6.2 × 10^{14} 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, $\vec{F}_B = -\left(6.2\times10^{-14}\text{ N}\right)\hat{\text{k}}.$

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

$$F_B = |q|\, vB \sin\phi = (+\,3.2\times10^{-19}\text{ C})\,(550\text{ m/s})\,(0.045\text{ T})\,(\sin 52°) = 6.2\times10^{-18}\text{ N}.$$

(b) The acceleration is

$$a = F_B/m = (6.2\times10^{-18}\text{ N})\,/\,(6.6\times10^{-27}\text{ kg}) = 9.5\times10^{8}\text{ m/s}^2.$$

(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,

$$E = B\sqrt{\frac{2eV}{m}} = \left(1.2\text{ T}\right)\sqrt{\frac{2\left(1.60\times10^{-19}\text{C}\right)\left(10\times10^{3}\text{V}\right)}{\left(9.99\times10^{-27}\text{kg}\right)}} = 6.8\times10^{5}\text{ V/m}.$$