9. **REASONING** The direction in which the electrons are deflected can be determined using Right-Hand Rule No. 1 and reversing the direction of the force (RHR-1 applies to positive charges, and electrons are negatively charged).

Each electron experiences an acceleration \( a \) given by Newton’s second law of motion, \( a = F/m \), where \( F \) is the net force and \( m \) is the mass of the electron. The only force acting on the electron is the magnetic force, \( F = q_0 v B \sin \theta \), so it is the net force. The speed \( v \) of the electron is related to its kinetic energy \( KE \) by the relation \( KE = \frac{1}{2} m v^2 \). Thus, we have enough information to find the acceleration.

**SOLUTION**

a. According to RHR-1, if you extend your right hand so that your fingers point along the direction of the magnetic field \( B \) and your thumb points in the direction of the velocity \( v \) of a *positive* charge, your palm will face in the direction of the force \( F \) on the positive charge.

For the electron in question, the fingers of the right hand should be oriented downward (direction of \( B \)) with the thumb pointing to the east (direction of \( v \)). The palm of the right hand points due north (the direction of \( F \) on a positive charge). Since the electron is negatively charged, it will be deflected due south.

b. The acceleration of an electron is given by Newton’s second law, where the net force is the magnetic force. Thus,

\[
a = \frac{F}{m} = \frac{q_0 v B \sin \theta}{m}
\]

Since the kinetic energy is \( KE = \frac{1}{2} m v^2 \), the speed of the electron is \( v = \sqrt{2(KE)/m} \). Thus, the acceleration of the electron is

\[
a = \frac{q_0 v B \sin \theta}{m} = \frac{q_0 B \sin \theta}{m} \sqrt{\frac{2(KE)}{m}}
\]

\[
\begin{align*}
&= \left( 1.60 \times 10^{-19} \text{ C} \right) \sqrt{\frac{2 \left( 2.40 \times 10^{-15} \text{ J} \right)}{9.11 \times 10^{-31} \text{ kg}}} \times \frac{(2.00 \times 10^{-5} \text{ T}) \sin 90.0^\circ}{9.11 \times 10^{-31} \text{ kg}} \\
&= 2.55 \times 10^{14} \text{ m/s}^2
\end{align*}
\]
13. **REASONING AND SOLUTION** In one revolution, the particle moves once around the circumference of the circle. Therefore, it travels a distance of \( d = 2\pi r \), where \( r \) is the radius of the circle. Since the particle moves at constant speed, \( v = \frac{d}{t} \), and the time required for one revolution is \( t = \frac{d}{v} \). According to Equation 21.2, \( r = \frac{mv}{qB} \), so \( v = \frac{qBr}{m} \). Thus, the time required for the particle to complete one revolution is

\[
\frac{2\pi}{q} \frac{r}{m} \frac{B}{(q/m)} = \frac{2\pi}{(0.72 \text{ T})(5.7 \times 10^8 \text{ C/kg})} = 1.5 \times 10^{-8} \text{ s}
\]

23. **REASONING** The particle travels in a semicircular path of radius \( r \), where \( r \) is given by Equation 21.2 \((r = \frac{mv}{qB})\). The time spent by the particle in the magnetic field is given by \( t = \frac{s}{v} \), where \( s \) is the distance traveled by the particle and \( v \) is its speed. The distance \( s \) is equal to one-half the circumference of a circle \((s = \pi r)\).

**SOLUTION** We find that

\[
t = \frac{s}{v} = \frac{\pi r}{v} = \frac{\pi \left( \frac{mv}{qB} \right)}{v} = \frac{\pi m}{qB} \left( \frac{6.0 \times 10^{-8} \text{ kg}}{(7.2 \times 10^{-6} \text{ C})(3.0 \text{ T})} \right) = 8.7 \times 10^{-3} \text{ s}
\]

41. **REASONING** The torque on the loop is given by Equation 21.4, \( \tau = NIAB \sin \phi \). From the drawing in the text, we see that the angle \( \phi \) between the normal to the plane of the loop and the magnetic field is \( 90^\circ - 35^\circ = 55^\circ \). The area of the loop is \( 0.70 \text{ m} \times 0.50 \text{ m} = 0.35 \text{ m}^2 \).

**SOLUTION**

a. The magnitude of the net torque exerted on the loop is

\[
\tau = NIAB \sin \phi = (75)(4.4 \text{ A})(0.35 \text{ m}^2)(1.8 \text{ T}) \sin 55^\circ = 170 \text{ N} \cdot \text{m}
\]

b. As discussed in the text, when a current-carrying loop is placed in a magnetic field, the loop tends to rotate such that its normal becomes aligned with the magnetic field. The normal to the loop makes an angle of \( 55^\circ \) with respect to the magnetic field. Since this angle decreases as the loop rotates, the \( 35^\circ \) angle increases.