1. (a) We use Eq. 29-3: $F_B = |q|vB\sin\phi = (+3.2\times10^{-19}\,\mathrm{C})(550\,\mathrm{m/s})(0.045\,\mathrm{T})(\sin 52^\circ) = 6.2\times10^{-18}\,\mathrm{N}$.

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

   (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.

17. (a) From $K = \frac{1}{2} m_e v^2$ we get

$$v = \sqrt{\frac{2K}{m_e}} = \sqrt{\frac{2(1.20 \times 10^3\,\text{eV})(1.60 \times 10^{-19}\,\text{eV/J})}{9.11 \times 10^{-31}\,\text{kg}}} = 2.05 \times 10^7 \text{ m/s} .$$

(b) From $r = m_e v / qB$ we get

$$B = \frac{m_e v}{qr} = \frac{(9.11 \times 10^{-31}\,\text{kg})(2.05 \times 10^7\,\text{m/s})}{(1.60 \times 10^{-19}\,\text{C})(25.0 \times 10^{-2}\,\text{m})} = 4.67 \times 10^{-4} \text{ T} .$$

(c) The "orbital" frequency is

$$f = \frac{v}{2\pi r} = \frac{2.07 \times 10^7\,\text{m/s}}{2\pi(25.0 \times 10^{-2}\,\text{m})} = 1.31 \times 10^7 \text{ Hz} .$$

(d) $T = 1/f = (1.31 \times 10^7\,\text{Hz})^{-1} = 7.63 \times 10^{-8}$ s.

35. The magnetic force on the wire must be upward and have a magnitude equal to the gravitational force mg on the wire. Applying the right-hand rule reveals that the current must be from left to right. Since the field and the current are perpendicular to each other the magnitude of the magnetic force is given by $F_B = iLB$, where L is the length of the wire. Thus,

$$iLB = mg \implies i = \frac{mg}{LB} = \frac{(0.0130\,\text{kg})(9.8\,\text{m/s}^2)}{(0.620\,\text{m})(0.440\,\text{T})} = 0.467\ \text{A}\ .$$

39. The applied field has two components: $B_x > 0$ and $B_z > 0$. Considering each straight-segment of the rectangular coil, we note that Eq. 29-26 produces a non-zero force only for the component of $\vec{B}$ which is perpendicular to that segment; we also note that the equation is effectively multiplied by $N = 20$ due to the fact that this is a 20-turn coil. Since we wish to compute the torque about the hinge line, we can ignore the force acting on the straight-segment of the coil which lies along the y axis (forces acting at the axis of rotation produce no torque about that axis). The top and bottom straight-segments experience forces due to Eq. 29-26 (caused by the B_z component), but these forces are (by the right-hand rule) in the $\pm y$ directions and are thus unable to produce a torque about the y axis. Consequently, the torque derives completely from the force exerted on the straight-segment located at $x = 0.050$ m, which has length $L = 0.10$ m and is shown in Figure 29-36 carrying current in the $-y$ direction. Now, the B_z component will produce a force on this straight-segment which points in the $-x$ direction (back towards the hinge) and thus will exert no torque about the hinge. However, the B_x component (which is equal to $B\cos\theta$ where $B = 0.50$ T and $\theta = 30°$) produces a force equal to $NiLB_x$ which points (by the right-hand rule) in the $+z$ direction. Since the action of this force is perpendicular to the plane of the coil, and is located a distance x away from the hinge, then the torque has magnitude

$$\tau = (NiLB_x)\,(x) = NiLxB\cos\theta = (20)(0.10)(0.10)(0.050)(0.50)\cos 30° = 0.0043$$

in SI units (N·m). Since $\vec{\tau} = \vec{r} \times \vec{F}$, the direction of the torque is $-y$. An alternative way to do this problem is through the use of Eq. 29-37. We do not show those details here, but note that the magnetic moment vector (a necessary part of Eq. 29-37) has magnitude

$$|\vec{\mu}| = NiA = (20)(0.10\,\mathrm{A})(0.0050\,\mathrm{m}^2)$$

and points in the $-z$ direction. At this point, Eq. 3-30 may be used to obtain the result for the torque vector.

54. Let $a = 30.0\,\text{cm}$, $b = 20.0\,\text{cm}$, and $c = 10.0\,\text{cm}$. From the given hint, we write

$$\begin{aligned}\vec{\mu} &= \vec{\mu}_1 + \vec{\mu}_2 = iab(-\hat{\text{k}}) + iac(\hat{\text{j}}) \\ &= ia(c\hat{\text{j}} - b\hat{\text{k}}) \\ &= (5.00\,\text{A})(0.300\,\text{m})[(0.100\,\text{m})\hat{\text{j}} - (0.200\,\text{m})\hat{\text{k}}] \\ &= (0.150\hat{\text{j}} - 0.300\hat{\text{k}})\,\text{A}\cdot\text{m}^2.\end{aligned}$$

Thus, using the Pythagorean theorem,

$$\mu = \sqrt{(0.150)^2 + (0.300)^2} = 0.335\ \text{A}\cdot\text{m}^2\ ,$$

and $\vec{\mu}$ is in the yz plane at angle θ to the $+y$ direction, where

$$\theta = \tan^{-1}\left(\frac{\mu_y}{\mu_x}\right) = \tan^{-1}\left(\frac{-0.300}{0.150}\right) = -63.4^\circ\ .$$