19.1 The direction in parts (a) through (d) is found by use of the right hand rule. You must remember that the electron is negatively charged and thus experiences a force in the direction exactly opposite that predicted by the right hand rule for a positively charged particle.

\[ F = qvB \sin \theta = qvB \sin(180^\circ) = 0 \]

19.2 (a) For a positively charged particle, the direction of the force is that predicted by the right hand rule. These are:

- (a') in plane of page and to left
- (b') into the page
- (c') out of the page
- (d') in plane of page and toward the top
- (e') into the page
- (f') out of the page

(b) For a negatively charged particle, the direction of the force is exactly opposite what the right hand rule predicts for positive charges. Thus, the answers for part (b) are reversed from those given in part (a).

19.3 Since the particle is positively charged, use the right hand rule. In this case, start with the fingers of the right hand in the direction of \( \vec{v} \) and the thumb pointing in the direction of \( \vec{F} \). As you start closing the hand, the fingers point in the direction of \( \vec{B} \) after they have moved 90°. The results are

- (a) into the page
- (b) toward the right
- (c) toward bottom of page
19.13 Use the right hand rule, holding your right hand with the fingers in the direction of the current and the thumb pointing in the direction of the force. As you close your hand, the fingers will move toward the direction of the magnetic field. The results are

(a) into the page  
(b) toward the right  
(c) toward the bottom of the page

19.8 The speed attained by the electron is found from $\frac{1}{2} m v^2 = q(\Delta V)$, or

$$v = \sqrt{\frac{2q(\Delta V)}{m}} = \sqrt{\frac{2(1.60 \times 10^{-19} \text{ C})(2.400 \text{ V})}{9.11 \times 10^{-31} \text{ kg}}} = 2.90 \times 10^7 \text{ m/s}$$

(a) Maximum force occurs when the electron enters the region perpendicular to the field.

$$F_{\text{max}} = q vB \sin 90^\circ = (1.60 \times 10^{-19} \text{ C})(2.90 \times 10^7 \text{ m/s})(1.70 \text{ T}) = 7.90 \times 10^{-12} \text{ N}$$

(b) Minimum force occurs when the electron enters the region parallel to the field.

$$F_{\text{min}} = q vB \sin 0^\circ = 0$$

19.18 To have zero tension in the wires, the magnetic force per unit length must be directed upward and equal to the weight per unit length of the conductor. Thus,

$$\frac{F}{L} = BI = \frac{m g}{L}, \text{ or}$$

$$I = \frac{(m / L)g}{B} = \frac{(0.040 \text{ kg/m})(9.80 \text{ m/s}^2)}{3.60 \text{ T}} = 0.109 \text{ A}$$

From the right hand rule, the current must be to the right if the force is to be upward when the magnetic field is into the page.
The speed of the particles emerging from the velocity selector is \( v = \frac{E}{B} \) (see Problem 29). In the deflection chamber, the magnetic force supplies the centripetal acceleration, so \( qvB = \frac{mv}{r} \), or \( r = \frac{mv}{qB} = \frac{m(E/B)}{qB} = \frac{mE}{qB^2} \).

Using the given data, the radius of the path is found to be

\[
r = \frac{(2.18 \times 10^{-26} \text{ kg})(950 \text{ V/m})}{(1.60 \times 10^{-19} \text{ C})(0.930 \text{ T})^2} = 1.50 \times 10^{-4} \text{ m} = 0.150 \text{ mm}
\]