32.7 The Magnetic Force on a Moving Charge

27. For each of the following, draw the magnetic force vector on the charge or, if appropriate, write "\( \vec{F} \) into page," "\( \vec{F} \) out of page," or "\( \vec{F} = 0 \)."

a. \( \vec{v} \) into page  
\[ \vec{F} \]

b. \( \vec{v} \) out of page  
\[ \vec{F} = 0 \]

c. \( \vec{F} \) out of page

28. For each of the following, determine the sign of the charge (+ or −).

a. \( \vec{v} \) into page  
\[ \vec{F} \]

b. \( \vec{v} \) into page

\[ q = \phantom{-} \]

c. \( \vec{v} \) into page

\[ q = \pm \]

d. \( \vec{v} \) into page

\[ q = \pm \]

29. The magnetic field is constant magnitude inside the dotted lines and zero outside. Sketch and label the trajectory of the charge for

a. A very weak field.
b. A moderate field.
c. A strong field.

30. A positive ion, initially traveling into the page, is shot through the gap in a magnet. Is the ion deflected up, down, left, or right? Explain. **Down. The magnetic field is left to right, from the north pole to the south pole.**
31. A positive ion is shot between the plates of a parallel-plate capacitor.
   a. In what direction is the electric force on the ion?  
      Down.
   b. Could a magnetic field exert a magnetic force on the ion that is opposite in direction to the electric force? If so, show the magnetic field on the figure.
      Yes.

32. In a high-energy physics experiment, a neutral particle enters a bubble chamber in which a magnetic field points into the page. The neutral particle undergoes a collision inside the bubble chamber, creating two charged particles. The subsequent trajectories of the charged particles are shown.
   a. What is the sign (+ or −) of particle 1?  
      +
   What is the sign (+ or −) of particle 2?  
    −
   b. Which charged particle leaves the collision with a larger momentum? Explain. (Assume that |q| = e for both particles.)

\[
\text{Particle 2. } \quad r = \frac{mv}{qB} \quad \text{mv} = rqB \\
\text{the larger radius particle had the greater momentum.}
\]

33. A solenoid is wound as shown and attached to a battery. Two electrons are fired into the solenoid, one from the end and one through a very small hole in the side.
   a. In what direction does the magnetic field inside the solenoid point? Show it on the figure.
   b. Is electron 1 deflected as it moves through the solenoid? If so, in which direction? If not, why not?
      No. \( \vec{F} = q \vec{v} \times \vec{B} \). There is no force on a charge moving antiparallel to a field because \( \vec{v} \times \vec{B} = 0 \).
   c. Is electron 2 deflected as it moves through the solenoid? If so, in which direction? If not, why not?
      Yes. Out of the page.

34. Two protons are traveling in the directions shown.
   a. Draw the electric forces on each proton.
   b. Draw the magnetic forces on each proton due to the other proton. Explain how you determined the directions.

   The moving charge on the left creates a magnetic field in the region between the charges that is into the page. This field exerts a magnetic force on the charge on the right that is to the right.