where m is the mass of the particle and q is its charge. The angular speed of the charged particle is

$$\omega = \frac{qB}{m} \qquad (29.14)$$

Questions

1. At a given instant, a proton moves in the positive x direction in a region where a magnetic field is directed in the negative z direction. What is the direction of the magnetic force? Does the proton continue to move in the positive x direction? Explain.
2. Two charged particles are projected into a region where a magnetic field is directed perpendicular to their velocities. If the charges are deflected in opposite directions, what can be said about them?
3. If a charged particle moves in a straight line through some region of space, can one say that the magnetic field in that region is zero?
4. Suppose an electron is chasing a proton up this page when suddenly a magnetic field directed perpendicular into the page is turned on. What happens to the particles?
5. How can the motion of a moving charged particle be used to distinguish between a magnetic field and an electric field? Give a specific example to justify your argument.
6. List several similarities and differences between electric and magnetic forces.
7. Justify the following statement: "It is impossible for a constant (in other words, a time-independent) magnetic field to alter the speed of a charged particle."
8. In view of the preceding statement, what is the role of a magnetic field in a cyclotron?
9. A current-carrying conductor experiences no magnetic force when placed in a certain manner in a uniform magnetic field. Explain.
10. Is it possible to orient a current loop in a uniform magnetic field such that the loop does not tend to rotate? Explain.
11. How can a current loop be used to determine the presence of a magnetic field in a given region of space?
12. What is the net force acting on a compass needle in a uniform magnetic field?
13. What type of magnetic field is required to exert a resultant force on a magnetic dipole? What is the direction of the resultant force?
14. A proton moving horizontally enters a region where a uniform magnetic field is directed perpendicular to the proton's velocity, as shown in Figure Q29.14. Describe the subsequent motion of the proton. How would an electron behave under the same circumstances?
15. In a magnetic bottle, what causes the direction of the velocity of the confined charged particles to reverse? (*Hint:* Find the direction of the magnetic force acting on the particles in a region where the field lines converge.)
16. In the cyclotron, why do particles of different velocities take the same amount of time to complete one half-circle trip around one dee?

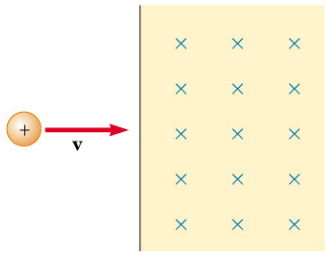

Figure Q29.14

17. The *bubble chamber* is a device used for observing tracks of particles that pass through the chamber, which is immersed in a magnetic field. If some of the tracks are spirals and others are straight lines, what can you say about the particles?
18. Can a constant magnetic field set into motion an electron initially at rest? Explain your answer.
19. You are designing a magnetic probe that uses the Hall effect to measure magnetic fields. Assume that you are restricted to using a given material and that you have already made the probe as thin as possible. What, if anything, can be done to increase the Hall voltage produced for a given magnetic field?
20. The electron beam shown in Figure Q29.20 is projected to the right. The beam deflects downward in the presence of a magnetic field produced by a pair of current-carrying coils. (a) What is the direction of the magnetic field? (b) What would happen to the beam if the current in the coils were reversed?

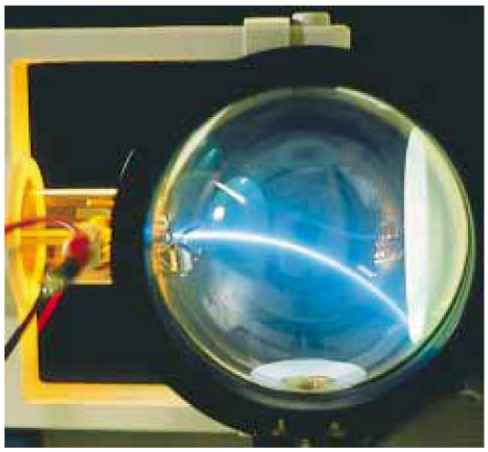

Figure Q29.20