PROBLEM SOLVING Magnetic Fields

Magnetic fields are somewhat analogous to the electric fields of Chapter 16, but there are several important differences to recall:

1. The force experienced by a charged particle moving in a magnetic field is *perpendicular* to the direction of the magnetic field (and to the direction of the velocity of the particle), whereas the force exerted by an electric field is *parallel* to the direction of the field (and unaffected by the velocity of the particle).
2. The *right-hand rule*, in its different forms, is intended to help you determine the directions of magnetic field, and the forces they exert, and/or the directions of electric current or charged particle velocity. The right-hand rules (Table 20–1) are designed to deal with the "perpendicular" nature of these quantities.
3. The equations in this Chapter are generally not printed as vector equations, but involve magnitudes only. Right-hand rules are to be used to find directions of vector quantities.

TABLE 20–1 Summary of Right-hand Rules (= RHR)

Physical Situation	Example	How to Orient Right Hand	Result
1. Magnetic field produced by current (RHR-1)	 Fig. 20–8c	Wrap fingers around wire with thumb pointing in direction of current I	Fingers point in direction of $\vec{\mathbf{B}}$
2. Force on electric current I due to magnetic field (RHR-2)	 Fig. 20–11c	Fingers point straight along current I, then bent along magnetic field $\vec{\mathbf{B}}$	Thumb points in direction of force
3. Force on electric charge $+q$ due to magnetic field (RHR-3)	 Fig. 20–14	Fingers point along particle's velocity $\vec{\mathbf{v}}$, then along $\vec{\mathbf{B}}$	Thumb points in direction of force

CONCEPTUAL EXAMPLE 20–6 **A helical path.** What is the path of a charged particle in a uniform magnetic field if its velocity is *not* perpendicular to the magnetic field?

RESPONSE The velocity vector can be broken down into components parallel and perpendicular to the field. The velocity component parallel to the field lines results in no force, so this component remains constant. The velocity component perpendicular to the field results in circular motion about the field lines. Putting these two motions together produces a helical (spiral) motion around the field lines as shown in Fig. 20–17.

EXERCISE E What is the sign of the charge in Fig. 20–17? How would you modify the drawing if the sign were reversed?

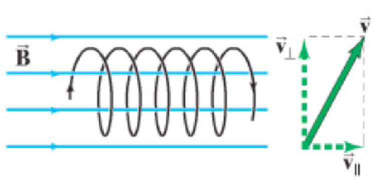

FIGURE 20–17 Example 20–6.