SECTION 1

Magnets and Magnetic Fields

SECTION OBJECTIVES

- For given situations, predict whether magnets will repel or attract each other.
- Describe the magnetic field around a permanent magnet.
- Describe the orientation of Earth's magnetic field.

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MAGNETS

Most people have had experience with different kinds of magnets, such as those shown in **Figure 1.** You have probably seen a variety of magnet shapes, such as horseshoe magnets, bar magnets, and the flat magnets frequently used to attach items to a refrigerator. All types of magnets attract iron-containing objects such as paper clips and nails. In the following discussion, we will assume that the magnet has the shape of a bar. Iron objects are most strongly attracted to the ends of such a magnet. These ends are called *poles;* one is called the *north pole,* and the other is called the *south pole.* The names derive from the behavior of a magnet on Earth. If a bar magnet is suspended from its midpoint so that it can swing freely in a horizontal plane, it will rotate until its north pole points north and its south pole points south. In fact, a compass is just a magnetized needle that swings freely on a pivot.

The list of important technological applications of magnetism is very long. For instance, large electromagnets are used to pick up heavy loads. Magnets are also used in meters, motors, generators, and loudspeakers. Magnetic tapes are routinely used in sound- and video-recording equipment, and magnetic recording material is used on computer disks. Superconducting magnets are currently being used to contain extremely high-temperature plasmas that are used in controlled nuclear fusion research. Superconducting magnets are also used to levitate modern trains. These *maglev* trains are faster and provide a smoother ride than the ordinary track system because of the absence of friction between the train and the track.

Figure 1
Magnets come in a variety of shapes and sizes, but like poles of two magnets always repel one another.

Like poles repel each other, and unlike poles attract each other

The magnetic force between two magnets can be likened to the electric force between charged objects in that unlike poles of two magnets attract one another and like poles repel one another. Thus, the north pole of a magnet is attracted to the south pole of another magnet, and two north poles (or two south poles) brought close together repel each other. Electric charges differ from magnetic poles in that they can be isolated, whereas magnetic poles cannot. In fact, no matter how many times a permanent magnet is cut, each piece always has a north pole and a south pole. Thus, magnetic poles always occur in pairs.