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Topic: Electromagnets
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Solenoids produce a strong magnetic field by combining several loops

A solenoid is important in many applications because it acts as a magnet when it carries a current. The magnetic field strength inside a solenoid increases with the current and is proportional to the number of coils per unit length. The magnetic field of a solenoid can be increased by inserting an iron rod through the center of the coil; this device is often called an *electromagnet*. The magnetic field that is induced in the rod adds to the magnetic field of the solenoid, often creating a powerful magnet.

Figure 8 shows the magnetic field lines of a solenoid. Note that the field lines inside the solenoid point in the same direction, are nearly parallel, are uniformly spaced, and are close together. This indicates that the field inside the solenoid is strong and nearly uniform. The field outside the solenoid is nonuniform and much weaker than the interior field. Solenoids are used in a wide variety of applications, from most of the appliances in your home to very high-precision medical equipment.

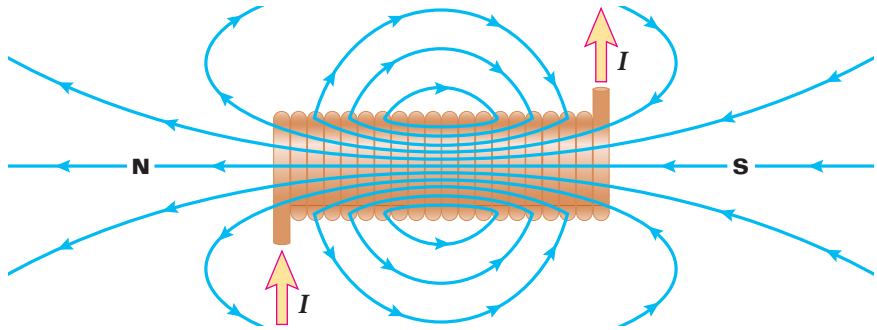

Figure 8
The magnetic field inside a solenoid is strong and nearly uniform. Note that the field lines resemble those of a bar magnet, so a solenoid effectively has north and south poles.

SECTION REVIEW

1. What is the shape of the magnetic field produced by a straight current-carrying wire?
2. Why is the magnetic field inside a solenoid stronger than the magnetic field outside?
3. If electrons behave like magnets, then why aren't all atoms magnets?
4. **Critical Thinking** In some satellites, torque coils are replaced by devices called *torque rods*. In torque rods, a ferromagnetic material is inserted inside the coil. Why does a torque rod have a stronger magnetic field than a torque coil?