

## Section 8.1: Magnets and Electromagnets

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1. A permanent magnet is a magnet that always behaves as a magnet, unlike some materials that only act as magnets in response to an applied magnetic field.
2. **(a)** Earth's magnetic field is directed slightly off from Earth's axis. The south magnetic pole attracts the north pole of a bar magnet. This means that, from a physical standpoint, the north pole of Earth's magnetic field is located near Earth's south geographic pole.  
**(b)** Charged particles from the Sun are directed downward toward Earth's surface by Earth's magnetic field. They are deflected near the equator and channelled along magnetic field lines toward the poles. These particles energize gas atoms in the upper atmosphere, causing the gas atoms to release the extra energy as rays of light, producing the beautiful colours of the auroras.  
**(c)** Magnetic compasses align with Earth's magnetic field. A hiker can use a compass to identify a northerly direction.
3. **(a)** I would hold the conductor in my right hand with my thumb pointing along its length. The direction of the magnetic field is in the direction of my curled fingers.  
**(b)** I would hold the loop of wire in my right hand with my thumb pointing along the loop. The direction of the magnetic field is in the direction of my curled fingers.  
**(c)** I would make a fist and hold my hand so that my fingers curl in the direction of the electric current. My thumb then points in the direction of the magnetic field lines in the core.
4. The field lines inside the coils are straight and directed along the length of the solenoid. The field lines outside the coils curve around from one end to the other.
5. The doorbell contains an electromagnet, which is a solenoid with a core of a magnetic metal. When the switch is closed, current flows through the coils of the electromagnet, producing a magnetic field according to the principle of electromagnetism. By the right-hand rule for a solenoid, the magnetic field attracts the metal plate away from the contact. When contact is broken, the hammer hits the doorbell.
6. To demonstrate the principle of electromagnetism, I would follow these steps:  
Make an electromagnet from an iron rod in a solenoid. Have the wires of the solenoid connected to a circuit with a battery. Using various types of batteries, experiment with how the electromagnet can attract paper clips as the voltage changes.
7. Answers may vary. Students' paragraphs should note that each crystal, called a magnetosome, is composed of a single magnetic domain. Bacteria use the magnetic areas like a compass to direct them downward, away from oxygen.