MAGNETISM
Chapter 16
Magnetism

16.1 Properties of Magnets

16.2 The Source of Magnetism

16.3 Earth’s Magnetic Field
What is a Magnet?

- If a material is *magnetic*, it has the ability to exert forces on magnets or other magnetic materials. **Iron** and **steel** are the best magnetic materials.

- A *permanent magnet* is a material that keeps its magnetic properties, even when it is not close to other magnets.
POLES

- All magnets have two opposite magnetic poles, the north pole and the south pole.

- If a magnet is cut in half, each half will have its own north and south poles.
THE MAGNETIC FORCE

- If two opposite poles face each other, the magnets attract. If two of the same poles face each other, the magnets repel.
Most materials are transparent to magnetic forces.
THE MAGNETIC FIELD

- Two magnets create forces on each other at a distance much larger than the size of the magnets.

- The diagram shows a drawing of the magnetic force around a magnet. The force points away from the north pole because a north pole would be repelled from a north pole. The force points toward the south pole because a north pole magnet would be attracted.
**Drawing the Magnetic Field**

- The magnetic field is a *force field*, because it represents a force at all points in space.

- The arrows we drew on the previous page are connected together into *magnetic field lines*.

![Diagram of a magnetic field with arrows showing the field lines around a permanent magnet.](image)
**Drawing the Magnetic Field (cont.)**

- You cannot just “stop” a field line anywhere.

- If field lines are *close* together, the force is *stronger*. If field lines are *farther* apart, the force is *weaker*.

- Magnetic field lines *always* point away from a magnet’s north pole and toward its south pole.
16.1 Review

Is it possible to have a magnetic south pole without a north pole? Explain your answer.

Describe the interaction between each set of magnetic poles: two north poles; a north and south pole; two south poles.

What does the direction of magnetic field lines tell you?
THE SOURCE OF MAGNETISM

Chapter 16.2
Electromagnets

Electromagnets are magnets created by electric current flowing in wires.

A simple electromagnet is a coil of wire wrapped around an iron core.

When the coil is connected to a battery, current flows and a magnetic field appears around the coil, just as if the coil were a permanent magnet.
The poles of an electromagnet

- Which end is the north pole depends on the direction of the electric current.

- When the fingers of your right hand curl in the direction of current, your thumb points toward the magnet’s north pole.

- This method of finding the magnetic poles is called the right-hand rule.
ADVANTAGES OF ELECTROMAGNETS

- You can switch an electromagnet on and off by switching the current on and off.

- You can switch an electromagnet’s north and south poles by reversing the direction of the current in the coil.

- The strength of an electromagnet’s field can be changed by changing the amount of current in the coil.

- Electromagnets can also be much stronger than permanent magnets because they can use large currents.
BUILDING A BETTER ELECTROMAGNET

- Increase the amount of electric current in the wire.

- The amount and type of material in the electromagnet’s core. (Iron is best)

- Increase the number of turns in the coil.
Magnetism in materials

- In **diamagnetic**, materials the magnetic fields of individual electrons in each atom cancel with each other. (Lead and diamond)

- The atoms in a piece of aluminum are randomly arranged, so the alignment of the north and south poles changes from one atom to the next making it **paramagnetic**.
Ferromagnetic Materials

- Atoms align themselves with neighboring atoms in groups called magnetic domains.

- Because atoms in a domain are aligned with each other the magnetic fields of individual atoms add up.

- Ferrum is Latin for Iron
HARD AND SOFT MAGNETS

- Material can be magnetized by rubbing it with another magnet or with a strong magnetic field.

- Steel is a soft magnet because it is easy to magnetize but loses its magnetization easily too.

- **Heat, shock, and other magnets** can demagnetize steel.

- The domains in hard magnets tend to remain aligned for a long time.

- Strong electromagnets are used to magnetize hard magnets.
DISCOVERING AND USING MAGNETISM

- The Greeks observed that one end of a suspended piece of lodestone pointed north and the other end pointed south, helping sailors and travelers find their way.

- This discovery led to the first important application of magnetism: the compass.
HOW DOES A COMPASS WORK?

- A compass needle is a magnet that is free to spin.

- The needle spins until it lines up with any magnetic field that is present.
GEOGRAPHIC AND MAGNETIC POLE

- When you use a compass, the north-pointing end of the needle points toward a spot near (but not exactly at) Earth’s geographic north pole.

- That means the *south magnetic pole* of the planet is near the *north geographic pole*.
MAGNETIC DECLINATION AND “TRUE NORTH”

- Earth’s geographic north pole (true north) and magnetic south pole are not located at the same place.

- The difference is called magnetic declination.
The source of the Earth’s magnetism

- Earth’s core is made of hot, dense molten iron, nickel, and that slowly circulate around a solid inner core.

- Huge electric currents flowing in the molten iron produce the Earth’s magnetic field.
The strength of Earth’s magnetic field

- The *gauss* is a unit used to measure the strength of a magnetic field.

- A small permanent magnet has a field between 300 and 1,000 gauss at its surface.

- The Earth’s magnetic field averages about 0.5 gauss.
MORE ON EARTH

- Historical data shows that both the strength of the planet’s magnetic field and the location of poles change over time.

- The reversal has happened every 500,000 years on average.

- The last field reversal occurred roughly 750,000 years ago. We are overdue!
MOVEMENTS OF THE MAGNETIC POLE

- The location of Earth’s magnetic poles is always
- The magnetic south pole is located about 600 miles from the geographic north pole.
The End