Chapter 21: Magnetism

- Section 21.1 Magnets and Magnetic Fields
- Section 21.2 Electromagnetism
- Section 21.3 Electrical Energy Generation and Transmission

Section 21.1 Magnets and Magnetic Fields

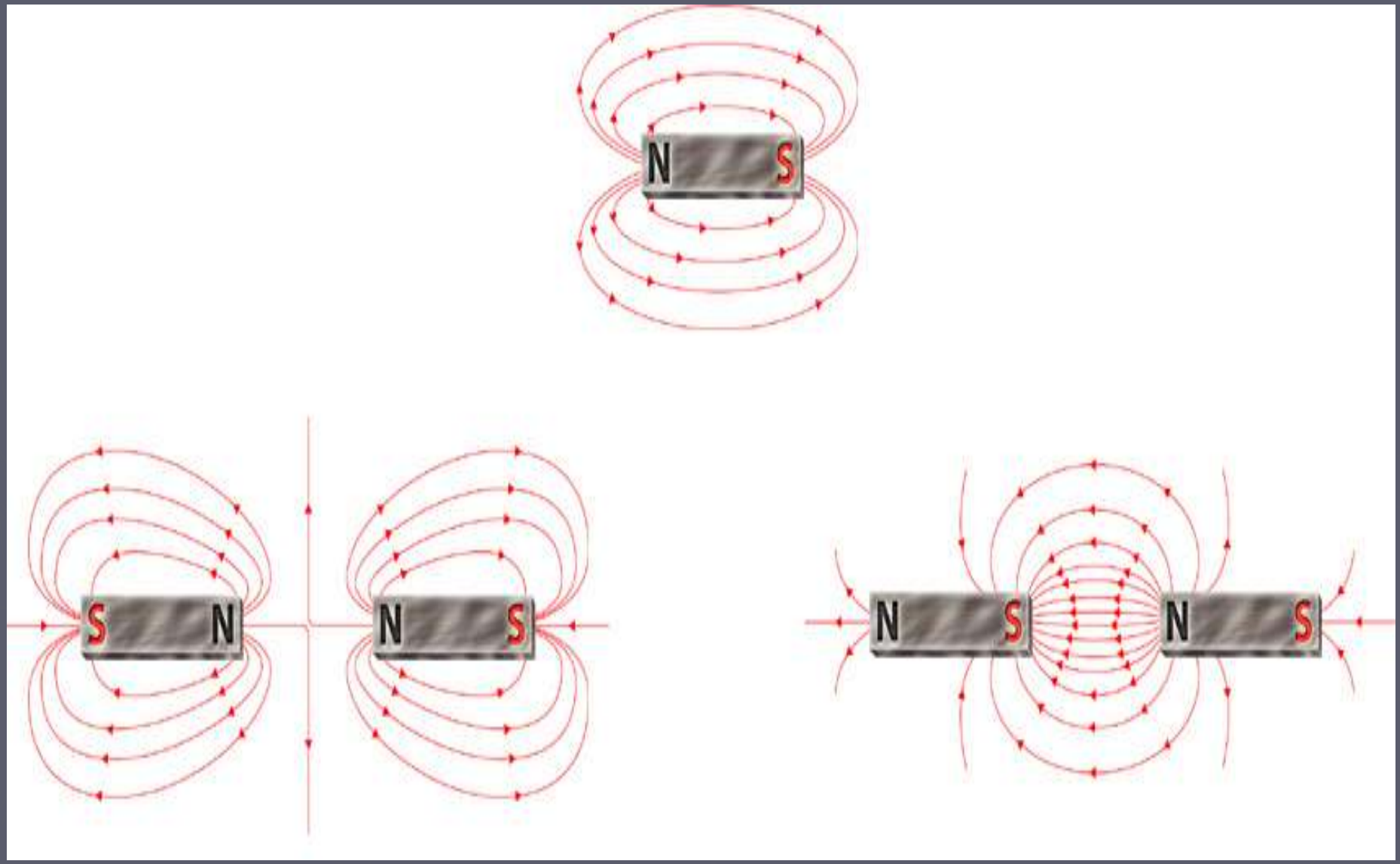
- Magnetic Forces
- Def.-the force a magnet exerts on another magnet, or iron or a similar metal, or on moving charges
- Act over a distance just like electric forces.
- Magnetic force is strongest at the poles; magnets have two magnetic poles (regions where the magnet's force is strongest)
- north pole and south pole
- Key Concept: Like magnetic poles repel one another, and opposite magnetic poles attract one another.

Section 21.1 Magnets and Magnetic Fields

- Magnetic Fields
- Def.-an area in a region of space that exerts magnetic forces and is produced by changing electric fields, by magnets, or by moving charges
- Key Concept: A magnetic field, which is strongest near a magnets poles, will either attract or repel another magnet that enters the field.

Figures 2 and 3

Magnetic Fields Around Magnets



Section 21.1 Magnets and Magnetic Fields

- Magnetic Fields
- Earth-big magnet surrounded by a magnetic field
- Magnetosphere-the area surrounding Earth that is influenced by its magnetic field
- A compass points north because it aligns with Earth's magnetic field
- Earth's magnetic poles are not at the geographic poles which are at 90° N latitude
- Magnetic north pole is 81° N latitude (compass may point east or west or north); the angle between direction to true north and magnetic north is magnetic declination (can vary based on where you are on Earth)

Section 21.1 Magnets and Magnetic Fields

- Magnetic Materials
- Movement of electrons around the nucleus and "spin-behavior mathematically resemble a spinning object" of electrons causes them to act like magnets.
- In materials electrons usually are paired with other electrons which have an opposite spin.
- Magnetic fields mostly cancel out; material has weak magnetic fields
- Other materials have one or more unpaired electrons which produce magnetic fields
- These magnetic fields usually don't combine because of atoms' arrangement being off.

Section 21.1 Magnets and Magnetic Fields

- Magnetic Materials
- Iron, nickel, cobalt-unpaired electrons do produce strong magnetic fields; form strong magnetic domains
- Magnetic domain- a region that has a very large number of atoms aligned with magnetic fields
- Ex. Ferromagnetic material (iron)-can be magnetized b/c it contains magnetic domains
- Key Concept: When a material is magnetized, most of its magnetic domains are aligned.

Section 21.1 Magnets and Magnetic Fields

- Nonmagnetized Materials
- Just because a material is ferromagnetic does not mean that it is a magnet.
- If the domains are aligned randomly, magnetization of the domains cancels=no magnet

Section 21.1 Magnets and Magnetic Fields

- Magnetized Materials
- Ferromagnetic material can be magnetized if placed in a magnetic field.
- Ex. Placing object near a magnet=object will become a magnet
- Magnetic field causes magnetic domains aligned with it to become larger.
- Can be temporary (if object moved away from magnet and domains return to random orientation)
- Can be permanent (domains stay aligned a long time) "permanent magnet"
- **Can be reversed by heating or forceful impact (realigns domains)

Section 21.1 Magnets and Magnetic Fields

- Magnetized Materials
- Cutting a magnet: the domains will still be aligned
- There will always be two different poles (north and south)
- A magnet will never have just a north pole or just a south pole.

Section 21.2 Electromagnetism

- There is some difficulty to determine the relationship between electricity and magnetism.
- Accidentally was discovered by Hans Christian Oersted in 1820.
- Two demonstrations: one with current wire and the other with a compass needle attached to a wood stand
- When current on for electricity demo, compass needle moved.
- When current off, needle moved back to its original position
- Was shown that current in the wire produced a magnetic field

Section 21. 2 Electromagnetism

- Electricity and Magnetism
- Both are different aspects of the same force (electromagnetic force)
- Electric force-result of charged particles
- Magnetic force-usually results from the movement of electrons in an atom
- Both are caused by electric charges

Section 21.2 Electromagnetism

- Magnetic Fields Around Moving Charges
- Key Concept: Moving electric charges create a magnetic field.
- Moving charges may be vibrating charges that produce an electromagnetic wave.
- May be moving charges in a wire (Oersted's experiment)
- Figure 7 pg. 636
- Magnetic field forms circles around a straight wire carrying a current.

Section 21.2

- Forces Acting on Moving Charges
- **Electric field exerts a force on an electric charge.
- Force is in same direction as electric field or in the opposite direction (depends on whether it is positive or negative charge)
- Magnetic field has different effect on a moving charge.
- Charge moving in a magnetic field will be deflected in a direction perpendicular to the magnetic field and velocity of charge. (pg. 636 Figure 8)
- If current carrying wire is in magnetic field, wire will be pushed in direction perpendicular to the field and the direction of the current.

Section 21.2 Electromagnetism

- Forces Acting on Moving Charges
- Reversing the direction of the current will still cause wire to be deflected just in the opposite direction.
- If current is parallel to the magnetic field, force is zero and there is no deflection.

Section 21.2 Electromagnetism

- Solenoids and Electromagnets
- To use electromagnetic force, have to be able to control it.
- Solenoid-a coil of current-carrying wire that produces a magnetic field
- Placing a ferromagnetic material inside the coil of a solenoid causes the strength of a magnetic field to increase.
- The magnetic field produced by the current in the wire will cause the material to become a magnet.
- Electromagnet-a solenoid with a ferromagnetic core.

Section 21.2 Electromagnetism

- Solenoids and Electromagnets
- Key Concept: Changing the current in an electromagnet controls the strength and direction of its magnetic field.
- Current also used to turn magnetic field off and on.
- The strength of an electromagnet depends on the current in the solenoid, the number of loops in the coil of the solenoid, and the type of ferromagnetic core.
- More current=stronger field
- More loops in the coil=stronger field
- Easier to magnetize the core=stronger electromagnets

Section 21.2 Electromagnetism

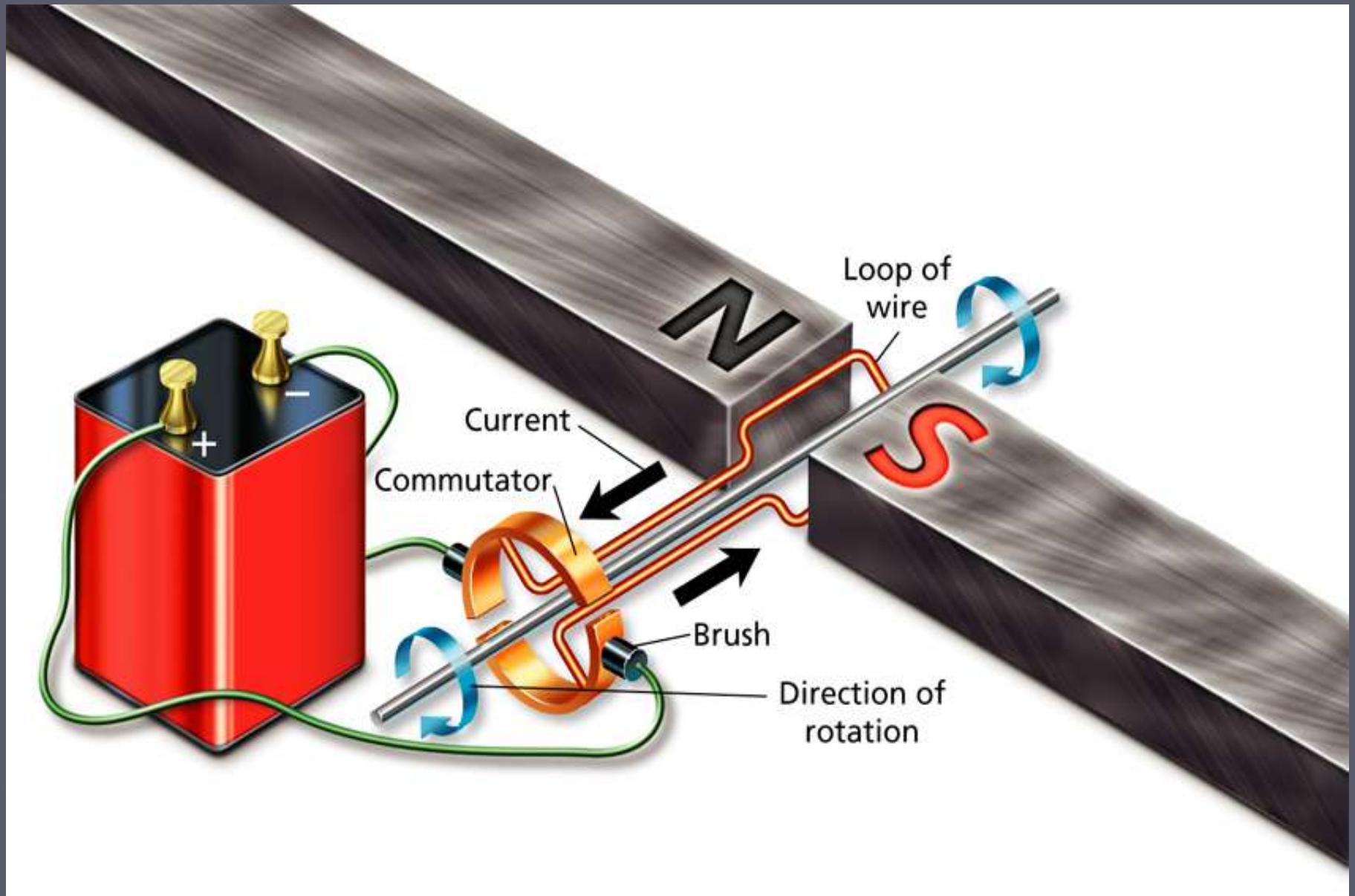
- Electromagnetic Devices
- Electromagnets can convert electrical energy into motion that can do work.
- Key Concept: Electromagnetic devices such as galvanometers, electric motors, and loudspeakers change electrical energy into mechanical energy.
- Galvanometers use electromagnets to measure small amounts of current. (pg. 638)
- Greater the current more electromagnet rotates (pointer)

Section 21.2 Electromagnetism

- Electromagnetic Devices
- Electric Motors use electromagnets to turn an axle.
- Many loops of wire around central iron core.
- Current flows through loops of wire and one side of the loop pushed by field of permanent magnet and pulled on the other side
- Loop is rotated; commutator ring reverses the current
- Forces change direction and coil continues to rotate as long as current flows

Figure 11

An Electric Motor



Section 21.2 Electromagnetism

- Electromagnetic Devices
- Loudspeakers contain electromagnets and permanent magnets.
- Current in wires entering speaker changes direction and increases or decreases to reproduce music, voices, or other sounds

Section 21.3 Electrical Energy Generation and Transmission

- Generating Electric Current
- Electromagnetic induction-the process of generating a current by moving an electrical conductor relative to a magnetic field
- Process discovered by Micheal Faraday (1831)
- Key Concept: According to Faraday's law, a voltage is induced in a conductor by a changing magnetic field.

Section 21.3 Electrical Energy Generation and Transmission

- Generators

- Most electrical energy used in homes and businesses is produced by large power plants using generators.
- Def.-a device that converts mechanical energy into electrical energy by rotating a coil of wire in a magnetic field (induction)
- Key Concept: The two types of generators are AC generators and DC generators.
- Most power plants use AC generators.

Section 21.3 Electrical Energy Generation and Transmission

- AC Generators

- Produces alternating current (charge flows in one direction and then in the other direction)
- Converts mechanical energy into electrical energy.

- DC Generators

- Produces a direct current
- Similar make up to AC generator; component parts are different.

Figure 14

A Simple AC Generator