

Section 1 Magnetism

- A. Magnetism—the properties and interactions of magnets
1. Interaction between two magnets called magnetic force increases as magnets move closer together.
 2. A magnetic field, which exerts the magnetic force, surrounds a magnet, and is strongest closest to the magnet.
- B. Magnetic poles—the regions of a magnet where the magnetic force exerted by the magnet is strongest
1. All magnets have a north pole and a south pole.
 2. Like poles attract. Unlike poles repel.
 3. Earth has magnetic poles.
 - a. A compass needle is a small bar magnet that can freely rotate.
 - b. A compass needle always points north.
- C. Magnetic materials—iron, cobalt, and nickel
1. The magnetic field created by each atom exerts a force on nearby atoms.
 2. Magnetic domains—groups of atoms with aligned magnetic poles
 - a. In a magnet, the like poles of all the domains point in the same direction.
 - b. Permanent magnets are made by placing a magnetic material in a strong magnetic field, forcing a large number of magnetic domains to line up.

Discussion Question

Permanent magnets can lose their magnetic properties if they are heated. Explain why magnetic properties are lost under these conditions. Permanent magnets are made by placing a magnetic material in a strong magnetic field. This causes alignment of a large number of magnetic domains in the magnetic material. The strong magnetic field inside the magnetic material keeps the magnetic domains aligned. Heating causes the atoms in the magnetic material to move faster. If the magnet is heated enough, the moving atoms can jostle all the magnetic domains out of alignment and the magnetic properties are lost.

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Section 2 Electricity and Magnetism**A. Moving charges and magnetic fields**

1. Moving charges, like those in an electric current, produce magnetic fields.
 - a. The magnetic field around a current-carrying wire forms a circular pattern about the wire.
 - b. The direction of the field depends on the direction of the current.
 - c. The strength of the magnetic field depends on the amount of current flowing in the wire.

B. Electromagnet—a temporary magnet made by placing a piece of iron inside a current-carrying coil of wire

1. Magnetic field is present only when current is flowing in the wire coil.
2. Increase strength of the magnetic field by adding more turns to the wire coil or increasing the current passing through the wire.
3. Magnetic properties of electromagnets can be controlled by changing the electric current flowing through the wire coil.
4. Converts electrical energy into mechanical energy to do work

C. Galvanometer—a device that uses an electromagnet to measure electric current**D. Electric Motor**—a device that changes electrical energy into mechanical energy

1. Contains an electromagnet that is free to rotate between the poles of a permanent, fixed magnet. The coil in the electromagnet is connected to a source of electric current.



2. When a current flows through the electromagnet, a magnetic field is produced in the coil.
3. Changing the direction of the current causes the coil in an electric motor to keep rotating.
4. Rotation speed of electric motors can be controlled.
 - a. Vary the amount of current flowing through the coil.
 - b. When more current flows through the coil, the electromagnet's magnetic field becomes stronger, the magnetic force between the coil and the permanent magnet increases, and the coil turns faster.

Discussion Question

How does a stereo speaker work? A CD player produces a varying electric current. The current passes through an electromagnet, which is then attracted to or repelled by a permanent, fixed magnet. The electromagnet then moves back and forth, toward or away from the fixed magnet. The speaker's flexible surface vibrates and produces sound.

Section 3 Producing Electric Current

A. From mechanical to electrical energy

1. **Electromagnetic induction**—the production of an electric current by moving a loop of wire through a magnetic field or moving a magnet through a wire loop
2. **Generator**—a device that produces electric current by rotating a coil of wire in a magnetic field
 - a. The wire coil is wrapped around an iron core and placed between the poles of a permanent magnet.
 - b. Coil is rotated by an outside source of mechanical energy.
 - c. As the coil turns within the magnetic field of the permanent magnet, an electric current flows through the coil.
 - d. Direction of the current in the coil in a generator changes twice with each revolution.
3. **Generating electricity**
 - a. Electricity used in the home comes from a power plant with huge generators.
 - b. Coils of electromagnets in the generators usually connected to a turbine—a large wheel that rotates when pushed by water, wind, or steam.

B. Direct and alternating currents

1. **Direct current (DC)** is current that flows in only one direction through a wire.
2. **Alternating current (AC)** reverses the direction of the current flow in a regular way.
 - a. In North America, generators produce alternating current at a frequency of 60 cycles per second, or 60 Hz.
 - b. A 60-Hz alternating current changes direction 120 times each second.



- C. **Transformer**—a device that increases or decreases the voltage of an alternating current
1. Made of two coils (primary and secondary) wrapped around the same iron core.
 2. Changing current in primary coil creates changing magnetic field around the iron core, which induces an alternating current in the secondary coil.
 3. A step-up transformer increases voltage. The secondary coil has more turns of wire than the primary coil does.
 4. A step-down transformer decreases voltage. The secondary coil has fewer turns of wire than the primary coil does.
 5. Power carried in power lines as high as 750,000 V is reduced by step-down transformers to household current (AC) of 120 V.

Discussion Question

In North America, generators produce alternating current at a frequency of 60 Hz. How is a frequency expressed in Hz related to the number of times the current changes direction? A frequency of 60 Hz means the current has a frequency of 60 cycles per second. During one cycle, the current changes direction twice. If a current has a frequency of 60 Hz, it changes direction 120 times each second.

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