Chapter 8-1
Polymers & Composites

- Polymers form when chemical bonds link large numbers of monomers in a repeating pattern, sometimes the same monomer and other times different ones.
- Some polymers are natural, meaning they come from animals and plants. Ex. cellulose in the cell wall of plants, the spider's web, silk from the silkworm, wool from sheep, proteins in fingernails/muscles/hormones/antibodies.
- Other polymers are synthetic, meaning made by humans. The starting materials come form coal/oil. Ex. plastics that can be molded and shaped; carpets, clothing, glue, and chewing gum can be made of such polymers. Synthetic polymers are flexible, yet strong, hard, lightweight. They are used in place of natural ones that are too expensive or wear out quickly. Ex. polyester and nylon in place of silk, wool, and cotton; laminated countertops and vinyl floors instead of wood.
- Composites combine 2 or more substances as a new substance with different properties. They work better than either one alone.
- A natural composite is wood made of cellulose fibers held together by lignin, another plant polymer.
- A synthetic composite is fiberglass made of strands of glass fibers woven together and strengthened with a liquid plastic.
- Synthetic polymers have caused problems as well. It is often cheaper to throw away plastic materials than to make a new one. This increases the volume of trash. Another problem is that plastics don't break down into simpler materials in the environment. One solution is to recycle.

Chapter 8-2
Metals/Alloys

- An alloy is a substance made of 2 or more elements having metal properties. Ex. bronze, brass, stainless steel
- Alloys are used more than metals because they are generally stronger and less likely to react with air or water.
- Many alloys can be made by
  - melting metals and mixing them together in carefully measured amounts
  - mixing the elements as powders and then heating them under high pressure. This uses less energy because they mix at lower temperatures
  - ion implantation: firing a beam of ions at a metal which forms a thin layer of alloy on the metal
- Alloys have many uses:
  - plumbing materials
  - musical instruments
  - sprinkler systems
  - tableware
  - cookware
  - doorknobs
  - amalgam (dental filling)
  - bridges
  - skyscrapers
  - surgical instruments
  - artificial joints
  - tools

Chapter 8-3
Ceramics and Glass

Ceramics

- Ceramics: hard, crystalline solid made by heating clay and other mineral materials to high temperatures
- The clay particles will stick together after the water they hold evaporates when heated. This process forms the hard pottery used in bricks and flowerpots. Once cooled, the materials have tiny spaces in their structure that absorb and hold water. The pottery is then brushed with a layer of silicon dioxide and heated again to form a glassy coating called a glaze, which makes it shiny and waterproof.
- Ceramics have the tendency to break, but can be useful because they resist moisture, don't conduct electricity, and can withstand higher temperatures.
- Ceramic pottery have been used to store food protecting it from moisture and animals, for roofing tiles/bricks/sewer pipes, as insulators in electric equipment/light fixtures, as oven tiles/bottom of space shuttle because they resist high temperatures, and as decoration.

Glass

- Sand mixed with limestone can be melted into a thick, hot liquid, which when cooled will form a clear solid with no crystalline structure called glass.
- Glassblowing is a process used to make beautiful shapes and patterns.
- Many materials can be added to glass to make it useful:
    - calcium/sodium added to the sand mixture will lower the melting point to make it easier to work with in the making of window glass and bottles
    - substituting lead oxide for the limestone makes glass bend light to be used in eyeglasses, telescopes, microscopes
    - adding boron oxide creates glass that resists heat better to be used in cookware and lab glassware
    - colored glass is made by adding minerals such as selenium/gold for red and cobalt for blue
- Optical fibers are threadlike pieces of glass/plastic used for transmitting light. When you speak into a telephone, the signal created by your voice is converted to light signals that travel through the glass fiber. At the other end, the light may be converted into electronic signals that can then be converted to sound. Optical fibers are more efficient because there is little loss of light during transmission and they are more stable because they do not corrode as metals do.

Chapter 8-4
Radioactive Elements

- Nuclear reactions involve the particles in the nucleus of an atom and produce atoms with different atomic numbers and masses.

- Isotopes: atoms with the same # of protons but different # of neutrons. This means their mass # (#of p and n) is different.

- Radioactive decay: process where the atomic nuclei of unstable isotopes release fast-moving particles and energy (nuclear radiation).

- Types of radioactive decay:

	Alpha decay	Beta decay	Gamma decay
Particle released	Alpha which is the same as helium nucleus with 2p and 2n	Beta which is an electron given off by the nucleus when a neutron breaks apart; a proton is formed	High-energy waves
Atomic #	Decreased by 2	Increased by 1	No change
Mass #	Decreased by 4	The same	No change
Speed	Very fast	Faster than alpha	Fastest and most penetrating
Stopped by	Collisions with atoms; thin sheet of paper/metal foil	Aluminum sheet more than 3 mm thick	Lead several cm thick or concrete about a meter thick
Damage	Injury like bad burn	Damage to human body cells	Severe damage to body cells

- Using radioactive isotopes:
  - radioactive dating: half-life of radioactive isotopes are used in determining ages of rocks/fossils
  - source of radiation
    a. engineers use to look for flaws in metal
    b. in radiation therapy used to destroy unhealthy cells
    c. in nuclear power plants as fuel such as Uranium-235
  - tracers which can be followed through the steps of chemical reactions
    a. studying reactions in plant growth
    b. finding weak spots in metal pipes
    c. detecting medical problems and treating diseases

- Illness, disease, death may result from overexposure to radiation. We need to use the radioactive materials safely, such as wearing protective clothing and using insulating shields. We also need to dispose of them safely.