CHAPTER 4 p. 92 - 123

MATTER

I. Matter- anything that has mass and takes up space; made of particles: atoms, molecules, or ions.
   A. state of matter depends on:
      1. the motion of the particles
      2. particle cohesiveness - the strength of the attraction between particles.
   B. 4 states of matter: solid, liquid, gas, and plasma
      1. most common state of matter in the universe: plasma - found in the sun, the stars, lightning, and neon lights.
      2. most familiar states of matter: solids, fluids: liquids, and gases.
         a. solids: definite shape; definite volume; tightly packed particles that vibrate.
            1). particles vibrate in place, but lack enough kinetic energy to move out of position; very cohesive.
            2). types:
               a). crystalline solids
                  1). most cohesive solids – little or no space between particles.
                  2). solids in which particles are arranged in repeating, 3-dimensional patterns (crystals).
                  3). ex. salt crystals (cubic sodium chloride), diamond (pyramid shaped carbon atoms), sugar, sand, and snow (hexagonal crystals).
               b). amorphous (noncrystalline) solids - solids in which large particles have a random arrangement, no repeating pattern (no crystal form). ex. rubber, plastic, and glass.
         b. liquids: fluid with no definite shape, but definite volume
            1). particles have enough kinetic energy to move out of their fixed position but not enough to move far apart; less cohesive than solids.
            2). viscosity – liquid's resistance to flow; results from the strength of the attraction between the particles of the liquid. ex. water has a low viscosity; honey has a high viscosity.
               a). viscosity increases as temperature decrease (v↑, t ↓)
               b). viscosity decreases as temperature increases (v↓, t↑).

MATTER

3). surface tension – uneven forces acting on particles on the surface of a liquid; surface particles are pulled towards each other and downward; particles below the surface are pulled in all directions.
   a). caused by attractive forces between water molecules:
      (1). which cause the liquid to act as if a thin film were stretched across its surface. Ex. a needle will float on water.
      (2). which cause droplets to form when the liquid is present in small amounts.

c. gases: fluid with no definite shape and no definite volume; particles move at high speeds in all directions.
   1). particles have enough kinetic energy to spread out evenly taking the shape of the container; no cohesiveness.
   2). particles can expand or be compressed
   3). water vapor – gas state of water.

II. Changes of state

A. energy – the ability to do work and cause change.
   1. kinetic energy – energy of motion.
      a. particles high in kinetic energy move faster and further apart.
      b. particles low in kinetic energy move slower and stay closer together.
   2. thermal energy – depends on the amount of the substance and the total kinetic energy of all the particles in a sample of matter
      a. temperature – average kinetic energy of the individual particles of a substance.
      b. heat – movement of thermal energy from a substance at a higher temperature to one at a lower temperature.
         1). when a substance is heated, it gains thermal energy, its particles move faster and its temperature rises.
         2). when a substance is cooled, it loses thermal energy, its particles move slower and its temperature goes down.

B. specific heat – measure of the amount of energy required to raise 1 g of a substance 1°C.
   1. substances with low specific heat - heat up and cool down quickly. Ex. most metals and sand.
   2. substances with high specific heat, heat up and cool down slowly. Ex. H_2O.

MATTER

C. changes in state of matter - results from changes in thermal energy:
   1. if thermal energy increases, kinetic energy increases and particles overcome the attractive forces holding them together.
   2. if thermal energy decreases, kinetic energy decreases and the attractive forces pull the particles together.
   3. during all changes of state, the temperature of a substance stays the same.
   4. changes between the solid and liquid states:
      a. melting – change from the solid state to the liquid state.
         1). crystalline solids – have a melting point; temperature rises then remains constant at the melting point until all crystal structures break down.
         2). amorphous solids – have no true melting point; as temperature rises solids get softer and softer. Ex. rubber and glass.
      b. freezing – change from the liquid state to the solid state.
      c. melting point of a solid = freezing point of a liquid.
         ex. solid H_2O (ice) melts at 0°C and liquid H_2O (water) freezes at 0°C.
   5. changes between the liquid and gas states:
      a. vaporization – change from the liquid state to the gaseous state.
         1). boiling – takes place below the surface of the liquid; occurs when gas bubbles form within the liquid and rise to the surface.
            a). as liquid H_2O (water) is heated its temperature rises and it absorbs kinetic energy and particle motion increases;
            b). liquid H_2O (water) changes to gaseous H_2O (water vapor) at 100°C.
         2). evaporation – takes place at the surface of the liquid when some of the fastest-moving molecules overcome the attractive forces of other molecules and escape.
            a). occurs at temperatures below the boiling point.
            b). cools the liquid and anything near the liquid.
      b. condensation – change from the gaseous state to the liquid state.
         1). as a gas cools its particles slow down and attractive forces bring the particles close together forming droplets releasing thermal energy.

MATTER

6. Changes between the solid and gas states:
   a. sublimation – change from the solid state to the gaseous state without going through the liquid state. ex. dry ice: solid form of CO_2
      1). surface particles of the solid gain enough kinetic energy to become a gas.
         a). dry ice absorbs thermal energy from water vapor in the air.
         b). the water vapor cools and condenses into liquid water droplets, forming a fog.

III. Behavior of Fluids: gases and liquids
   A. force - the push or pull on an object; measured in Newton's (N).
   B. area - a surface an object occupies; measured in square units; ex. square meters (m^2).
   C. pressure - force exerted on a surface divided by the total area over which the force is exerted; measured in N/m^2 or Pascal's (Pa). $P = F/A$
      1. changes in forces result in changes in pressure:
         a. as force increases, pressure increases (F↑, p↑).
         b. as force decreases, pressure decreases (F↓, p↓).
      2. changes in area result in changes in pressure:
         a. as the area increases, pressure decreases (area↑, p↓).
         b. as the area decreases, pressure increases (area↓, p↑).
   D. atmospheric pressure - the force of the air on all objects; 101,300 N/m^2 or 101,300 Pa.
      1. 101,300 Pa = 101.3 kilopascals (kPa).
      2. kilopascals (kPa) - 1000 Pascals; unit used to express atmospheric pressure.
      3. balanced pressure - upward or outward pressure exerted by an object that is equal to the pressure exerted by the atmosphere.
         a. explains why objects are not crushed by atmospheric pressure that's about the same as that of a large truck.
      4. atmospheric pressure: changes with altitude - height above sea level.
         a. as altitude increases pressure decreases (alt↑, p↓); pressure decreases due to decrease in air particles.
            1). Pascal's balloon experiment - helium balloon inflates ↑ mtn.
            2). ears popping - air pressure behind the eardrum becomes greater than surrounding air pressure; release of air as pressure equalizes - results in popping sound.

b. as altitude decreases pressure increases (alt↓, p↑).

E. gas pressure:
1. Boyle's Law - changes in volume, provided temperature remains constant.
   a. as volume decreases, pressure increases (vol↓, p↑).
   b. as volume increases, pressure decreases (vol↑, p↓).
2. Charles' Law - changes with temperature, provided volume remains constant.
   a. as temperature increases, pressure increases (t↑, p↑).
   b. as temperature decreases, pressure decreases (t↓, p↓).

F. water pressure - as depth increases, pressure increases
1. Archimedes' principle - states that the buoyant force on an object is equal to the weight of the fluid displaced by the object.
   a. buoyant force - upward force exerted on an object immersed in a fluid.
      1). if the buoyant force is equal to the weight of the object (F↑= F↓), the object will float, i.e., it will show no acceleration.
      2). if the buoyant force is less than the weight of the object (F↑< F↓), the object will sink, i.e., it will accelerate downward.
      3). if the buoyant force is greater than the weight of the object (F↑>F↓), the object will accelerate upward.
   b. density - mass of an object divided by its volume; measured in g/cm^3 or g/mL. **D = m / V**
      1). an object will float in a fluid more dense than itself.
      2). an object will sink in a fluid less dense than itself.
      3). an object will neither sink nor float but instead stay at the same level in a fluid with the same density as itself.

G. Pascal's principle - states that when a force is applied to a confined fluid, an increase in pressure is transmitted equally to all parts of the fluid.
1. hydraulic systems - pistons use Pascal's principle to lift heavy objects using relatively small forces.
2. force pumps - fluid will be pushed out through an opening in an otherwise closed container when squeezed.