CHAPTER 6

6.1 Air: A Mixture of Gases - skim

6.2 The Kinetic Molecular Theory

The kinetic molecular theory deals with the behavior of gases. The word kinetic means “motion” in Greek. There are six basic postulates of the kinetic molecular theory:

1. All matter is composed of discrete particles (either atoms, ions or molecules.)

2. The particles of a gas are in rapid motion, moving in straight lines.

3. There are wide open spaces between gaseous particles. Therefore, gases can be easily compressed.

4. There is little attraction between gaseous particles. Otherwise they will turn into liquids.

5. Gaseous particles collide with one another with no total loss in energy. Energy may be transferred from one particle to another, however. As gas particles strike the wall of their container they exert a “pressure.”

6. Temperature is a measure of the average speed of the gaseous particles. As temperature increases, the average speed of the particles increases.

6.3 Atmospheric Pressure

Pressure is defined as force per unit area. In the English system of units, pressure is measured in lb/in^2. In the metric system, pressure in measured in pascals (Pa).

Atmospheric air pressure is measured using a barometer (see Figure 6.3, page 153.) Barometric pressure is expressed in inches (on weather reports) or millimeters (in science labs) of mercury. Average atmospheric pressure at sea level is 760 mm Hg = 29.92 in Hg = 1 atm.

6.4 Boyle's Law: The Pressure-Volume Relationship

Boyle's law states that for a given amount of gas at constant temperature, as the pressure on the gas increases its volume decreases. This translates into this equation:

$$P_1V_1 = P_2V_2$$

In all problems involving Boyle's Law, an initial pressure (P_1) and volume (V_1) will be given for a gas sample. The gas will undergo a change and either a new volume (V_2) will be given and you will be asked to calculate the new pressure (P_2), or the new pressure will be given (P_2) and you will be asked to calculate the new volume (V_2).

Example 1. If a 12.0 L sample of gas at 2.45 atm pressure is reduced to a volume of 4.00 L, what is its new pressure?

$$P_2 = \frac{P_1V_1}{V_2} = \frac{2.45\ \text{atm} \mid 12.0\ \text{L}}{\mid 4.00\ \text{L}} = 7.35\ \text{atm}$$

Example 2. If the pressure of 455 mL sample of gas at 742.4 mm Hg pressure is increased to 865.4 mm Hg, what is its new volume?

$$V_2 = \frac{P_1V_1}{P_2} = \frac{742.4\ \text{mm Hg} \mid 455\ \text{mL}}{865.4\ \text{mm Hg} \mid} = 390.3304\ \text{mL}$$

Which, when rounded to 3 significant figures is 390 mL.

During normal breathing, the volume of the lungs increases during inhalation causing the air pressure in the lungs to decrease around 3 mm Hg below atmospheric pressure. This causes air to enter the lungs. The reverse is true during exhalation.

6.5 to 6.8 skip

6.9 Henry's Law: The Pressure-Solubility Relationship

Henry's law states that the solubility of a gas in a liquid increases as the pressure of the gas at the surface of the liquid increases. In a warm bottle of unopened soda, the pressure of CO_2 at the liquid surface is more than that of atmospheric pressure. So, when you open the bottle, you can hear a hissing sound which releases the pressure of CO_2 at the surface of the liquid. Since the pressure of CO_2

at the surface is decreased, the solubility of CO_2 in the liquid decreases, and the soda fizzes. This is illustrated graphically in Figure 8.8 on page 206.

6.10 Dalton's Law of Partial Pressures

Dalton's law of partial pressures states that the total pressure of a mixture of gases is equal to the sum of the partial pressures of each individual gas.

Example 3. If a cylinder contains a mixture of nitrogen at a pressure of 0.845 atm, oxygen at a pressure of 0.123 atm and helium at a pressure of 0.098 atm, what is the total pressure of gas in the cylinder?

P_{TOTAL} = 0.845 atm + 0.123 atm + 0.098 atm = 1.066 atm

Water dissolved in air is referred to as humidity. The maximum amount of water that can dissolve in air at various temperatures is displayed in Table 6.2 on page 167.

6.11 Partial Pressures and Respiration

The process by which gases are transported through the body is diffusion. Gases always diffuse from an area of higher concentration to an area of lower concentration. The concentration of a gas dissolved in a liquid is directly proportional to its partial pressure. Oxygen diffuses from the lungs to the cells and carbon dioxide diffuses from the cells to the lungs.