Gases and Stoichiometry: Kinetic Theory of Gases: Student Review Notes

This models on a molecular level the macroscopic properties of an ideal gas.

The kinetic theory of gases assumes that gases are made up of hard little balls which are moving very rapidly and often run into each other and the walls of the container (pressure within the container). **Collisions between molecules are completely elastic** (no intermolecular forces).

Kinetic energy is directly proportional to the temperature. At the same temperature, all ideal gases will have the same kinetic energy. They won't necessariy be traveling at the same speed because they can have different masses but understand that KE is only a function of temperature for an ideal gas.

Postulates of the Kinetic Theory

1. **Gases consists of particles (atoms or molecules) in continuous, random motion**. These particles frequently collide with the walls of the container and with each other. The pressure exerted by the gas is do to the forces associated with wall collisions. Pressure is force per unit area.

2. **Collisions between gas particles are elastic**. The collision of two particles conserves energy. The individual energies of colliding particles may change (one may gain energy and the other lose energy), but the overall energy of the two particles before and after the collision is the same. This means that no kinetic energy is converted to hear energy and therefore the temperature of a gas insulated from its surroundings does not change.

3. **The volume occupied by gas molecules is negligibly small** compared to that of the container in which the molecules are confined. This assumption breaks down at high temperature and pressure.

4. **Their are no attractive forces between gas molecules or atoms**. The gaseous particles are do not interact in any way other than through conservative elastic collisions.

5. **The average energy of translational motion of a gas particle is directly proportional to temperature**. At a given temperature, the average energy of any ideal gas is the same. They may have different average velocities due to a difference in mass, but the kinetic energy is the same for all species at the same temperature.

$$\text{Kinetic Energy of a particle of anideal gas at temperature T} = \frac{1}{2}mu^2 = \frac{3\ RT}{2\ \ N}$$

$$\text{Average speed of a particle: } \bar{U} = \left(\frac{3\ RT}{MM}\right)^{1/2}$$

m = particle mass
u = Speed
R = Gas constant
T = Temperature
N = Avagodro's No.
MM = Molar Mass

Graham's Law of Effusion: at a given temperature, the rate of effusion of a gas is inversely proportional to the square root of its molar mass. Therefore, the ratio of rates of effusion of two ideal gases would be:

$$\frac{\text{rate of effusion of gas A}}{\text{rate of effusion of gas B}} = \left(\frac{MM_B}{MM_A}\right)^{1/2}$$