5.1 Characteristics of Gases

- Gas molecules are very far apart, so total volume of gases is mostly empty space.
- Gas molecules move at high velocities and high kinetic energies.
- Gas volume is dependent on pressure, temperature and moles of the gas.

5.2 Real Gases and Ideal Gases

- Real gases obey the laws of "ideal" gases at non-extreme conditions.
- Therefore, gas behavior (pressure, temperature, volume, and number of particles) is determined using gas laws.

5.3 Pressure

- Pressure is the force per unit area.

$$P = \frac{Force}{Area} \quad or \quad P = \frac{F}{A} \tag{5.1}$$

- So, the pressure will increase with a greater force exerted on an area or with a certain force exerted on a smaller area.

5.4 Measuring Pressure

- A barometer is one way to measure pressure.
- The height of the mercury column in the tube correlates to the atmospheric pressure.

5.5 Pressure Units

- There are several different units used to describe pressure. We will focus on four of them:

  atm atmospheres

  mmHg millimeters of Mercury

  torr

  psi pounds per square inch

- 1 atm = 760 mmHg, 1 atm = 760 torr, and 1 atm = 14.7 psi
- So 1 mmHg = 1 torr.
  - Note: atm, mmHg, and torr are all exact values; psi has been rounded to three sig figs.

5.6 Examples

1. A tire pressure gauge reads 33 psi. What is this pressure reading in torr?

$$33 \text{ psi} \times \frac{1 \text{ atm}}{14.7 \text{ psi}} \times \frac{760 \text{ torr}}{1 \text{ atm}} = 1,706.12245 \text{ torr}$$

2. In a near-vacuum, the pressure is 0.100 mmHg. What is this pressure in atmospheres?

$$0.100 \text{ mmHg} \times \frac{1 \text{ atm}}{760 \text{ mmHg}} = 1.31579 \times 10^{-4} \text{ atm}$$

5.7 Temperature

- One factor involved in gas behavior is temperature (a measure of hot and cold).
- In the lab, temperature is measured in °C + 273.15
- **Lecture Problem:** A gas is collected in the laboratory at 34°C. What is the temperature on the Kelvin scale? $34°C + 273.15 = 307.15°K$

5.8 The Gas Laws

- The Gas Laws focus on the relationship between pressure, temperature, volume, and the amount of a gas.
- We will discuss four gas laws in these sections: Boyle's Law, Charles' Law, Amonton's Law, and the Combined Gas Law.
- Note: Any references to standard temperature and pressure (STP) means 273 °K and 1 atm.

5.9 Boyle's Law

- If the temperature and amount of a gas are held constant, then the volume of a gas will be inversely proportional to its pressure.

$$\mathbf{P} \uparrow \mathbf{V} \downarrow \text{ and } \mathbf{P} \downarrow \mathbf{V} \uparrow \tag{5.2}$$

5.9.1 Boyle's Law Mathematically

Since volume and pressure are inversely proportional to each other, then the mathematical relationship would be:

$$V = \frac{k}{P} \text{ or } PV = k \text{ where } k \text{ is a constant.}$$