Gasses

After solutions the next most common reaction medium is the gas phase. To understand how gasses behave we need to understand pressure.

The first device to measure pressure was developed in 1643 by Italian chemist Evangelista Torricelli. The barometer was a glass tube filled with mercury and inverted in a dish of mercury.

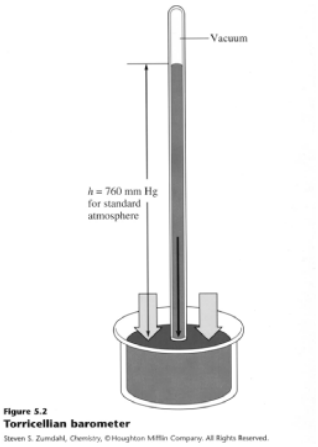

Figure 5.2
Torricellian barometer

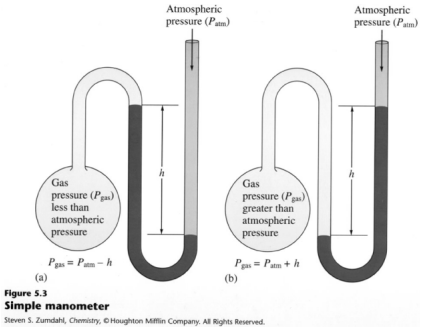

Figure 5.3
Simple manometer

A similar devices called a manometer is used to measure the pressure of a gas in relative to atmospheric pressure.

The most common unit for measuring pressure is the mmHg (millimeters of mercury). That is the height of the mercury column from the barometer. This unit is also called a torr in honor of Torricelli. The other two units used are, the standard atmosphere(atm), and the pascal(Pa).

$$1\text{ atm} = 760\text{ mmHg} = 760\text{ torr} = 101,325\text{ Pa}$$

Ex:

Gas Laws

There are three empirical laws that are used to describe gas behavior:

Boyle's law- Robert Boyle studied the relationship between pressure and the volume of a gas in the mid 17th century.

Boyle found that there is an inverse relationship between the volume of a gas and the pressure it is under. $PV = k$

$$1.00\text{atm} \cdot \text{V}_1 = 5.25\text{atm} \cdot 10.0\text{L}$$

$$\text{V}_1 = \frac{5.25\text{atm} \cdot 10.0\text{L}}{1.00\text{atm}}$$

$$\text{V}_1 = 52.5\text{L}$$

Charles's law- Jacques Charles studied the relationship between volume and temperature in the mid 18th century.

Charles found that there was a direct relationship between the temperature and volume of a gas. $V = bT$

$$\frac{1.00\text{atm}\cdot\text{V}_1}{298\text{K}} = \frac{5.25\text{atm}\cdot10.0\text{L}}{273\text{K}}$$

$$\text{V}_1 = \frac{5.25\text{atm}\cdot10.0\text{L}\cdot298\text{K}}{273\text{K}\cdot1.00\text{atm}}$$

$$\text{V}_1 = 57.3\text{L}$$

Avogadro's law- Avogadro postulate in the early 19th century that there was a relationship between the volume of a gas and the number of particles.

Avogadro's law states that there is a direct relationship between the number of particles and the volume of a gas. $V = an$

$$\frac{1.00\text{atm}\cdot\text{V}_1}{298\text{K}\cdot2.54\text{mol}} = \frac{5.25\text{atm}\cdot10.0\text{L}}{273\text{K}\cdot2.34\text{mol}}$$

$$\text{V}_1 = \frac{5.25\text{atm}\cdot10.0\text{L}\cdot298\text{K}\cdot2.54\text{mol}}{273\text{K}\cdot2.34\text{mol}\cdot1.00\text{atm}}$$

$$\text{V}_1 = 62.2\text{L}$$

Ex:

We can combine all of these equations in to one, the ideal gas law. $PV = nRT$

$$\mathrm{P} \cdot 10.5\mathrm{L} = 3.50\mathrm{mol} \cdot 0.0821 \frac{\mathrm{atm\ L}}{\mathrm{mol\ K}} \cdot 308\mathrm{K}$$

$$\mathrm{P} = \frac{3.50\mathrm{mol} \cdot 0.0821 \frac{\mathrm{atm\ L}}{\mathrm{mol\ K}} \cdot 308\mathrm{K}}{10.5\mathrm{L}}$$

$$\mathrm{P} = 8.43\mathrm{atm}$$

Ex: