Homework Assignments:

- Reopened Chapter 4 HW and due next Monday, October 1st at11:55 pm

The Ideal Gas Law

Ideal Gas Law: $\boxed{PV = nRT}$

R is the universal gas constant and same for all gases

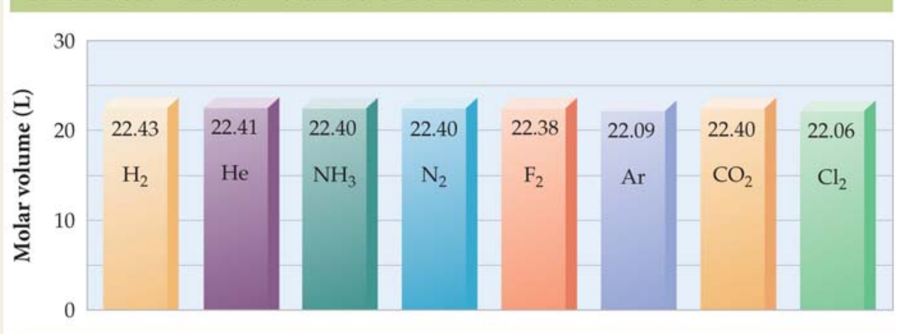
R = 0.08206 L atm mol^{-1} K^{-1}; used in most gas equations
R = 8.314 J mol^{-1} K^{-1}; used in equations involving energy

Standard Temperature and Pressure (STP) for Gases
$\left\{ \begin{array}{l} T = 0^\circ \text{ C (273.15 K)} \\ P = 1 \text{ atm} \end{array} \right.$

- What is the volume of 1 mol of gas at STP? (Standard molar volume)

$$V = \frac{nRT}{P} = \frac{(1\ \text{mol})\left(0.08206\,\dfrac{\text{L atm}}{\text{K mol}}\right)(273.15\ \text{K})}{(1\ \text{atm})} = 22.41\ \text{L}$$

TABLE 9.4 Molar Volumes of Some Real Gases at 0 °C and 1 atm



- All real gases are non ideal to some extent and deviate slightly from the behavior predicted by the gas laws.

Example Problem

3) A sample of C_2H_6 gas has a volume of 575 cm^3 at 752 torr and 72° F
   - What is the mass of ethane in this sample?

$$T = (72 - 32) \times 5/9 = 22°C = 295\ K$$
$$V = 575\ cm^3 = 575\ mL = 0.575\ L$$

For P, we will leave the value in torr and choose the corresponding value for R. We could also convert from torr to atm, of course.

$$n = \frac{PV}{RT} = \frac{(752\ torr)\ (0.575\ L)}{(62.37\ L\ torr\ mol^{-1}\ K^{-1})\ (295\ K)} = 0.0235\ mol$$

The gas in our sample is C_2H_6, with a molar mass of 30.070 g/mol, so

$$0.0235\ mol \times \frac{30.070\ g}{mol} = 0.707\ g\ C_2H_6$$

Stoichiometric Relationships with Gases

(1) How many liters of N_2 at 1.15 atm and 30.0 ° C are produced by decomposition of 45.0 g NaN_3 (sodium azide)? (Molar mass of NaN_3 = 65.010 g/mol)

$$2\ NaN_3(s) \longrightarrow 2\ Na(s) + 3\ N_2(g)$$

Stoichiometric Relationships with Gases

$$2\ NaN_3(s) \longrightarrow 2\ Na(s) + 3\ N_2(g)$$

Moles of N_2 produced:

$$\frac{45.0\ g}{65.010\ g/mol} \times \frac{3\ mol\ N_2}{2\ mol\ NaN_3} = 1.04\ mol$$

Volume of N_2 produced:

$$V = \frac{nRT}{P} = \frac{(1.04\ mol)\left(0.082\ 06\ \dfrac{L\ atm}{K\ mol}\right)(303\ K)}{(1.15\ atm)} = 22.5\ L$$