HW 14 – February 6.

The mole, molar gas volume, Clapeyron-Mendeleev equation

- To calculate masses of products and reactants using *balanced* chemical equations we use a unit called **mole**. One mole of a substance is the amount whose mass equals the molecular or atomic weight (in atomic mass units, amu) of the substance **expressed in grams**. This means that molecular weight of any substance in amu (from periodic table) is equal to molar weight in grams.
- An example of stoichiometry calculations
  Calculate how many grams of water and sulfur trioxide is needed to produce 100g of sulfuric acid according to the following chemical reaction:

$$SO_3 + H_2O \rightarrow H_2SO_3$$

	SO_3	H_2O	H_2SO_3
Molecular weight	80	18	98
Molar weight (g/mole)	80	18	98
Coefficients (moles reacting)	1	1	1
Known	?	?	100g
Number of moles to obtain the product and needed of reagents	1.02	1.02	100/98 = 1.02
Mass needed (g)	1.02(mole)x80(g/mole)=81.6(g)	1.02(mole)x18(g/mole)=18.36 (g)	

- If you need to calculate the volume of SO_3 gas needed you should remember that 1 mole of each gas takes 22.4 L. Then 1.02 moles will take 1.02x22.4 = 22.85L
- If the coefficients of the reactions were different from 1 you would have to calculate the number of moles of the reagents needed for the number of moles of the product using the reaction coefficients. For example, in the following reaction of S and O_2 2 moles of S react with 3 moles of O_2 to produce 2 moles of SO_3. In this case to obtain 1 mole of SO_3 you would need 1 mole of S and 3/2 moles of O_2.

$$2S + 3O_2 \rightarrow 2SO_3$$

- *A mole of anything has 6.022 x 10^{23} particles*. This is called Avogadro's number, after Amedeo Avogadro, who first suggested that equal volumes of gas have equal numbers of molecules.
- 1 mole of any gas takes a volume of 22.4 liters at "normal conditions ". This is a molar gas volume under the normal conditions. Normal conditions are temperature of 0^{o}C (273 K) and pressure of 1 atm (101 325 Pa)

- For conditions that differ from normal we use Clapeyron-Mendeleev equation:
  pV = nRT
  n – gas mole number
  p – gas pressure (atm)
  V – gas volume (liters)
  T – temperature (K)
  R – gas constant (0.0821 l x atm/mole x K)

1. Determine the molar mass of a gaseous compound of oxygen and nitrogen with a density of 1.34 g/L under normal conditions. What is its molecular formula?
2. A steel container with the volume of 40 L is filled with hydrogen under a pressure of 60 atm and at a temperature of 25^{o}C. How many moles of hydrogen are in the container? How many grams? What volume this hydrogen will take under normal conditions? (Remember to convert temperature from Celsius to Kelvin)
3. Methanol is combusted according to the balanced chemical equation below. How many grams of oxygen are required to react with 45 g of methanol?

$$2\ CH_3OH + 3\ O_2 \rightarrow 2\ CO_2 + 4\ H_2O$$