HW February 12, 2023

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.
- *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°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)

Redox chemical reactions can be balances by looking at the transfer of electrons:

$Al + O_2 \rightarrow Al_2O_3$

$Al - 3e \rightarrow Al^{+3}$ 4

$O_2 + 4e \rightarrow 2O^{-2}$ 3

$4Al + 3O_2 \rightarrow 2Al_2O_3$

1. Insert the missing equation coefficients:

? Mg + O_2 = 2MgO

? Fe + 3 Cl_2 = ?$FeCl_3$

? Al + ? S = Al_2S_3

? Cu + ? O_2 = ?CuO

P + N_2O = N_2 + P_2O_5 (use the electron balance and show your work)

$NH_3 + O_2 = NO + H_2O$ (use electron balance and show your work)

2. What number of moles of Cr (52 amu) is in 20.8 g of this metal?
3. What is the mass of $6.02x10^{23}$ molecules of methane CH_4?
4. 4 g of hydrogen (H_2) were mixed with 64 g of oxygen (O_2). The mixture exploded forming water (H_2O). Write down the equation of the chemical reaction. Balance it! How many grams of water did form? How many grams of oxygen remained unreacted?
5. Write down a reaction between magnesium and oxygen with the formation of magnesium oxide. How many grams of magnesium and how many liters of oxygen will be necessary to obtain 50 g of magnesium oxide?
6. There are 180 g of water in a glass. How many molecules are there? How many moles?
7. 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°C. How many moles of hydrogen are in the container? How many grams? What volume this hydrogen will take under normal conditions?