HW 18

Molar gas volume, ideal gas equation

- *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^oC (273 K) and pressure of 1 atm (101 325 Pa)
- For conditions that differ from normal we use ideal gas 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)

- The density of gas is given by the equation d = pM/RT

  p – gas pressure, 1 atm at standard conditions
  M – molar mass, g/mol
  R – gas constant
  T – temperature, 273 K at standard conditions

Ideal Gas Equation is

$PV = nRT$ n = no. of moles

$P \times V = \frac{mass}{molar\,mass} \times R \times T$ $n = \frac{weight/mass}{molar\,mass}$.

Let molar mass = M
mass = m.

$\Rightarrow P \times V = \frac{m}{M} \times R \times T$

$\Rightarrow M = \frac{m \times R \times T}{P \times V}$

we know that density $= \frac{mass}{Volume} = \frac{m}{V}$ $\therefore d = \frac{m}{V}$

Substitute the value $\frac{m}{V}$ with d

$\therefore \boxed{M = \frac{d \times R \times T}{P}}$

- **Calculations involving moles and masses**

a) The coefficients in the chemical reaction tell us the molar ratio of reactants and products.

b) Work out the number of moles of anything you can.

c) Convert moles to the required quantity: mass, volumes, etc.

d) if we have one reactant in excess, we generally do not use its mass to figure out the masses of products in the reaction. Use the limiting reactant to determine the mass of products in the reaction (if you need to find the limiting reactant, divide the number of moles of each reactant by its coefficient. The lowest number will give you the limiting reactant).

$2H_2 + O_2 \rightarrow 2H_2O$ look at the coefficient, molar ratio H_2:O_2:H_2O - 2:1:2

If we want the hydrogen and oxygen to react with each other completely and exactly we need to figure out the masses of H_2 and O_2 that correspond to the given ratio (2:1)

	H_2	O_2	H_2O
moles	2	1	2
Masses,g	$2molx2gmol^{-1}=4g$	$1molx32gmol^{-1}=64g$	$2molx18gmol^{-1}=36g$
moles	20	10	20
Masses,g	40	320	360
moles	0.2	0.1	0.2
Masses,g	0.4	0.32	0.36

Remember, number of moles=mass/molar mass

Questions

1. 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. How many grams of water did form? How many grams of oxygen remained unreacted?
2. There are 180 g of water in a glass. How many molecules are there? How many moles?
3. A gas has a density of 3.17 g/L under normal conditions. What is its molar mass and molecular weight? What is the gas? Write down its formular using periodic table of elements. Hint: it has two identical atoms in a molecule.