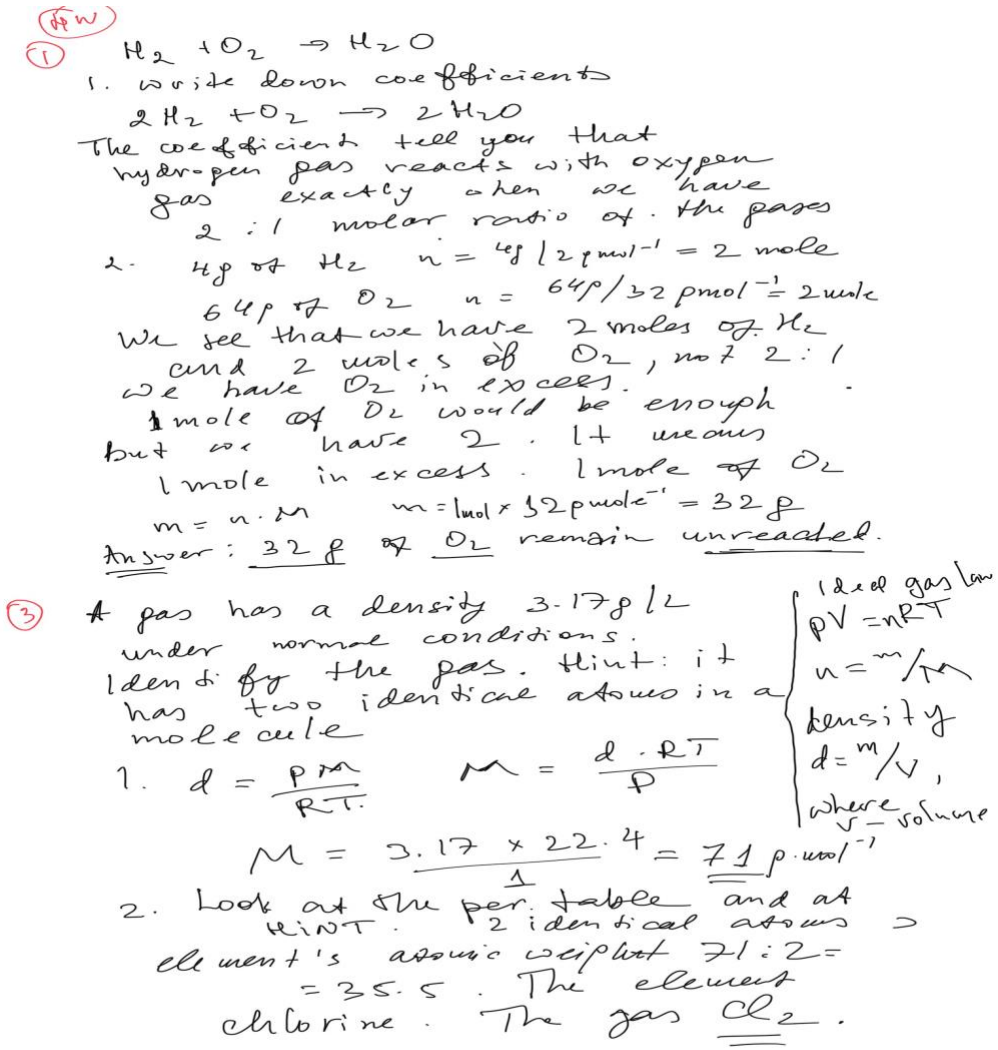
HW19 **Calculations involving moles, masses and volumes of gases.**

- 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 the 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)

Worked examples from the previous homework and from the class (also look at the notes from the previous homework HW18):



(1) $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

If 1 L of oxygen reacts with 0.3 L of methane how much oxygen (O_2) will be left at the end of the reaction.

1. We have our coefficients at place, so we can tell that molar ratio of CH_4 and O_2 is 1 to 2

2. We have 0.3 L of CH_4 and 1 L of O_2. From the molar ration we know that we need only twice as much O_2 to completely react with CH_4. It means we need $0.3\,L \times 2 = 0.6\,L$ of O_2

3. At the beginning we had 1 L of O_2. $1\,L - 0.6\,L = 0.4\,L$ of O_2 remained.

(2) We have standart conditions Calculate the volume of CO_2 produced when 10 g of calcium carbonate decomposes

$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

1. We have 10 g of $CaCO_3$. We can calculate the number of moles. $n = m/M$

$n = 10\,g / 100\ g\,mol^{-1}$

$n = 0.1$ mol

M of $CaCO_3$ = 100 $g\,mol^{-1}$

Ca - 40

O = 16 x 3 = 48

C - 12

10 g of $CaCO_3$ has 0.1 moles

2. Look at the coefficient in the chemical equation. Molar ration of $CaCO_3 : CO_2$ 1 : 1. It means if we have 0.1 mol of $CaCO_3$, we will end up with 0.1 mol of CO_2

3. Convert moles to volume. Remember 22.4 L will have 1 mole of any gas. It means 2.24 L will have 0.1 mole.

The answer: 10 g of $CaCO_3$ will produce 2.24 L of CO_2.

Questions:

1. Propene undergoes combustion

   $C_3H_6 + O_2 \rightarrow CO_2 + H_2O$

   Find equation coefficients. Find the volume of carbon dioxide produced when 0.36 L of propene react with 0.36 L of oxygen at 273K and 100 kPa pressure?

2. An explosion took place because of the following two reactions:

$Na + H_2O = H_2 + NaOH$

$2H_2 + O_2 = 2\ H_2O$ (explosion)

Find equation coefficients for the first equation and calculate how much (by volume) hydrogen exploded if 2.3 g of Na reacted.

3. We have a flask with a volume of 5.6 L. The flask is kept at 0 degrees C, we mix 36.5 grams of HCl and 7.1 grams of Cl_2 and 3.4 grams of NH_3. A reaction occurs in the flask:

$HCl\ (g) + NH_3\ (g) \rightarrow NH_4Cl\ (s)$

The product of the reaction NH_4Cl is in crystal form.

Figure out the atmospheric pressure inside of the flask.