HW17 Stoichiometric relationships – study of the ratios in which chemical substances combine.

The number of moles present in the certain mass of a substance can be figured out using the following equation

Number of moles (n) = mass of substance/ molar mass

$n = m/M$

Molar mass numerically equal to molecular mass (M_r), but Molar mass has its own units. The unit for M (molar mass) is g/mol or $gmol^{-1}$

Mass of substance (m) must be in grams.

The units for moles is mol.

Consider sulfur, if A_r of S is 32.06

Molar mass of sulfur 32.06 $gmol^{-1}$

This means 32.06 g of S contains $6.02x10^{23}$ sulfur atoms or 1 mole of sulfur.

- 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:

$SO_3 + H_2O \rightarrow H_2SO_4$

	SO_3	H_2O	H_2SO_4
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 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.

  $2S + 3O_2 \rightarrow 2SO_3$

- **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 mass.

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 (the one that is not in excess) 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. Write down the total number of hydrogen atoms in each of the following

a) 1.00 mol H_2
b) 0.200 mol CH_4
c) 0.0500 mol NH_3

2. How many moles of hydrogen gas are produced when 0.4 mol of sodium react with excess of water

   $2Na + 2H_2O \rightarrow 2NaOH + H_2$

3. How many moles of O_2 react with 0.01 mol C_3H_8?

   $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

4. Calculate the mass of arsenic(III) chloride produced when 0.15 g of arsenic reacts with excess chlorine

   $2As + 3Cl_2 \rightarrow 2AsCl_3$