HW 22

Calculations using chemical formulas and chemical equations

Example 1.

How many liters of SO_3 (gas) and grams of water will be required to produce 100g of sulfuric acid according to the following reaction:

$$SO_3 + H_2O = H_2SO_4$$

Let's write down this chemical equation with all the known information:

Equation	SO_3 +	H_2O =	H_2SO_4
Molecular weight	80	18	98
Molar weight	80 g/mole	18 g/mole	98 g/mole
Molar ratio	1 mole	1 mole	1 mole
What is known	? L of gas	? g of water	100 g (1.02 moles)

100 g of H_2SO_4 is 1.02 moles (100g/98g/mole = 1.02 moles H_2SO_4). This means that we will need 1.02 moles of SO_3 (1 mole of the gas makes 1 mole of the acid, so 1.02 moles of the gas will make 1.02 moles of the acid). 1.02 moles will take the volume of 1.02 moles x 22.4 L/mole = 22.85 L.

We will also need 1.02 moles of water or 1.02 moles x 18 g/mole = 18.4 g of water.

Example 2. Let's make it more complicated – if there is no SO_3 but only sulfur and oxygen. How much S and O_2 will be required to obtain 100 g of H_2SO_4?

$$2S + 3O_2 = 2SO_3$$

It will be easier if we divide both parts of the equation by 2 so we will have only 1 mole of SO_3 in the right part of the equation:

Equation	S +	3/2 O_2 =	SO_3
Molecular weight	32	32	80
Molar weight	32 g/mole	32 g/mole	80 g/mole
Molar ratio	1 mole	3/2 mole	1 mole
What is known	? g	? L of gas	22.85L (1.02 moles)

It is clear from the chemical equation that we will need 1.02 moles of S or 1.02 moles x 32 g/mole = 32.6 g.

On the other hand, we will need 3/2 x 1.02 moles = 1.53 moles of oxygen. This number of moles will take up 1.53 moles x 22.4 L/moles = 34.27 L of O_2.

Questions:

1. To obtain NaCl 0.1 mole of NaOH and 0.3 moles of HCl were mixed. Which of the reagents will remain (in excess) and how many moles of it will remain? The chemical equation is:

$$NaOH + HCl = NaCl + H_2O$$

2. Glucose is oxidized by a body according to the following chemical equation:

$$C_6H_{12}O_6 + 6O_2 = 6CO_2 + 6H_2O$$

   2.1. How many moles of CO_2 forms from each mole of glucose?
   2.2. How many moles of oxygen is required to oxidize each mole of glucose?
   2.3. How many liters of oxygen is required to oxidize each mole of glucose?
   2.4. How many liters of CO_2 forms from oxidation of 276 g of glucose?
   2.5. How many grams of water forms from oxidation of 552 g of glucose?

3. Aluminum can be oxidized by oxygen according to the following chemical equation:

$$4Al + 3O_2 = 2Al_2O_3$$

   3.1. How many moles of Al_2O_3 forms from each mole of Al?
   3.2. How many grams of oxygen is needed to oxidize 54 g of Al?
   3.3. How many moles of oxygen is needed to oxidize each mole of Al?
   3.4. How many liters of oxygen is needed to oxidize 54 g of Al?
   3.5. How many grams of Al_2O_3 forms from 54 grams of Al?