Cosmo School

Chemistry

Class-10

Chapter-6

Concept of Mole and Chemical counting

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Revision Work sheet -3

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Unit-1: Stoichiometry

Stoichiometry measures the quantitative relationships between reactants and products in a chemical equation. It is used to determine the amount of products and reactants that are produced or needed in a given reaction. Describing the quantitative relationships among substances as they participate in chemical reactions is known as reaction stoichiometry.

The information that can be gathered regarding mole from a balanced chemical equation is the stoichiometry of that reaction. Using the concept of mole, we can convert anything from the level of atoms and molecules to the level of grams and kilograms.

Exercise-1:

1. What is stoichiometry?
2. Concept of mole is the main basis of stoichiometry-explain shortly.

Unit-2: Writing a chemical reaction as a chemical equation

Let's consider a simple chemical reaction—

Nitrogen gas reacts with hydrogen gas to produce ammonia gas.

$$N_2(g) \quad + \quad H_2(g) \quad \rightarrow \quad NH_3(g)$$

This reaction is written as an equation, in which the reactants combine on the left to yield the product on the right. During a reaction bonds are broken in reactant molecules and new bonds are formed in product. But the number of atoms of each element remains the same. That means the reaction follows the conservation of mass.

When writing a chemical reaction as an equation, the number of atoms of each element has to be exactly the same on the both sides of reaction. This is known as equation balancing.

Exercise-2.1:

1. Why balancing of chemical equation is important for stoichiometric analysis?

For stoichiometry balancing of chemical equation is very important. It is very useful for understanding the proportions of chemical substances as these react at a molecular level. But in practically we cannot deal with atoms and molecules.

But in a lab, or in industry, or in our lives, we have to work with measurable amounts of substances. We have to use chemicals by measuring with real scale (gram, kilogram scale etc,).

So, we have to need applying the stoichiometric concept to calculate specific masses of the reactants and products.

Exercise-2.2:

1. How can you analyze the significance of using stoichiometric concept?

Unit-3: Calculations considering mole concept in stoichiometry

Let's consider a simple chemical reaction—

Nitrogen gas reacts with hydrogen gas to produce ammonia gas.

$$N_2(g) + H_2(g) \rightarrow NH_3(g)$$

This equation is not balanced. So, we have to add necessary coefficients in front of molecules.

$$N_2(g) + 3\,H_2(g) \rightarrow 2NH_3(g)$$

Ratio: 1 : 3 : 2

And the coefficients can represent –

a) A specific amount of each substances
b) Ratio of reactants and products in the reaction

Coefficients tell us how many particles or molecules are reacting in the reaction and how many particles or molecules will be produced.

That means, in the above reaction 1 molecule of nitrogen reacts with 3 molecules of hydrogen to produce 2 molecules of ammonia. And the ratio of reactants and product is $N_2 : H_2 : NH_3 = 1:3:2$

So, for this reaction it will be always reacting in 1:3:2 ratio; no matter how many molecules of each reactants and products we have.

And coefficients are constant for any one particular chemical equation.

Exercise-3:

1. Find out the information for the following two reactions that are called the stoichiometry of the reactions.
   a) $2Mg\ (s) + O_2(g) \rightarrow 2\ MgO(s)$
   b) $H_2\ (g) + Cl_2(g) \rightarrow 2\ HCl\ (g)$
2. How many moles of O_2 id necessary to produce 6 moles of water?
3. How much NH_3 in liter will be formed out of 4 liter N_2 at standard temperature and pressure?
4. How many grams of magnesium oxide will be produced if we put the necessary amount of oxygen with 2 grams magnesium metal?

Unit-4: Limiting reactant

When we react two substances, it's essentially impossible to have them in precisely the correct amounts for both of them to react completely. One of them will be the reactant in excess and other one of them will be the limiting reactant. The limiting reactant is the one that runs out first which makes reacting further impossible. The other reactant will then be in excess because there will be some left over. In order to identify which is the limiting reactant, we have to see which quantity will limit the reaction stoichiometrically and it won't automatically be the substance that is present in the lesser amount. Limiting reactant is not the reactant we have the least of. Instead, it is the first reactant to run out during the reaction. So, the total amount of product that we can make is completely dependent on the amount of limiting reactant. Limiting reactant produces the least amount of product.

Limiting reactant is the first reactant that is used up in a reaction. When the limiting reactant is all used up, no more product can form, and the reaction stops.

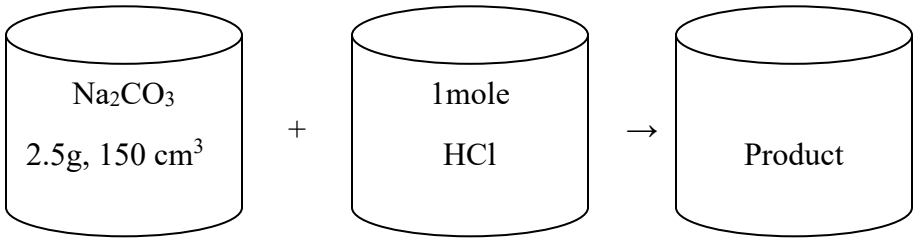
Excess reactant is what is left over after the reaction stops because the limiting reactant got all used up.

Theoretical yield is whatever the limiting reactant actually produces.

Exercise-4:

1. What is limiting reactant and excess reactant?
2. 75 g chlorine gas is mixed with 5 g hydrogen gas. Which is the limiting reactant here? How much of which reactant will be left over at the end of the reaction? What will be the theoretical yield of HCl?/ Calculate the amount of product in the reaction.
3. To prepare 325 g of calcium chloride 120 g of calcium and 205 g of chlorine is mixed. Which one is the limiting reactant of the reaction?

4.



Identify limiting reactant of given reaction & calculate number of carbon dioxide that formed in given reaction.

Unit-5: Percent yield/ percentage of yield

An important real-life limitation of chemistry is that the amount of product we calculate that we should get is actually just the theoretical yield. This is the amount of product we calculate which we can expect, if every molecule of reactant converts into product. But in reality, this does not occur. When we work in a lab and do a chemical reaction and expect to get the amount of product from stoichiometric calculations from balanced chemical equation, we get the actual yield after doing experiment that less than theoretical yield.

The reactants or chemical substances used in reactions are not 100% pure. The purest chemical substances or reactants which are 99% pure called analar. When the reactant is not 100% pure, the reaction does not yield the amount of product that is calculated from the amount of limiting reactant. Sometime this happens because of different types of error such as random error, systematic error and personal error.

The actual yield will always be some fraction of theoretical yield which called the percent yield.

$$\frac{\textbf{\textit{Amount of product obtained from reaction}}(\textbf{\textit{Actual yield}})}{\textbf{\textit{Calculated amount of product from reaction}}\ (\textbf{\textit{Theoretical yield}})} \times 100 = \%\ \text{yield}$$

Percent yield is an important measure of the efficiency of a chemical reaction and is very useful in planning any synthesis of compound.

Exercise-5:

1. What is analar?
2. If 39g CaO is obtained by heating 80g $CaCO_3$, calculate the percent amount of the product.