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If you feel any inconvenience regarding these online calculators, feel free to Contact Us. Increase your mathematical productivity with the Calculator Online, your best companion in mathematics. Mapping based Best Questions (Indian Geography)Starting Soon The limiting reactant calculator works to calculate the limiting reactant in a chemical reaction. It balances the chemical equation and shows the reactants and products along with their coefficients. Then, by adding values of reactants, itidentifies the limiting reagent that is completely consumed and the maximum amount of product that can be formed based on the limitations. What Is A Limiting Reactant? In a chemical reaction, the limiting reactant is the reactant that gets completely consumed, limiting the amount of final product (also called yield) that can be formed. The limiting reactant can be determined with the help of the stoichiometry of the balanced chemical equation. A stoichiometry refers to the balanced chemical equation that indicates the relative ratios of reactants required to react completely and to form the product. How To Find Limiting Reactant? 1. Balance The Chemical Equation: It is necessary to have a balanced chemical equation for the reaction. A balanced equation contains the reactants (starting materials) on the left side and the products (formed substances) on the right side, with coefficients showing their quantities. You must balance your chemical reaction to highlight the limiting reactant before going further. For example, in an equation like: H2 + O2 =H2O Balanced Equation: 2 H2 + O2 -> 2 H2O. 2. Identify Mole Ratios: The coefficients in the balanced equation represent the mole ratios of reactants and the products that are formed. In the above example, the mole ratio of H2 to O2 is 2:1, meaning 2 moles of H2 react with 1 mole of O2 to form 2 moles of H2O. 3. Convert Quantities to moles: If you have information about the initial amounts of reactants (mass, volume), you can convert them to moles using their molar masses or molar volumes (for gases). This allows you to compare them directly using mole ratios. 4. Compare Reactant Quantities (or Mole Ratios): Without Initial Quantities: Compare the mole ratios, the reactant that has the smallest ratio is called the limiting reactant. With Initial Quantities: Divide the amount (in moles) of each reactant by its mole ratio from the balanced equation. The reactant that has the smallest result after division is the limiting reactant. Example: Let's suppose, you react propane (C3H8) and oxygen (O2) to produce carbon dioxide (CO2) and water (H2O), given 5 moles of propane and 8 moles of oxygen. Now find the limiting reactant and the amount of CO2 produced. Solution: Step #1: Balanced Chemical Equation The balanced chemical equation for this reaction is: C3H8 + 5O2 -> 3CO2 + 4H2O It shows that 1 mole of Propane (C3H8) reacts with 5 moles of Oxygen (O2) to produce 3 moles of Carbon Dioxide (CO2) and 4 moles of Water (H2O). Step #2: Mole Ratios Propane (C3H8) to Oxygen (O2) = 1:5 (1 mole C3H8 reacts with 5 moles O2) Propane (C3H8) to Carbon Dioxide (CO2) = 1:3 (1 mole C3H8 produces 3 moles CO2) Step #3: Convert Quantities to Moles We are given the initial quantities of the reactants in moles: Propane (C3H8): 5 moles Oxygen (O2): 8 moles Step #4: Compare Reactant Ratios Divide the initial moles of each reactant by its corresponding mole ratios: Propane (C3H8): Moles (ratio to O2) Propane (C3H8) = 5 moles Oxygen (O2): Moles (ratio to C3H8) Oxygen (O2): 8 5 Oxygen (O2) = 1.6 moles Analyze The Results: If all the Propane (4 moles) is used based on its mole ratio, it will require 5 moles x 5 (ratio) = 25 moles of Oxygen. But we only have 8 moles of Oxygen which will be used up before all the Propane reacts. Limiting Reagent = Oxygen (O2) Apart from these steps, the limiting reactant finding process can be automated with the use of our limiting reactant calculator. Why Limiting Reactants Important? Predicting Product Yield: By identifying the limiting reactant, you can calculate the theoretical yield, which is the maximum amount of product that can be formed based on the available limiting reactant. It is very useful in planning experiments and optimizing processes Optimizing Reactions: Knowing the limiting reactant allows you to use your starting materials more efficiently. You can adjust the initial quantities of reactants to minimize waste and maximize the desired product Understanding Reaction Stoichiometry: Limiting reactants help you bridge the gap between the balanced chemical equation (theoretical) and a real-world reaction (practical). For instance, you have a specific amount of ingredients. Now with the help of limiting reactant, you can understand how many cookies you can bake even when you have an excess amount of some ingredients Environmental Chemistry: The limiting reactants help assess what limits the breakdown of pollutants in the environment. This knowledge is used to design strategies for remediation, like adding the missing element to accelerate the breakdown of a pollutant FAQs: Can There Be A Limiting Reagent If Only One Reactant Is Involved In The Reaction? No, there can be a limiting reactant if only one reactant is involved in the chemical reaction. The limiting reactant is the situation where multiple reactants are involved in a reaction. What Is The Limiting Reactant Used To Calculate? The limiting reactant is used to find the amount of product that can be obtained from a reactions which are involved in a specific quantity. Is Limiting Reactant Always The Same For Given Chemical Reaction? Yes, for a specific reaction where the initial reactants are given, the limiting reactant will remain the same. You can use the limiting reagent calculator to analyze the reaction by identifying the limiting reactant. References: From the source of Wikipedia: Limiting reagents, Comparison, Comparison of product amounts. From the source of Khan Academy: Limiting reactant, Reaction yields, Stoichiometry. From the source of Lumen Learning: Limiting Reagents, Chemical Reactions. Chemical reactant totally consumed when the reaction is finishedThis article needs additional citations for verification. Please help improve this article by adding citations to reliable sources. Unsourced material may be challenged and removed.Find sources:"Limiting reagent"news newspapers books scholar JSTOR (June 2015) (Learn how and when to remove this message)Equal masses of iron (Fe) and sulfur (S) react to form iron sulfide (FeS), but because of its higher atomic weight, iron is the limiting reagent and once all the iron is consumed some sulfur remains unreactedThe limiting reagent (or limiting reactant or limiting agent) in a chemical reaction is a reactant that is totally consumed when the chemical reaction is completed.[1][2] The amount of product formed is limited by this reagent, since the reaction cannot continue without it. If one or more other reagents are present in excess of the quantities required to react with the limiting reagent, they are described as excess reagents or excess reactants (sometimes abbreviated as "xs"), or to be in abundance.[3]The limiting reagent must be identified in order to calculate the percentage yield of a reaction since the theoretical yield is defined as the amount of product obtained when the limiting reagent reacts completely. Given the balanced chemical equation, which describes the reaction, there are several equivalent ways to identify the limiting reagent and evaluate the excess quantities of other reagents.This method is most useful when there are only two reactants. One reactant (A) is chosen, and the balanced chemical equation is used to determine the amount of the other reactant (B) necessary to react with A. If the amount of B actually present exceeds the amount required, then B is in excess and A is the limiting reagent. If the amount of B present is less than required, then B is the limiting reagent.Consider the combustion of benzene, represented by the following chemical equation: 2 C 6 H 6 (l) + 15 O 2 (g) 12 CO 2 (g) + 6 H 2 O (l) {\displaystyle {\ce {2 C6H6(l) + 15 O2(g) -> 12 CO2(g) + 6 H2O(l)}}} This means that 15 moles of molecular oxygen (O2) is required to react with 2 moles of benzene (C6H6)The amount of oxygen required for other quantities of benzene can be calculated using cross-multiplication (the rule of three). For example,if 1.5mol C6H6 is present, 11.25mol O2 is required: 1.5 mol C 6 H 6 15 mol O 2 2 mol C 6 H 6 = 11.25 mol O 2 {\displaystyle 1.5\ {\ce {mol\,C6H6}}\times {\frac {15\ {\ce {mol\,O2}}}{2\ {\ce {mol\,C6H6}}}}=11.25\ {\ce {mol\,O2}}} If in fact 18mol O2 are present, there will be an excess of (18 - 11.25) = 6.75mol of unreacted oxygen when all the benzene is consumed. Benzene is then the limiting reagent.This conclusion can be verified by comparing the mole ratio of O2 and C6H6 required by the balanced equation with the mole ratio actually present:required: mol O 2 mol C 6 H 6 = 15 mol O 2 2 mol C 6 H 6 = 7.5 mol O 2 {\displaystyle {\frac {\ce {mol\,O2}}{\ce {mol\,C6H6}}}={\frac {15\ {\ce {mol\,O2}}}{2\ {\ce {mol\,C6H6}}}}=7.5\ {\ce {mol\,O2}}} actual: mol O 2 mol C 6 H 6 = 18 mol O 2 1.5 mol C 6 H 6 = 12 mol O 2 {\displaystyle {\frac {\ce {mol\,O2}}{\ce {mol\,C6H6}}}={\frac {18\ {\ce {mol\,O2}}}{1.5\ {\ce {mol\,C6H6}}}}=12\ {\ce {mol\,O2}}} Since the actual ratio is larger than required, O2 is the reagent in excess, which confirms that benzene is the limiting reagent.In this method the chemical equation is used to calculate the amount of one product which can be formed from each reactant in the amount present. The limiting reactant is the one which can form the smallest amount of the product considered. This method can be extended to any number of reactants more easily than the first method.20.0 g of iron (III) oxide (Fe2O3) are reacted with 8.00 g aluminium (Al) in the following thermite reaction: Fe 2 O 3 (s) + 2 Al (s) 2 Fe (l) + Al 2 O 3 (s) {\displaystyle {\ce {Fe2O3(s) + 2 Al(s) -> 2 Fe(l) + Al2O3(s)}}} Since the reactant amounts are given in grams, they must be first converted into moles for comparison with the chemical equation, in order to determine how many moles of Fe can be produced from either reactant.Moles of Fe which can be produced from reactant Fe2O3 mol Fe 2 O 3 = grams Fe 2 O 3 g / mol Fe 2 O 3 = 20.0 g 159.7 g / mol = 0.125 mol {\displaystyle {\begin{aligned}{\ce {mol~Fe2O3}}&={\frac {\ce {grams~Fe2O3}}{\ce {g/mol~Fe2O3}}}\\&={\frac {20.0~{\ce {g}}}{159.7~{\ce {g/mol}}}}=0.125~{\ce {mol}}\end{aligned}}} mol Fe = 0.125 mol Fe 2 O 3 2 mol Fe 1 mol Fe 2 O 3 = 0.250 mol Fe {\displaystyle {\ce {mol~Fe}}=0.125~{\ce {mol~Fe2O3}}\times {\frac {\ce {2~mol~Fe}}{\ce {1~mol~Fe2O3}}}=0.250~{\ce {mol~Fe}}} Moles of Fe which can be produced from reactant Al mol Al = grams Al g / mol Al = 8.00 g 26.98 g / mol = 0.297 mol {\displaystyle {\begin{aligned}{\ce {mol~Al}}&={\frac {\ce {grams~Al}}{\ce {g/mol~Al}}}\\&={\frac {8.00~{\ce {g}}}{26.98~{\ce {g/mol}}}}=0.297~{\ce {mol}}\end{aligned}}} mol Fe = 0.297 mol Al 2 mol Fe 2 mol Al = 0.297 mol Fe {\displaystyle {\ce {mol~Fe}}=0.297~{\ce {mol~Al}}\times {\frac {\ce {2~mol~Fe}}{\ce {2~mol~Al}}}=0.297~{\ce {mol~Fe}}} There is enough Al to produce 0.297mol Fe, but only enough Fe2O3 to produce 0.250mol Fe. This means that the amount of Fe actually produced is limited by the Fe2O3 present, which is therefore the limiting reagent.It can be seen from the example above that the amount of product (Fe) formed from each reagent X (Fe2O3 or Al) is proportional to the quantity Moles of Reagent X Stoichiometric Coefficient of Reagent X {\displaystyle {\frac {\mbox{Moles of Reagent X }}{\mbox{Stoichiometric Coefficient of Reagent X}}}} This suggests a shortcut which works for any number of reagents. Just calculate this formula for each reagent, and the reagent that has the lowest value of this formula is the limiting reagent. We can apply this shortcut in the above example.Limiting factor^ Olmsted, John; Williams, Gregory M. (1997). Chemistry: The Molecular Science. Jones & Bartlett Learning. p.163. ISBN0815184506.^ Zumdahl, Steven S. (2006). Chemical Principles (4thed.). New York: Houghton Mifflin Company. ISBN0-618-37206-7.^ Masterton, William L.; Hurley, Cecile N. (2008). Chemistry: Principles and Reactions (6ed.). Cengage Learning. ISBN978-0-495-12671-3.Retrieved from " CLASSES Study Material and Notes to learn the concept of Limiting Reagent with easy-to-understand examples and solved MCQs. Perfect for JEE, NEET, and Class 11 Chemistry students. Includes detailed explanations for conceptual clarity.A chemical reaction involves reactants turning into products. Example: $$\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$$In this reaction:Hydrogen (H) and Chlorine (Cl) are reactantsHydrogen chloride (HCl) is the productBut in real life, you may not always mix the exact amount of H and Cl as needed in the balanced equation. So, what happens then?That brings us to the concept of the limiting reagent.The limiting reagent (or limiting reactant) is the reactant that gets used up first in a chemical reaction, stopping the reaction from continuing and limiting the amount of product formed. Key Point:The limiting reagent determines the maximum amount of product that can be formed in a reaction.Because it limits or controls how much product can be made. Even if other reactants are present in excess, the reaction cannot proceed once the limiting reagent is consumed.Those are called excess reagents because they are not fully used up.Imagine youre making sandwiches Each sandwich requires:2 slices of bread1 slice of cheeseYou have:10 slices of bread3 slices of cheese How many sandwiches can you make?Lets calculate:10 slices of bread make 5 sandwiches (because 2 per sandwich)3 slices of cheese make 3 sandwichesSo, even though you have enough bread for 5 sandwiches, you can only make 3 sandwiches because cheese runs out first. Cheese is the limiting reagent. Bread is the excess reagent.Answer:It allows us to accurately calculate the amount of product that can be formed.It helps in preventing wastage of excess reactants.It is essential in industrial chemistry for cost-effective production.Answer:Follow these steps:Step 1: Write the balanced chemical equation.Make sure the equation is balanced with correct stoichiometric coefficients.Step 2: Convert the given quantities (mass or volume) into moles of each reactant.Step 3: Divide the number of moles of each reactant by their respective coefficients in the balanced equation.$$\text{Ratio} = \frac{\text{Given moles}}{\text{Stoichiometric coefficient}}$$Step 4: Compare the ratios. The smallest ratio indicates the limiting reagent.Answer:Example:For the reaction: $$\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$$Suppose we have: Step 1: Calculate molesMolar mass of N2 = 28 g/mol Moles = 28/28 = 1 molMolar mass of H2 = 2 g/mol Moles = 6/2 = 3 mol Step 2: Use the mole ratio from the balanced equation1 mol of N2 reacts with 3 moles of H2So we have:Required: 1 mol N2 : 3 mol H2Given: 1 mol N2 and 3 mol H2 Hence, both are in exact proportion no limiting reagent.But now, lets change the amount of hydrogen to 2 moles.Now:$\frac{1}{1}$ = 1 (for N)$\frac{2}{3}$ $= 0.6632=0.66 (for H)Since 0.66 is less than 1, Hydrogen (H) is the limiting reagent.Answer:An excess reagent is a reactant that is not completely used up in the reaction. It is present in more than the required amount, leading to the limiting reagent.Answer:The limiting reagent controls the amount of product formed. Once it is consumed, the reaction stops.ProductFormed Amountoflimitingreagent So, to calculate the theoretical yield of the product, we use the moles of the limiting reagent.Lets look at the reaction: $$\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$$Suppose we have:1 mol of H22 moles of Cl2Balanced Equation:$$\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$$The mole ratio is 1:1Given moles:According to the balanced equation, 1 mole of H needs 1 mole of ClSo 1 mole of H will react with 1 mole of Cl to form 2 moles of HCl. Whats left?H is completely used upCl still has 1 mole left excess So, Hydrogen (H) is the limiting reagent Product formed = 2 moles of HCl$$\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$$You have 1 mole of nitrogen gas and 2 moles of hydrogen gas. What is the limiting reagent?A. NitrogenB. HydrogenC. AmmoniaD. None of these Solution:From the balanced equation:1 mol N reacts with 3 mol HGiven:1 mol NOnly 2 mol H (less than 3 mol needed) Hydrogen is less than required it will be used up first Correct Answer: B. Hydrogen$$\text{Al} + 3\text{Cl}_2 \rightarrow 2\text{AlCl}_3$$If you start with 4 moles of Al and 6 moles of Cl, what is the limiting reagent?A. Aluminium (Al)B. Chlorine (Cl)C. Both are limitingD. No limiting reagent Solution:Balanced equation mole ratio:Al : Cl = 2 : 3Lets divide each given mole by its stoichiometric coefficient: Both give the same value Correct Answer: D. No limiting reagent$$\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$$A. HydrogenB. OxygenC. WaterD. Cannot be determined Solution:Molar masses:H = 2 g/mol moles = 10/2 = 5 molO = 32 g/mol moles = 80/32 = 2.5 molMole ratio needed = 2 (H:O)Available ratio = 5:2.5 = 2:1 exact stoichiometric ratio Correct Answer: D. Cannot be determined (based on the trick in question, but technically both are in correct ratio, so no limiting reagent)A. It is the reactant that is present in the greatest amountB. It is the reactant that determines the amount of product formedC. It is always the one with the smallest mass.It is the reactant that is completely consumed first and therefore limits the product Solution:Limiting reagent determines the maximum product formed. It may or may not be the one in smallest mass.It is used up first, so it doesnt remain. Correct Answer: B. It is the reactant that determines the amount of product formedA. AB. BC. CD. No limiting reagent Solution Required ratio A : B = 1 : 2Available = 5 : 5Now divide each by their respective coefficients:Smaller value = 2.5 (from B) B will be used up first Correct Answer: B. BIn a chemical reaction, the limiting reagent is the reactant that determines the quantity of the products that are produced. The other reactants present in the reactions are sometimes found to be in excess since there is some leftover quantity of them after the limiting reagent is completely used up. The maximum amount of product that is produced is known as the theoretical yield. The limiting reagent should be identified to calculate the percentage yield of a reaction. Given the balanced chemical equation, that describes the reaction, there are many equivalent ways to identify the limiting reagent and calculate the excess quantities of other reagents in the reaction. In this article, we will discuss what is limiting agent is, how to find limiting reagents and some limiting reagent questions. Limiting Reagent DefinitionLimiting reagents are defined as the substances which are entirely consumed in the completion of a chemical reaction. They are also referred to as limiting reactants or limiting agents. According to the stoichiometry of chemical reactions, a fixed amount of reactants is necessary for the reaction to complete.This reactant usually determines when the reaction would stop. The exact amount of reactant that would be needed to react with another element is calculated from the reaction stoichiometry. The limiting reagent depends on the mole ratio and not on the masses of the reactants present.Consider the following reaction for the formation of ammonia:3H2 + N2 ---> 2NH3In the reaction shown above, 3 moles of hydrogen gas is required for the reaction with 1 mole of nitrogen gas for the formation of 2 moles of ammonia. But what if, during the time of the reaction, there are only 2 moles of hydrogen gas available with 1 mole of nitrogen?In this case, the entire quantity of nitrogen cannot be used since the entirety of nitrogen requires 3 moles of hydrogen gas to react. Therefore, the hydrogen gas is limiting the reaction and is hence called the limiting reagent for this reaction. Limiting Reagent ExamplesLet us now look at some of the limiting reagent examples.ExampleConsider the combustion of benzene which is represented by the following chemical equation:2C6H6(l) + 15 O2(g) ---> 12CO2(g) + 6HO2(l)It means that 15 moles of molecular oxygen O2 are needed to react with 2 moles of benzene C6H6.The amount of oxygen that is required for other quantities of benzene is calculated using cross-multiplication. For example, if 1.5 mol C6H6 is present, 11.25 mol O2 is required:1.5 mol C6H6 x \[\frac{15\;mol\;O_{2}}{2\;mol\;C_{6}H_{6}}\] = 11.25 mol O2If in 18 mol O2 are present, there would be an excess of (18 - 11.25) = 6.75 mol of unreacted oxygen when all of the benzene is consumed. Benzene is, therefore, the limiting reagent. How to Find Limiting Reagent in a Reaction?Let us now learn about how to determine limiting reagent in a reaction.There are two ways for how to calculate limiting reagent. One method is to find and compare the mole ratio of the reactants that are used in the reaction. Another method is to calculate the grams of products produced from the quantities of reactants in which the reactant which produces the smallest amount of product is the limiting reagent.Method 1: Finding the limiting reagent by looking at the number of moles of every reactant.First, determine the balanced chemical equation for the given chemical reaction.Then, convert all the given information into moles (by using molar mass as a conversion factor).The next step is to calculate the mole ratio from the given information. Then, compare the calculated ratio to the actual ratio.Use the amount of limiting reactant for calculating the amount of product produced.Lastly, if necessary, calculate how much of the non-limiting agent is left in excess. Method 2: Finding the limiting reagent by calculating and comparing the amount of product each reactant would produce.The first step is to balance the chemical equation for the given chemical reaction.Then, convert the given information into moles.Use stoichiometry for each individual reactant for finding the mass of product produced.The reactant which produces a lesser amount of product would be the limiting reagent.The reactant which produces a larger amount of product would be the excess reagent.Lastly, for finding the amount of remaining excess reactant, subtract the mass of excess reagent consumed from the total mass given of the excess reagent. Limiting Reagent ProblemsDetermine the limiting reagent if 76.4 grams of C2H3Br3 reacts with 49.1 grams of O2.4 C2H3Br3 + 11 O2 ---> 8 CO2 + 6HO2 + 6Br2Solution:Using method 1,76.4 g x \[\frac{1\;mol}{266.72g}\] = 0.286 moles of C2H3Br349.1 g x \[\frac{1\;mol}{32g}\] = 1.53 moles of O2If you assume that all of the oxygen is used up,1.53 x 411, or, 0.556 moles of C2H3Br3 are required. Since there are only 0.286 moles of C2H3Br3 that are available, C2H3Br3 is the limiting reagent here.Using method 2,76.4 g C2H3Br3 \[\frac{1\;mol}{266.72g}\] x \[\frac{8\;mol\;CO_{2}}{4\;mol\;C_{2}H_{3}Br_{3}}\] x \[\frac{44.01\;g\;CO_{2}}{1\;mol\;CO_{2}}\] = 25.2 g CO249.1 g O2 x \[\frac{1\;mol\;O_{2}}{32\;g\;O_{2}}\] x \[\frac{8\;mol\;CO_{2}}{11\;mol\;O_{2}}\] x \[\frac{44.01\;g\;CO_{2}}{1\;mol\;CO_{2}}\] = 49.1 g CO2Hence, by using any of these methods, C2H3Br3 is the limiting reagent.In a chemical reaction, the limiting reactant (or limiting reagent) is the reactant that is used first, limiting the amount of product that can be created. There are a variety of methods for determining the limiting reactant, as we saw in the above examples, but they all rely on mole ratios from the balanced chemical equation.The theoretical yield is the amount of product that can be created depending on the limiting reactant. In fact, the actual yield, or the amount of product obtained, is usually always less than the theoretical yield. The actual yield is commonly represented as a percent yield, indicating how close the actual yield was to the theoretical yield. Limiting reagent refers to the reactant which gets completely dissolved during a chemical reaction. The product quantity produced due to this kind of reaction is very low since the chemical reaction gets stunned due to less availability of the reagent. Limiting reagent is also called limiting agents or limiting reactants. When a reaction is carried out practically, it is difficult to determine the exact proportions of the reactant. This is due to the limitations found in the measuring instruments. If one or more reagents which are present in excess quantities react with the limiting reagent, they are called excess reagents. The result of the reaction can be optimized when determining the quantity of the limiting reactants. Key Terms: Limiting Reagent, Chemical Reaction, Limiting Agents, Limiting Reactants, Excess Reagents, Reagents, Mole Ratio, Product Yield Method [Click Here for Sample Questions] The process in which two or more substances react with each other and convert into new substances is called chemical reaction. The reactants are the substances that react and products are the new substances that are produced after the reaction. When these reactions are carried out, the product yield will be determined by the reactant that is completely consumed. The reactant whichgets used up first thus stoppingthe reaction from proceeding further, and limits the product formed is called limitingreagent. The factor determining the amount of reactant is the mole ratio and not the masses of reactants present. These limiting reagents in turn determine the time when the reaction stops. Since the product yield is determined from the reactants, limiting reagents should be identified in order to calculate the percentage and quantity of product yield. Let us consider a chemical reaction for the formation of Sulphur hexafluoride to understand the concept of limiting reagent: S + 3F2 = SF6 As per the Stoichiometry, 1 mole of Sulphur reacts with 3 moles of fluorine to form 1 mole of Sulphur Hexafluoride and therefore 3 moles of Sulphur reacts with 9 moles of fluorine to form 3 moles of Sulphur Hexafluoride. In this case, all the available Sulphur gets consumed and therefore it limits the further reaction. Hence Sulphur is the limiting reagent and fluorine is the excess reagent. The remaining three moles of fluorine are in excess and do not react. Limiting Reagent Read More:- How to find Limiting Reagent? [Click Here for Sample Questions] Two methods are used to find the limiting reactant for a chemical reaction. Reaction Stoichiometry Method The reaction Stoichiometry Method involves the comparison of the mole ratios to calculate the value of the limiting reagent. It is also known as mole ratio approach. The steps involved in the reaction stoichiometry method are as follows: First, write the balanced chemical equation for the reaction. Then, determine the amount of moles of reactant of each type involved in the reaction. The mole ratio is calculated by dividing the amount of reactant by the respective stoichiometric coefficient in the balanced equation. Then, compare the mole ratios of each reactant to determine the smaller mole ratio. Product Yield Method The product yield method involves determining the limiting reactant by comparing the amount of product produced by each of the reactants. The steps involved in the reaction are as follows: Like the reaction stoichiometry method, first write the balanced chemical equation for the reaction. Next, convert the amount of each reactant produced in the reaction into the number of moles. Determine the moles of products produced from each reactant after assuming other reactants are present in excess. The reactant with the least amount of product will form the limiting reagent. Limiting Reagent Examples [Click Here for Sample Questions] The limiting reagent examples are as follows: Example: 50.0 kg of N2(g) and 10.0 kg of H2 (g) are mixed to produce NH3 (g). Calculate the NH3 (g) formed. In this process of production of NH3, find the limiting reagent. Solution: A balanced equation for the above reaction is written as follows: Calculation of moles: N2(g)+ 3H2(g) 2NH3(g) moles of N2 = 50.0 kg N2 1000 g N2/ 1 kg N2 1molN2/ 28.0g N2 = 17.86102mol moles of H2 = 10.00 kg H2 1000 g H2/ 1 kg H2 1mol H2/ 2.016 g H2 = 4.96103mol According to the above equation, 1 mol N2 (g) requires 3 mol H2 (g), for the reaction. Hence, for 17.8610^2 mol of N2, the moles of H2 (g) required would be = 17.86102mol N2 3 mol H2(g)/1mol N2(g) = 5.36 103mol H2 But we have only 4.96103mol H2. Hence, dihydrogen is the limiting reagent in this case. So NH3(g) would be formed only from that amount of available dihydrogen i.e., 4.96 103mol. Since 3 mol H2(g) gives 2 mole NH3(g) = 4.96103mol H2(g) 2 mol NH2(g)/3mol H2(g) = 3.30103mol NH3(g) = 3.30103mol NH3(g) is obtained. To convert to gram below method is followed: 1 mol NH3(g) = 17.0 g NH3(g) 3.30103mol NH3(g) 17.0 g NH3(g)/1mol NH3(g) = 3.3010317 g NH3(g) = 56.1103g NH3 = 56.1 kg NH3 Note: There are two ways to calculate the limiting reagent in a chemical reaction. One method is by comparing the mole ratio of the reactants present in a chemical reaction. Another method is by comparing the masses of the reactants present in a chemical reaction. The reactant which produces a smaller amount of product is the limiting reagent. Things to Remember Limiting reagents is a part of CBSE class 11 unit 1 Some Basic Concepts of Chemistry. This unit carries a total of 10 periods and 4 to 6 marks. The reagent is important in a reaction since it is completely consumed it determines when the reaction stops. Volume, Number of moles, mass, and the partial pressure of the reactant helps in determining the limiting reagent. Two limiting reagentsare never possible in a single chemical reaction. Read More:- Ques. What is the limiting reagent? (3 marks) Ans. In a chemical reaction limiting reagent is the reactant that is consumed first and prevents any further reaction from occurring. The amount of product formed during the reaction is determined by the limiting reagent. For example, let us consider the reaction of solution and chlorine. 2Na+Cl22NaCl 2Na atoms react with 1 Cl2 molecule. So, if we have 6Na moles, 3Cl2 molecules will be required, if there are more than 3 moles of Cl2 gas, sodium(Na) will act as a limiting reagent and some Cl2 molecules will remain as an excess reagent. Ques. Why is limiting reagent important? (3 marks) Ans. The limiting reagent is the reactant that is completely used up in a reaction and thus determines when the reaction stops. From the reaction stoichiometry, the exact amount of reactant needed to react with another element can be calculated. If the reactants are not mixed in the correct stoichiometric proportions (as indicated by the balanced chemical equation), then one of the reactants will be entirely consumed while another will be leftover. The limiting reagent is the one that is totally consumed; it limits the reaction from continuing because there is none left to react with the in-excess reactant. In chemistry, it is like the weakest link in a process, that limits how much reaction you can expect to occur. Ques.Take the reaction: NH3+ O2NO + H2O. In an experiment, 3.25 g of NH3are allowed to react with 3.50 g of O2. a. Which reactant is the limiting reagent? b. How many grams of NO are formed? c. How much of the excess reactant remains after the reaction?(3 marks) Ans. a. O2reactant is the limiting reagent 2.63g of NO are formed 1.76g NH3of the excess reactant remains after the reaction Ques.If 4.95 g of ethylene (C2H4) is combusted with 3.25 g of oxygen. a. What is the limiting reagent? b. How many grams of CO2are formed?(2 marks) Ans. a. O2is the limiting reagent. Ques.Consider the reaction of C6H6+ Br2C6H5Br + HBr a. What is the theoretical yield of C6H5Br if 42.1 g of C6H6reacts with 73.0 g of Br2? b. If theactual yield of C6H5Br is 63.6 g, what is the percent yield?(2 marks) Ans. a. 71.6g C6H5Bris the theoretical yield of C6H5Br if 42.1 g of C6H6reacts with 73.0 g of Br2 88.8%is the percent yield if theactual yield of C6H5Br Ques.A reaction container holds 5.77 g of P4and 5.77 g of O2. The following reaction occurs P4+ O2P4O6. If enough oxygen is available then the P4O6reacts further: P4O6+ O2P4O10. a. What is the limiting reagent for the formation of P4O10? b. What mass of P4O10is produced? c. What mass of excess reactant is left in the reaction container?(3 marks) Ans. a. O2is the limiting reagent for the formation of P4O10 b. 5.78g P4O10ofmass of P4O10is produced c. 5.76g P4O6remainis left in the reaction container Ques. How do you calculate the mass of zink and iodine that are consumed to produce zink iodide? (2marks) Ans. In order to calculate the mass of zink and iodine, write the balanced reaction Zn + I2ZnI2. On the basis of this equation, 1 mole of Zink and 1 mole of Iodine react with each other in order to produce zink iodide. This forms the primary base for stoichiometric ratios. Ques. What is a limiting reactant? (2marks) Ans. A limiting reactant refers to a substance that takes part in a chemical reaction and helps to determine the total number of products that can be produced from the reactants when there is an absence of the reactants in stoichiometric qualities. Ques. What two differences between a reagent and a reactant? (2 marks) Ans.Thedifferences between a reagent and a reactant are as follows: Reagents Reactants A reagent is a catalyst A reactant is a substrate It binds a reaction It is consumed in a reaction. Ques. When 4.00 mol H2is mixed with 2.00 mol Cl2how many moles of HCL can form? H2(g) + Cl2(g)2 HCL.Calculate the moles of each reactant and find the limiting reagent?(3marks) Ans.Limiting Reagent using Moles: HCL from H2: 4.00 mol H2 2.00 mol HCL / 1.00 mol H2= 8.00 mol HCL (not possible) HCL from Cl2: 2.00 mol Cl2 2.00 mol HCL / 1.00 mol Cl2= 4.00 mol HCL (smaller number) The limiting reagent is Cl2since it is used up first. Thus, Cl2produces a smaller amount of Product. Checking Calculations: Category H2 Cl2 HCL Initially 4.00 mol 2.00 mol 0 mol Reacted -2.00 mol -2.00 mol +4.00 mol Left after reaction 2.00 mol excess 0 mol limiting 4.00 mol Ques. If 4.80 mol Ca is mixed with 2.00 mol N2which is the limiting reagent in3Ca(s) + N2(g)Ca3N2(s)?(3marks) Ans. Limiting Reagent using Masses: Moles of Ca3H2from Ca: 4.80 mol Ca 1.00 mol Ca3N2/ 3.00 mol Ca = 1.60 mol Ca3N2(Ca used up) Moles of Ca3N2from N2: 2.00 mol N2 1.00 mol Ca3N2/ 1.00 mol N2= 2.00 mol Ca3N2(not possible) When 1.60 mol Ca3N2forms, all Ca gets used up. Thus, Ca is the limiting reagent. For Latest Updates on Upcoming Board Exams, Click Here: Check-Out: In a chemical reaction, the limiting reagent is the reactant that determines the quantity of the products that are produced. The other reactants present in the reactions are sometimes found to be in excess since there is some leftover quantity of them after the limiting reagent is completely used up. The maximum amount of product that is produced is known as the theoretical yield. The limiting reagent should be identified to calculate the percentage yield of a reaction. Given the balanced chemical equation, that describes the reaction, there are many equivalent ways to identify the limiting reagent and calculate the excess quantities of other reagents in the reaction. In this article, we will discuss what is limiting agent is, how to find limiting reagents and some limiting reagent questions. Limiting Reagent DefinitionLimiting reagents are defined as the substances which are entirely consumed in the completion of a chemical reaction. They are also referred to as limiting reactants or limiting agents. According to the stoichiometry of chemical reactions, a fixed amount of reactants is necessary for the reaction to complete.This reactant usually determines when the reaction would stop. The exact amount of reactant that would be needed to react with another element is calculated from the reaction stoichiometry. The limiting reagent depends on the mole ratio and not on the masses of the reactants present.Consider the following reaction for the formation of ammonia:3H2 + N2 ---> 2NH3In the reaction shown above, 3 moles of hydrogen gas is required for the reaction with 1 mole of nitrogen gas for the formation of 2 moles of ammonia. But what if, during the time of the reaction, there are only 2 moles of hydrogen gas available with 1 mole of nitrogen?In this case, the entire quantity of nitrogen cannot be used since the entirety of nitrogen requires 3 moles of hydrogen gas to react. Therefore, the hydrogen gas is limiting the reaction and is hence called the limiting reagent for this reaction. Limiting Reagent ExamplesLet us now look at some of the limiting reagent examples.ExampleConsider the combustion of benzene which is represented by the following chemical equation:2C6H6(l) + 15 O2(g) ---> 12CO2(g) + 6HO2(l)It means that 15 moles of molecular oxygen O2 are needed to react with 2 moles of benzene C6H6.The amount of oxygen that is required for other quantities of benzene is calculated using cross-multiplication. For example, if 1.5 mol C6H6 is present, 11.25 mol O2 is required:1.5 mol C6H6 x \[\frac{15\;mol\;O_{2}}{2\;mol\;C_{6}H_{6}}\] = 11.25 mol O2If in 18 mol O2 are present, there would be an excess of (18 - 11.25) = 6.75 mol of unreacted oxygen when all of the benzene is consumed. Benzene is, therefore, the limiting reagent. How to Find Limiting Reagent in a Reaction?Let us now learn about how to determine limiting reagent in a reaction.There are two ways for how to calculate limiting reagent. One method is to find and compare the mole ratio of the reactants that are used in the reaction. Another method is to calculate the grams of products produced from the quantities of reactants in which the reactant which produces the smallest amount of product is the limiting reagent.Method 1: Finding the limiting reagent by looking at the number of moles of every reactant.First, determine the balanced chemical equation for the given chemical reaction.Then, convert all the given information into moles (by using molar mass as a conversion factor).The next step is to calculate the mole ratio from the given information. Then, compare the calculated ratio to the actual ratio.Use the amount of limiting reactant for calculating the amount of product produced.Lastly, if necessary, calculate how much of the non-limiting agent is left in excess. Method 2: Finding the limiting reagent by calculating and comparing the amount of product each reactant would produce.The first step is to balance the chemical equation for the given chemical reaction.Then, convert the given information into moles.Use stoichiometry for each individual reactant for finding the mass of product produced.The reactant which produces a lesser amount of product would be the limiting reagent.The reactant which produces a larger amount of product would be the excess reagent.Lastly, for finding the amount of remaining excess reactant, subtract the mass of excess reagent consumed from the total mass given of the excess reagent. Limiting Reagent ProblemsDetermine the limiting reagent if 76.4 grams of C2H3Br3 reacts with 49.1 grams of O2.4 C2H3Br3 + 11 O2 ---> 8 CO2 + 6HO2 + 6Br2Solution:Using method 1,76.4 g x \[\frac{1\;mol}{266.72g}\] = 0.286 moles of C2H3Br349.1 g x \[\frac{1\;mol}{32g}\] = 1.53 moles of O2If you assume that all of the oxygen is used up,1.53 x 411, or, 0.556 moles of C2H3Br3 are required. Since there are only 0.286 moles of C2H3Br3 that are available, C2H3Br3 is the limiting reagent here.Using method 2,76.4 g C2H3Br3 \[\frac{1\;mol}{266.72g}\] x \[\frac{8\;mol\;CO_{2}}{4\;mol\;C_{2}H_{3}Br_{3}}\] x \[\frac{44.01\;g\;CO_{2}}{1\;mol\;CO_{2}}\] = 25.2 g CO249.1 g O2 x \[\frac{1\;mol\;O_{2}}{32\;g\;O_{2}}\] x \[\frac{8\;mol\;CO_{2}}{11\;mol\;O_{2}}\] x \[\frac{44.01\;g\;CO_{2}}{1\;mol\;CO_{2}}\] = 49.1 g CO2Hence, by using any of these methods, C2H3Br3 is the limiting reagent.In a chemical reaction, the limiting reactant (or limiting reagent) is the reactant that is used first, limiting the amount of product that can be created. There are a variety of methods for determining the limiting reactant, as we saw in the above examples, but they all rely on mole ratios from the balanced chemical equation.The theoretical yield is the amount of product that can be created depending on the limiting reactant. In fact, the actual yield, or the amount of product obtained, is usually always less than the theoretical yield. The actual yield is commonly represented as a percent yield, indicating how close the actual yield was to the theoretical yield. The reactant that is entirely used up in a reaction is called limiting reagent.Limiting reagents are substances that are completely consumed in the completion of a chemical reaction. They are also referred to as limiting agents or limiting reactants. According to the stoichiometry of chemical reactions, a fixed amount of reactants is required for the completion of the reaction. Let us consider the following reaction of the formation of ammonia:3H2 + N2 2NH3In the reaction given above, 3 moles of Hydrogen gas are required to react with 1 mole of nitrogen gas to form 2 moles of ammonia. But what if, during the reaction, only 2 moles of hydrogen gas are available along with 1 mole of nitrogen.In that case, the entire quantity of nitrogen cannot be used (because the entirety of nitrogen requires 3 moles of hydrogen gas to react). Hence, the hydrogen gas is limiting the reaction and is therefore called the limiting reagent for this reaction.Table of Contents Limiting Reagent ExplanationThis reactant generally determines when the reaction will stop. The exact amount of reactant which will be needed to react with another element can be calculated from the reaction stoichiometry. The limiting reagent depends on the mole ratio, not on the masses of the reactants present.Limiting Reagent Before and After ReactionFrom the illustration shown above, it can be observed that the limiting reactant is the reason the reaction cannot continue since there is nothing left to react with the excess reactant. It is the reactant that is entirely consumed over the course of the reaction. Limiting Reagent ExamplesConsider 1 mol of oxygen and 1 mol of hydrogen are present to undergo the following reaction.2H2 + O2 2H2OSince the reaction uses up hydrogen twice as fast as oxygen, the limiting reactant would be hydrogen.Example: 100g of hydrochloric acid is added to 100g of zinc. Find the volume of hydrogen gas evolved under standard laboratory conditions.Solution:The chemical equation for these reactions is given below.2HCl(aq) + Zn(s) ZnCl2(aq) + H2(g)Zinc chloride is formed in excess so the limiting reagent here is hydrochloric acid.73g of HCl = 22.4l of H2100g of HCl = yL of H2y/22.4 = 100/73y = (100 x 22.4)/73y = 30.6LTherefore, 33.6L of H2 is produced under standard laboratory conditions. How to find Limiting Reagent?The determination of the limiting reactant is typically just a piece of a larger puzzle. In most limiting reactant stoichiometry problems, the real goal is to determine how much product could be formed from a particular reactant mixture.The limiting reactant or reagent can be determined by two methods.Using the mole rationUsing the product approachIn order to calculate the mass of the product first, write the balanced equation and find out which reagent is in excess. Using the limiting reagent calculate the mass of the product.The following points should be considered while attempting to identify the limiting reagent:When there are only two reactants, write the balanced chemical equation and check the amount of reactant B required to react with reactant A. When the amount of reactant B is greater, reactant A is the limiting reagent.The reactant which is in a lesser amount than is required by stoichiometry is the limiting reactant.In an alternate method of finding the limiting reagent, the amount of product formed by each reactant is calculated.The limiting reactant is the reactant from which the minimum amount of product is formed.Also, if we calculate the amount of one reactant needed to react with another reactant, then the reactant which is in shortage would be the required limiting reactant.Thus, the required limiting reagent for the reaction can be identified using the points provided above. These reagents are very important while calculating the percentage yield of a given reaction.Recommended VideoApplications Of Stoichiometry Limiting ReagentA reactant in a chemical reaction that determines the amount of product that is produced is the limiting reactant or limiting reagent. The reason for a limiting reactant is that elements and compounds react in a balanced chemical equation according to the mole ratio between them.A reactant is a substance that reacts directly when the reaction is initiated, whereas a reagent is a substance that participates in a chemical reaction.The limiting reagent/reactant is important because it can tell a chemist that only x moles of compounds can form when the perfect quantity is used with how much of this material they use, because it restricts the reaction, instead of the hypothetically.The limiting reactant determines the maximum amount of product that can be formed from the reactants when reactants are not present in stoichiometric quantities.In a chemical reaction, the task of limiting reagent or reactant is significant because it can help the chemist predict the maximum quantity of reactant is consumed, since it restricts the reaction, only the necessary moles of products can be produced instead of the hypothetical yield where the perfect quantity is used.In a chemical reaction, the limiting reagent is the reactant that determines the quantity of the products that are produced. The other reactants present in the reactions are sometimes found to be in excess since there is some leftover quantity of them after the limiting reagent is completely used up. The maximum amount of product that is produced is known as the theoretical yield. The limiting reagent should be identified to calculate the percentage yield of a reaction. Given the balanced chemical equation, that describes the reaction, there are many equivalent ways to identify the limiting reagent and calculate the excess quantities of other reagents in the reaction. In this article, we will discuss what is limiting agent is, how to find limiting reagents and some limiting reagent questions. Limiting Reagent DefinitionLimiting reagents are defined as the substances which are entirely consumed in the completion of a chemical reaction. They are also referred to as limiting reactants or limiting agents. 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In fact, the actual yield, or the amount of product obtained, is usually always less than the theoretical yield. The actual yield is commonly represented as a percent yield, indicating how close the actual yield was to the theoretical yield.What is a limiting reagent? Explain.The reactant which gets consumed and limits the amount of product formed is called the limiting reagent.When a chemist carries out a reaction, the reactants are not usually present in exact stoichiometric amounts, that is, in the proportions indicated by the balanced equation.This is because the goal of a reaction is to produce the maximum quantity of a useful compound from the starting materials. Frequently, a large excess of one reactant is supplied to ensure that the more expensive reactant is completely converted into the desired product.The reactant which is present in a lesser amount gets consumed after some time and subsequently, no further reaction takes place, whatever be the amount left of the other reactant present.Hence, limiting reagent is the reactant that gets consumed entirely and limits the reaction.shaalaa.comIs there an error in this question or solution? The reactant which is totally consumed during the course of reaction and when it is consumed reaction stops. The concept of limiting reactant is applicable to reaction other than monomolecular i.e., when more than one type reactant involved. For example. These is no limiting reactant. To determine the limiting reagent amount of all reactants and mole ratio of reactants must be known. If the ratio of moles of reactant A with respect to reactant B is greater than the ratio the moles of A to moles of B for a balanced chemical equation than B is the limiting reactant. All other terms like left (unused) mass of other reactant, amount of formed product can be known stoichiometrically by knowing the amount of limiting reactant. Method of Expressing Concentration of Solution Molarity (M): The molarity of a solution is the number of moles of solute present in one litre (1dm3) of the solution The molality (m): The molality is the number of moles of solute present in one Kg of solvent Relation between molarity and molality (Where d = density of solution) Parts per million parts (ppm): For every dilute solution, i.e., when a very small quantity of a solute is present in large quantity of a solution, the concentration of the solute is expressed in terms ppm. It is defined as the mass of the solute present in one million (106) parts by mass of the solution. Thus for a solute A, The pollution of the atmosphere is also reported in ppm but it is expressed in terms of volumes rather than masses, i.e. volume of the harmful gas (e.g. SO2) in cm3 present in 103 cm3 of the air. (ii) Relationship between molarity (M) and molality (m): Molarity M means M moles of solute are present in 100 cc. of the solution. If density of the solution is d g/cc, mass of solution = 1000 f grams. Mass of solute = MM2g (M2 is mol mass of solute). Hence mass of solvent = 1000d MM2g. Molality (m) = = Thus m = or or (iii) Relationship between molality (m) and mole fraction (x2): Molality (m) means m moles of the solute in 1000 g of the solvent = 1000 / M1 moles (M1 = mol of mass of the solvent). Hence (iv) Relationship between molarity (M) and mole fraction (x2): Referring to calculations in (ii) above, Thus x2 = Or rearrangement, we get Or Note: If molarity (M) is in moles / litre and density d is kg/litre and molality m is in moles / kg of the solvent, 1000 will be replaced by 1 in the above formulae. The following scenario demonstrates the importance of limiting the number of reagents used. In order to put together a car, four tyres and two headlights are required (among other things). Consider the following scenario: the tyres and headlights are reactants, and the car is the product of the reaction between four tyres and two headlights. If you have 20 tires and 14 headlights, how many cars can you make with those materials? Because there are four tyres to a car, a set of 20 tyres can be used to produce five cars. Seven automobiles can be constructed from 14 headlights (each car needs 2 headlights). Despite the fact that more cars can be constructed from the available headlights, only five complete automobiles are possible due to the limited number of tyres available. In this instance, the number of headlights is excessive. Because the number of cars formed by 20 tyres is less than the number of cars formed by 14 headlights, the tyres serve as the limiting reagent in the car formation process (they limit the full completion of the reaction, in which all of the reactants are used up).Limiting reagents are substances that are completely consumed by a chemical reaction before it can be completed successfully. They are also referred to as limiting agents or limiting reactants in some instances. When it comes to chemical reactions, the stoichiometry of the reaction states that a fixed amount of reactants is required for the reaction to be completed.Explanation of ReagentsIn most cases, this reactant determines when the reaction will come to an end. Because of the stoichiometry of the reaction, it is possible to calculate the exact amount of reactant that will be required to react with a different element. The limiting reagent is determined by the mole ratio of the reactants present, rather than the masses of the reactants present.Using Reagents to a MinimumReducing the amount of reagent used before and after the reactionIt can be seen in the illustration above that the limiting reactant is the reason that the reaction cannot continue because there is nothing left to react with the excess reactant after the limiting reactant has been consumed. During the course of the reaction, it is the reactant that is completely depleted of all of its energy.Examples of ReagentsConsider the following scenario: 1 mol of oxygen and 1 mol of hydrogen are present for the reaction to take place.2H2O is formed by the reaction of 2H2 and O2.Because hydrogen depletes the reactions supply twice as quickly as oxygen, hydrogen would be the reactions limiting reactant.As an illustration, 100g of hydrochloric acid is mixed with 100g of zinc. Calculate the amount of hydrogen gas that has been produced under standard laboratory conditions.Solution:The chemical equations for these reactions are shown in the following section.The reaction 2HCl(aq) + Zn(s) produces ZnCl2(aq) + H2 (g)Because excessive amounts of zinc chloride are formed, hydrochloric acid serves as the limiting reagent in this reaction.22.4 litres of water from 73 grammes of HCl100g of HCl is equal to yL of H2.y/22.4 = 100/73 y = (100 x 22.4)/73 y = 30.6L y/22.4 = 100/73 y = (100 x 22.4)/73 y = 30.6LAs a result, under standard laboratory conditions, 33.6L of H2 is produced per hour.Best way to locate Limiting ReagentIt is common practice for the determination of the limiting reactant to be just one piece of a larger puzzle. While solving most limiting reactant-stoichiometry problems, the ultimate goal should be determining the amount of product that could be formed from a specific reactant mixture. Identifying the limiting reactant or reagent can be accomplished through one of two methods.Using the mole ratio as a guidelineTaking a product-oriented approachThe balanced equation must be written first in order to calculate the mass of the product, and then it must be determined which reagent has an excess amount. Calculate the mass of the finished product by using the limiting reagent.Attempt to identify the limiting reagentIn cases where there are only two reactants, write a balanced chemical equation and determine the amount of reactant B that is required for the reaction to occur between reactants A and B. When the amount of reactant B is greater than the amount of reactant A, the reactant A serves as the limiting reagent.The limiting reactant is the reactant that is present in a lower concentration than that required by stoichiometric equations.An alternative method of determining the limiting agent involves calculating the amount of product formed by each reactant.The limiting reactant is the reactant that results in the formation of the smallest amount of product possible.If we calculate the amount of one reactant that is required to react with another reactant, the reactant that is in short supply would be the limiting reactant that is required to complete the reaction.As a result, the limiting reagent for the reaction can be determined by referring to the information provided above. When calculating the percentage yield of a given reaction, the presence of these reagents is critical to success. A reagent, also known as an analytical reagent, is a substance or compound that is added to a system to initiate or test a chemical reaction. The terms reactant and reagent are frequently used interchangeably, but reactant refers to a substance consumed during a chemical reaction.Definition: The limiting reactant (or limiting reagent) is the reactant that is consumed first in a chemical reaction, limiting the amount of product that can be formed. There are numerous methods for determining the limiting reactant, but they all rely on mole ratios from the balanced chemical equation.The theoretical yield is the amount of product that can be formed based on the limiting reactant. In practise, the actual yield, or amount of product collected, is almost always less than the theoretical yield. The actual yield is typically expressed as a percentage yield, indicating what percentage of the theoretical yield was obtained.Limiting Reagent Chemistry Questions with SolutionsQ1. We can calculate the limiting reagent in a reaction by many factors, but which of the factors cannot help to determine the limiting reactant:Number of molesMass givenVolume givenPressure givenCorrect Answer: (d) Pressure givenQ2. Silicon nitride (Si3N4) is made by combining Si and nitrogen gas (N2) at a high temperature. How much (in g) Si is needed to react with an excess of nitrogen gas to prepare 125 g of silicon nitride if the percent yield of the reaction is 95.0%? Correct Answer: (b) 79.1 gQ3. What is a limiting reactant? The reactant that is used up first and prevents more product from being made.The reactant that makes the product.The reactant that is used up last and prevents more product from being madeThe substance that is in excess that doesnt get used up as a reactant.Correct Answer: (a) The reactant that is used up first and prevents more product from being made.Q4. In the following reaction: 4NH3(g) + 5O2 (g) 4NO (g) + 6H2O (l) When 1 mole ammonia and 1 mole of O2 are mixed, then the number of moles of NO formed willbe: Correct Answer: (a) 0.8 moleQ5. 10 g of marble(calcium carbonate) was added to 15 g of dilute hydrochloric acid, product formed is calcium chloride, water and carbon dioxide. Which of the following is true?Hydrochloric acid is the limiting reactantHydrochloric acid is the excess reactantCalcium carbonate is the excess reactantNone of the aboveCorrect Answer: (b) Hydrochloric acid is the excess reactantQ6. What is a Limiting reagent?Answer. A limiting reagent is a reactant that occurs in lower concentrations in a reaction. When it is consumed, the reaction will stop, regardless of the amount of reactant present in the reaction. It restricts the amount of product produced. In other words, it determines the magnitude of the reaction.Q7. NO2 is formed when 0.740 g of O3 reacts with 0.670 g of NO. What is the limiting reagent?Answer. O3 + NO O2 +NO21 mole of O3 reacts with 1 mole of NO.0.74 g O3 = 0.74 / 48 = 0.0154 mol O30.67 g NO = 0.67 / 30 = 0.0223 mol NOO3 is the limiting reagent and NO is in excess.Q8. How do you determine which product is the limiting one?Answer. Compare the calculated amount of a reactant to the actual amount available to determine which reactant is the limiting one. If more is needed than what is available, it is the limiting reactant.Q9. If 4.95 g of ethylene (C2H4) are combusted with 3.25 g of oxygen. What is the limiting reagent? Answer. The limiting reagent would be O2.Q10. Calculate the limiting reagent in 2H2 + O2 2H2OAnswer. Given 1 mol of hydrogen and 1 mol of oxygen in the reaction:2H2 + O2 2H2OThe limiting reactant would be hydrogen because the reaction uses up hydrogen twice as fast as oxygen.Q11. 50.0 kg of N2 (g) and 10.0 kg of H2 (g) are mixed to produce NH3 (g).Identify the limiting reagent in the production of NH3 in this situation.Answer.N2 + 3H2 2NH31 mol N2 (g) requires 3 mol H2 (g), for the reaction.Hence, for 17.86 102 mol of N2, the moles of H2 (g) required would be 17.86 102 mol N2 (3 mol H2 (g)) / (1 mol N2 (g)= 5.36 103 mol H2But we have only 4.96103 mol H2. Hence, dihydrogen is the limiting reagentQ12. What is the greatest amount of MgO (i moles) that can be made with 7.8 moles of Mg and 4.7 moles of O2? Which is the limiting reagent?Answer. 2Mg + O2 2MgOFor 7.8 moles of Mg = (1 moles of O2 / 2 moles of Mg) 7.8 mole Mg = 3.9 moles of O2For 4.7 moles of O2 = (2moles of Mg / 1 mole of O2) 4.7 moles O2 = 9.4 moles Mg.Therefore, Mg is the limiting reagent.Q13. Calculate the amount of C formed in the reaction 2A + 4B 3C + 4D when 5 moles of A react with 6 moles of B.Answer. The balanced reaction is 2A + 4B 3C + 4DMoles given is 5 moles of A and 6 moles of BRatio of moles given and stoichiometry coefficients:For A: 5/2 = 2.5For B: 6/4 = 1.5Since 1.5 is less than 2.5, B is the limiting reagent because it will be used first.Therefore, the moles produced of C = = 4.5 mol.Q14 What would be the limiting reagent if 75 grams of C2H3BrO reacted with 50.0 grams of O2 in the following reaction:4C2H3Br3 + 11O2 8CO2 + 6H2O + 6Br2.Answer. Conversion to moles75 g (1mole / 266.72 g) = 0.28 mole C2H3Br350 g (1mole /32 g) = 1.56 mol O2To calculate how much C2H3Br3 would be required if all the O2 is used up:1.56 mol O2 (4 mol C2H3Br3 /11 mol O2) = 0.567 mol C2H3Br3This shows that 0.567 mol C2H3Br3 is needed to react with all of the oxygen. C2H3Br3 is the limiting reagent because there is only 0.28 mol of it present.Q15. What would be the limiting reagent if 80.0 grams of Na2O2 reacted with 30.0 grams of H2O in the reaction?2Na2O2 + 2H2O 4NaOH + O2Answer. 80 g Na2O2 (1 mol Na2O2/77.98 g Na2O2) (4moles NaOH / 2moles Na2O2) = 2.06 moles NaOH30 g H2O (1 mol H2O/18g H2O) (4moles NaOH / 2moles Na2O2) = 3.33 moles NaOHSince Na2O produces less NaOH than H2O, it is the limiting reagent.Practise Questions on Limiting ReagentQ1. The reactant which is not consumed completely in the reaction is _____.Q2. In a reaction: A + B2 AB2Identify the limiting reagent, if any, in the following reaction mixtures.(i) 300 atoms of A + 200 molecules of B(ii) 2 mol A + 3 mol B(iii) 100 atoms of A + 100 molecules of B(iv) 5 mol A + 2.5 mol B(v) 2.5 mol A + 5 mol BQ3. The reactant which is entirely consumed in the reaction is known as the limiting reagent. In the reaction 2A + 4B 3C + 4D, if 5 moles of A react with 6 moles of B then, which is the limiting reagent? Q4. If you have an actual yield of 29.3 grams of product and the theoretical yield is 35.0 grams, what is your percent yield?Q5. 6 g of H2 reacts with 14 g of N2 to form NH3 until the reaction consumes the limiting reagent completely. The amount of another reactant remaining in g is:Click the PDF to check the answers for Practice Questions. Download PDF The reactant which reacts completely in the reaction is called limiting reactant or limiting reagent.The reactant which is not consumed completely in the reaction is called excess reactant .Question : 3 g of H2 react with 29 g of O2 to form H2O.Which is the limiting reagent ?Answer:Thus O2 is present in excess.Hence H2 is the limiting reagent. A limiting reagent or limiting reactant is a substance that has been wholly consumed in a chemical reaction. Thus, the limiting reagent determines when to complete and stop a reaction. Since the limiting reagent is consumed in a reaction, no amount remains to react with another reactant. Therefore, the other reactant remains in excess and is known as the excess reagent. The amount of products resulting from the chemical reaction is limited by the limiting reagent. Limiting reagent is important in chemistry because it tells a chemist how much product will be produced if a limited amount of reactants are used in the reaction. Limiting Reagent Example 1: Consider the reaction between hydrogen (H2) and nitrogen (N2) to form ammonia (NH3). In this reaction, three moles of H2 react with one mole of N2 to produce two moles of NH3. The balanced chemical reaction is given as follows: 3 H2 + N2 2 NH3 This relationship among the different quantities or moles of the reactants and products is known as stoichiometry. In the above reaction, H2, N2, and NH3 are in stoichiometric amounts. If two moles of H2 react with one mole of N2, then all N2 will not be used since there is insufficient H2 in the reaction. Therefore, hydrogen is the limiting reagent. Example 2: Consider the reaction between two moles of H2 and one mole of oxygen (O2) to give two moles of water (H2O). 2 H2 + O2 2 H2O If instead, one mole of H2 reacts with one mole of O2, the reaction will not be complete, and hydrogen becomes the limiting reagent. When two reactants mix to form products, they combine in a specific ratio determined by the reactions stoichiometry. The first step is to balance the chemical reaction. Consider the following balanced reaction: A + B Products Suppose the quantities of A and B are known in a mass unit, such as grams. The next step is to convert grams to moles. Formula to Calculate the Number of Moles from Mass To find the concentrations of the reactants and products in moles, one has to know their quantities and molar masses. Suppose x grams of A, whose molar mass is M grams, are present in the reaction. Then, the amount in moles n is given by: n = x/M There are two general methods to find the limiting reagent. Method 1 One trick to determine the limiting reagent is to compare the reactants molar ratio to the actual stoichiometric ratio. The reactant having fewer moles than required is the limiting reagent. Then, proceed to calculate the amount of product produced by the reactants and the remaining excess reagent left in the reaction. Method 2 Another method of determining the limiting reagent is comparing the amounts of products formed from each reactant. An advantage of this method over the previous method is that it can be extended to many reactants. After balancing the chemical reaction, use stoichiometry to calculate the quantities of the products produced for each separate reactant. The reactant that produces the least amount of products is the limiting reagent. The amount of the products in grams formed from the limiting reagent is defined as the theoretical yield. Example: Consider the reaction between solid aluminum (Al) and gaseous chlorine (Cl2) to give sodium aluminum chloride (AlCl3). The reaction is as follows: 2 Al (s) + 3 Cl2 (g) 2 AlCl3 (s) Suppose 3.5 grams of Al and 5.2 grams of Cl2 are present in the reaction. Determine the limiting reagent. Also, calculate the remaining amount of excess reagent and the amount of product produced. The molar mass of Al is 27 g, and that of Cl2 is 71 g. Solution: Step 1: Calculate the number of moles of Al and Cl2. Number of moles of Al = 3.5 g/27 g = 0.13 mol. Number of moles of Cl2 = 5.2 g/71 g = 0.073 mol. Using Method 1 Step 2: Calculate and compare the required and actual molar ratios. Molar ratio = Number of mol. of Al/Number of mol. of Cl2 Required molar ratio = 2/3 = 0.66 Actual molar ratio = 0.13/0.073 = 1.775 The actual molar ratio of Al to Cl2 is higher than required, which means that Al is in excess. If Al is excess, Cl2 must be in a limited amount. Therefore, Cl2 is the limiting reagent. Using Method 2 Step 2: Calculate the amount of AlCl3 produced from the given amounts of Al and Cl2. 2 mol. of Al produces 2 mol. of AlCl3 Therefore, 0.13 mol. will produce = 2/2 x 0.13 = 0.13 mol. of AlCl3 3 mol. of Cl2 produces 2 mol. of AlCl3 Therefore, 0.073 mol. will produce = 2/3 x 0.073 = 0.049 mol. of AlCl3 Since Cl2 produces the least amount of AlCl3, it is the limiting reagent. The molar mass of AlCl3 is 27 + 3/2 x 71 = 133.5 g Therefore, amount of AlCl3 produced in the reaction = 0.049 x 133.5 = 6.54 g. Step 3: Calculate the remaining amount of excess reagent. Al is the excess reagent. 3 mol. of Cl2 reacts with 2 mol. of Al Therefore, 0.073 mol. of Cl2 reacts with 2/3 x 0.073 = 0.049 mol. of Al Amount of Al present = 0.13 mol. Therefore, remaining amount of Al = 0.13 0.049 = 0.081 mol. Remaining amount of Al in gram = 0.081 x 27 = 2.2 g P.1. Consider the following reaction: 2 Na + Cl2 2 NaCl 3.5 g of sodium (Na) metal is transferred to a 4L flask filled with chlorine (Cl2) gas at STP. Determine the limiting reagent and the remaining amount of excess reactant present if the molar mass of Na is 23 g, the molar mass of Cl2 is 71 g, and the molar volume of Cl2 is 22.4 L. Solution. Step 1: Determine the number of moles. Number of mol. of Na = 3.5/23 = 0.152 mol. Number of mol. of Cl2 = 4/22.4 = 0.179 mol. Step 2: Using method 1 to calculate the molar ratios. Molar ratio = No. of mol. of Na/No. of mol. of Cl2 Required molar ratio: 2/1 = 2 Actual molar ratio: 0.152/0.179 = 0.85 The actual molar ratio is less than required, which means that Na is the limiting reagent. Step 3: Determine the remaining amount of excess reagent. The excess reagent is Cl2. 2 mol. of Na react with 1 mol. of Cl2 Therefore, 0.152 mol. of Na react with = x 0.152 = 0.076 mol. of Cl2 Amount of Cl2 present in the reaction = 0.179 mol. Therefore, remaining amount of Cl2 = 0.179 0.076 = 0.103 mol. Remaining amount of Cl2 in L = 0.103 x 22.4 = 2.3 L P.2. Identify the limiting reactant if 4.45 moles of sodium (Na) react with 3.75 moles of oxygen (O2) in the following equation: 4 Na + O2 2 Na2O Also, find the remaining amount of excess reagent and the amount of product produced. Solution. Step 1: Find the limiting reagent using method 2. 4 mol. of Na produces 2 mol. of Na2O Therefore, 4.45 mol. of Na produces 2/4 x 4.45 = 2.23 mol. of Na2O 1 mol. of O2 produces 2 mol. Na2O Therefore, 3.75 mol. of O2 produces 2/1 x 3.75 = 7.5 mol. of Na2O In the above reaction, Na produces less amount of Na2O than O2. Therefore, Na is the limiting reagent. The amount of Na2O produced in this reaction is 2.23 mol. Step 2: Calculate the remaining amount of excess reagent. O2 is the excess reagent. 4 mol. of Na react with 1 mol. of O2 Therefore, 4.45 mol. of Na react with x 4.45 = 1.11 mol. of O2 Hence, the remaining amount of O2 is 3.75 1.11 = 2.64 mol. References

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