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Chemical reactant totally consumed when the reaction is finished This 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 unreacted The 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 1.5 mol C6H6 is present, 11.25 mol 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 18 mol O2 are present, there will be an excess of (18 - 11.25) = 6.75 mol 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 0.297 mol Fe, but only enough Fe2O3 to produce 0.250 mol 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. ISBN 0815184506. ^ Zumdahl, Steven S. (2006). Chemical Principles (4th ed.). New York: Houghton Mifflin Company. ISBN 0-618-37206-7. ^ Masterton, William L.; Hurley, Cecile N. (2008). Chemistry: Principles and Reactions (6 ed.). Cengage Learning. ISBN 978-0-495-12671-3. Retrieved from " Bri L. asked • 11/01/20 NH3(g)+HCl(g)⟶NH4Cl(s) A 6.44 g sample of NH3 gas and a 6.44 g sample of HCl gas are mixed in a 0.50 L flask at 25 ∘C.Identify the limiting reagent.How many grams of NH4Cl will be formed by this reaction?What is the pressure in atmospheres of the gas remaining in the flask? Ignore the volume of solid NH4Cl produced by the reaction. 1 Expert Answer NH3(g) + HCl(g) ==> NH4Cl(s) ... balanced equationOne easy way to identify the limiting reagent is to divided the moles of each reactant by its coefficient in the balanced equation and whichever value is less is the limiting reagent. In the current problem we have...NH3: 6.44 g NH3 x 1 mol NH3/17 g = 0.3688 moles NH3 (÷ 1 = 0.3688)HCl: 6.44 g HCl x 1 mol HCl/36.5 g = 0.1764 moles HCl (÷ 1 = 0.1764) -> LIMITING REAGENTHow many grams of NH4Cl will be formed by this reaction?0.1764 moles HCl x 1 mole NH4Cl / mole HCl x 53.49 g NH4Cl/mole = 9.44 g NH4Cl (3 sig. figs.)What is the pressure in atmospheres of the gas remaining in the flask?NH3(g) + HCl(g) ==> NH4Cl(s)0.3688.....0.1764.....0.....Initial-0.1764....-0.1764.....+0.1764...Change0.1924 .....0.....+0.1924....EquilibriumThe only gas remaining in the flask is NH3 and there are 0.1924 moles. This is in a volume of 0.5 L at a temperature of 25ºC (+273 = 298K). Using the ideal gas law, we can then solve for the pressure (P).PV = nRTP = nRT/V = (0.1924 mol)(0.0821 Latm/Kmol)(298K) / 0.5 LP = 9.41 atm Share — copy and redistribute the material in any medium or format for any purpose, even commercially. Adapt — remix, transform, and build upon the material for any purpose, even commercially. The licensor cannot revoke these freedoms as long as you follow the license terms. Attribution — You must give appropriate credit , provide a link to the license, and indicate if changes were made . You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. ShareAlike — If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. No additional restrictions — You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits. You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation . No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. Sports and Culture, New Religious MovementsLIVE NOWManoj Sonker Identify a limiting reagent from a set of reactants. Calculate how much product will be produced from the limiting reagent. Calculate how much reactant(s) remains when the reaction is complete. One additional assumption we have made about chemical reactions—in addition to the assumption that reactions proceed all the way to completion—is that all the reactants are present in the proper quantities to react to products. This is not always the case. Consider Figure 5.1 “Making Water”. Here we are taking hydrogen atoms and oxygen atoms (left) to make water molecules (right). However, there are not enough oxygen atoms to use up all the hydrogen atoms. We run out of oxygen atoms and cannot make any more water molecules, so the process stops when we run out of oxygen atoms. Figure 5.1 “Making Water.” In this scenario for making water molecules, we run out of O atoms before we use up all the H atoms. Similar situations exist for many chemical reactions when one reactant runs out before the other. A similar situation exists for many chemical reactions: you usually run out of one reactant before all of the other reactant has reacted. The reactant you run out of is called the limiting reagent; the other reactant or reactants are considered to be in excess. A crucial skill in evaluating the conditions of a chemical process is to determine which reactant is the limiting reagent and which is in excess. The key to recognizing which reactant is the limiting reagent is based on a mole-mass or mass-mass calculation: whichever reactant gives the lesser amount of product is the limiting reagent. What we need to do is determine an amount of one product (either moles or mass) assuming all of each reactant reacts. Whichever reactant gives the least amount of that particular product is the limiting reagent. It does not matter which product we use, as long as we use the same one each time. It does not matter whether we determine the number of moles or grams of that product; however, we will see shortly that knowing the final mass of product can be useful. For example, consider this reaction: 4As(s) + 3O2(g) → 2As2O3(s) Suppose we start a reaction with 50.0 g of As and 50.0 g of O2. Which one is the limiting reagent? We need to perform two mole-mass calculations, each assuming that each reactant reacts completely. Then we compare the amount of the product produced by each and determine which is less. The calculations are as follows: Comparing these two answers, it is clear that 0.334 mol of As2O3 is less than 1.04 mol of As2O3, so arsenic is the limiting reagent. If this reaction is performed under these initial conditions, the arsenic will run out before the oxygen runs out. We say that the oxygen is “in excess.” Identifying the limiting reagent, then, is straightforward. However, there are usually two associated questions: What mass of product (or products) is then actually formed? What mass of what reactant is left over? The first question is straightforward to answer: simply perform a conversion from the number of moles of product formed to its mass, using its molar mass. For As2O3, the molar mass is 197.84 g/mol; knowing that we will form 0.334 mol of As2O3 under the given conditions, we will get: The second question is somewhat more convoluted to answer. First, we must do a mass-mass calculation relating the limiting reagent (here, As) to the other reagent (O2). Once we determine the mass of O2 that reacted, we subtract that from the original amount to determine the amount left over. According to the mass-mass calculation: Because we reacted 16.0 g of our original O2, we subtract that from the original amount, 50.0 g, to get the mass of O2 remaining: 50.0 g O2 − 16.0 g O2 reacted = 34.0 g O2 left over You must remember to perform this final subtraction to determine the amount remaining; a common error is to report the 16.0 g as the amount remaining. A 5.00 g quantity of Rb are combined with 3.44 g of MgCl2 according to this chemical reaction: 2Rb(s) + MgCl2(s) → Mg(s) + 2RbCl(s) What mass of Mg is formed, and what mass of what reactant is left over? Solution Because the question asks what mass of magnesium is formed, we can perform two mass-mass calculations and determine which amount is less. The 0.711 g of Mg is the lesser quantity, so the associated reactant — 5.00 g of Rb — is the limiting reagent. To determine how much of the other reactant is left, we have to do one more mass-mass calculation to determine what mass of MgCl2 reacted with the 5.00 g of Rb and then subtract the amount reacted from the original amount. Because we started with 3.44 g of MgCl2, we have: 3.44 g MgCl2 − 2.78 g MgCl2 reacted = 0.66 g MgCl2 left Test Yourself Given the initial amounts listed, what is the limiting reagent, and what is the mass of the leftover reagent? 22.7 g MgO(s) + 17.9 H2S(g) → MgS(s) + H2O(ℓ) Answer H2S is the limiting reagent; 1.5 g of MgO are left over. The limiting reagent is that reactant that produces the least amount of product. Mass-mass calculations can determine how much product is produced and how much of the other reactants remain. Questions The box below shows a group of nitrogen and hydrogen molecules that will react to produce ammonia, NH3. What is the limiting reagent? The box below shows a group of hydrogen and oxygen molecules that will react to produce water, H2O. What is the limiting reagent? Given the statement “20.0 g of methane is burned in excess oxygen,” is it obvious which reactant is the limiting reagent? Given the statement “the metal is heated in the presence of excess hydrogen,” is it obvious which substance is the limiting reagent despite not specifying any quantity of reactant? Acetylene (C2H2) is formed by reacting 7.08 g of C and 4.92 g of H2. 2C(s) + H2(g) → C2H2(g) What is the limiting reagent? How much of the other reactant is in excess? Ethane (C2H6) is formed by reacting 7.08 g of C and 4.92 g of H2. 2C(s) + 3H2(g) → C2H6(g) What is the limiting reagent? How much of the other reactant is in excess? Given the initial amounts listed, what is the limiting reagent, and how much of the other reactant is in excess? 35.6 g P4O6(s) + 4.77 g 6H2O(ℓ) → 4H3PO4 Given the initial amounts listed, what is the limiting reagent, and how much of the other reactant is in excess? 377 g 3NO2(g) + 244 g H2O(ℓ) → 2HNO3(aq) + NO(g) To form the precipitate PbCl2, 2.88 g of NaCl and 7.21 g of Pb(NO3)2 are mixed in solution. How much precipitate is formed? How much of which reactant is in excess? In a neutralization reaction, 18.06 g of KOH are reacted with 13.43 g of HNO3. What mass of H2O is produced, and what mass of which reactant is in excess? Nitrogen is the limiting reagent. Yes; methane is the limiting reagent. C is the limiting reagent; 4.33 g of H2 are left over. H2O is the limiting reagent; 25.9 g of P4O6 are left over. 6.06 g of PbCl2 are formed; 0.33 g of NaCl is left over. Media Attributions definitionThe reactant that runs out first for a given chemical reaction. 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 reaction’s 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 = ½ 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 ¼ x 4.45 = 1.11 mol. of O2 Hence, the remaining amount of O2 is 3.75 – 1.11 = 2.64 mol. References Chem.libretexts.orgCsun.eduUah.eduJove.comColorado.edu 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 → 2NH3 In 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 Explanation This 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 Reaction From 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 Examples Consider 1 mol of oxygen and 1 mol of hydrogen are present to undergo the following reaction. 2H2 + O2 → 2H2O Since 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 H2 100g of HCl = yL of H2 y/22.4 = 100/73 y = (100 x 22.4)/73 y = 30.6L Therefore, 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 ration Using the product approach In 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 Video Applications Of Stoichiometry – Limiting Reagent A 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. The limiting reactant is the one that controls how much product is made in a reaction.To find the limiting reactant, compare the actual mole ratio to the balanced equation's mole ratio.Another way to identify the limiting reactant is by calculating the smallest mass of product formed. The limiting reactant or limiting reagent is a reactant in a chemical reaction that determines the amount of product that is formed. Identification of the limiting reactant makes it possible to calculate the theoretical yield of a reaction. The reason there is a limiting reactant is that elements and compounds react according to the mole ratio between them in a balanced chemical equation. For example, if the mole ratio in the balanced equation states it takes one mole of each reactant to produce a product (1:1 ratio) and one of the reactants is present in a higher amount than the other, the reactant present in the lower amount would be limiting reactant. All of it would be used up before the other reactant ran out. Given 1 mol of hydrogen and 1 mol of oxygen in the reaction:2 H2 + O2 → 2 H2O The limiting reactant would be hydrogen because the reaction uses up hydrogen twice as fast as oxygen. There are two methods used to find the limiting reactant. The first is to compare the actual mole ratio of the reactants to the mole ratio of the balanced chemical equation. The other method is to calculate the gram masses of the product resulting from each reactant. The reactant that yields the smallest mass of product is the limiting reactant. Using the Mole Ratio: Balance the equation for the chemical reaction. Convert the masses of reactants to moles, if needed. If the quantities of reactants are given in moles, skip this step. Calculate the mole ratio between reactants using the actual numbers. Compare this ratio to the mole ratio between reactants in the balanced equation. Once you identify which reactant is the limiting reactant, calculate how much product it can make. You can check that you selected the correct reagent as the limiting reactant by calculating how much product the full amount of the other reactant would yield (which should be a larger number). You can use the difference between the moles of non-limiting reactant that are consumed and the starting number of moles to find the amount of excess reactant. If necessary, convert the moles back to grams. Using the Product Approach: Balance the chemical reaction.Convert the given quantities of reactants to moles.Use the mole ratio from the balanced equation to find the number of moles of product that would be formed by each reactant if the full amount was used. In other words, perform two calculations to find the moles of product.The reactant that yielded the smaller amount of product is the limiting reactant. The reactant that yielded the larger amount of produce is the excess reactant.The amount of excess reactant may be calculated by subtracting the moles of excess reactant from the number of moles used (or by subtracting the mass of excess reactant from the total mass used). Mole to gram unit conversions may be necessary to provide answers for homework problems. 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.Example Consider 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 O2 If 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 C2H3Br3 49.1 g x \[\frac{1\;mol}{32g}\] = 1.53 moles of O2 If 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 CO2 49.1 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 CO2 Hence, 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. Calculator-online.net is your ultimate destination for a wide range of free online calculators. These tools include AI tools, health, finance, statistics, maths, physics, and chemistry. Everyone deserves instant and free access to reliable calculations. Our mission is to provide accurate and up-to-date results to tackle challenges with precision. Why does Calculator Online strive to be a one-stop destination? The team of online calculators continues to update, and new tools are being added regularly. Whether you are tackling basic maths problems or delving into more complex equations, this platform is designed to streamline your mathematical endeavours. Every tool developed by the Calculator Online is designed for accurate results, showing our strong commitment to your satisfaction. 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. In this tutorial, you will learn what a limiting reagent is, how to find the limiting reactant, and see some example problems. The limiting reactant is the reagent (compound or element) to be totally consumed in a chemical reaction. Limiting reactant is also what prevents a reaction from continuing because there is none left. The limiting reactant may also be referred to as limiting reagent or limiting agent. The reactant that is not used up is referred to as the excess reactant. For example, consider if you are trying to put together a burger that has two pieces of bread, a piece of tomato, and a piece of meat. The reaction would be You have 3 tomato pieces, 2 pieces of meat, and 6 pieces of bread. When combined to make sandwiches, the first ingredient to run out is the meat. You only have enough meat to make two burgers but enough tomato and bread to make three burgers Therefore, the meat is the limiting reagent. The meat is the first ingredient to be used up. The bread and tomato have excess and therefore are called the excess reactant. The same idea is true for chemical reactions. It is important to be able to find the limiting reagent because we can’t always add exactly the number of molecules we want to perfectly balance our equations. Often time, one reagent will be added in excess because it is cheaper and make sure the more expensive reagent is completely used up. From the limiting reactant, the theoretical yield can also be calculated. The theoretical yield is the maximum amount of product that can be formed from the limiting reagent. However, the actual yield in a reaction is almost always less than the theoretical yield. Which is why the percent yield is calculated to compare the theoretical yield to the actual yield. There are several ways to find the limiting reagent. One key is to always start with a balanced chemical reaction. It is also essential to always compare mole amounts, not weight (ie grams). Only moles work for determining the limiting reagent because it tells us how many molecules there are. For working through this method we will consider the reaction between nitrogen and hydrogen to make ammonia. 1. Start with a balanced chemical equation 2. Convert any amount given to moles of each reagent using stoichiometry. 3. For each reagent, calculate how many moles of product would be produced. 4. The reagent that produces the LEAST amount of product is your limiting reagent. Therefore H2 is the limiting reagent 1. Start with a balanced chemical equation 2. Convert any amount given (for example in grams) to moles of each reagent. 3. Using the mole ratio, calculate the needed amount of product B to consume all A. 4. If the calculated amount of B is higher than the actual amount that means B is the limiting reactant. If the calculated amount is less than the actual amount than B is NOT the limiting reagent. The calculated amount of B: The actual amount of B: Because the calculated B is greater than the actual B, we know H2 IS the limiting reagent in producing ammonia in this problem. Notice that every method starts with balancing the chemical equation and then converting all amounts to moles. Then compare the mole ratios of either the product formed or the required amount of reagent. Problem: You have and to make water. Which is the limiting reactant in producing water? Solution: Start by balancing the chemical reaction. Convert the amounts given in grams to moles. Calculate the amount of product produced by each reagent Compare the amount of product produced to therefore see which comes in the smaller amount. The above result shows that oxygen (O2) generates more water (H2O) than hydrogen (H2). Therefore, hydrogen acts as the limiting reagent. Problem 1 You mix of aqueous with of aqueous in excess acid. Which is the limiting reactant? H2O2 and KMnO4 react according to the following equation: In excess acid, Problem 2 You mix into a aqueous solution of .