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11- 3 practice problems limiting reactants answers

Learning objectives Identify limiting reagent (reagent limiting) in a chemical reaction date. Calculate how much product will be produced by the limiting reactor. Calculate how much reacts(s) remains when the reaction is complete. In all the examples discussed so far, the reactionaries have been assumed to be present in stoichiometric quantities. Consequently, none of the reactionaries were left at the end of the reaction. This is often desirable, as in the case of a space shuttle, where excess oxygen or hydrogen is not only an extra transport to be transported in orbit, but also a risk of explosion. More often, however, reactives are present in mass relationships which are not the same as the ratio of coefficients in balanced chemical equation. As a result, one or more of them will not be used completely, but will be left behind when the reaction is completed. In this situation, the amount of product that can be obtained is limited by the amount of only one of the reactives. The reactor limiting the amount of product obtained is called the limiting reactor. The reactor that remains after a reaction went to completion is excess. Consider a non-chemical example. Suppose you invited some friends for dinner and want to bake brownies for dessert. Find two brownie mix boxes in your pantry and see that each package requires two eggs. The balanced equation for brownie preparation is: $\text{1 box mix} + 2 \text{ eggs} \rightarrow \text{1 batch}$ If you have a dozen eggs, what ingredient will determine the number of batches of brownies that you can prepare? Since each brownie mix box requires two eggs and you have two boxes, you need four eggs. Twelve eggs are eight more eggs than you need. Although the ratio between eggs and boxes is 2:1, the ratio in your possession is 6:1. Then the eggs are the ingredient (reactant) present in excess, and the brownie mixture is the limiting reactor. Even if you have a refrigerator full of eggs, you could only make two batches of brownies. Figure 1: The concept of a limiting reactor in the preparation of the Brownies. For a chemist, balanced chemical equation is the recipe that must be followed. PHET Simulation: Reactants, Products and Leftovers View this interactive simulation that illustrates the concepts of limiting and reacting excess. Consider this concept now with regard to a chemical process, the reaction of hydrogen with chloride to produce hydrogen chloride: $\text{H}_2 + \text{Cl}_2(\text{g}) \rightarrow 2\text{HCl}(\text{g})$ The balanced equation shows that hydrogen and chlorine react in a ratio of 1:1 stoichiometric. If these reactives are provided in any other amount, one of the reactives will almost always be completely consumed, thus limiting the amount of product that can be generated. This substance is the limiting reactor, and the other substance is the reactive excess. Identifying limiting and excess reagents for a given situation requires processing quantity of each reactor supplied and comparing them with the stoichiometric amounts represented in the balanced chemical equation. For example, imagine combining 3 h2 and 2 cl2 moles. This represents a 3:2 (or 1.5:1) ratio of hydrogen to chlorine present for reaction, which is greater than the 1:1 stoichiometric ratio. Hydrogen, therefore, is present in excess, and chlorine is the limiting reactor, the reaction of all the chlorine supplied (2 mol) will consume 2 mol of the 3 mol of hydrogen supplied, leaving 1 mol of hydrogen unreacted. an alternative approach to the identification of the limiting reactor involves comparing the quantity of product envisaged for the complete reaction of each reactor. each reactivating amount is used to calculate separately the amount of product that would be formed for the stoichiometry of the reaction, the reactor producing the least quantity of product is the limiting reactor. For example, in the preceding paragraph, the complete reaction of hydrogen would yield: $\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$ since sufficient hydrogen has been supplied to produce 6 hcl, there will be no remaining hydrogen once this reaction is complete. Therefore, it is the limiting reactor and hydrogen is the reactive excess (Figure 2). Figure 3: When H2 and Cl2 are combined in non-stoichiometric quantities, one of these reactives will limit the amount of HCl that can be produced. This illustration shows a reaction in which hydrogen is present in excess and chlorine is the limiting reactor. A similar situation exists for many chemical reactions: it is usually performed by a reactor before all other reactors reacted. The reactor from which the limiting reactor is used is called; other reactors or reagents are considered to be excess. A crucial ability to assess the conditions of a chemical process is to determine which reactor is the limiting reactor and which is excess. How to identify Reactant Limitant (Limiting Reagent) There are two ways to determine the limiting reactor. One method is to find and compare the ratio of size of the reactives used in the reaction (Approx 1). Another way is to calculate the grams of products produced by the dates of reactive quantities; the reactor producing the smallest amount of product is the limiting reactor (Approx 2). This section will focus more on the second method. Approach 1 (the "Reactor Pier Report Method"): Find the limiting reactor by looking at the number of molecules of each reactor. Determine the balanced chemical equation for the chemical reaction. Convert all the information provided to mole (very likely, thorough molar mass as a conversion factor.) calculates the ratio moles from the information indicated. compare the calculated ratio with the real ratio. use the limiting amount of reactor to calculate the quantity of product. if necessary, calculate how much is left in excess of the non-limiting reactor (excess.) approach 2 (the method of the product): Find the limiting reactor by calculating and comparing the quantity of product that each reactor will produce. balance the chemical equation for the chemical reaction. convert the information provided to mole. use the stoichiometry for each reactor to find the product mass. the reactor producing a lower quantity of product is the limiting reactor. the reactor producing a greater quantity of product is the excess reagent. to find the remaining excess reagent quantity, subtract the excess reagent mass consumed by the total mass of excess reagent given. the key to recognizing which reactor is the limiting reactor is based on a mass or mass calculation: any reactor gives the least amount of product is the limiting reactor. what we have to do is determine a quantity of a product (or mass) taking all reacts. any reactor gives the minimum quantity of that particular product is the limiting reactor. no matter which product we hate, until we do the same every time. no matter if you determine the number of molesgrams of that product; However, we will shortly see that knowing the final mass of product can be useful. example 1: Identify the limiting reactant as an example, consider the balanced equation $\text{C}_2\text{H}_3\text{Br}_3 + 11 \text{O}_2 \rightarrow 8 \text{CO}_2 + 6 \text{H}_2\text{O} + 6 \text{Br}_2$ number 1 which is the limiting reactor if 76.4 grams of $\text{C}_2\text{H}_3\text{Br}_3$ reacted with 49.1 grams of solution using approach 1: Step 1: Balance the chemical equation. the equation is already balanced with the ratio 4 mol $\text{C}_2\text{H}_3\text{Br}_3$ to 11 mol O_2 to 6 mol H_2O to 6 mol Br_2 step 2: convert all the information provided in mole. I'm sorry. O_2 number 1 step 3: calculates the ratio moles from the information indicated. compare the calculated ratio with the real ratio, assuming that all oxygen is used. $1.53 \text{ mol O}_2 \times \frac{1 \text{ mol C}_2\text{H}_3\text{Br}_3}{11 \text{ mol O}_2} = 0.556 \text{ mol C}_2\text{H}_3\text{Br}_3$ are necessary, since 0.556 $\text{C}_2\text{H}_3\text{Br}_3$ molecules required > 0.286 $\text{C}_2\text{H}_3\text{Br}_3$ molecules available, $\text{C}_2\text{H}_3\text{Br}_3$ is the limiting reactor. using approach 2: step 1: balance the chemical equation, the equation is already balanced with the ratio 4 mol $\text{C}_2\text{H}_3\text{Br}_3$ to 11 mol O_2 to 6 mol H_2O to 6 mol Br_2 step 2 and step 3: to harassment and stoichiometry. $\times \text{CO}_2$ number 1 Step 4: The reactor producing a smaller quantity of product is the limiting reactor. Therefore, with both methods, $\text{C}_2\text{H}_3\text{Br}_3$ is the limiting reactor. Example 2: Identifying the Reactant Limitant and Mass of Excess Reactant For example, in the reaction of metal and magnesium oxygen, calculate the mass of magnesium oxide that can be produced if 2.40 g Mg reacts with 10.0 g O_2 . Also determine the amount of excess reagent. MgO is the only product in the reaction. Solution After Approach 1: Step 1: Equilibrate the chemical equation. $2 \text{Mg (s)} + \text{O}_2 (\text{g}) \rightarrow 2 \text{MgO (s)}$ The balanced equation provides the ratio of 2 Mg to 1 Mg O_2 to 2 MgO Step 2 and Step 3: Convert mass into mass and stoichiometry. $2.40 \text{ g Mg} \times \frac{1 \text{ mol Mg}}{24.31 \text{ g/mol}} \times \frac{2 \text{ mol MgO}}{2 \text{ mol Mg}} = 2.40 \text{ g MgO}$ Step 4: The reactor producing a smaller quantity of product is the limiting reactor. Mg produces less MgO than O_2 (3.98 g MgO vs 25.2 g MgO), so Mg is the limiting reactor in this reaction. Step 5: The reactor producing a greater quantity of product is the excess reagent. O_2 produces more MgO quantities than Mg (25.2g MgO vs. 3.98 MgO), so O_2 is the reactive excess in this reaction. Step 6: Find the remaining excess reagent by subtracting the excess reactor mass consumed by the total excess reagent mass given. Excess reactor mass calculated using the limiting reactor: $2.40 \text{ g Mg} \times \frac{1 \text{ mol MgO}}{24.31 \text{ g/mol}} \times \frac{2 \text{ mol MgO}}{2 \text{ mol Mg}} = 2.40 \text{ g MgO}$ Excess reactor mass calculated using product mass: $10.0 \text{ g O}_2 \times \frac{1 \text{ mol MgO}}{40.31 \text{ g/mol}} \times \frac{2 \text{ mol MgO}}{1 \text{ mol O}_2} = 4.97 \text{ g MgO}$ Therefore, O_2 is excess. Example 3: Limit Reactant What is the limiting reactor if 78.0 grams of Na_2O_2 were reacted with 29.4 grams of H_2O ? The unbalanced chemical equation is $\text{Na}_2\text{O}_2(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{NaOH}(\text{aq}) + \text{H}_2\text{O}_2(\text{l})$ Solution Steps for problem solving- The Product Method Example 1: Identify the information provided and what the problem asks you to find. Data: 78.0 grams of Na_2O_2 29.4 g H_2O Find: limiting reactor Lists other known quantities. 1 mol $\text{Na}_2\text{O}_2 = 77.96 \text{ g/mol}$ 1 mol $\text{H}_2\text{O} = 18.02 \text{ g/mol}$ Since the quantity of product in grams is not necessary, only molar mass of reactors is necessary. $\text{Na}_2\text{O}_2(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow 2\text{NaOH}(\text{aq}) + \text{H}_2\text{O}_2(\text{l})$ The balanced equation provides the ratio of 1 Na_2O_2 to 2 H_2O 2mol NaOH to 1 H_2O_2 mol Prepare a concept map and use the correct conversion factor. 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As the question poses which magnesium mass is formed, we can perform two mass calculations and determine which quantity is lower. $5.00 \text{ g Rb} \times \frac{1 \text{ mol Mg}}{24.31 \text{ g/mol}} \times \frac{1 \text{ mol Mg}}{2 \text{ mol Rb}} = 0.103 \text{ mol Mg}$ $3.44 \text{ g MgCl}_2 \times \frac{1 \text{ mol Mg}}{95.21 \text{ g/mol}} \times \frac{1 \text{ mol Mg}}{1 \text{ mol MgCl}_2} = 0.036 \text{ mol Mg}$ Since the quantity of product in grams is not necessary, only molar mass of reactors is necessary. $\text{Na}_2\text{O}_2(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow 2\text{NaOH}(\text{aq}) + \text{H}_2\text{O}_2(\text{l})$ The balanced equation provides the ratio of 1 Na_2O_2 to 2 H_2O 2mol NaOH to 1 H_2O_2 mol Prepare a concept map and use the correct conversion factor. As the question asks only the limiting reactor, we can perform two mass-moles calculations and determine which amount is lower. 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