Limiting reagent questions

Problem 1: In a combustion reaction, 10g of sucrose and 10g of oxygen are reacting. To find the limiting reagent, calculate the moles of each substance. The ratio of oxygen to sucrose is 12:1, so more oxygen is required than is available. Therefore, oxygen is the limiting reagent. **Problem 2:** When 50 molecules of NaBr3 and 57 formula units of NaOH react, how many NaBr formula units are formed? Treat numbers of molecules or formula units as moles. Calculate the limiting reagent by dividing by the coefficients in the balanced equation. Since NaOH is the limiting reagent, use its molar ratio with NaBr to find the number of NaBr formula units produced. **Problem 3:** When aluminum reacts with chlorine gas to form aluminum chloride, how many grams of aluminum chloride can be produced from 34g of aluminum and 39g of chlorine gas? Calculate the moles of each substance and determine the limiting reagent. Since chlorine is the limiting reagent, use its molar ratio with aluminum chloride to find the number of moles produced. Finally, convert this amount to grams. Note: The problems are presented in a straightforward manner, without any additional explanations or comments. To find the mass of aluminum remaining after a reaction, use the proper molar ratio. Alternatively, calculate the amount of Al reacted and unreacted by subtracting masses from each other. However, this method only works when all substances in the reaction have known masses. Next, solve three problems related to chemical reactions: Problem #4: * 3 atoms of carbon combine with 4 molecules of hydrogen to produce methane (CH4) * 7 molecules of hydrogen and 2 molecules of nitrogen gases react to produce ammonia * 4 molecules of hydrogen and 5 molecules of chlorine react For problem a), the balanced equation is C + 2H2 --> CH4. The carbon-hydrogen molar ratio is 1:2, meaning one atom of carbon reacts with two molecules of hydrogen. To determine the limiting reagent, compare the mole ratios: * Carbon: 3/1 = 3 (hydrogen) - Hydrogen is the limiting reagent. * Amount of carbon consumed: 1 is to 2 as x is to 4; x = 2 * Remaining amount of carbon (excess): 3 - 2 = 1 atom remaining For problem b), the balanced equation is N2 + 3H2 --> 2NH3. The molar ratio of nitrogen to hydrogen is 1:3, with nitrogen being the limiting reagent. One molecule of hydrogen remains. For problem c), the balanced equation is H2 + Cl2 --> 2HCl. Chlorine is in excess by one molecule. Problem #5: * 316.0 g aluminum sulfide reacts with 493.0 g of water * What mass of the excess reactant (aluminum sulfide) remains? The unbalanced equation is Al2S3 + H2O --> Al(OH)3 + H2S. To solve this, balance the equation: Al2S3 + 6H2O --> 2Al(OH)3 + 3H2S. Then, determine the limiting reagent and calculate the grams of water that react. Finally, Problem #6: * CaCO3 reacts with HCl * What mass of CaCO3 remains unreacted? First, verify that HCl is the limiting reagent by comparing mole ratios. Then, calculate the amount of CaCO3 remaining using the molar ratio from the equation. To calculate the amount of xenon tetrafluoride (XeF4) produced, we need to determine which reactant (Xe or F2) is limiting. We start by writing the balanced chemical equation: Xe(g) + 2F2(g) → XeF4(g). Next, we calculate the number of moles of Xe present using the ideal gas law: PV = nRT. With a pressure of 0.893 atm and a volume of 20.0 L at 673 K, we find that there are approximately 0.323396 mol of Xe. We then use a ratio to determine the number of moles of XeF4 produced if Xe is the limiting reagent: 1 mol Xe → 0.323396 mol XeF4. Using this proportion, we calculate the expected yield if Xe were the limiting reagent. However, F2 is actually found to be the limiting reagent. We repeat the calculation for F2: (1.37 atm) (20.0 L) = nRT, and we find that there are approximately 0.49614 mol of F2. Using a ratio, we calculate the expected yield if F2 were the limiting reagent. Since F2 is the limiting reagent, we know that only 0.248085 mol of XeF4 will be produced. To find the mass of XeF4 produced, we multiply this amount by its molar mass (207.2836 g/mol). **Example 1** A reaction involves the combustion of glucose (C6H12O6) to produce carbon dioxide (CO2). * The amount of glucose reacted is given as 3.2/180 = 0.018 mol. * From the equation, CO2 is produced in a ratio of 6:1 with glucose. * Therefore, the moles of CO2 produced are 6 x 0.018 = 0.11 mol. * The mass of CO2 produced is then calculated as 0.11 x 44 = 4.8 g. **Example 2** A reaction involves the combination of rubidium hydroxide (RbOH) and phosphoric acid (H3PO4) to form rubidium phosphate (Rb3PO4). * The moles of RbOH are given as 6.02/102 = 0.059 mol. * The moles of H3PO4 are given as 8.3/98 = 0.085 mol. * Since the moles of RbOH (0.059) is less than the moles of H3PO4 (0.085), RbOH is the limiting reactant. * The mass of Rb3PO4 formed is then calculated as 0.020 x 350 = 7.0 g. **General Information** A limiting reactant is a reactant in a reaction that is not in excess, and the amount of product formed is directly proportional to the amount of limiting reactant used. In general chemistry problems, it's essential to: * Break down calculations into steps * Identify the limiting reactant * Calculate the mass of products formed The provided examples demonstrate these concepts, with step-by-step calculations and clear explanations. Step 3: Determine Which Reactant is in Excess. Moles of HCl are less than moles of NaOH, so NaOH is in excess. This online quiz provides extra practice in performing stoichiometric conversions, including limiting reagent and percent yield problems, aligning with the HS-PS1-7 NGSS standard. Twelve grams of sodium react with 20g of water. Which reagent is limiting? Sixty kilograms of methane are reacted with 42kg of steam. Which reagent is limiting? One tonne of sulfur reacts with 1.2 tonnes of oxygen, producing sulfur dioxide. Which reagent is limiting? One tonne of sulfur dioxide reacts with 1.2 tonnes of oxygen, producing sulfur trioxide. Which reagent is limiting? Forty-six kilograms of nitrogen react against 20kg of hydrogen. Which reagent is limiting? One hundred grams of fluorine react against 90g of calcium. Which reagent is limiting? Eighteen grams of copper oxide react against 24g of carbon. Which reagent is limiting? Forty grams of propane react with 35g of oxygen. Which reagent is limiting? A five-gram piece of sodium reacts with 12cm3 of 0.1moldm-3 of HCl. Which reagent is limiting? Thirty-two kilograms of methane react with 20m3 of oxygen. Which reagent is limiting? Forty grams of phosphorous trichloride react with 25 cm3 of 1moldm-3 potassium iodide. Which reagent is limiting? Fifty grams of iodine were reacted with 50dm3 of fluorine gas, forming iodine pentafluoride. Which reagent is limiting? Fifty cubic meters of nitrogen was reacted with 80 cubic meters of hydrogen. Which reagent is limiting? Acidified KMnO4 reacts with KCl ions in the reaction given below. If you started with 5cm3 of 0.2moldm-3 KMnO4, 8cm3 of 0.5moldm-3 H2SO4 and 10cm3 of 0.2moldm-3 KCl, which reagent is limiting? A substance or compound added to a system to initiate or test a chemical reaction is known as an analytical reagent. Reactant and reagent are often used interchangeably, but reactant refers specifically to substances consumed during a chemical reaction. The limiting reactant (or limiting reagent) is the substance that gets consumed first in a chemical reaction, limiting the amount of product that can be formed. Determining the limiting reactant involves using mole ratios from balanced chemical equations. The theoretical yield is the amount of product that can be formed based on the limiting reactant, but actual yields are typically less than theoretical due to factors like incomplete reactions or impurities. In a reaction between silicon nitride (Si3N4) and nitrogen gas (N2), 125 g of Si3N4 would require approximately 79.1 g of Si if the percent yield is 95%. A limiting reactant is the substance that gets used up first, preventing more product from being made. When 1 mole of ammonia (NH3) and 1 mole of O2 are mixed in a reaction producing NO, only 0.8 moles of NO will be formed. In a reaction between marble (calcium carbonate) and dilute hydrochloric acid, the hydrochloric acid is present in excess. A limiting reagent is a reactant that occurs in lower concentrations in a reaction, determining the amount of product produced by getting consumed first. The limiting reagent is the substance that runs out first in a chemical reaction, determining how much product can be formed. To identify the limiting reagent, compare the calculated amount of each reactant needed for the reaction to the actual amount available. The examples below illustrate how to apply this concept: 1. Combining 4.95g of ethylene (C2H4) and 3.25g of oxygen, the limiting reagent is oxygen. 2. In the reaction 2H2 + O2 → 2H2O, the limiting reactant is hydrogen because it's used up twice as fast as oxygen. 3. Mixing 50kg of N2 and 10kg of H2 to produce NH3, the limiting reagent is dihydrogen (H2) because more H2 is needed than available. 4. Combining 7.8moles of Mg and 4.7moles of O2 to form MgO, the limiting reagent is magnesium (Mg). 5. Reacting 5moles of A with 6moles of B to form C and D, the limiting reagent is B because it's used up first. 6. Combining 75g of C2H3Br3 with 50g of O2 to form CO2, H2O, and Br2, the limiting reagent is C2H3Br3. 7. Reacting 80g of Na2O2 with 30g of H2O to form NaOH and O2, the limiting reagent is Na2O2. Practise questions on the limiting reagent include: 1. The reactant which is not consumed completely in the reaction is __________. 2. Identify the limiting reagent in the following reaction mixtures: (i) 300 atoms of A + 200 molecules of B, (ii) 2 mol A + 3 mol B, etc. These examples demonstrate how to determine the limiting reagent by comparing calculated and actual amounts of reactants needed for a chemical reaction. The concept of a limiting reagent is crucial in understanding the quantity of products produced in a chemical reaction. It refers to the reactant that determines the maximum amount of product formed, known as the theoretical yield. The other reactants present may be in excess, with some leftover quantity after the limiting reagent is completely consumed. In the reaction 2A + 4B⟶ 3C + 4D, if 5 moles of A react with 6 moles of B, the limiting reagent needs to be identified. Considering the mole ratio of the reactants, it can be seen that 10 moles of B are required to completely react with 5 moles of A. However, only 6 moles of B are available, making B the limiting reagent. To calculate the percentage yield, given an actual yield of 29.3 grams and a theoretical yield of 35.0 grams, we can use the formula: (Actual Yield / Theoretical Yield) x 100 = % Yield. Substituting the values, we get (29.3 / 35.0) x 100 = 83.6%. This indicates that the actual yield is approximately 83.6% of the theoretical yield. In a chemical reaction involving 6 g of H2 and 14 g of N2 to form NH3 until the limiting reagent is completely consumed, we need to determine which reactant will be left over in grams. Considering the stoichiometry of the reaction, if all 6 g of H2 reacts with some amount of N2, it would require a corresponding quantity of H2 to completely consume it. Since there are multiple ways to identify the limiting reagent and calculate excess quantities, understanding the mole ratio and stoichiometry of chemical reactions is essential. Determining the Limiting Reagent in a Chemical Reaction To identify the limiting reagent in a chemical reaction, two primary methods are employed: comparing mole ratios and calculating product amounts. These approaches help determine which reactant is consumed first, thereby limiting the production of the final product. **Method 1: Mole Ratio Comparison** 1. **Balance the Chemical Equation**: Begin by balancing the given chemical equation to ensure it represents the reaction accurately. 2. **Convert Information into Moles**: Convert all given information (amounts or masses) into moles using molar mass as a conversion factor. 3. **Calculate and Compare Ratios**: Determine the mole ratio between reactants from the balanced equation and compare this with the calculated ratio from the given information. 4. **Determine Product and Excess Reagent**: Use the amount of limiting reagent to calculate the product produced, then determine the excess reagent by subtracting the consumed mass from the total given. **Method 2: Calculating Product Amounts** 1. **Balance the Equation**: Balance the chemical equation as in Method 1. 2. **Convert Information into Moles**: Convert all information into moles. 3. **Use Stoichiometry for Each Reactant**: For each reactant, use stoichiometry to find how much product would be produced (considering the mole ratio from the balanced equation). 4. **Identify Limiting and Excess Reagents**: The reactant producing a smaller amount of product is the limiting reagent; the one producing more is in excess. **Example Problem** Given: 76.4 grams of C2H3Br3 reacts with 49.1 grams of O2 to produce products. Solution: Using Method 1, calculate moles for both reactants and compare ratios or use Method 2 by calculating product amounts from the given quantities, then determine which is limiting based on these calculations. For both methods, conclude that C2H3Br3 is the limiting reagent due to insufficient availability compared to required consumption for complete reaction with all oxygen provided. Actual reaction output falls short of predicted maximum output. A percentage representation is often used to show the extent to which the real outcome deviates from ideal expected results.