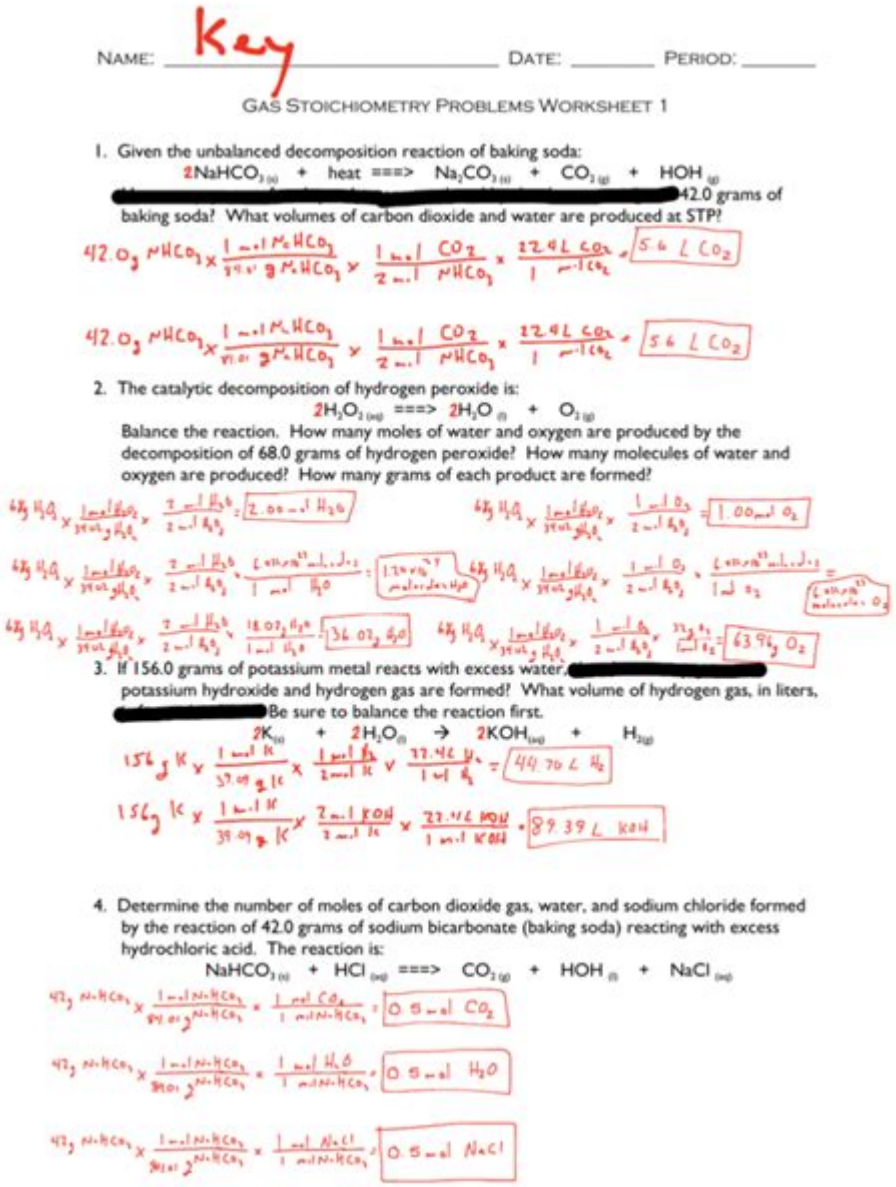
Gas Stoichiometry Worksheet Answer Key



NAME: Key DATE: _____ PERIOD: _____

GAS STOICHIOMETRY PROBLEMS WORKSHEET 1

1. Given the unbalanced decomposition reaction of baking soda:

$2NaHCO_{3(s)} + \text{heat} \Longrightarrow Na_2CO_{3(s)} + CO_{2(g)} + HOH_{(g)}$

[redacted] 42.0 grams of baking soda? What volumes of carbon dioxide and water are produced at STP?

$42.0\ g\ NaHCO_3 \times \frac{1\ mol\ NaHCO_3}{84.01\ g\ NaHCO_3} \times \frac{1\ mol\ CO_2}{2\ mol\ NaHCO_3} \times \frac{22.4\ L\ CO_2}{1\ mol\ CO_2} = 5.6\ L\ CO_2$

$42.0\ g\ NaHCO_3 \times \frac{1\ mol\ NaHCO_3}{84.01\ g\ NaHCO_3} \times \frac{1\ mol\ CO_2}{2\ mol\ NaHCO_3} \times \frac{22.4\ L\ CO_2}{1\ mol\ CO_2} = 5.6\ L\ CO_2$

2. The catalytic decomposition of hydrogen peroxide is:

$2H_2O_{2(aq)} \Longrightarrow 2H_2O_{(l)} + O_{2(g)}$

Balance the reaction. How many moles of water and oxygen are produced by the decomposition of 68.0 grams of hydrogen peroxide? How many molecules of water and oxygen are produced? How many grams of each product are formed?

$68\ g\ H_2O_2 \times \frac{1\ mol\ H_2O_2}{34.02\ g\ H_2O_2} \times \frac{2\ mol\ H_2O}{2\ mol\ H_2O_2} = 2.00\ mol\ H_2O$

$68\ g\ H_2O_2 \times \frac{1\ mol\ H_2O_2}{34.02\ g\ H_2O_2} \times \frac{1\ mol\ O_2}{2\ mol\ H_2O_2} = 1.00\ mol\ O_2$

$68\ g\ H_2O_2 \times \frac{1\ mol\ H_2O_2}{34.02\ g\ H_2O_2} \times \frac{2\ mol\ H_2O}{2\ mol\ H_2O_2} \times \frac{6.02 \times 10^{23}\ molecules\ H_2O}{1\ mol\ H_2O} = 1.20 \times 10^{24}\ molecules\ H_2O$

$68\ g\ H_2O_2 \times \frac{1\ mol\ H_2O_2}{34.02\ g\ H_2O_2} \times \frac{1\ mol\ O_2}{2\ mol\ H_2O_2} \times \frac{6.02 \times 10^{23}\ molecules\ O_2}{1\ mol\ O_2} = 6.02 \times 10^{23}\ molecules\ O_2$

$68\ g\ H_2O_2 \times \frac{1\ mol\ H_2O_2}{34.02\ g\ H_2O_2} \times \frac{2\ mol\ H_2O}{2\ mol\ H_2O_2} \times \frac{18.02\ g\ H_2O}{1\ mol\ H_2O} = 36.02\ g\ H_2O$

$68\ g\ H_2O_2 \times \frac{1\ mol\ H_2O_2}{34.02\ g\ H_2O_2} \times \frac{1\ mol\ O_2}{2\ mol\ H_2O_2} \times \frac{32\ g\ O_2}{1\ mol\ O_2} = 63.9\ g\ O_2$

3. If 156.0 grams of potassium metal reacts with excess water, [redacted] potassium hydroxide and hydrogen gas are formed? What volume of hydrogen gas, in liters, [redacted] Be sure to balance the reaction first.

$2K_{(s)} + 2H_2O_{(l)} \rightarrow 2KOH_{(aq)} + H_{2(g)}$

$156\ g\ K \times \frac{1\ mol\ K}{39.09\ g\ K} \times \frac{1\ mol\ H_2}{2\ mol\ K} \times \frac{22.4\ L\ H_2}{1\ mol\ H_2} = 44.7\ L\ H_2$

$156\ g\ K \times \frac{1\ mol\ K}{39.09\ g\ K} \times \frac{2\ mol\ KOH}{2\ mol\ K} \times \frac{22.4\ L\ KOH}{1\ mol\ KOH} = 89.3\ L\ KOH$

4. Determine the number of moles of carbon dioxide gas, water, and sodium chloride formed by the reaction of 42.0 grams of sodium bicarbonate (baking soda) reacting with excess hydrochloric acid. The reaction is:

$NaHCO_{3(s)} + HCl_{(aq)} \Longrightarrow CO_{2(g)} + HOH_{(l)} + NaCl_{(aq)}$

$42\ g\ NaHCO_3 \times \frac{1\ mol\ NaHCO_3}{84.01\ g\ NaHCO_3} \times \frac{1\ mol\ CO_2}{1\ mol\ NaHCO_3} = 0.5\ mol\ CO_2$

$42\ g\ NaHCO_3 \times \frac{1\ mol\ NaHCO_3}{84.01\ g\ NaHCO_3} \times \frac{1\ mol\ H_2O}{1\ mol\ NaHCO_3} = 0.5\ mol\ H_2O$

$42\ g\ NaHCO_3 \times \frac{1\ mol\ NaHCO_3}{84.01\ g\ NaHCO_3} \times \frac{1\ mol\ NaCl}{1\ mol\ NaHCO_3} = 0.5\ mol\ NaCl$

Gas Stoichiometry Worksheet Answer Key: Mastering Mole Ratios in Gases

Are you struggling with gas stoichiometry problems? Feeling lost in a sea of moles, liters, and pressure conversions? You're not alone! Gas stoichiometry can be challenging, but mastering it is crucial for success in chemistry. This comprehensive guide provides a detailed explanation of gas stoichiometry, along with a sample worksheet and its answer key, to help you conquer this important topic. We'll break down the concepts, offer step-by-step solutions, and equip you with the skills to confidently tackle any gas stoichiometry problem. Let's dive in!

Understanding Gas Stoichiometry: A Foundation for

Success

Before we jump into the worksheet, let's solidify our understanding of the fundamentals. Gas stoichiometry involves applying stoichiometric principles—the relationship between reactants and products in a chemical reaction—specifically to gases. This means incorporating the Ideal Gas Law (PV = nRT) into our calculations. We'll be working with moles, molar masses, volumes (often at STP or standard temperature and pressure), and sometimes pressure and temperature.

Key Concepts to Master:

Ideal Gas Law (PV = nRT): This equation is your best friend. Understanding how to manipulate it to solve for different variables (pressure (P), volume (V), number of moles (n), temperature (T), and the ideal gas constant (R)) is essential.
Molar Volume: At standard temperature and pressure (STP: 0°C and 1 atm), one mole of any ideal gas occupies approximately 22.4 liters. This is a vital conversion factor.
Stoichiometric Ratios: These ratios, derived from the balanced chemical equation, tell us the relative amounts of reactants and products involved in a reaction. They are the bridge between moles of one substance and moles of another.
Unit Conversions: Accuracy relies heavily on consistent unit conversions. Make sure all your units are compatible with the ideal gas constant you choose (R).

Sample Gas Stoichiometry Worksheet Problems

Let's work through some example problems to illustrate the application of these concepts. This worksheet focuses on common scenarios encountered in introductory chemistry courses.

(Note: The following problems are illustrative. Your actual worksheet may differ.)

Problem 1: Consider the reaction: $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$. If 5.0 liters of hydrogen gas react at STP, what volume of oxygen gas is required?

Problem 2: The combustion of propane (C_3H_8) produces carbon dioxide and water. If 10.0 grams of propane are burned, what volume of CO_2 is produced at 25°C and 1.2 atm?

Problem 3: Ammonia (NH_3) is synthesized from nitrogen and hydrogen gases. If 2.00 liters of nitrogen gas react with excess hydrogen at STP, what mass of ammonia is produced?

Gas Stoichiometry Worksheet Answer Key: Detailed Solutions

Here's a step-by-step solution for each problem in the sample worksheet. Remember to always show your work to ensure you understand each step of the process.

Problem 1 Solution:

1. Moles of H_2: Using molar volume at STP (22.4 L/mol), we find moles of H_2: (5.0 L)/(22.4 L/mol) = 0.223 mol H_2
2. Moles of O_2: From the balanced equation, the mole ratio is 1 mol O_2: 2 mol H_2. Thus, moles of O_2 = (0.223 mol H_2) (1 mol O_2/2 mol H_2) = 0.112 mol O_2
3. Volume of O_2: Using molar volume, volume of O_2 = (0.112 mol O_2) (22.4 L/mol) = 2.50 L O_2

Problem 2 Solution:

1. Moles of C_3H_8: Calculate moles of C_3H_8 using its molar mass (44.1 g/mol): (10.0 g)/(44.1 g/mol) = 0.227 mol C_3H_8
2. Moles of CO_2: The balanced equation is $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$. The mole ratio is 3 mol CO_2: 1 mol C_3H_8. Moles of CO_2 = (0.227 mol C_3H_8) (3 mol CO_2/1 mol C_3H_8) = 0.681 mol CO_2
3. Volume of CO_2: Use the Ideal Gas Law (PV=nRT), R = 0.0821 L·atm/mol·K, T = 298 K (25°C + 273). V = (nRT)/P = (0.681 mol 0.0821 L·atm/mol·K 298 K) / 1.2 atm = 13.9 L CO_2

Problem 3 Solution:

1. Moles of N_2: At STP, moles of N_2 = (2.00 L)/(22.4 L/mol) = 0.0893 mol N_2
2. Moles of NH_3: The balanced equation is $N_2 + 3H_2 \rightarrow 2NH_3$. The mole ratio is 2 mol NH_3: 1 mol N_2. Moles of NH_3 = (0.0893 mol N_2) (2 mol NH_3/1 mol N_2) = 0.179 mol NH_3
3. Mass of NH_3: Using the molar mass of NH_3 (17.0 g/mol), mass of NH_3 = (0.179 mol NH_3) (17.0 g/mol) = 3.04 g NH_3

Conclusion

Gas stoichiometry may seem daunting at first, but with a solid understanding of the Ideal Gas Law, stoichiometric ratios, and careful attention to units, you can master it. Practice is key. Work through various problems, checking your answers against the solutions provided. Don't hesitate to seek help from your instructor or peers if you encounter difficulties. With consistent effort, you'll confidently navigate the world of gas stoichiometry.

FAQs

Q1: What is the Ideal Gas Constant (R), and why are there different values? The Ideal Gas Constant relates pressure, volume, temperature, and the number of moles. Different values of R reflect different units of measurement (e.g., L·atm/mol·K, J/mol·K). Choose the value consistent with the units in your problem.

Q2: What is STP, and why is it important in gas stoichiometry? STP (Standard Temperature and Pressure) provides a standardized reference point (0°C and 1 atm) for comparing gas volumes, simplifying calculations using the molar volume of 22.4 L/mol.

Q3: How do I handle limiting reactants in gas stoichiometry problems? Identify the limiting reactant by comparing the mole ratios of reactants to the stoichiometric ratios from the balanced equation. The reactant that produces the least amount of product is limiting.

Q4: What if the gas isn't ideal? The Ideal Gas Law assumes no intermolecular forces and negligible gas particle volume. At high pressures or low temperatures, deviations from ideality occur, requiring more complex equations like the van der Waals equation.

Q5: Where can I find more practice problems? Your textbook, online chemistry resources, and practice websites offer numerous gas stoichiometry problems to further hone your skills. Remember to check your answers against solutions!

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