Consider The Balanced Reaction Of Magnesium And Oxygen. 2 M G O 2 2 M G O What Mass, In Grams, Of Mgo

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Understanding chemical reactions is fundamental in chemistry, especially when it involves common elements like magnesium and oxygen. When magnesium reacts with oxygen, it forms magnesium oxide (MgO), a compound with numerous applications ranging from refractory materials to medical uses. This article delves into the balanced chemical equation for this reaction, how to interpret the stoichiometry involved, and ultimately, how to calculate the mass of magnesium oxide produced in a typical reaction scenario.

The Balanced Chemical Equation: Magnesium Reacting with Oxygen

Writing the Unbalanced Equation

The initial step in understanding any chemical reaction is to write the unbalanced formula. Magnesium (Mg), a metal, reacts with oxygen (O_2), a diatomic molecule, to produce magnesium oxide (MgO). The unbalanced reaction looks like this:

$Mg + O_2 \rightarrow MgO$

Balancing the Equation

To ensure the law of conservation of mass holds true, the number of atoms for each element must be the same on both sides of the reaction. Magnesium oxide consists of magnesium and oxygen atoms in a 1:1 ratio. Since oxygen appears as O_2 (two oxygen atoms), the balanced equation requires adjusting the coefficients:

$2\ Mg + O_2 \rightarrow 2\ MgO$

This balanced equation indicates that 2 moles of magnesium react with 1 mole of oxygen to produce 2 moles of magnesium oxide.

Understanding the Stoichiometry of the Reaction

Mole Ratios in the Reaction

From the balanced equation, the mole ratios are clear:
- 2 moles of Mg produce 2 moles of MgO
- 1 mole of O_2 produces 2 moles of MgO

These ratios are crucial for calculating the mass of MgO formed from a given amount of magnesium or oxygen.

Implications for Mass Calculations

Knowing the molar masses:
- Magnesium (Mg): approximately 24.305 g/mol
- Oxygen (O): approximately 16.00 g/mol
- Magnesium oxide (MgO): approximately 40.31 g/mol

The molar ratios help convert between mass and moles, enabling us to determine how much MgO is formed from a specific amount of magnesium or oxygen.

Calculating the Mass of Magnesium Oxide Formed

Given Data and Assumptions

Suppose the question involves a scenario where 2 grams of magnesium react with oxygen. The task is to find the mass of MgO produced.

Step 1: Convert grams of magnesium to moles
$$
\text{Moles of Mg} = \frac{\text{Mass of Mg}}{\text{Molar mass of Mg}} = \frac{2 \text{ g}}{24.305 \text{ g/mol}} \approx 0.0823 \text{ mol}
$$

Step 2: Use the mole ratio from the balanced equation
From the balanced reaction:

2 Mg : 2 MgO

This simplifies to 1 Mg : 1 MgO, meaning that 1 mole of magnesium produces 1 mole of magnesium oxide.

Number of moles of MgO produced:
$$
\[

$$
0.0823 \text{ mol Mg} \times \frac{2 \text{ mol MgO}}{2 \text{ mol Mg}} = 0.0823 \text{ mol MgO}
$$

Step 3: Convert moles of MgO to grams

$$
\text{Mass of MgO} = \text{Moles of MgO} \times \text{Molar mass of MgO}
$$

$$
= 0.0823 \text{ mol} \times 40.31 \text{ g/mol} \approx 3.32 \text{ g}
$$

Result: Approximately 3.32 grams of magnesium oxide are formed when 2 grams of magnesium react completely with oxygen.

Factors Affecting the Reaction and Yield

Purity of Reactants

Impurities in magnesium or oxygen can affect the amount of MgO produced. Ensuring high purity materials leads to more predictable and efficient reactions.

Reaction Conditions

Temperature and pressure influence the reaction rate and completeness:
- Higher temperatures typically increase reaction rates.
- Adequate oxygen supply is necessary for complete oxidation.

Limitations and Side Reactions

In practical scenarios, side reactions or incomplete reactions can reduce yields. Proper control of reaction conditions minimizes such issues.

Applications and Significance of Magnesium Oxide

Industrial Uses

- Refractory material in furnace linings
- Insulation in high-temperature applications
- As a refractory brick additive

Medical and Environmental Uses

- Used as an antacid to treat indigestion
- Soil pH correction in agriculture
- Water purification processes

Educational Value

Studying the magnesium-oxygen reaction provides valuable insights into stoichiometry, mole concept, and chemical balancing — foundational principles in chemistry education.

Conclusion: Mastering Stoichiometry for Accurate Calculations

The reaction between magnesium and oxygen exemplifies fundamental chemical principles. By understanding the balanced equation, mole ratios, and molar masses, students and professionals can accurately determine the amount of magnesium oxide produced from a given quantity of magnesium. This knowledge not only aids in academic pursuits but also in real-world applications where precise chemical calculations are essential for safety, efficiency, and cost management. Whether in laboratory settings or industrial processes, mastering these concepts ensures effective and predictable outcomes in chemical reactions involving magnesium and oxygen.

Frequently Asked Questions

What is the balanced chemical equation for the reaction between magnesium and oxygen?

The balanced chemical equation is $2Mg + O_2 \rightarrow 2MgO$.

How do you calculate the mass of magnesium oxide (MgO) produced from a given mass of magnesium?

First, determine the moles of magnesium using its molar mass, then use the stoichiometry from the balanced equation to find moles of MgO, and finally convert moles of MgO to grams using its molar mass.

If 24 grams of magnesium react with excess oxygen, what mass of magnesium oxide is formed?

Moles of Mg = 24 g / 24.305 g/mol ≈ 0.987 mol. Since 2 mol Mg produce 2 mol MgO, MgO produced = 0.987 mol. Mass of MgO = 0.987 mol × 40.305 g/mol ≈ 39.75

grams.

What is the molar mass of magnesium oxide (MgO), and why is it important for calculations?

The molar mass of MgO is approximately 40.305 g/mol. It is important because it allows you to convert moles to grams and vice versa during stoichiometric calculations.

How does the mole ratio in the balanced reaction help determine the amount of product formed?

The mole ratio (2 mol Mg : 2 mol MgO) indicates that the amount of MgO produced is directly proportional to the amount of Mg reacted, enabling calculation of product mass based on the initial reactant mass.

Additional Resources

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Introduction

In the realm of chemical reactions, few are as straightforward and illustrative of fundamental principles as the synthesis of magnesium oxide from magnesium and oxygen. This reaction not only exemplifies the core concepts of chemical balancing and stoichiometry but also offers a window into how elemental properties translate into measurable compound masses. When considering the balanced reaction of magnesium and oxygen—specifically, the equation:

$$ 2 \text{Mg} + \text{O}_2 \rightarrow 2 \text{MgO} $$

—one of the fundamental questions posed is: What mass, in grams, of MgO is produced when a certain amount of magnesium reacts completely with oxygen? This investigation seeks to dissect the reaction in detail, exploring the stoichiometric relationships, underlying principles, and practical calculations necessary to answer this question comprehensively.

The Chemical Reaction: Magnesium and Oxygen

Overview of the Reaction

Magnesium (Mg), a light metal with atomic number 12, readily reacts with

oxygen (O_2), a diatomic molecule, to form magnesium oxide (MgO). This process is highly exothermic and is often demonstrated in laboratory settings to illustrate oxidation reactions.

The balanced chemical equation is:

$$ 2 \text{Mg} (s) + \text{O}_2 (g) \rightarrow 2 \text{MgO} (s) $$

This equation indicates that two moles of magnesium combine with one mole of oxygen gas to produce two moles of magnesium oxide.

Deep Dive into the Stoichiometry

Understanding the Mole Ratios

From the balanced equation, the key mole ratios are:

- Mg : MgO = 2 : 2 = 1 : 1
- O_2 : MgO = 1 : 2

This means:

- For every 2 moles of Mg consumed, 2 moles of MgO are produced.
- For every 1 mole of O_2 consumed, 2 moles of MgO are produced.

These ratios are crucial when calculating the mass of MgO generated from a given amount of magnesium.

Molar Masses

To translate moles into grams, the molar masses are essential:

- Magnesium (Mg): approximately 24.305 g/mol
- Oxygen (O): approximately 16.00 g/mol

Therefore:

- Molar mass of O_2 = 2 × 16.00 g/mol = 32.00 g/mol
- Molar mass of MgO = 24.305 + 16.00 = 40.305 g/mol

Calculating the Mass of MgO Produced

Suppose we start with a known mass of magnesium, say m grams. The goal is to determine how much MgO is produced from this amount.

Step 1: Convert grams of Mg to moles

$$ \text{moles of Mg} = \frac{m}{24.305} $$

Step 2: Use the mole ratio to find moles of MgO

Since the molar ratio of Mg to MgO is 1 : 1:

$$ \text{moles of MgO} = \frac{m}{24.305} $$

Step 3: Convert moles of MgO to grams

$$ \text{mass of MgO} = \text{moles of MgO} \times 40.305 $$

$$ \text{mass of MgO} = \left(\frac{m}{24.305}\right) \times 40.305 $$

Simplifying:

$$ \boxed{
\text{Mass of MgO} = m \times \frac{40.305}{24.305}
} $$

which approximately equals:

$$ \text{Mass of MgO} \approx m \times 1.66 $$

This means that for every gram of magnesium reacted, approximately 1.66 grams of magnesium oxide are produced.

Practical Application: Example Calculation

Question: If 10 grams of magnesium are completely reacted with oxygen, what mass of MgO is formed?

Solution:

Using the derived formula:

$$ \text{Mass of MgO} \approx 10 \times 1.66 = 16.6 \text{ grams} $$

Therefore, 10 grams of magnesium yields approximately 16.6 grams of magnesium oxide upon complete oxidation.

Factors Influencing the Reaction and Yield

While stoichiometry provides the theoretical yield, real-world reactions often deviate due to various factors:

- Reaction Completeness: Not all reactions proceed to 100% completion; some

magnesium may remain unreacted.
- Purity of Reactants: Impurities can reduce the efficiency of the reaction.
- Environmental Conditions: Temperature, pressure, and oxygen availability influence reaction rates and yields.
- Measurement Accuracy: Precise weighing and handling are essential for accurate calculations.

Broader Context: Significance of Magnesium Oxide

Magnesium oxide has numerous industrial and medical applications, including:

- Refractory material in furnace linings
- Dietary supplement for magnesium intake
- Component in fireproofing and insulation

Understanding the stoichiometry of magnesium oxidation is vital for optimizing production processes and ensuring efficient resource utilization.

Conclusion

The balanced chemical reaction between magnesium and oxygen, represented by:

$$ 2 \text{Mg} + \text{O}_2 \rightarrow 2 \text{MgO} $$

serves as a fundamental example of stoichiometric principles in chemistry. By analyzing the molar ratios and molar masses, we can determine the theoretical mass of magnesium oxide produced from a known amount of magnesium.

The key takeaway is that for every gram of magnesium reacted, approximately 1.66 grams of MgO are formed under ideal conditions. This calculation not only highlights the importance of balanced equations in quantitative chemistry but also underscores the practical applications where such knowledge is indispensable.

Whether in laboratory synthesis, industrial manufacturing, or environmental considerations, understanding and applying these principles allow chemists and engineers to control reactions efficiently, minimize waste, and optimize yields—hallmarks of scientific precision and economic efficiency.

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