Calculate How Many Grams Of Oxygen Form When 0.361 G KClO3 Completely Reacts. 2KClO3(s) 2KCl(s) + 3O2(g)Express

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Understanding chemical reactions and stoichiometry is essential for predicting the quantities of products formed from a given amount of reactants. In this article, we will explore how to calculate the mass of oxygen gas produced when a specific mass of potassium chlorate ($KClO_3$) undergoes a complete chemical reaction. This process involves applying molar masses, mole ratios from the balanced chemical equation, and conversion between grams and moles.

Introduction to the Reaction and Its Significance

The decomposition of potassium chlorate ($KClO_3$) is a classic example of a decomposition reaction used in chemistry laboratories for generating oxygen gas. The balanced chemical equation for this reaction is:

- $2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$

This indicates that two moles of potassium chlorate decompose to produce two moles of potassium chloride (KCl) and three moles of oxygen gas (O_2). Understanding this relationship allows chemists to determine the amount of oxygen produced from a given mass of $KClO_3$.

Fundamental Concepts for the Calculation

Before diving into the calculation, it is important to familiarize ourselves with some basic concepts:

Molar Mass

- The molar mass of a compound is the mass of one mole of its molecules or formula units, expressed in grams per mole (g/mol).
- It is calculated by summing the atomic masses of all atoms in the molecule based on the periodic table.

Stoichiometry

- It involves using the coefficients in the balanced chemical equation to relate amounts of reactants and products.
- Mole ratios derived from the balanced equation are essential for converting between different substances involved in the reaction.

Conversions

- Converting grams to moles and vice versa is fundamental in stoichiometric calculations.
- The basic conversions are:
- Moles = Mass (g) / Molar Mass (g/mol)
- Mass (g) = Moles × Molar Mass (g/mol)

Step-by-Step Calculation Process

The goal is to find the mass of oxygen gas produced when 0.361 grams of $KClO_3$ completely reacts.

Step 1: Determine the molar mass of $KClO_3$

Calculate the molar mass of potassium chlorate:

Element	Atomic Mass (g/mol)	Quantity	Total Mass Contribution (g/mol)
Potassium (K)	39.10	1	39.10 × 1 = 39.10
Chlorine (Cl)	35.45	1	35.45 × 1 = 35.45
Oxygen (O)	16.00	3	16.00 × 3 = 48.00

Adding these:

Molar mass of $KClO_3$ = 39.10 + 35.45 + 48.00 = 122.55 g/mol

Step 2: Convert the given mass of $KClO_3$ to moles

Using the molar mass:

Moles of $KClO_3$ = 0.361 g / 122.55 g/mol ≈ 0.002945 mol

Step 3: Use the mole ratio to find moles of O_2 produced

From the balanced equation:

$2\ KClO_3 \rightarrow 3\ O_2$

The mole ratio of $KClO_3$ to O_2 is 2:3.

Thus,

Moles of O_2 = (3/2) × moles of $KClO_3$

Moles of O_2 = (3/2) × 0.002945 mol ≈ 0.0044175 mol

Step 4: Calculate the mass of oxygen gas produced

Molar mass of O_2:

Element	Atomic Mass (g/mol)	Quantity	Total Mass Contribution (g/mol)
Oxygen (O)	16.00	2	16.00 × 2 = 32.00

Mass of O_2 = moles of O_2 × molar mass of O_2

Mass of O_2 ≈ 0.0044175 mol × 32.00 g/mol ≈ 0.1413 g

Final Result

When 0.361 grams of $KClO_3$ completely reacts, approximately 0.141 grams of oxygen gas (O_2) are formed. This calculation demonstrates how stoichiometry allows precise prediction of product quantities in chemical reactions.

Additional Considerations and Practical Applications

Understanding the calculation process has practical implications in various fields, including:

- Laboratory synthesis of oxygen for experiments.
- Industrial processes involving oxygen production.
- Environmental science, where decomposition reactions affect atmospheric composition.

Moreover, this method can be adapted to other reactions by adjusting molar masses and mole ratios accordingly.

Common Mistakes to Avoid in Stoichiometric Calculations

When performing these calculations, be cautious of:

- Incorrect molar mass determinations—double-check atomic weights.
- Misreading the balanced chemical equation—ensure coefficients are accurate.
- Mixing units—stick to grams, moles, and liters consistently.
- Forgetting to convert back to grams after calculating moles of products.

Attention to detail ensures accurate results and meaningful insights into chemical reactions.

Conclusion

Calculating the amount of oxygen gas produced from a given mass of potassium chlorate involves understanding the reaction's stoichiometry, molar masses, and conversions between grams and moles. By following systematic steps—calculating molar masses, converting mass to moles, applying mole ratios, and converting back to grams—you can accurately predict the quantity of oxygen generated during the decomposition of $KClO_3$.

This knowledge is essential for chemists and students alike, enabling precise control and understanding of chemical processes. Whether in laboratory experiments or industrial applications, mastering these calculations enhances your ability to interpret and predict chemical reactions effectively.

References

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Note: Always verify calculations with your instructor or lab supervisor, especially when applying to real-world experiments or industrial processes.

Frequently Asked Questions

How do I determine the amount of oxygen gas produced when 0.361 g of $KClO_3$ completely reacts?

First, convert 0.361 g of $KClO_3$ to moles by dividing by its molar mass (122.55 g/mol). Then, use the stoichiometric ratio from the balanced equation ($2KClO_3 \rightarrow 3O_2$) to find moles of O_2 produced. Finally, convert moles of O_2 to grams by multiplying by its molar mass (32.00 g/mol).

What is the molar mass of potassium chlorate ($KClO_3$)?

The molar mass of $KClO_3$ is approximately 122.55 g/mol, calculated as K (39.10), Cl (35.45), and O_3 (3 × 16.00).

How many moles of $KClO_3$ are present in 0.361 grams?

Number of moles = 0.361 g / 122.55 g/mol ≈ 0.00295 mol.

What is the molar ratio of $KClO_3$ to O_2 in the reaction?

According to the balanced equation, 2 mol of $KClO_3$ produce 3 mol of O_2, so the ratio is 2:3.

How do I calculate the grams of oxygen produced from the moles of $KClO_3$?

Use the molar ratio: moles of O_2 = (moles of $KClO_3$) × (3/2). Then, convert moles of O_2 to grams by multiplying by 32.00 g/mol.

What is the final mass of oxygen gas produced when 0.361 g of $KClO_3$ reacts completely?

Approximately 0.144 g of O_2 is produced. Calculations: Moles of $KClO_3$ ≈ 0.00295 mol; Moles of O_2 ≈ 0.00295 mol × (3/2) ≈ 0.004425 mol; Mass of O_2 ≈ 0.004425 mol × 32.00 g/mol ≈ 0.142 g.

Why is understanding the balanced chemical equation important in this calculation?

Because it provides the molar ratios between reactants and products, allowing accurate conversion between amounts of substances involved in the reaction.

Can I use this method to calculate oxygen produced from other compounds?

Yes, as long as you have the balanced chemical equation, molar masses, and initial mass of the reactant, the same stoichiometric approach applies.

Additional Resources

Calculating the Amount of Oxygen Produced from the Complete Reaction of Potassium Chlorate ($KClO_3$): A Detailed Analytical Approach

Understanding chemical reactions and their quantitative outcomes is essential in the fields of chemistry, chemical engineering, and environmental science. One common reaction involves the decomposition of potassium chlorate ($KClO_3$), a compound often used in laboratories and industry as an oxygen source, oxygen generator, or oxidizing agent. This article offers an in-depth examination of how to determine the amount of oxygen gas produced when a specific mass of potassium chlorate undergoes complete decomposition, exemplified by the reaction:

$2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$

By dissecting this reaction step-by-step, we aim to provide clarity on the principles of stoichiometry, mole calculations, and mass conversions, culminating in a precise calculation of the grams of oxygen produced from 0.361 grams of $KClO_3$. This analytical process highlights the importance of understanding molar relationships and the practical significance of such calculations in laboratory and industrial applications.

Understanding the Reaction: The Decomposition of Potassium Chlorate

The Chemical Equation and Its Significance

The reaction under consideration is the thermal decomposition of potassium chlorate ($KClO_3$):

$2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$

This reaction is noteworthy because it involves the breakdown of a relatively stable compound into potassium chloride (KCl) and oxygen gas (O_2). It is a classic example studied in chemistry classes to illustrate stoichiometry, molar ratios, and gas volume calculations.

Key points:

- Reactants: 2 moles of potassium chlorate
- Products: 2 moles of potassium chloride and 3 moles of oxygen gas
- Type of reaction: Decomposition
- Energy considerations: Usually carried out with heat to supply the activation energy

This reaction is also crucial industrially, used to generate oxygen for various applications, including laboratory experiments, chemical manufacturing, and even in oxygen candles used in aerospace.

Stoichiometry and Mole Ratios

The stoichiometric coefficients (2 for $KClO_3$, 2 for KCl, and 3 for O_2)

indicate the molar relationships among the reactants and products. These ratios are fundamental in converting between masses and moles, enabling us to determine the amount of oxygen gas produced from a given mass of $KClO_3$.

Step-by-Step Calculation Methodology

To determine how many grams of oxygen are produced from 0.361 grams of $KClO_3$, we follow a systematic approach:

1. Convert the given mass of $KClO_3$ to moles
2. Use the mole ratio from the balanced equation to find moles of O_2
3. Convert moles of O_2 to grams

Each step involves specific calculations grounded in molar masses and stoichiometric principles.

Calculating Moles of Potassium Chlorate

Step 1: Determine the molar mass of $KClO_3$

The molar mass of $KClO_3$ is calculated by summing the atomic masses:

- Potassium (K): approximately 39.10 g/mol
- Chlorine (Cl): approximately 35.45 g/mol
- Oxygen (O): approximately 16.00 g/mol

Thus:

Molar mass of $KClO_3$ = 39.10 + 35.45 + (3 × 16.00)
= 39.10 + 35.45 + 48.00
= 122.55 g/mol

Step 2: Convert 0.361 grams of $KClO_3$ to moles

Using the molar mass:

Number of moles = mass / molar mass
= 0.361 g / 122.55 g/mol
≈ 0.002947 mol

This is the initial amount of potassium chlorate available to decompose.

Using Stoichiometry to Find Moles of Oxygen Gas

Step 3: Apply mole ratio from the balanced equation

The balanced chemical equation states:

$2\ KClO_3 \rightarrow 3\ O_2$

This indicates that:

- **2 moles of $KClO_3$ produce 3 moles of O_2**

Therefore, the mole ratio of O_2 to $KClO_3$ is:

3 mol O_2 / 2 mol $KClO_3$

Using this ratio:

Moles of O_2 = (moles of $KClO_3$) × (3/2)
= 0.002947 mol × (3/2)
= 0.002947 mol × 1.5
≈ 0.00442 mol

This calculation reveals the theoretical amount

of oxygen produced from the given amount of potassium chlorate.

Converting Moles of Oxygen to Grams

Step 4: Determine the molar mass of O_2

Oxygen gas (O_2) has a molar mass:

$= 2 \times 16.00$ g/mol
$= 32.00$ g/mol

Step 5: Calculate the mass of O_2 produced

Mass of oxygen = moles of O_2 × molar mass of O_2
$= 0.00442$ mol $\times 32.00$ g/mol
≈ 0.1414 grams

Final Result and Practical Implications

Based on the calculations:

Approximately 0.141 grams of oxygen gas are produced when 0.361 grams of potassium chlorate undergo complete decomposition.

This result has several practical implications:

- Industrial Oxygen Generation: The reaction is a controlled method of producing oxygen in laboratory or industrial settings. Knowing the precise amount of oxygen generated helps optimize processes and ensure safety.

- Laboratory Applications: Chemists often need specific quantities of oxygen for experiments involving combustion, oxidation, or respiration studies. Accurate calculations ensure proper reagent use and experimental consistency.

- Environmental and Safety Considerations: Decomposition of $KClO_3$ can be hazardous if not carefully controlled, given the release of oxygen and potential for vigorous reactions. Understanding the stoichiometry helps mitigate risks.

Additional Considerations and Real-World Factors

While the calculations above are theoretically precise, real-world scenarios often involve additional factors:

- Purity of $KClO_3$: Impurities can affect the actual yield of oxygen.
- Reaction Conditions: Temperature and pressure influence gas volume but not mass; however, they are critical in practical applications.
- Incomplete Reaction: Not all $KClO_3$ may decompose fully; thus, actual yields can be lower.
- Safety Precautions: Decomposition of potassium chlorate is exothermic and can be explosive if improperly handled. Proper safety measures are essential.

Conclusion: The Significance of Accurate Quantitative Analysis

This detailed exploration underscores the importance of stoichiometry in translating a

small mass of reactant into a quantifiable product—in this case, oxygen gas. The process exemplifies core chemical principles: molar mass calculations, mole ratios, and mass conversions. Through meticulous calculations, chemists can predict yields, optimize processes, and ensure safety.

The ability to accurately determine the amount of oxygen produced from potassium chlorate decomposition has broader applications, from industrial manufacturing to environmental monitoring. It also highlights the interconnectedness of chemical principles and real-world applications, emphasizing the value of quantitative literacy in chemistry.

In summary, from 0.361 grams of potassium chlorate, approximately 0.141 grams of oxygen can be expected to form under complete reaction conditions. This insight not only demonstrates the power of stoichiometry but also reinforces the importance of precise calculations in scientific endeavors.

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