How Many Moles Of O2 Are Needed To React Completely With 35.0 Mol Of 10 PointsFeCl3? *4FeCl3 + 3O2 2Fe2O3

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Understanding chemical reactions and stoichiometry is fundamental in chemistry, especially when calculating the amount of reactants needed for a reaction to proceed completely. In this article, we will explore how to determine the number of moles of oxygen (O_2) required to fully react with a given amount of iron(III) chloride ($FeCl_3$). Specifically, we will analyze the reaction involving 35.0 mol of $FeCl_3$ and utilize the balanced chemical equation:

$4FeCl_3 + 3O_2 \rightarrow 2Fe_2O_3 + 12Cl$

By the end of this comprehensive guide, you will understand the step-by-step process to perform stoichiometric calculations, interpret chemical equations, and arrive at accurate answers for similar problems.

Understanding the Chemical Reaction

Before diving into calculations, it is essential to understand the chemical reaction involved. The balanced equation provided is:

$4FeCl_3 + 3O_2 \rightarrow 2Fe_2O_3 + 12Cl$

This reaction depicts the oxidation of iron(III) chloride ($FeCl_3$) with oxygen (O_2) to produce iron(III) oxide (Fe_2O_3) and chlorine gas (Cl_2).

Key points about the reaction:

- Reactants: $FeCl_3$ and O_2
- Products: Fe_2O_3 and Cl_2
- Stoichiometry: The molar ratio between $FeCl_3$ and O_2 is 4:3

This ratio indicates that 4 moles of $FeCl_3$ react with 3 moles of O_2 to produce the products.

Step-by-Step Calculation Process

To determine how many moles of O_2 are needed to react completely with 35.0 mol of $FeCl_3$, follow these steps:

1. Write Down the Balanced Chemical Equation

The balanced equation is:

$4FeCl_3 + 3O_2 \rightarrow 2Fe_2O_3 + 12Cl$

This tells us that:

- 4 mol of $FeCl_3$ reacts with 3 mol of O_2

2. Identify the Known and Unknown Quantities

- Known: 35.0 mol $FeCl_3$
- Unknown: Moles of O_2 needed (let's denote this as x mol)

3. Use Mole Ratio from the Balanced Equation

The mole ratio between $FeCl_3$ and O_2 is:

4 mol $FeCl_3$: 3 mol O_2

This ratio allows us to set up a proportion to find x:

$$
\frac{\text{Moles of FeCl}_3}{\text{Moles of O}_2} = \frac{4}{3}
$$

Rearranged for O_2:

$$
\text{Moles of O}_2 = \frac{3}{4} \times \text{Moles of FeCl}_3
$$

4. Calculate the Moles of O_2 Needed

Substitute the known value:

\[

$$x = \frac{3}{4} \times 35.0\, \text{mol} = 0.75 \times 35.0\, \text{mol} = 26.25\, \text{mol}$$

Therefore, 26.25 mol of O_2 are required to react completely with 35.0 mol of $FeCl_3$.

Additional Considerations

While the calculation appears straightforward, there are other factors to consider:

1. Ensuring Complete Reaction

- The calculation assumes ideal conditions with no side reactions.
- Excess reactants or incomplete reactions can affect actual outcomes.

2. Molar Ratios and Reaction Efficiency

- Real-world reactions may not proceed to 100% completion.
- Reaction efficiency can be factored into calculations if data is available.

3. Units and Significant Figures

- The calculated moles are rounded to three significant figures, consistent with the initial data (35.0 mol).

4. Application to Laboratory Settings

- When performing laboratory experiments, it's essential to consider measurement accuracy, gas purity, and reaction conditions.

Practical Examples and Related Problems

To deepen your understanding, consider the following related problems:

- How many grams of O_2 are needed to react with 35.0 mol of $FeCl_3$?
- If only 20 mol of O_2 is available, how much $FeCl_3$ can react completely?
- What is the percent yield if only 24 mol of O_2 reacts with 35 mol of $FeCl_3$?

Each problem involves similar stoichiometric calculations, emphasizing the importance of understanding mole ratios and balanced equations.

Conversion of Moles to Mass

For practical applications, it’s often necessary to convert moles into grams:

- Molar mass of O_2: 32.00 g/mol
- Mass of O_2 required:

$$
\text{Mass} = \text{Moles} \times \text{Molar mass} = 26.25 \text{ mol} \times 32.00 \text{ g/mol} = 840.0 \text{ g}
$$

Thus, approximately 840.0 grams of O_2 are needed to fully react with 35.0 mol of $FeCl_3$.

Summary of Key Steps and Formulas

Step	Description	Formula / Ratio	Result
1	Write balanced equation	$4FeCl_3 + 3O_2 \rightarrow 2Fe_2O_3 + 12Cl$	N/A
2	Identify known and unknown	Known: 35.0 mol $FeCl_3$; Unknown: x mol O_2	N/A
3	Use mole ratio	$\frac{3\, \text{mol O}_2}{4\, \text{mol FeCl}_3}$	x = $\frac{3}{4} \times 35.0$ mol
4	Calculate	x = 26.25 mol	Moles of O_2 needed
5	Convert to grams (if needed)	grams = moles × molar mass	26.25 mol × 32.00 g/mol = 840.0 g

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Conclusion

Determining the number of moles of oxygen required for a complete reaction with a given amount of

$FeCl_3$ involves understanding the stoichiometry of the balanced chemical equation. For 35.0 mol of $FeCl_3$, approximately 26.25 mol of O_2 are needed to react fully under ideal conditions. This calculation underscores the importance of mole ratios and balanced equations in quantitative chemistry.

Such calculations are fundamental in laboratory planning, industrial processes, and environmental chemistry, where precise reactant quantities are essential for efficiency and safety. By mastering these concepts, students and professionals can confidently approach a wide array of chemical stoichiometry problems.

Meta Description:
Learn how to calculate the moles of oxygen needed to react completely with 35.0 mol of $FeCl_3$, using stoichiometry and balanced chemical equations. Step-by-step guide with practical examples.

Frequently Asked Questions

What is the balanced chemical equation for the reaction between $FeCl_3$ and O_2?

The balanced equation is $4FeCl_3 + 3O_2 \rightarrow 2Fe_2O_3 + 6Cl_2$.

How many moles of $FeCl_3$ are involved in the reaction?

There are 35.0 moles of $FeCl_3$ involved.

How do you determine the number of moles of O_2 needed to react

completely with 35.0 mol of $FeCl_3$?

Use the mole ratio from the balanced equation: 4 mol $FeCl_3$ reacts with 3 mol O_2. Set up a proportion to find the moles of O_2 needed.

What is the mole ratio of O_2 to $FeCl_3$ in the reaction?

The ratio is 3 mol O_2 per 4 mol $FeCl_3$.

How many moles of O_2 are required to react completely with 35.0 mol of $FeCl_3$?

Number of moles of O_2 needed = $(3/4) \times 35.0$ mol = 26.25 mol.

What is the significance of understanding mole ratios in stoichiometry?

Mole ratios allow us to convert between amounts of reactants and products, ensuring complete reactions without excess or deficiency.

If you have 35.0 mol of $FeCl_3$, how much O_2 would be needed for complete reaction?

You would need approximately 26.25 mol of O_2 for complete reaction.

Additional Resources

Oxygen Reactivity and Stoichiometry Analysis: How Many Moles of O_2 Are Needed to Completely React with 35.0 mol of $FeCl_3$?

Understanding the precise amount of reactants needed in chemical reactions is fundamental in chemistry, especially in industrial processes, laboratory experiments, and environmental applications. Here, we explore the specific question: How many moles of oxygen (O_2) are required to completely react with 35.0 mol of $FeCl_3$? To answer this, we will analyze the reaction involving iron(III) chloride ($FeCl_3$) and oxygen, interpret the balanced chemical equation, and perform detailed stoichiometric calculations.

Fundamental Concepts in Chemical Stoichiometry

Before diving into calculations, it's essential to understand some key concepts:

- Moles: The amount of substance, where 1 mole corresponds to Avogadro's number (approximately 6.022×10^{23} entities).
- Reactants and Products: Substances that start the reaction versus those produced.
- Stoichiometry: The quantitative relationship between reactants and products in a balanced chemical equation.
- Balancing Equations: Ensuring that the number of atoms for each element is conserved on both sides of the reaction.

The Reaction Under Consideration

The reaction provided is:

$$4FeCl_3 + 3O_2 \rightarrow 2Fe_2O_3 + 6Cl_2$$

This is a typical oxidation process where iron(III) chloride reacts with oxygen to produce iron(III) oxide (Fe_2O_3) and chlorine gas (Cl_2).

Key points:

- Reactants: $FeCl_3$ and O_2
- Products: Fe_2O_3 and Cl_2
- Reaction Type: Oxidation-reduction (redox) process, where Fe^{3+} ions are oxidized to Fe_2O_3, and O_2 acts as the oxidizing agent.

Step 1: Confirming the Balanced Equation

The balanced chemical equation is:

$$ 4 \text{FeCl}_3 + 3 \text{O}_2 \rightarrow 2 \text{Fe}_2\text{O}_3 + 6 \text{Cl}_2 $$

Verification:

- Iron (Fe): 4 on reactants side; 2×2=4 on products side.
- Chlorine (Cl): 4×3=12 on reactants; 6×2=12 on products.
- Oxygen (O): 3 on reactants; 2×3=6 on products (from Fe_2O_3) and 6 Cl_2 (no oxygen), so the oxygen atoms are balanced as 3 O_2 molecules (3×2=6 O atoms).

The equation is balanced correctly.

Step 2: Stoichiometric Ratios and Calculations

What we need to find: The number of moles of O_2 required to react completely with 35.0 mol of $FeCl_3$.

Approach:

- Understand the molar ratio between $FeCl_3$ and O_2 from the balanced equation.
- Use stoichiometry to relate the given amount of $FeCl_3$ to the required O_2.

Understanding the Mole Ratio

From the balanced equation:

$$ 4 \text{FeCl}_3 : 3 \text{O}_2 $$

This ratio indicates:

- 4 mol of $FeCl_3$ react with 3 mol of O_2.
- To find out how much O_2 is needed for 1 mol of $FeCl_3$:

$$ \frac{3 \text{ mol O}_2}{4 \text{ mol FeCl}_3} = 0.75 \text{ mol O}_2 / \text{mol FeCl}_3 $$

- For 35.0 mol of $FeCl_3$:

$$ \text{O}_2 \text{ needed} = 35.0 \text{ mol FeCl}_3 \times \frac{3 \text{ mol O}_2}{4 \text{ mol FeCl}_3} $$

Step 3: Performing the Calculation

Calculating the required moles of O_2:

$$\text{O}_2 \text{ needed} = 35.0 \times \frac{3}{4}$$

$$\text{O}_2 \text{ needed} = 35.0 \times 0.75$$

$$\text{O}_2 \text{ needed} = 26.25 \text{ mol}$$

Result: 26.25 mol of O_2 are required to react completely with 35.0 mol of $FeCl_3$.

Additional Considerations

1. Reaction Conditions:
While stoichiometry provides the theoretical quantities, actual conditions such as temperature, pressure, and purity can influence the reaction efficiency. In industrial settings, excess oxygen might be supplied to ensure complete reaction.

2. Purity of Reactants:
Impurities in $FeCl_3$ or O_2 could affect the amount needed, but for theoretical calculations, pure substances are assumed.

3. Safety and Handling:
Reactions involving chlorine gases and oxygen require proper safety protocols due to their reactive nature.

Implications and Applications of the Calculation

Understanding the exact amount of O_2 needed is crucial for:

- Industrial Synthesis: Optimizing oxygen consumption in manufacturing processes involving iron oxides.
- Environmental Control: Managing emissions and waste products in chlorination or oxidation processes.
- Laboratory Experiments: Precise reagent measurement ensures accurate results and safety.

Summary and Final Remarks

To sum up, based on the balanced chemical equation:

$$4 \text{FeCl}_3 + 3 \text{O}_2 \rightarrow 2 \text{Fe}_2\text{O}_3 + 6 \text{Cl}_2$$

The amount of oxygen required to react completely with 35.0 mol of $FeCl_3$ is 26.25 mol. This calculation assumes ideal conditions and complete reaction efficiency. Such detailed stoichiometric analysis exemplifies the importance of balanced equations and mole ratios in chemical calculations, ensuring precise reagent use and understanding of reaction dynamics.

In essence: Whether you're optimizing industrial processes or designing experiments, knowing the exact molar requirements helps in resource management, cost reduction, and safety assurance. This calculation underscores the power of chemical stoichiometry as a foundational tool in chemistry that bridges theoretical concepts with practical applications.

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