# If 27.1 Grams Of Bromine And 12.0 Grams Of Chlorine Combine To Form Bromine Monochloride, How Many Grams

**If 27.1 Grams Of Bromine And 12.0 Grams Of Chlorine Combine To Form Bromine Monochloride, How Many Grams** is a common question in chemistry that involves understanding chemical reactions, molar calculations, and stoichiometry. In this comprehensive article, we will explore the process step-by-step to determine the amount of bromine monochloride produced when 27.1 grams of bromine reacts with 12.0 grams of chlorine. Whether you're a student studying chemistry or a science enthusiast, mastering this type of problem is essential for understanding chemical reactions and quantitative analysis.

## Understanding the Reaction: Bromine and Chlorine Form Bromine Monochloride

### The Chemical Equation

The chemical reaction between bromine ($Br_2$) and chlorine ($Cl_2$) to produce bromine monochloride (BrCl) can be represented by the balanced chemical equation:

$$Br_2 + Cl_2 \rightarrow 2\ BrCl$$

This indicates that one mole of bromine reacts with one mole of chlorine to produce two moles of bromine monochloride.

### Relevance of the Reaction

Bromine monochloride is an important chemical in various industrial applications, such as disinfectants and in organic synthesis. Understanding the stoichiometry of its formation from bromine and chlorine helps in process design, yield calculation, and safety management.

## Step-by-Step Calculation Process

### 1. Find the molar masses of the reactants and product

Knowing the molar masses allows us to convert grams to moles, which is essential for stoichiometric calculations.

- Bromine ($Br_2$):
- Atomic mass of Br ≈ 79.90 g/mol
- Molar mass of $Br_2$ = 2 × 79.90 = 159.80 g/mol

- Chlorine ($Cl_2$):
- Atomic mass of Cl ≈ 35.45 g/mol
- Molar mass of $Cl_2$ = 2 × 35.45 = 70.90 g/mol

- Bromine monochloride (BrCl):
- Molar mass of BrCl = 79.90 + 35.45 ≈ 115.35 g/mol

## 2. Convert the given masses to moles

Using the molar masses, convert the grams of bromine and chlorine into moles:

- Bromine:

  $$\text{moles } Br_2 = 27.1 \text{ g} / 159.80 \text{ g/mol} \approx 0.1697 \text{ mol}$$

- Chlorine:

  $$\text{moles } Cl_2 = 12.0 \text{ g} / 70.90 \text{ g/mol} \approx 0.1692 \text{ mol}$$

## 3. Determine the limiting reactant

The balanced equation tells us that the molar ratio of $Br_2$ to $Cl_2$ is 1:1.

Compare the moles:
- Bromine: ≈ 0.1697 mol
- Chlorine: ≈ 0.1692 mol

Since both are close, but chlorine is slightly less, chlorine is the limiting reactant because it will be exhausted first in the reaction.

## 4. Calculate the amount of bromine monochloride produced

From the balanced equation:
- 1 mol of $Br_2$ reacts with 1 mol of $Cl_2$ to produce 2 mol of BrCl.

Given that chlorine is limiting:
- Moles of BrCl formed = 2 × moles of $Cl_2$ (limiting reactant)
- Moles of BrCl = 2 × 0.1692 mol ≈ 0.3384 mol

## 5. Convert the moles of bromine monochloride to grams

Using the molar mass of BrCl:

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Mass of BrCl = moles × molar mass ≈ 0.3384 mol × 115.35 g/mol ≈ 39.05 g
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Answer: When 27.1 grams of bromine reacts with 12.0 grams of chlorine, approximately 39.05 grams of bromine monochloride are produced.

# Additional Considerations and Practical Implications

## Yield and Efficiency

In real-world scenarios, reactions may not proceed to 100% efficiency due to side reactions, incomplete mixing, or other factors. The calculated amount assumes ideal conditions.

## Safety Precautions

Handling bromine and chlorine requires appropriate safety measures because both are toxic and corrosive. Proper ventilation, protective gear, and adherence to safety protocols are essential.

## Applications of Bromine Monochloride

Understanding the stoichiometry of bromine monochloride formation aids in its industrial production, ensuring optimal yield and minimal waste.

# Summary of Key Points

- The reaction between bromine and chlorine produces bromine monochloride according to the balanced equation: $Br_2 + Cl_2 \rightarrow 2\ BrCl$.
- Calculating molar masses allows conversion from grams to moles.
- Identify the limiting reactant to determine the maximum amount of product formed.

- Use molar ratios from the balanced equation to find the moles of product formed.
- Convert moles of product back to grams for the final answer.

# Conclusion

By carefully analyzing the reaction and performing stoichiometric calculations, we determined that combining 27.1 grams of bromine with 12.0 grams of chlorine results in approximately 39.05 grams of bromine monochloride. Mastery of these concepts is fundamental for chemistry students and professionals involved in chemical manufacturing, laboratory experiments, and safety management. Remember, understanding the molar relationships and limiting reactants is key to accurate chemical calculations and successful experimental outcomes.

If you want to learn more about chemical reactions, stoichiometry, or laboratory techniques, consult reputable chemistry textbooks or academic resources to deepen your understanding and enhance your practical skills.

# Frequently Asked Questions

## What is the molar mass of bromine and chlorine used in calculating the mass of bromine monochloride?

The molar mass of bromine ($Br_2$) is approximately 159.8 g/mol, and that of chlorine ($Cl_2$) is approximately 70.9 g/mol. For bromine monochloride (BrCl), the molar mass is about 86.9 g/mol.

## How do you determine the limiting reactant when combining bromine and chlorine to form bromine monochloride?

By calculating the moles of each reactant, bromine and chlorine, and comparing their molar ratios based on the reaction's stoichiometry, you can identify the limiting reactant. Bromine (27.1 g) is approximately 0.169 mol, and chlorine (12.0 g) is about 0.169 mol; since the molar ratio matches the reaction, both are limiting reactants in equal amounts.

## What is the balanced chemical equation for the formation of bromine monochloride?

The balanced equation is: $Br_2 + Cl_2 \rightarrow 2\ BrCl$.

## How do you calculate the mass of bromine monochloride formed from the given reactants?

Identify the limiting reactant, then use its moles to determine the amount of product formed. Since both reactants are in equal molar amounts, the maximum mass of BrCl formed is based on the

limiting reactant's moles multiplied by the molar mass of BrCl (86.9 g/mol).

## What is the theoretical yield of bromine monochloride when 27.1 g of bromine reacts with 12.0 g of chlorine?

The limiting reactant is bromine, with 0.169 mol. Therefore, the maximum mass of bromine monochloride produced is 0.169 mol × 86.9 g/mol ≈ 14.7 grams.

## If the actual yield of bromine monochloride is less than the theoretical yield, what could be the reasons?

Possible reasons include incomplete reactions, side reactions, loss of product during handling, or impurities. These factors can reduce the actual amount of bromine monochloride obtained compared to the theoretical yield.

# Additional Resources

If 27.1 grams of bromine and 12.0 grams of chlorine combine to form bromine monochloride, how many grams of bromine monochloride are produced? This question taps into fundamental concepts of chemical reactions, stoichiometry, and the conservation of mass. Understanding how to determine the amount of product formed from given reactants is essential in both academic chemistry and practical applications such as manufacturing and laboratory synthesis. In this comprehensive guide, we will explore the step-by-step process to answer this question, including balancing the chemical equation, calculating molar amounts, and applying stoichiometric principles to arrive at the final mass of bromine monochloride.

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Introduction to Bromine Monochloride and Its Formation

Bromine monochloride (BrCl) is a chemical compound that belongs to the halogen family. It is a reddish-brown liquid at room temperature with distinct pungent odor and is used in various applications, including as a disinfectant, in organic synthesis, and in photographic processes. The formation of bromine monochloride typically involves a direct combination of bromine ($Br_2$) and chlorine ($Cl_2$) gases under specific conditions.

In the scenario where 27.1 grams of bromine and 12.0 grams of chlorine are involved, the key question is: How many grams of bromine monochloride are produced? To answer this, we need to analyze the reaction, determine the limiting reactant, and perform calculations based on molar quantities.

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Step 1: Write and Balance the Chemical Equation

The first critical step in any stoichiometric calculation is to write the correct balanced chemical equation for the reaction.

Unbalanced Equation

$$ \text{Bromine} + \text{Chlorine} \rightarrow \text{Bromine Monochloride} $$

Since bromine monochloride is a compound of one bromine atom and one chlorine atom, the formation reaction can be written as:

$$ \text{Br}_2 + \text{Cl}_2 \rightarrow 2\, \text{BrCl} $$

However, to reflect the formation of one molecule of bromine monochloride, the balanced equation is:

Balanced Equation:

$$ \text{Br}_2 + \text{Cl}_2 \rightarrow 2\, \text{BrCl} $$

Note: This indicates that one mole of bromine reacts with one mole of chlorine to produce two moles of bromine monochloride.

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Step 2: Determine Moles of Reactants

Knowing the mass of each reactant, convert these to moles using their molar masses.

Molar Masses

- Bromine ($Br_2$):
$2 \times 79.904\, \text{g/mol} = 159.808\, \text{g/mol}$

- Chlorine ($Cl_2$):
$2 \times 35.453\, \text{g/mol} = 70.906\, \text{g/mol}$

Moles of Bromine

$$ \text{Moles of Br}_2 = \frac{\text{Mass of Br}_2}{\text{Molar mass of Br}_2} = \frac{27.1\, \text{g}}{159.808\, \text{g/mol}} $$

$$ \approx 0.1696\, \text{mol} $$

Moles of Chlorine

$$ \text{Moles of Cl}_2 = \frac{\text{Mass of Cl}_2}{\text{Molar mass of Cl}_2} = \frac{12.0\, \text{g}}{70.906\, \text{g/mol}} $$

$$ \approx 0.1690\, \text{mol} $$

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Step 3: Identify the Limiting Reactant

Based on the balanced equation:

$$ \text{Br}_2 + \text{Cl}_2 \rightarrow 2\, \text{BrCl} $$

The molar ratio of bromine to chlorine is 1:1. Comparing the moles:

- Bromine: 0.1696 mol
- Chlorine: 0.1690 mol

Since chlorine has slightly fewer moles, chlorine is the limiting reactant. This means all the chlorine will be consumed, and the amount of bromine monochloride produced will be based on the amount of chlorine available.

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Step 4: Calculate the Moles of Bromine Monochloride Formed

From the balanced equation, 1 mol of $Cl_2$ produces 2 mol of BrCl.

Therefore:

$$ \text{Moles of BrCl} = 2 \times \text{Moles of Cl}_2 $$

$$ = 2 \times 0.1690\, \text{mol} $$

$$ \approx 0.3380\, \text{mol} $$

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Step 5: Convert Moles of Bromine Monochloride to Mass

Molar mass of bromine monochloride (BrCl):

$$ 79.904\, \text{g/mol} + 35.453\, \text{g/mol} = 115.357\, \text{g/mol} $$

Total mass of bromine monochloride produced:

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

$$ = 0.3380\, \text{mol} \times 115.357\, \text{g/mol} $$

$$ \approx 38.99\, \text{g} $$

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Final Answer:

Approximately 39.0 grams of bromine monochloride are formed when 27.1 grams of bromine and 12.0 grams of chlorine react under ideal conditions.

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Additional Considerations

1. Reaction Efficiency

In real-world scenarios, reactions may not proceed to 100% efficiency due to side reactions, incomplete conversion, or experimental conditions. Therefore, the theoretical maximum mass of product (as calculated) might differ slightly from actual yields.

2. Purity of Reactants

Impurities in reactants can affect the amount of product formed. The calculations assume pure bromine and chlorine.

3. Temperature and Pressure

While not directly affecting the stoichiometric calculations, reaction conditions such as temperature and pressure influence reaction rates and equilibrium. Bromine monochloride formation is typically conducted under controlled conditions to optimize yield.

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Summary Table

| Step | Description | Calculation / Result |
|---|---|---|
| 1 | Molar mass of $Br_2$ | 159.808 g/mol |
| 2 | Molar mass of $Cl_2$ | 70.906 g/mol |
| 3 | Moles of $Br_2$ | 0.1696 mol |
| 4 | Moles of $Cl_2$ | 0.1690 mol |
| 5 | Limiting reactant | $Cl_2$ (limiting) |
| 6 | Moles of BrCl formed | 0.3380 mol |
| 7 | Mass of BrCl | 38.99 g (~39.0 g) |

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Conclusion

By carefully balancing the chemical equation, converting reactant masses to moles, identifying the limiting reactant, and applying stoichiometry, we determine that approximately 39.0 grams of bromine monochloride are produced from the given quantities of bromine and chlorine. This process exemplifies the practical application of stoichiometric principles in chemistry, enabling precise calculations vital for laboratory synthesis, industrial production, and academic understanding.

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