# Compound X Has A Molar Mass Of 180.15 G.mol^−1 And The Following CompositionElement Mass %Carbon 40.00%Hydrogen

**Compound X Has A Molar Mass Of 180.15 G.mol^−1 And The Following Composition Element Mass %Carbon 40.00%Hydrogen**. This precise information provides a foundational understanding of the compound's molecular structure and composition. Determining the molecular formula from such data is a fundamental step in chemistry, allowing scientists to analyze, synthesize, and utilize compounds effectively. In this article, we'll explore how to interpret this data, determine the molecular formula, and understand the significance of such compounds in various chemical contexts.

## Understanding the Composition Data of Compound X

### Elemental Percentages and Their Significance

The given data indicates that Compound X comprises 40.00% carbon and a certain percentage of hydrogen. While the percentage of hydrogen isn't explicitly specified in the initial statement, typical analysis involves determining the remaining composition, which can include other elements such as oxygen, nitrogen, or halogens, depending on context. For this example, we will assume that the remaining percentage accounts for other elements or that the compound is primarily composed of carbon and hydrogen.

Elemental composition data helps chemists:
- Deduce the empirical formula.
- Understand the molecular structure.
- Calculate the molar ratio of elements within the compound.

### Molar Mass and Its Role

The molar mass, 180.15 g/mol, serves as a vital clue. It provides the total weight of one mole of the compound, enabling calculations of the number of atoms of each element present in the molecular formula.

## Calculating the Empirical Formula of Compound X

To derive the empirical formula, which represents the simplest whole-number ratio of elements in the compound, follow these steps:

## Step 1: Convert Percentage Composition to Mass

Assuming a 100 g sample:
- Carbon: 40.00 g
- Hydrogen: (Assuming the remaining percentage is hydrogen, which is common in organic compounds). If only carbon and hydrogen are present, then hydrogen would be 60.00 g.

Note: If the actual hydrogen percentage is provided, use that value; otherwise, deduction is necessary.

## Step 2: Calculate Moles of Each Element

Use atomic masses:
- Carbon (C): 12.01 g/mol
- Hydrogen (H): 1.008 g/mol

Calculations:
- Moles of C: 40.00 g / 12.01 g/mol ≈ 3.33 mol
- Moles of H: 60.00 g / 1.008 g/mol ≈ 59.52 mol

## Step 3: Determine the Mole Ratio

Divide each by the smallest number of moles:
- C: 3.33 / 3.33 ≈ 1
- H: 59.52 / 3.33 ≈ 17.88 ≈ 18

Therefore, the empirical formula is approximately $CH_{18}$.

# Calculating the Molecular Formula of Compound X

The empirical formula mass:
- C: 12.01 g/mol
- $H_{18}$: 18 × 1.008 g/mol ≈ 18.14 g/mol

Total: 12.01 + 18.14 ≈ 30.15 g/mol

Given the molar mass of the compound is 180.15 g/mol, find the ratio:
- 180.15 g/mol / 30.15 g/mol ≈ 6

Multiply the empirical formula by this factor:
- $(CH_{18})$ × 6 = $C_6H_{110}$

Thus, the molecular formula is $C_6H_{110}$.

# Significance of the Molecular Formula

Understanding the molecular formula $C_6H_{110}$ provides insights into:
- The compound's degree of saturation.
- Its possible classification as an alkane, alkene, or other hydrocarbons.
- Its physical properties such as boiling point, melting point, and solubility.

## Applications and Examples of Similar Compounds

Many organic compounds, especially hydrocarbons, have similar compositions and molar masses. For example:

- Alkanes (saturated hydrocarbons) like hexane ($C_6H_{14}$) have molar masses close to 86 g/mol, but larger alkanes or branched chains can reach higher molar masses like 180 g/mol.
- Complex hydrocarbons or derivatives such as waxes or fatty acids may have similar molar masses and compositions.

## Understanding the Structural Implications

Given the high number of hydrogen atoms relative to carbon, Compound X likely has a long hydrocarbon chain or a complex structure with multiple branches or functional groups. These structural features influence:
- The compound's reactivity.
- Its physical state at room temperature.
- Its potential uses in industry, such as in lubricants, fuels, or as chemical intermediates.

## Additional Considerations in Composition Analysis

In real-world scenarios, compounds often contain other elements:
- Oxygen (O)
- Nitrogen (N)
- Halogens (Cl, Br, I, F)

If such elements are present, they alter the calculation of empirical and molecular formulas. Advanced techniques like mass spectrometry, NMR spectroscopy, and IR spectroscopy are used for precise determination.

## Conclusion

Determining the molecular formula of Compound X from its molar mass and elemental composition is a fundamental skill in chemistry. By converting percentage composition into moles, establishing the empirical formula, and then calculating the molecular formula, chemists gain valuable insights into the structure and properties of the compound. This process not only aids in understanding the compound's chemical nature but also facilitates its practical application in various industries. Whether in research, manufacturing, or academic settings, mastery of these calculations is essential for advancing chemical knowledge and innovation.

# Frequently Asked Questions

## What is the molecular formula of Compound X based on its molar mass and composition?

To determine the molecular formula, first find the molar amount of each element: Carbon (C) and Hydrogen (H). Given the mass percentages and molar mass of 180.15 g/mol, approximate the moles of each element and derive the simplest whole number ratio to identify the molecular formula.

## How do you calculate the empirical formula of Compound X from its composition?

Convert the mass percentages to moles by dividing by each element's atomic mass (C: 12.01 g/mol, H: 1.008 g/mol). Then, divide all mole values by the smallest number of moles to get the simplest whole number ratio, which gives the empirical formula.

## What is the likely empirical formula of Compound X given 40% carbon and the molar mass?

Calculating from the percentages, the empirical formula is likely $CH_2$, assuming the ratios. This is consistent with the molar mass calculation and the given composition, but further analysis is needed to confirm the molecular formula.

## How do you determine the molecular formula of Compound X from its empirical formula and molar mass?

Calculate the molar mass of the empirical formula (e.g., $CH_2$ = 14.03 g/mol). Divide the molecular molar mass (180.15 g/mol) by the empirical formula mass to find the factor. Multiply the subscripts in the empirical formula by this factor to obtain the molecular formula.

## What are common compounds with a molar mass close to 180 g/mol and containing approximately 40% carbon?

Common compounds fitting this profile include certain organic molecules like benzene derivatives or specific hydrocarbons. For example, compounds like phenylmethane (toluene) have molar masses around 92 g/mol, but larger aromatic hydrocarbons or substituted derivatives could match the molar mass and composition.

## How does the composition of Compound X influence its potential chemical properties?

With 40% carbon and a high molar mass, Compound X is likely an organic molecule with significant carbon-hydrogen content, suggesting it may be nonpolar, hydrophobic, and capable of undergoing typical hydrocarbon reactions such as combustion or substitution.

## What analytical techniques can confirm the molecular formula of Compound X?

Techniques such as mass spectrometry, nuclear magnetic resonance (NMR), and infrared (IR) spectroscopy can provide detailed information about the molecular weight, structure, and functional groups to confirm the molecular and empirical formulas.

# Additional Resources

Compound X Has A Molar Mass Of 180.15 G.mol^-1 And The Following Composition Element Mass % Carbon 40.00% Hydrogen

Understanding the characteristics and composition of chemical compounds is fundamental in chemistry, both for academic purposes and practical applications. Compound X, with a molar mass of 180.15 g/mol and a composition that includes 40.00% carbon and an unspecified percentage of hydrogen, presents an intriguing subject for analysis. This article delves into the detailed examination of this compound, exploring its elemental makeup, possible structural formulas, physical and chemical properties, and potential uses.

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# 1. Determining the Composition of Compound X

## Elemental Breakdown

The provided data indicates that Compound X contains 40.00% carbon by mass. To fully understand its composition, we need to determine the percentage of hydrogen and possibly other elements present. Since only carbon and hydrogen are explicitly mentioned, we'll assume for this analysis that the compound primarily consists of these two elements unless evidence suggests otherwise.

Given:
- Molar mass of Compound X = 180.15 g/mol
- Mass percentage of Carbon = 40.00%

Calculating the mass of carbon in one mole:
- Mass of carbon = 40.00% of 180.15 g = 0.40 × 180.15 g = 72.06 g

Number of moles of carbon:
- Moles of C = 72.06 g / 12.01 g/mol ≈ 6.00 mol

Now, the remaining mass (100% − 40% = 60%) is attributed to hydrogen:
- Mass of hydrogen = 60% of 180.15 g = 0.60 × 180.15 g = 108.09 g

Number of moles of hydrogen:
- Moles of H = 108.09 g / 1.008 g/mol ≈ 107.3 mol

Simplifying the molar ratio:
- C:H ≈ 6.00 : 107.3 ≈ 1 : 17.88

To derive a whole-number ratio, divide both by 6.00:
- C ≈ 1
- H ≈ 17.88 / 6 ≈ 2.98 ≈ 3

Thus, the empirical formula approximates to $CH_3$, but this is unlikely considering the molar mass. To refine, let's compute the molar ratio based on the atomic counts:

Number of carbons: 6.00 mol
Number of hydrogens: 107.3 mol

Total atomic counts per formula unit:
- C atoms: 6
- H atoms: 107.3 / 6 ≈ 17.88 ≈ 18

So, the empirical formula is roughly $C_1H_{18}$.

Molecular weight estimate:
- (1 × 12.01) + (18 × 1.008) = 12.01 + 18.144 = 30.154 g/mol

Since the molar mass of the actual compound is 180.15 g/mol, the molecular formula is a multiple of the empirical formula:

- 180.15 / 30.15 ≈ 6

Therefore, the molecular formula is approximately $C_6H_{18}$.

Conclusion:
Compound X likely has a molecular formula of $C_6H_{18}$, which corresponds to hexane, a well-known alkane.

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# 2. Structural and Chemical Features of Compound X

## Possible Structural Identity

Based on the molecular formula $C_6H_{18}$, Compound X appears to be hexane, a saturated hydrocarbon with six carbon atoms. Hexane is part of the alkane family, characterized by single bonds between carbon atoms and a linear or branched structure.

Features of Hexane:

- Molecular Structure: Linear chain (n-hexane) or branched isomers like 2-methylpentane, 3-methylpentane, etc.
- Physical State: Colorless, flammable liquid at room temperature.
- Boiling Point: Approximately 69°C for n-hexane; varies with isomerism.
- Solubility: Insoluble in water but soluble in organic solvents such as ethanol, ether, and benzene.
- Chemical Reactivity: Relatively inert but can undergo combustion, substitution, and cracking reactions.

## Isomerism and Variants

Hexane has several structural isomers, each with subtle differences in physical and chemical properties:

- n-Hexane: Straight-chain structure.
- 2-Methylpentane: Methyl group attached to the second carbon.
- 3-Methylpentane: Methyl group attached to the third carbon.
- 2,2-Dimethylbutane: Two methyl groups attached to the second carbon.
- 2,3-Dimethylbutane: Methyl groups on the second and third carbons.
- 2,2,3-Trimethylbutane: Multiple methyl substitutions.

These isomers differ in boiling points, density, and reactivity, impacting their practical applications.

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# 3. Physical Properties of Compound X

Boiling and Melting Points:
Hexanes exhibit a range of boiling points depending on isomerism. The linear n-hexane boils at 68.7°C, while branched isomers tend to have lower boiling points due to decreased surface area and weaker intermolecular forces.

Density:
Typically around 0.66 g/mL at room temperature, making it less dense than water.

Viscosity:
Relatively low, which facilitates its use as a solvent.

Vapor Pressure:
High vapor pressure (~124 mm Hg at 20°C), indicating volatility.

Flammability:
Highly flammable; vapors can form explosive mixtures with air.

Physical State Summary:

| Property | Approximate Value |
|---|---|
| Boiling Point | 68.7°C (n-hexane) |
| Melting Point | -95°C |
| Density | 0.66 g/mL at 20°C |
| Vapor Pressure | 124 mm Hg at 20°C |
| Flash Point | -22°C |

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# 4. Chemical Behavior and Reactions

Hexane's chemical inertness makes it a good solvent, but it can participate in several reactions under appropriate conditions:

- Combustion:
Complete combustion produces $CO_2$ and $H_2O$, releasing energy.

- Radical Substitution:
Under UV light, hexane can undergo free radical halogenation, leading to halogenated derivatives.

- Cracking and Reforming:
Used in petrochemical processes to produce shorter alkanes or aromatics.

- Environmental Reactivity:
Hexanes are volatile organic compounds (VOCs) that contribute to air pollution and smog formation.

Pros and Cons of Hexane (Compound X):

Pros:
- Excellent solvent for nonpolar substances.
- Chemically stable under normal conditions.
- Easily distilled and purified.
- Widely used in industries, including extraction and cleaning.

Cons:
- Highly flammable and poses fire hazards.
- Volatile, leading to inhalation risks.
- Environmental concerns due to VOC emissions.
- Not biodegradable, contributing to pollution.

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# 5. Applications of Compound X

Given its properties and chemical nature, hexane (and by extension, Compound X) finds numerous industrial and laboratory applications:

- Solvent in Extraction:
Commonly used to extract vegetable oils from seeds and other plant materials.

- Laboratory Use:
Serves as a nonpolar solvent in chromatography, sample preparation, and cleaning.

- Industrial Processing:
Involved in catalytic cracking in petroleum refining.

- Cleaning Agent:
Used for degreasing and cleaning electronic components.

- Research and Development:
Studied in organic synthesis and reaction mechanism investigations.

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## 6. Safety and Environmental Considerations

Hexane, while useful, must be handled with caution:

- Health Risks:
Inhalation can cause dizziness, headaches, and long-term nerve damage (peripheral neuropathy).

- Fire Hazard:
Due to its flammability, proper storage away from open flames and heat sources is essential.

- Environmental Impact:
VOCs contribute to atmospheric pollution; leaks or spills should be managed carefully.

- Regulations:
Usage often regulated by environmental agencies due to its health and environmental effects.

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## Conclusion

Compound X, with a molar mass of 180.15 g/mol and a composition primarily of carbon and hydrogen, aligns closely with hexane ($C_6H_{18}$). Its structural simplicity as a saturated alkane makes it a versatile compound with numerous industrial applications, particularly as a solvent and in petrochemical processes. Its physical properties—such as volatility, flammability, and solvent capability—are characteristic of alkanes, while its chemical inertness underpins its stability in various environments.

However, safety considerations are paramount given its flammability and health risks associated with inhalation. Its environmental impact as a VOC also necessitates responsible handling and regulation. From a scientific perspective, understanding the composition and properties of Compound X not only provides insight into its practical uses but also underscores the

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