

# Difference Between Unimolecular and Bimolecular Reactions

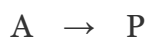
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## Key Difference - Unimolecular vs Bimolecular Reactions

In chemistry, the term molecularity is used to express the number of molecules that come together to react in an elementary reaction. An elementary reaction is a single step reaction that gives the final product directly after the reaction between [reactants](#). This means that the elementary reactions are chemical reactions that have no intermediate steps before the formation of the final product. Unimolecular and bimolecular reactions are such elementary reactions. The **key difference** between Unimolecular and bimolecular reactions is that **unimolecular reactions involve only one molecule as a reactant whereas bimolecular reactions involve two molecules as reactants**.

## What are Unimolecular Reactions?

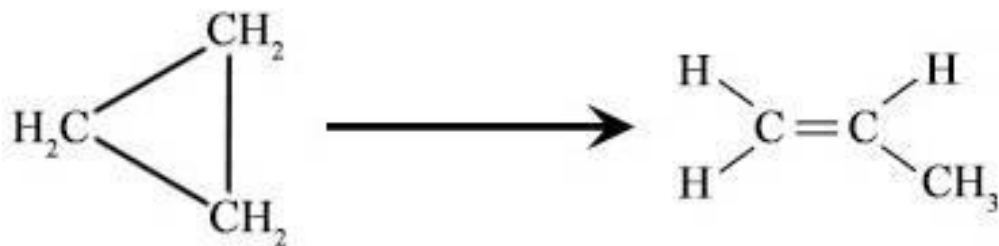
Unimolecular reactions are elementary reactions that involve only one molecule as a reactant. There, the reaction is a rearrangement reaction. The single molecule rearranges to form more different molecules as final products. But this occurs in a single step. There are no intermediate steps that the reactant molecule undergoes in the formation of the final product. It directly gives the final products. The equation for the reaction can be given as



Here A is reactant and P is the product. According to the first order of rate law, the rate of this reaction can be given as below.

$$\text{Rate} = k [\text{reactant}]$$

Some examples of unimolecular reactions include followings:

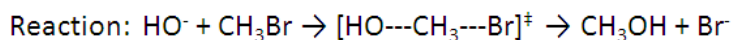
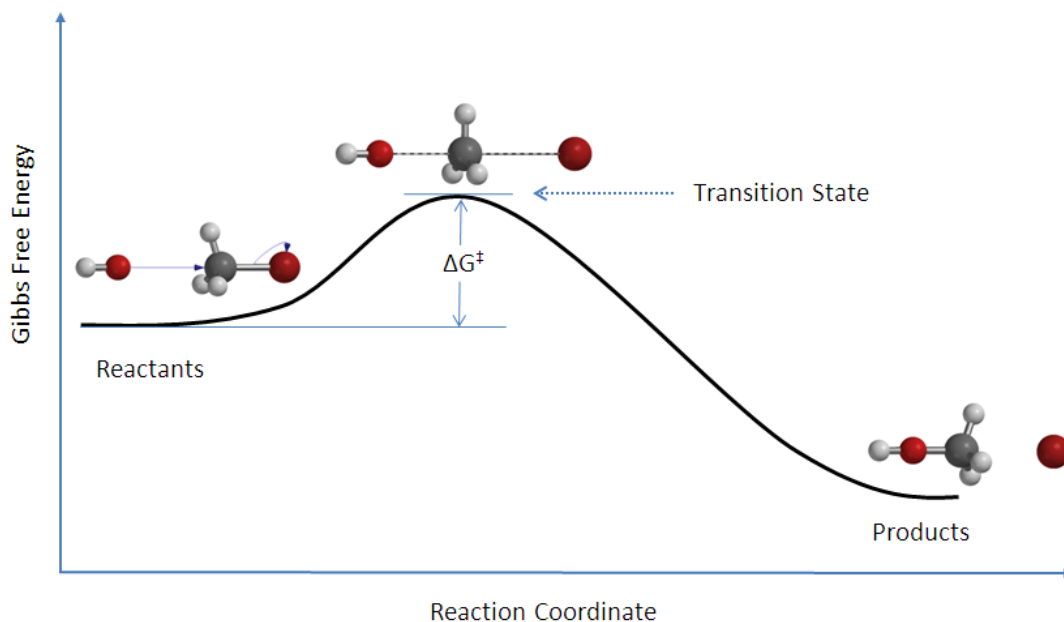


**Figure 01: Cyclopropane rearrangement to form propane.**

1. Conversion of  $\text{N}_2\text{O}_4$  into two  $\text{NO}_2$  molecules
2. Conversion of cyclopropane into propene
3. Conversion of  $\text{PCl}_5$  into  $\text{PCl}_3$  and  $\text{Cl}_2$

## What are Bimolecular Reactions?

Bimolecular reactions are elementary chemical reactions that involve two molecules as reactants. It can be described as the collision of two molecules or particles. These are common chemical reactions in [organic and inorganic chemistry](#). The two molecules can be of the same or different types. For example, the two molecules can be two  $\text{NOCl}$  molecules with the same atomic arrangement or can be  $\text{C}$  and  $\text{O}_2$  having different atomic combinations. The equations for the bimolecular reactions is given as below.



**Figure 02: Energy diagram for a bimolecular reaction.**

Since there are two reactants, these reactions are explained as second-order reactions. Therefore, these bimolecular reactions are described by the second order rate law;

$$\text{Rate} = [\text{A}]^2$$

Or

$$\text{Rate} = [A][B]$$

In which the overall order is always 2. Some examples of bimolecular reactions are given below.

1. Reaction between CO and  $\text{NO}_3$
2. Reaction between two NOCl molecules
3. Reaction between Cl and  $\text{CH}_4$

## What are the Similarities Between Unimolecular and Bimolecular Reactions?

- Both Unimolecular and Bimolecular Reactions are elementary reactions.
- Both Unimolecular and Bimolecular reactions give the product in a single step.
- Both Unimolecular and Bimolecular reactions have no intermediate steps.

## What is the Difference Between Unimolecular and Bimolecular Reactions?

Unimolecular vs Biomolecular Reactions	
Unimolecular reactions are elementary reactions that involve only one molecule as a reactant.	Bimolecular reactions are elementary chemical reactions that involve two molecules as reactants.
Reactants	
Unimolecular reactions have one reactant	Bimolecular reactions have two reactants.
Order of Rate Law	
Unimolecular reactions are explained via first order of rate law.	Bimolecular reactions are explained via second-order rate law.
Overall Order	
The overall order of the rate equation of unimolecular reactions is always 1.	The overall order of the rate equation of bimolecular reactions is always 2.

## Summary - Unimolecular vs Bimolecular Reactions

Unimolecular and bimolecular reactions are elementary reactions. These reactions give the product in a single step. These reactions can be expressed using rate laws as well. The

difference between Unimolecular and bimolecular reactions is that unimolecular reactions involve only one reactant whereas bimolecular reactions involve two molecules as reactants.

**Reference:**

1. "Elementary Reactions." Chemistry LibreTexts, Libretexts, 26 May 2017. [Available here](#)
2. "Elementary reaction." Wikipedia, Wikimedia Foundation, 10 Feb. 2018. [Available here](#)
3. "Molecularity." Wikipedia, Wikimedia Foundation, 13 Feb. 2018. [Available here](#)

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