

Difference Between Universal Gas Constant and Characteristic Gas Constant

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Key Difference - Universal Gas Constant vs Characteristic Gas Constant

Gaseous phase is one of the three major phases matter can exist. It is the most compressible state out of three states of matter. Only 11 elements out of other elements exist as gases under normal conditions. However, the “ideal gas law” gives us an equation that can be used to explain the behavior of a normal gas. It has a proportionality constant which is called universal gas constant and when it is applied to a real gas, this constant is used with a modification. Then it is called a characteristic gas constant. The key difference between universal gas constant and characteristic gas constant is that **universal gas constant is only applicable for ideal gases** whereas **characteristic gas constant is applicable for real gases**.

What is Universal Gas Constant?

Gas molecules are capable of free motion throughout the space since they are very light molecules. Forces between gas molecules are weak Van Der Waal attraction forces. However, in order to explain the behavior of a gas, scientists have derived theories using a hypothetical gas known as Ideal gas. They have also derived a law regarding this ideal gas, which is known as the Ideal gas law.

First, we should know what an ideal gas means. It is a hypothetical gas which would show the following properties if it was a real gas. These are only assumptions.

- An ideal gas is composed of a large number of small gas molecules.
- The volume of those gas molecules is negligible.
- There are no attractions between gas molecules.
- The motion of these gas molecules obeys the Newton's law of motion.
- Collisions of molecules are completely elastic.

By looking at these properties, it is understandable that none of the real gases are ideal.

The ideal gas law indicates the state of an ideal gas and is explained by an equation as follows.

$$PV = nRT$$

P – Pressure of the ideal gas

V – Volume of the ideal gas

n – Number of moles of the ideal gas (amount of substance)

T – Temperature

The term R here is the universal gas constant. The value of R can be calculated by considering the standard temperature and pressure which are 0⁰C and 1atm pressure. This gives a value for the universal gas constant as 0.082057 L/(K.mol).

What is Characteristic Gas Constant?

When applying the ideal gas equation for normal gases, the above equation requires modification because none of the real gases behave as an ideal gas. Thus, characteristic gas constant, instead of universal gas constant, is used there. The properties of real gases that are different from an ideal gas can be listed as below.

- Real gases are composed of distinguishable large molecules compared to ideal gases.
- These gas molecules bear a certain volume.
- There are weak Van Der Waal forces between gas molecules.
- Collisions are not completely elastic.

Therefore, the ideal gas law cannot be applied directly to a real gas. Thus a simple modification is done; the universal gas constant is divided by the [molar mass](#) of the gas before applying it in the equation. It can be shown as follows.

$$R_{\text{specific}} = R/M$$

R_{specific} - Characteristic gas constant

R - Universal gas constant

M - Molar mass of the gas

This can be used even for a mixture of gases. Then, the R constant should be divided by the molar mass of the mixture of gases. This characteristic gas constant is also known as the **specific gas constant** because its value depends on the gas or the mixture of gases.

What is the difference between Universal Gas Constant and Characteristic Gas Constant?

| Universal Gas Constant vs Characteristic Gas Constant | |
|--------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| Universal gas constant is only applied for an ideal gas. | Characteristic gas constant is applied for a real gas. |
| Calculation | |
| Universal gas constant is calculated using standard temperature and pressure (STP) values. | Characteristic gas constant is calculated with STP values along with the molar mass of the real gas. |
| Relationship with the Gas | |
| Universal gas constant is independent of the gas taken. | Characteristic gas constant is dependent on the gas. |
| Value | |
| The value of universal gas constant is 0.082057 L/(K.mol). | The value for characteristic gas constant will always depend on the gas. |

Summary - Universal Gas Constant vs Characteristic Gas Constant

An ideal gas is a hypothetical gas which is assumed to have properties that are very different from a real gas. The ideal gas law is formed to explain the behavior of an ideal gas. However, in using this constant on real gases, it should be modified by applying characteristic gas constant other than universal gas constant. That is because none of the real gases behave as an ideal gas. The main difference between

universal gas constant and characteristic gas constant is that universal gas constant is applicable only for ideal gases whereas characteristic gas constant is applicable for real gases.

Reference:

1. LeTran, Duke. "The Ideal Gas Law." N.p., 09 Jan. 2017. Web. [Available here](#). 09 June 2017.
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