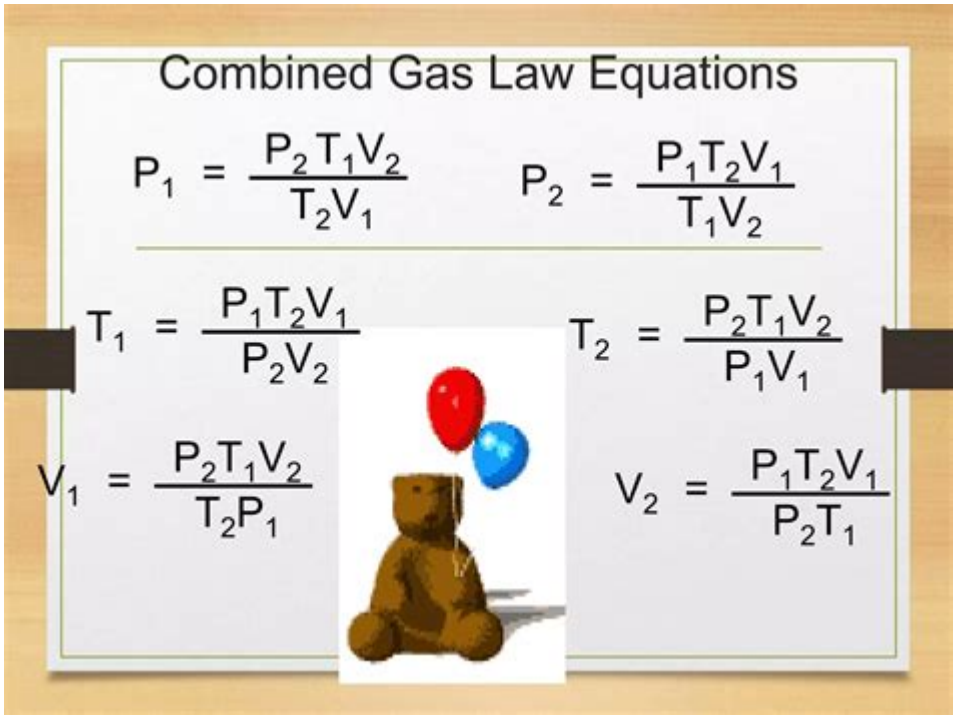
Using The Combined Gas Law Aleks



Using the combined gas law is essential for understanding the relationships among temperature, pressure, and volume of gases in various scientific fields, including chemistry and physics. This law is a critical tool in both academic studies and practical applications, allowing scientists and engineers to predict how a gas will behave under different conditions. This article will explore the combined gas law, its derivation, applications, and practical examples to enhance your understanding of this fundamental principle.

Understanding the Combined Gas Law

The combined gas law is a mathematical relationship that combines three individual gas laws: Boyle's Law, Charles's Law, and Gay-Lussac's Law. Each of these laws describes how gases behave under specific conditions:

- Boyle's Law states that the pressure of a gas is inversely proportional to its volume when the temperature is held constant. This can be expressed as:

$$
P_1V_1 = P_2V_2
$$

- Charles's Law states that the volume of a gas is directly proportional to its temperature (in Kelvin) when the pressure is held constant:

$$
\frac{V_1}{T_1} = \frac{V_2}{T_2}
$$

- Gay-Lussac's Law states that the pressure of a gas is directly proportional to its temperature (in Kelvin) when the volume is held constant:

$$
\frac{P_1}{T_1} = \frac{P_2}{T_2}
$$

The combined gas law integrates these three relationships into a single equation, which is useful for solving problems where more than one variable changes:

$$
\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}
$$

Deriving the Combined Gas Law

To derive the combined gas law, we start with the three individual laws mentioned above.

1. From Boyle's Law, we can express temperature as a constant:
$$
P \propto \frac{1}{V} \quad (T \text{ constant})
$$

2. From Charles's Law, we express pressure as a constant:
$$
V \propto T \quad (P \text{ constant})
$$

3. From Gay-Lussac's Law, we express volume as a constant:
$$
P \propto T \quad (V \text{ constant})
$$

By combining these relationships, we find that:
$$
PV \propto T
$$

This leads us to the combined gas law, which holds true when the amount of gas remains constant. It's important to remember that all temperatures must be in Kelvin for these formulas to work correctly.

Applications of the Combined Gas Law

The combined gas law has numerous practical applications across various fields. Here are some of the most common uses:

- **Laboratory Experiments:** Scientists use the combined gas law to predict how gases will respond to changes in pressure, volume, and temperature during experiments.
- **Engineering:** Engineers apply the combined gas law in the design of equipment that involves gas storage and usage, such as compressors and gas tanks.
- **Aerospace:** The law is essential in the aerospace industry for calculating how gases behave at high altitudes where pressure and temperature differ significantly from sea level.
- **Environmental Science:** It helps in understanding how gases in the atmosphere behave, which is crucial for

studying air pollution and climate change.

Example Problems Using the Combined Gas Law

To further illustrate the use of the combined gas law, let's solve a couple of example problems.

Example 1: Pressure Change

Problem: A gas has a volume of 5.0 L at a pressure of 1.0 atm and a temperature of 300 K. If the volume changes to 10.0 L, what is the new pressure at the same temperature?

Solution:

Using the combined gas law:
$$
\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}
$$

Since the temperature is constant (T1 = T2), we can simplify to:
$$
P_1V_1 = P_2V_2
$$

Plugging in the known values:
$$
(1.0 \, \text{atm})(5.0 \, \text{L}) = P_2(10.0 \, \text{L})
$$

Solving for P_2:
$$
P_2 = \frac{(1.0 \, \text{atm})(5.0 \, \text{L})}{10.0 \, \text{L}} = 0.5 \, \text{atm}
$$

The new pressure is 0.5 atm.

Example 2: Volume Change with Temperature

Problem: A gas occupies a volume of 2.0 L at a pressure of 3.0 atm and a temperature of 273 K. If the temperature is raised to 546 K and the pressure is reduced to 1.5 atm, what is the new volume?

Solution:

Using the combined gas law:
$$
\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}
$$

Substituting the known values:
$$
\frac{(3.0 \, \text{atm})(2.0 \, \text{L})}{273 \, \text{K}} = \frac{(1.5 \, \text{atm})V_2}{546 \, \text{K}}
$$

\]

Cross-multiplying gives:
\[
(3.0)(2.0)(546) = (1.5)V_2(273)
\]

Calculating the left side:
\[
3.0 \times 2.0 \times 546 = 3276
\]

Now, calculating the right side:
\[
1.5 \times 273 = 409.5
\]

So:
\[
3276 = 409.5V_2
\]

Now solve for \(V_2\):
\[
V_2 = \frac{3276}{409.5} \approx 8.0 \, \text{L}
\]

The new volume is approximately 8.0 L.

Conclusion

Using the combined gas law is essential for anyone studying gases, whether in an academic setting or a professional field. By understanding the relationships between pressure, volume, and temperature, you can make accurate predictions about gas behavior under varying conditions. This knowledge is not only fundamental in theoretical physics and chemistry but also has real-world applications in industries ranging from engineering to environmental science. As you continue to explore the sciences, mastering the combined gas law will enhance your problem-solving skills and deepen your understanding of the gaseous state of matter.

Frequently Asked Questions

What is the combined gas law and how is it used in ALEKS?

The combined gas law is an equation that relates pressure, volume, and temperature of a gas. In ALEKS, it is used to solve problems involving changes in these properties, allowing students to calculate one variable when the others are known.

How do you rearrange the combined gas law equation in ALEKS?

To rearrange the combined gas law equation (PV/T = constant), you can isolate any variable by multiplying or dividing through by the other variables. For example, to solve for volume (V), you would rearrange it to V = nRT/P.

Can you provide an example problem using the combined gas law in ALEKS?

Sure! If a gas has a pressure of 2 atm, a volume of 5 L, and a temperature of 300 K, and you want to find the new volume when the pressure is changed to 1 atm and the temperature to 400 K, you would use the combined gas law to solve for the new volume.

What common mistakes should be avoided when using the combined gas law in ALEKS?

Common mistakes include forgetting to convert units (e.g., temperature must be in Kelvin), not maintaining consistent units for pressure and volume, and incorrectly rearranging the formula, which can lead to wrong answers.

How does ALEKS help in understanding the combined gas law?

ALEKS provides interactive tutorials and practice problems that guide students through the application of the combined gas law, offering immediate feedback and step-by-step solutions to reinforce understanding.

Using The Combined Gas Law Aleks

What are the uses of "using" in C#? - Stack Overflow
Mar 8, 2017 · User kokos answered the wonderful Hidden Features of C# question by mentioning the using keyword. Can you elaborate on that? ...

What is the logic behind the "using" keyword in C++?
Dec 26, 2013 · 239 What is the logic behind the "using" keyword in C++? It is used in different situations and I am trying to find if all those have ...

How do I UPDATE from a SELECT in SQL Server? - Stack ...
Feb 25, 2010 · Although the question is very interesting, I have seen in many forum sites and made a solution using INNER JOIN with screenshots. At ...

How to update/upgrade a package using pip? - Stack Ov...
Nov 2, 2017 · What is the way to update a package using pip? those do not work: pip update pip upgrade I know this is a simple question but it is needed as it ...

What is the difference between 'typedef' and 'using'?
Updating the using keyword was specifically for templates, and (as was pointed out in the accepted answer) when you are working with non ...

What are the uses of "using" in C#? - Stack Overflow
Mar 8, 2017 · User kokos answered the wonderful Hidden Features of C# question by mentioning the using keyword. Can you elaborate on that? What are the uses of using?

What is the logic behind the "using" keyword in C++?
Dec 26, 2013 · 239 What is the logic behind the "using" keyword in C++? It is used in different situations and I am trying to find if all those have something in common and there is a reason ...

How do I UPDATE from a SELECT in SQL Server? - Stack Overflow
Feb 25, 2010 · Although the question is very interesting, I have seen in many forum sites and made a solution using INNER JOIN with screenshots. At first, I have created a table named ...

How to update/upgrade a package using pip? - Stack Overflow
Nov 2, 2017 · What is the way to update a package using pip? those do not work: pip update pip upgrade I know this is a simple question but it is needed as it is not so easy to find (pip ...

What is the difference between 'typedef' and 'using'?
Updating the using keyword was specifically for templates, and (as was pointed out in the accepted answer) when you are working with non-templates using and typedef are ...

c# - Using .ToDictionary () - Stack Overflow
Aug 31, 2010 · Edit The ToDictionary() method has an overload that takes two lambda expressions (nitpick: delegates); one for the key and one for the value. For example: var ...

Windows Kill Process By PORT Number - Stack Overflow
Mar 23, 2019 · Option 2 PowerShell Get-Process -Id (Get-NetTCPConnection -LocalPort portNumber).OwningProcess cmd C:\> netstat -a -b (Add -n to stop it trying to resolve ...

Accessing Microsoft Sharepoint files and data using Python
Jan 30, 2020 · I am using Microsoft sharepoint. I have an url, by using that url I need to get total data like photos,videos,folders,subfolders,files,posts etc... and I need to store those data in ...

Defining and using a variable in batch file - Stack Overflow
Defining and using a variable in batch file Asked 13 years, 2 months ago Modified 4 months ago Viewed 1.3m times

git - SSL certificate problem: self signed certificate in certificate ...
Apr 24, 2023 · This should be the accepted answer. Disabline SSL verification is a workaround suitable for diagnostics, but in a well configured Windows dev environment, Git really ought to ...

Back to Home