Historical Overview of Thermodynamic Laws

Early scientists explored the relationships among the **pressure of a gas (*P*) and its temperature (*T*), volume (*V*), and amount (*n*)** **by** holding two of the four variables constant (amount and temperature, for example), varying a third (such as pressure), and measuring the effect of the change on the fourth (in this case, volume).

Boyle's Law: The Pressure-Volume Law

"The volume of a given amount of gas held at constant temperature varies inversely with the applied pressure when the temperature and mass are constant"

$$V \propto \frac{1}{P}$$

Another way to describing it is saying that their products are constant.

$PV = C$ اي ان هناك علاقة عكسية

From the equation above, this can be derived:

$P_1V_1 = P_2V_2 = P_3V_3$ **etc.**

This equation states that the product of the initial volume and pressure is equal to the product of the volume and pressure after a change in one of them under constant temperature.

Charles' Law: The Temperature-Volume Law

"The volume of a given amount of gas held at constant pressure is directly proportional to the Kelvin temperature".

$V \propto T$

Same as before, a constant can be put in:

$V / T = C$ اي ان هناك علاقة طردية

The initial and final volumes and temperatures under constant pressure can be calculated.

$V_1 / T_1 = V_2 / T_2 = V_3 / T_3$ **etc.**

Gay-Lussac's Law: The Pressure Temperature Law

"The pressure of a given amount of gas held at constant volume is directly proportional to the Kelvin temperature".

$P \propto T$

Same as before, a constant can be put in:

$P / T = C$ **اي ان هناك علاقة طردية**

The initial and final pressures and temperatures under constant volume can be calculated.

$P_1 / T_1 = P_2 / T_2 = P_3 / T_3$ **etc.**

Avogadro's Law: The Volume Amount Law

It gives the relationship between volume and amount (moles) when pressure and temperature are held constant. Also, since volume is one of the variables, that means the container holding the gas is flexible in some way and can expand or contract.

$V \propto n$ **اي ان هناك علاقة طردية**

As before, a constant can be put in:

$V / n = C$

This means that the volume-amount fraction will always be the same value if the pressure and temperature remain constant.

$V_1 / n_1 = V_2 / n_2 = V_3 / n_3$ etc.

The Combined Gas Law

Now we can combine everything we have into one proportion:

$$V \propto \frac{T}{P}$$

"The volume of a given amount of gas is proportional to the ratio of its Kelvin temperature and its pressure".
Same as before, a constant can be put in:

$PV / T = C$

As the pressure goes up, the temperature also goes up, and vice-versa. Also same as before, initial and final volumes and temperatures under constant pressure can be calculated.

$P_1V_1 / T_1 = P_2V_2 / T_2 = P_3V_3 / T_3$ etc.

The Ideal Gas Law

The previous laws all assume that the gas being measured is an *ideal gas*, a gas that obeys them all exactly. But over a wide range of temperature, pressure, and volume, real gases deviate slightly from ideal. Since, according to Avogadro, the same volumes of gas contain the same number of moles, chemists could now determine the formulas of gaseous elements and their formula masses. The idea gas law is:

$PV = nRT$