

NATURE OF GASES: LAWS AND FORMULAS

A gas has no definite volume or shape, like solids and liquids do. A gas will always completely fill the container in which it is stored. The following laws will provide a foundation for understanding how gases are applied in the vacuum pump process. For example, these laws allow for the calculations needed to size and select a pump needed for a given application.

Boyle's Law

An increase in volume results in a decrease in pressure. A decrease in volume results in an increase in pressure. Boyle established this inverse relation under constant temperature.

In mathematical terms it is expressed as:

$$\boxed{P \times V = \text{Constant}} \quad \text{in which} \quad \begin{array}{l} P = \text{pressure} \\ V = \text{volume} \end{array}$$

When transferring a gas from a volume V_1 under a pressure P_1 , into a volume V_2 at a pressure of P_2 , the law becomes:

$$\boxed{P_1 \times V_1 = C = P_2 \times V_2} \quad \text{or} \quad \boxed{\frac{P_1}{P_2} = \frac{V_1}{V_2}}$$

Charles' Law or Law of Guy Lussac

This law established the relationship between gas temperature and volume, and between gas temperature and pressure. For each degree in temperature change an equal change in pressure or volume occurs. It can be expressed as follows:

$$\boxed{\frac{V_1}{T_1} = \frac{V_2}{T_2}} \quad \boxed{\frac{P_1}{T_1} = \frac{P_2}{T_2}}$$

T is expressed in absolute temperature.

When dealing with temperature -t- expressed in degrees Celsius, the absolute temperature T is expressed in degrees Kelvin (T):

$$\boxed{tc + 273 = T}$$

When dealing with temperature -t- expressed in degrees Fahrenheit, the absolute temperature T is expressed in degrees Rankin:

$$\boxed{tf + 460 = T}$$

General Gas Law

This law combines Boyle's Law and Charles' Law to establish the relationship between the pressure, the volume, and the temperature of gas.

It is expressed mathematically as:

$$\boxed{\frac{P \times V}{T} = \text{Constant}} \quad \text{or} \quad \boxed{\frac{P_1 \times V_1}{T_1} = \frac{P_2 \times V_2}{T_2}}$$



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