

Ideal Gas Laws

Boyles Law $P \propto \frac{1}{V}$ Pressure inversely proportional to volume **AT** constant T (temperature) and N (number of molecules)



Robert Boyle [1627 –1691](https://en.wikipedia.org/wiki/Robert_Boyle) Irish chemist/philosopher. Authored *The Sceptical Chymist* regarded as a cornerstone book in the field of chemistry.

Charles Law $V \propto T$ Volume proportional to temperature if P and n are constant. But T must be units of Kelvin. $K=C +273$. Concept of absolute zero



Jacques Alexandre César Charles (November 12, 1746 – April 7, 1823) was a [French inventor](#), [scientist](#), [mathematician](#), and [balloonist](#). Charles wrote almost nothing about mathematics, and most of what has been credited to him was due to mistaking him with another Jacques Charles, also a member of the Paris Academy of Sciences, entering on May 12, 1785. He was sometimes called Charles the Geometer. (See J. B. Gough, Charles the Obscure, Isis 70, #254, pgs 576-579) Charles and the [Robert brothers](#) launched the world's first unmanned [hydrogen](#)-filled [gas balloon](#) in August 1783.

[https://en.wikipedia.org/wiki/Jacques_Charles]

**Avogadro's Law $V \propto N$ Volume is proportional to amount of gas
(at constant T and constant P)**



https://en.wikipedia.org/wiki/Amedeo_Avogadro

Amedeo Carlo Avogadro^[1] (1776 -1856), **Count** of **Quaregna** and **Cerreto**, was an **Italian scientist**, most noted for his contribution to **molecular theory** now known as **Avogadro's law**, which states that equal volumes of gases under the same conditions of temperature and pressure will contain equal numbers of molecules. In tribute to him, the number of elementary entities (**atoms**, **molecules**, **ions** or other particles) in 1 **mole** of a substance, $6.022140857(74) \times 10^{23}$, is known as the **Avogadro constant**, one of the seven **SI** base units and represented by N_A .

IDEAL GAS LAW $PV=nRT$

Pressure in Pascals (Pa), V in m³, T in Kelvin

R is the gas constant = 8.31 Joules/mole K

VERY USEFUL

Examples

A)

1 m³ of helium gas in a steel cylinder at 0 C is heated to 200 C. If the initial pressure was 100 kPa (1 atmos approx..) what is the final pressure.

V = constant

$$P(\text{final}) = P(\text{initial}) * T(\text{final})/T(\text{initial})$$
$$= 100 * 473/273 = 173 \text{ Pa} = 1.73 \text{ atmos.}$$

B) The pressure of a 100 cm³ cylinder of N₂ gas at 20 C has a pressure of 100 atmos. What is the mass of N₂ in the cylinder?

$$m = M (PV/RT) \quad M \text{ is the molecular weight} = 28 \text{ kg/kmole}$$

$$R = 83100 \text{ J/kmole K}$$

Calculate m = 12 grams. You can determine how much gas is in cylinder by weighing it. (Need to know empty weight of cylinder.)