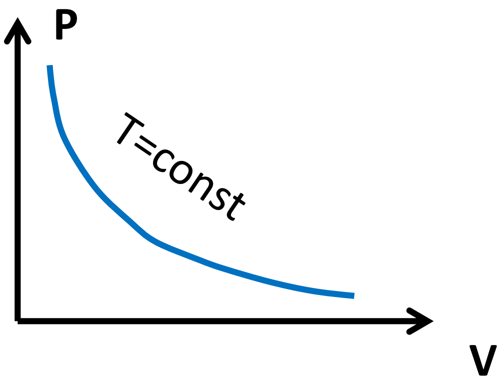
Experimental Gas Laws

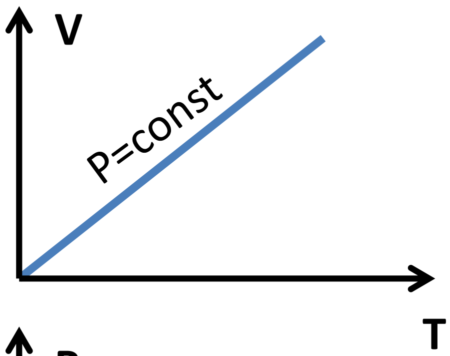
Boyle's Law:

$$PV = const \quad (\text{when} \quad T = const)$$



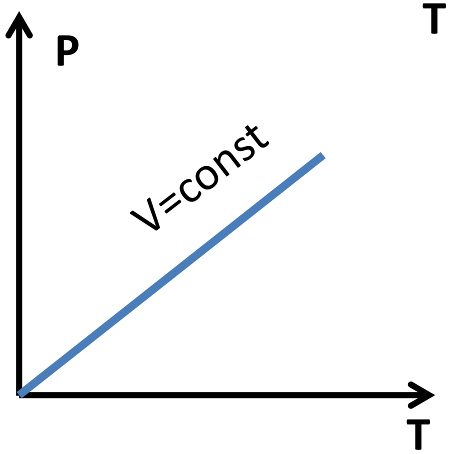
Charles's Law:

$$\frac{V}{T} = const \quad (\text{when} \quad P = const)$$



Gay-Lussac's Law:

$$\frac{P}{T} = const \quad (\text{when} \quad V = const)$$



$$T[K] \approx T\,{}^{0}C + 273.15$$

Combined Gas Law

$$PV = nRT$$

$\mathrm{n}[mol] = \frac{\mathrm{m}}{\mu}$ – quantity of substance (number of moles)

$m\,[\mathrm{g}]$ – Mass of gas

$\mu\left[\frac{\mathrm{g}}{mol}\right]$ – Molar Mass (molecular weight from periodic table)

$\mathrm{P}[\mathrm{Pa}]$ – Pressure; $V[m^3]$ – Volume

The formula also works if we switch to more convenient units: $\mathrm{P}[\mathrm{kPa}]$ and $V[l]$

$R \approx 8.3\frac{J}{mol \cdot K}$ is called Universal Gas Constant.

$$T[K] \approx T^0C + 273.15$$

Homework

Problem 1

Mole is a unit of so-called “quantity of substance”: it always contains the same number of molecules (known as Avogadro number). The number of moles is calculated as mass (in grams) divided by the molecular weight.
It is widely known that 1 mole of any gas occupies the same volume at normal conditions (atmospheric pressure, P=101kPa and room temperature T=20^{o}C). Starting with unified gas law, find this pressure (in liters).

Problem 2

1 gram of air contains approximately 0.23 g of Oxygen (O_2), 0.755 g of Nitrogen (N_2), 0.01 g of Argon and 0.005 g of CO_2. Find the density of air at normal conditions. Note that the total pressure is equal to sum of pressures of each gas occupying the same volume V.