# Boyle´s Law

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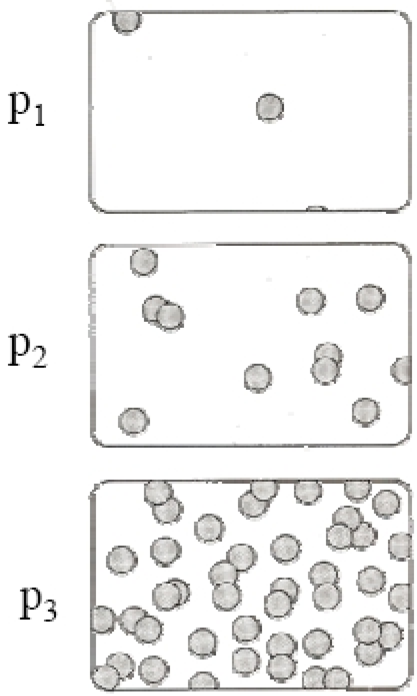
## 1 Boyle’s Law




Boyle’s law (or Boyle-Mariotte), named after Robert Boyle (1627-1691) describes the dependancy of the volume and pressure of a gas. Boyle’s law states that the pressure of an ideal gase is inversely proportional to its volume provided the temperature and quantity remain constant. If the pressure on a specific quantity of gas is increased the volume decreases. On decreasing the pressure the volume expands.

p = pressure
V = Volume

The space between the gas atoms decreases

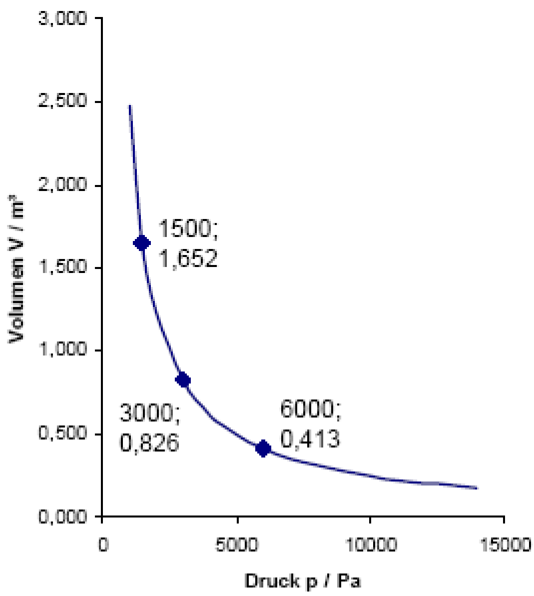
$p_1 < p_2 < p_3$

The possibilities of dependancy:

$x \rightarrow e^x$
$x \rightarrow 1/x$

which means the volume becomes half on doubling the pressure.

$$\Rightarrow \qquad V \propto \frac{1}{p}$$




$$\Rightarrow V \propto \frac{1}{p} \qquad oder \qquad V = K \bullet \frac{1}{p}$$

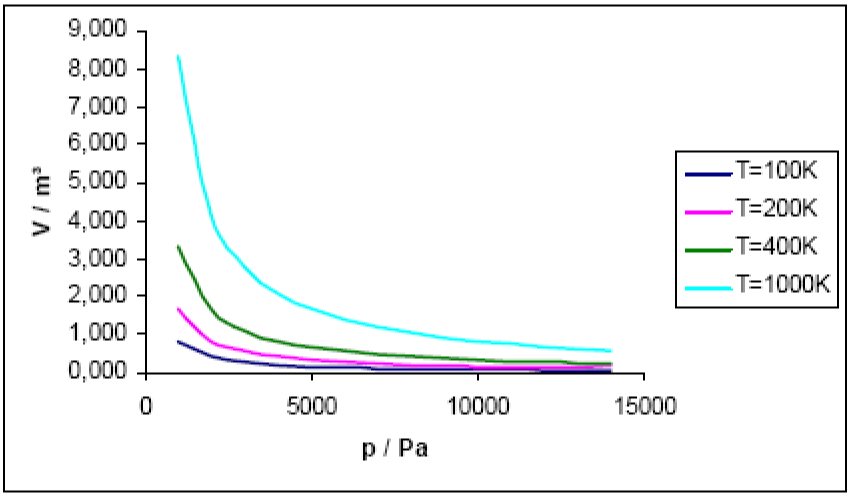
*ebenso gilt*

$$p \propto \frac{1}{V} \quad oder \quad p = K \bullet \frac{1}{V}$$

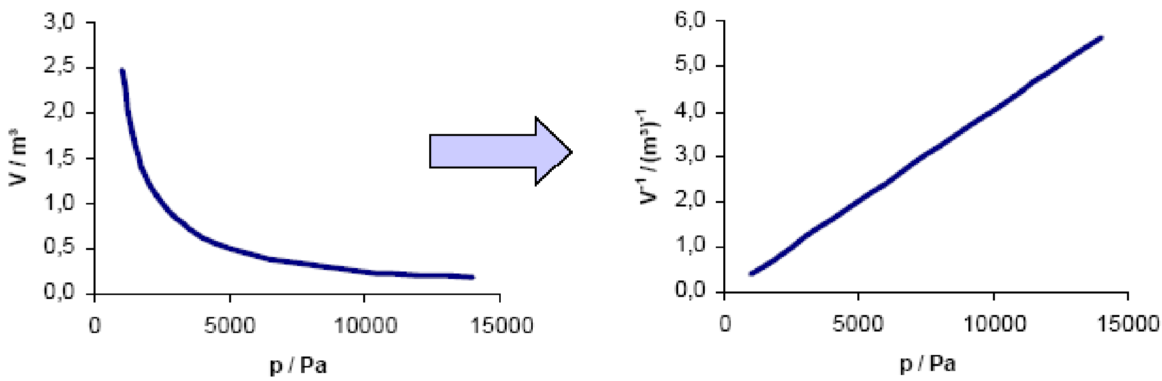
**Condition:** Temperature and quantity remain constant. Mathematical formula:

$$V \propto \frac{1}{p}\bigg|_{const.T,n}$$

Behaviour at different temperatures produce isotherms




Determining the constant K by linearization of the plot.



**In the Plot: p → 1/V is K the progression**

$$K = \frac{\Delta \frac{1}{V}}{\Delta p} = \frac{\frac{1}{V_2} - \frac{1}{V_1}}{p_2 - p_1}$$

$$p \propto \frac{1}{V} \quad oder \quad p = K \cdot \frac{1}{V}$$

**Example:**
A sample of air has a volume of 1.0 K at 10°C and 0.5 bar. How much pressure will be needed to compress the air to a volume of 100 cm³ at the same temperature?

**Solution:**
$p_1 = K \cdot 1 / V_1$

$K = 0.5 \cdot 1000 = 500$

$p_2 = 500 / 100 = 5$ bar

## 2 Laws of Boyle and Gay – Lussac

The law of Gay-Lussac states that the volume of an ideal gas is directly proportional to the temperature at constant pressure and quantity. A gas expands on heating and contracts on cooling.

$$V(T) = V_0\,(1 + \gamma_0[T - T_0]) \qquad \text{mit} \qquad \gamma_0 = \frac{1}{T_0} = \frac{1}{273{,}15\ \text{K}}$$

$T_0$ is the temperature at point 0 on the celsius scale, that is 273.15 K or 0°C. In contrast to this T is the temperature to be deduced by which care should be taken that the same unit is used as with $T_0$. Analogous to this, V is the volume at T, $V_0$ the volume at $T_0$ and $\gamma_0$ the volume expansion coefficient at T0, which is generally $\gamma = 1/T$ for ideal gases.