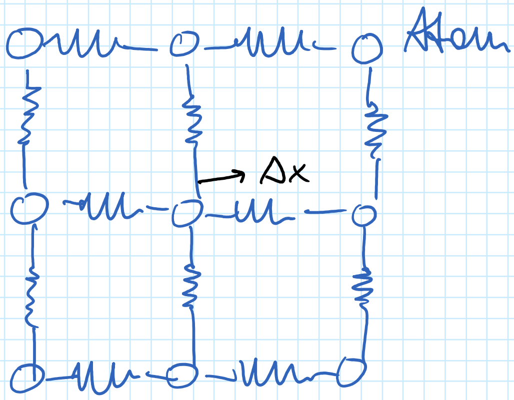
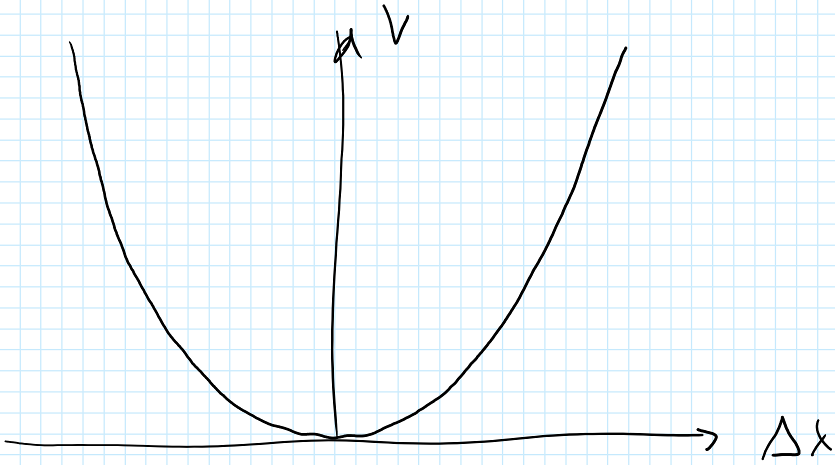
Festkörper



Potential : $V = \frac{1}{2} k \Delta x^2 \rightarrow \vec{F} = - \text{grad}\, V$

$F = - k \Delta x$



Gase

: Robert Brown 1827
„Brown'sche Bewegung“

p, V, T

$pV = \text{const}$ (Boyle)

$\frac{V}{T} = \text{const}$ (Gay-Lussac)

$$\frac{V}{T} = const \quad \text{(Gay-Lussac)}$$

$$\frac{V}{N} = const \quad \text{(Avogadro Prinzip)}$$

$N_A = 6{,}022 \cdot 10^{23}\ mol^{-1}$: Avogadro Konstante

(für 1 mol)

$$N = n \cdot N_A$$

molares Volumen : $V_{mol} = \frac{V}{n}$

Teilchendichte : $N_D = \frac{N}{V} = \frac{n \cdot N_A}{n \cdot V_{mol}} = \frac{N_A}{V_{mol}}$

1) $pV = const$

2) $V \sim T$

$$\boxed{pV = const \cdot T}$$

$$\Downarrow$$

$$p \sim T$$

3) $\frac{V}{N} = const \longrightarrow \frac{V}{n} = const$

$$V \sim n$$

$$\Rightarrow \boxed{pV = const \cdot nT}$$

$$\Rightarrow \quad \boxed{pV = \text{const} \cdot nT}$$

$$\Downarrow$$

8,31446

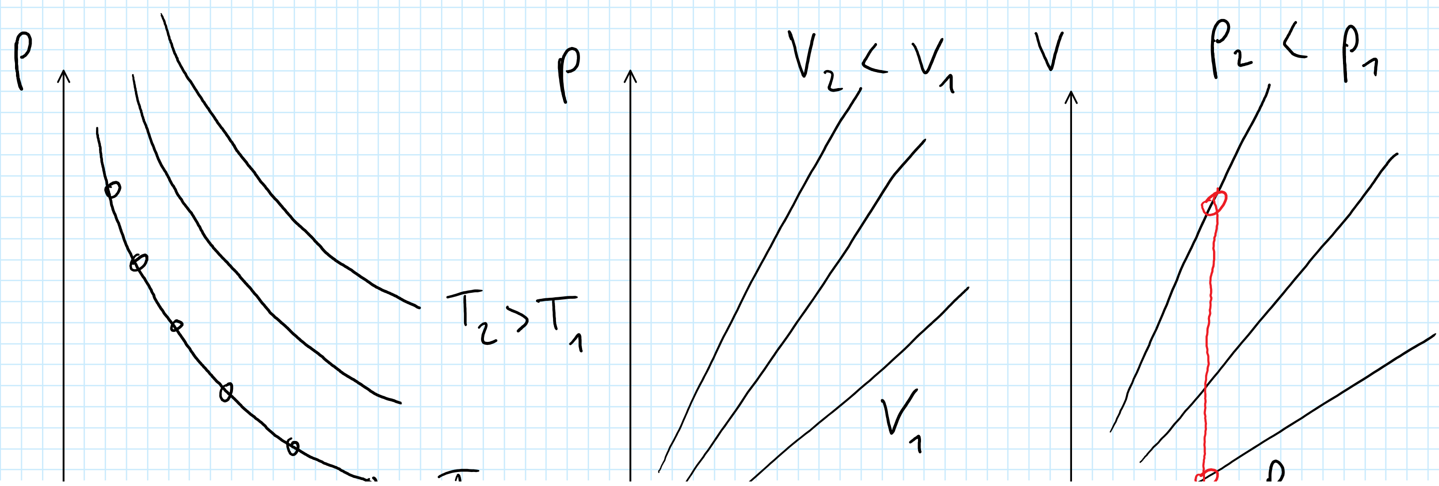
$$[\text{const}] = \frac{[p][V]}{[n][T]}$$

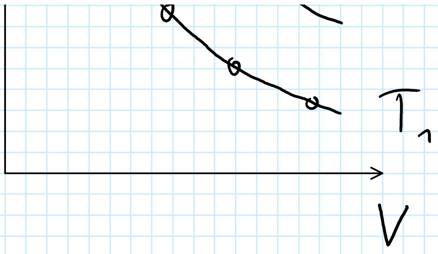
$$= \frac{\frac{kg}{m\,s^2} \cdot m^3}{mol\ K} = \frac{J}{mol\,K}$$

$$\boxed{R = 8{,}31446 \frac{J}{mol\,K}}$$ universelle Gaskonstante

$$\boxed{pV = nRT}$$ Zustandsgleichung eines idealen Gases

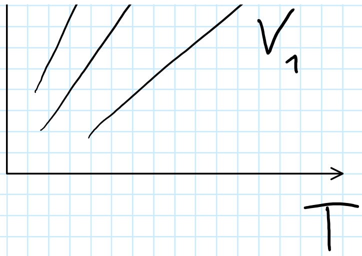
$p, V, n, T \rightarrow$ "Zustandsgrößen"





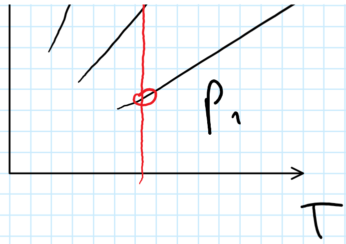
Isotherme
$(T = \text{const})$

$p \sim \frac{1}{V}$



Isochore
$(V = \text{const})$

$p \sim T$



Isobare
$(p = \text{const})$

$V \sim T$

$$p(V,T) = \frac{nRT}{V}$$

$(n = \text{const})$

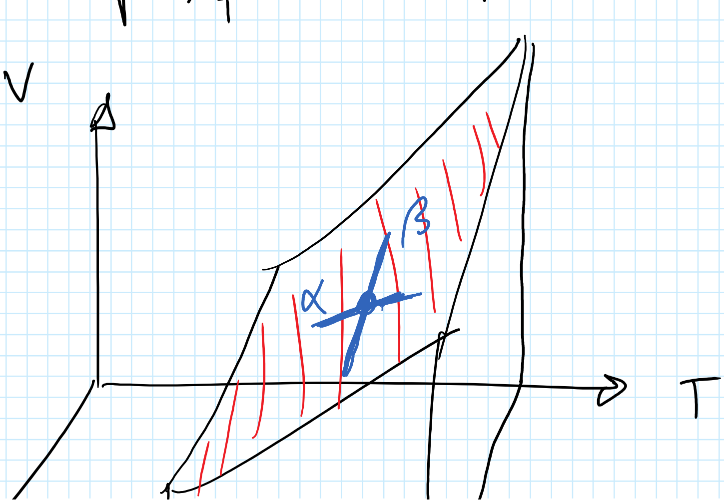
$$\left(\frac{\partial p}{\partial V}\right)_T$$

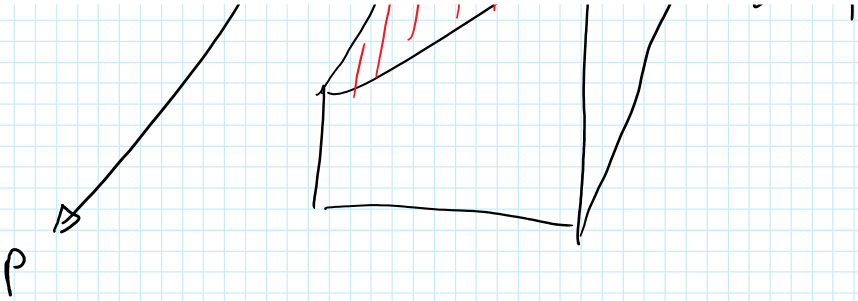
$$\left(\frac{\partial p}{\partial T}\right)_V$$

$$\alpha = \frac{1}{V_0}\left(\frac{\partial V}{\partial T}\right)_p$$: thermischer Ausdehnungskoeff.

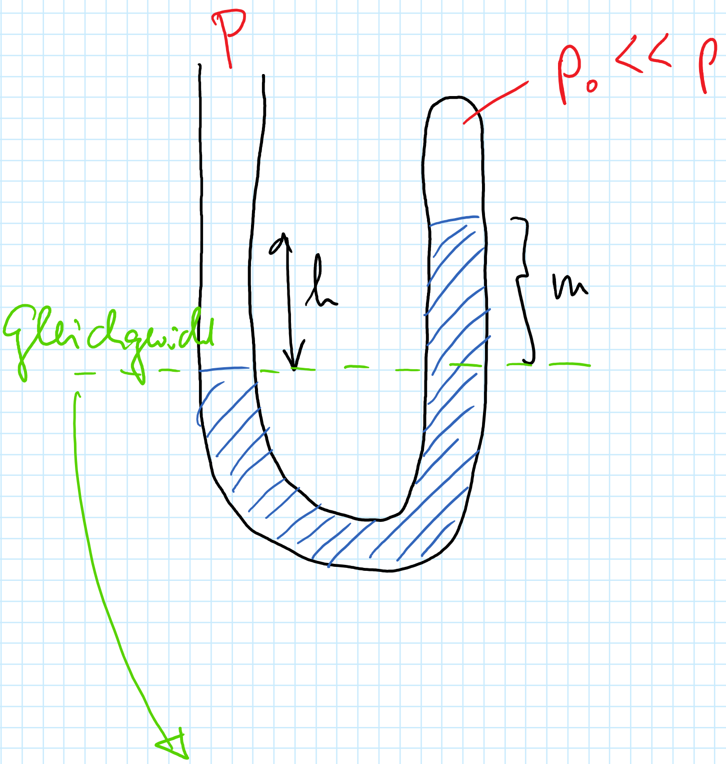
(vgl. Gay-Lussac)

$$\beta = \frac{1}{V_0}\left(\frac{\partial V}{\partial p}\right)_T$$: Kompressibilität





II.3 Zustandsgrößen p, V und T



Torricelli Barometer

$$p = \frac{F}{A}$$

$$[p] = \frac{\frac{kg\,m}{s^2}}{m^2} = \frac{kg}{m\,s^2} = Pa$$

$$p_{links} = p_{rechts}$$

$$p = p_0 + \frac{F}{A}$$

$$p = p_0 + \frac{mg}{A}$$

$$p = p_0 + \frac{m}{A \cdot h} \cdot h g$$

$$\Downarrow$$

$$A \cdot h = V \quad ? \quad m \qquad \rho V$$

$$\left.\begin{aligned} A \cdot h &= V \\ m &= \rho \cdot V \end{aligned}\right\} \quad \frac{m}{A \cdot h} = \frac{\rho V}{V} = \rho$$

$$p - p_0 = \rho g h$$

$$\boxed{p = \rho g h}$$

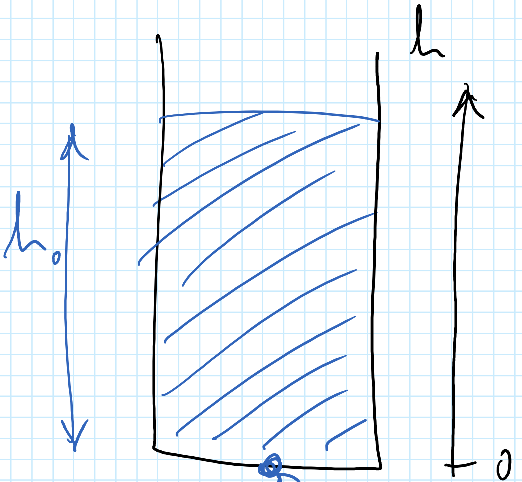
$\rho(Hg)$, g sind bekannt

p = Luftdruck $\Longrightarrow$ $h = 760$ mm

$$1 \text{ Torr} = p\,(h = 1\,\text{mm})$$

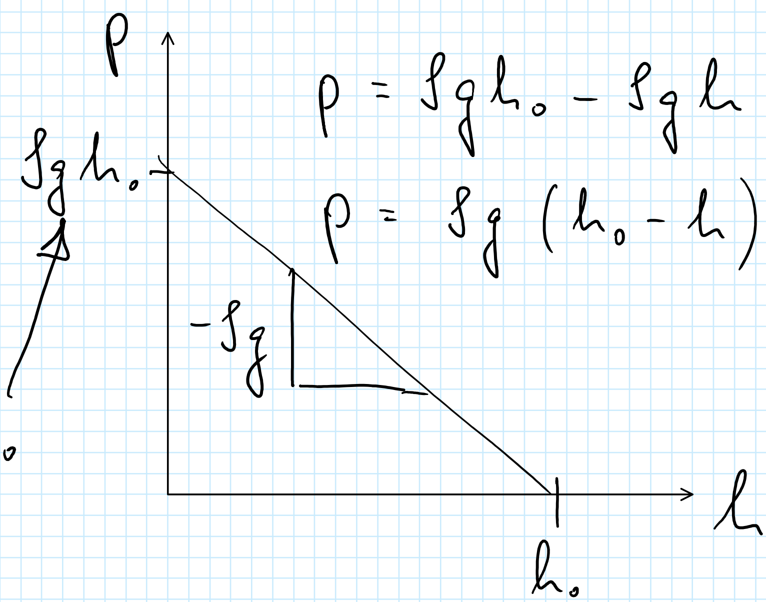
$$= \frac{1}{760} \text{ Atmosphärendruck}$$

$$\approx 133 \text{ Pa}$$



$\rho(h) = \text{const}$

$p = \rho g h_0$



$$p = \rho g h_0 - \rho g h$$

$$p = \rho g (h_0 - h)$$

Gedankenexperiment :

$$\rho_{Luft} = const = 1{,}29 \ \frac{kg}{m^3}$$

$$p = \rho g h \rightarrow h = \frac{p}{\rho g} = \frac{1{,}013 \cdot 10^5 \ \frac{kg}{m \cancel{s^2}}}{1{,}29 \ \frac{kg}{m^{\cancel{3}\,2}} \cdot 9{,}81 \ \frac{\cancel{m}}{\cancel{s^2}}}$$

$$h \simeq 8000 \ m$$