\ ExPhys 1 \

Formeln

Ergebnisse

①

(a) $pV = NRT$ (R: k_B) $\Rightarrow$ $N = \frac{pV}{RT} = \frac{1{,}01 \cdot 10^5 \cdot \frac{1}{1000}}{1{,}38 \cdot 10^{-23} \cdot 273\,K}$

$\approx 2{,}68 \cdot 10^{19} \;\hat{=}\; 44{,}68\ \mu mol$

(b) $l = \frac{1}{n \cdot \sigma}$ $\sigma = \pi a^2$

$n = \frac{p}{R \cdot T} = \frac{10^5 Pa}{1{,}38 \cdot 10^{-23} \cdot 273 K} = 2{,}65 \cdot 10^{25} \frac{1}{m^3}$

$l \approx 0{,}733\ \mu m$

(c) $\frac{3}{2} k_B \cdot T = U = \frac{1}{2} m \bar{v}^2 \Rightarrow$

$\bar{v} = \sqrt{3 k_B T / m} \approx 1303 \frac{m}{s}$

$\frac{3 \cdot 1{,}38 \cdot 10^{-23} \cdot 273}{0{,}004}$

$\bar{v} = l/t$ $\bar{v} = l \cdot \nu$ $\Rightarrow \nu = \frac{\bar{v}}{l} \approx 1{,}78\ \text{Mrd}\ \frac{1}{s}$

$\approx 1{,}78 \frac{1}{s}$

$m = 4u$

$\frac{J}{K} K / kg$

$\frac{N \cdot m}{kg} = \frac{m}{s^2} \cdot m$

② Freiheitsgrade: $f = 5$ $T = 273 K$

(a) $\bar{U} = \frac{5}{2} k_B \cdot T N \approx 9{,}42 \cdot 10^{-21} J\ N$

(b) $N_0 + \frac{3}{2}$

$N_0 = \frac{pV}{k_B T_0}$ $N_H = \frac{pV}{k_B T_H}$ $\frac{N_0}{N_H} = \frac{pV \cdot k_B T_H}{pV \cdot k_B T_0} = r$ ($T_H = 250$, $T_0 = 310$)

$\bar{U}_0 = \frac{5}{2} k_B \cdot T_0 = 1{,}0695 \cdot 10^{-20} J$

$\bar{U}_H = \frac{3}{2} k_B T_H = 5{,}175 \cdot 10^{-21} J$

beide unter Berücksichtigung d. Teilchenverhältnisse.

$N = 56$

Mittlere Freiheitsgrade $f(3,5)$

$U_{ges} = 7{,}626 \cdot 10^{-21} J$

$f_{ges} = 3{,}89$

$T_{ges} = \frac{U_{ges} \cdot \frac{2}{f}}{k_B} \approx 2863 K$

$f: a, b \mapsto \frac{25a + 31b}{56}$

$T_{ges} = \frac{f\left(\frac{5}{2} k_B T_0, \frac{3}{2} k_B T_H\right) \cdot \frac{2}{f(3,5)}}{k_B}$

(5)

(a) = $\cancel{\Delta Q = \frac{f}{2} k_B N \Delta T}$

$\Delta Q = \cancel{\frac{f}{2}} C_V \cdot \Delta T = \frac{3}{2} \cdot k_B \, \Delta T \, N$

$\cancel{\Delta T = \frac{\Delta p \cdot V_0}{k_B}}$

$N_A = N_0 = \frac{p_A V_A}{k_B \cdot T_A} = 2{,}999 \cdot 10^{+23} \approx \frac{1}{2} \text{mol}$

$pV = N k_B T$

$\Delta T = \frac{\Delta p \cdot V}{N \, k_B} = 144{,}98 \, K$

$pV = N k_B T$

$\Rightarrow \Delta Q = \frac{3}{2} \cdot 1{,}38 \cdot 10^{-23} \cdot 144{,}98 \, K \cdot 3 \cdot 10^{23} \approx 900 \, J$

$\cancel{\Delta Q = \frac{3}{2} \cdot k_B \cdot N \; \frac{\Delta p \, V_0 \, N \, k_B}{p_A \, V_A}}$

(b) $\Delta V = 2\,l \mathrel{\hat{=}} 0{,}002 \, m^3$ $\quad \Delta p = 0$

$C = \frac{3}{2} k_B \cdot N$

$\Delta Q = C \cdot \Delta T + p \cdot \Delta V$

$\Delta T = \frac{p \cdot \Delta V}{N \cdot k_B}$

$\Delta Q = C \cdot \frac{p \cdot \Delta V}{N \, k_B} + p \Delta V$

$= \frac{3}{2} \cdot k_B \, N \cdot \frac{p \, V}{N \, k_B} + p \cdot \Delta V = \frac{5}{2} \cdot p \cdot \Delta V \approx 600 \, J$

$T_C = 320\,K - 145\,K + 58\,K = 232{,}97 \, K$

Muss gleichen Druck behalten, also müssen Teilchen schneller fliegen

(c) $\Delta W = \Sigma \Delta Q$

$\Delta W = |900 - 600| \, J = 300 \, J$

wird vom Gas geleistet