41 $T = 245\,^\circ C = 518{,}15\,K$

$M = 39{,}948\ \frac{g}{mol}$

(a) $v_{max} = \sqrt{\frac{2RT}{M}} = \sqrt{\frac{2 \cdot 8{,}31448\ \frac{J}{mol\,K} \cdot 518{,}15\,K}{0{,}039948\ \frac{kg}{mol}}}$

$v_{max} = 464{,}422 \sqrt{\frac{J}{kg}}$ $\qquad \frac{J}{kg} = \frac{kg\ m^2}{s^2\ kg} = \frac{m^2}{s^2}$

$v_{max} = 464\ \frac{m}{s}$

(b) $v_{max,2} = 3 \cdot v_{max} \longrightarrow T_2 = ?$

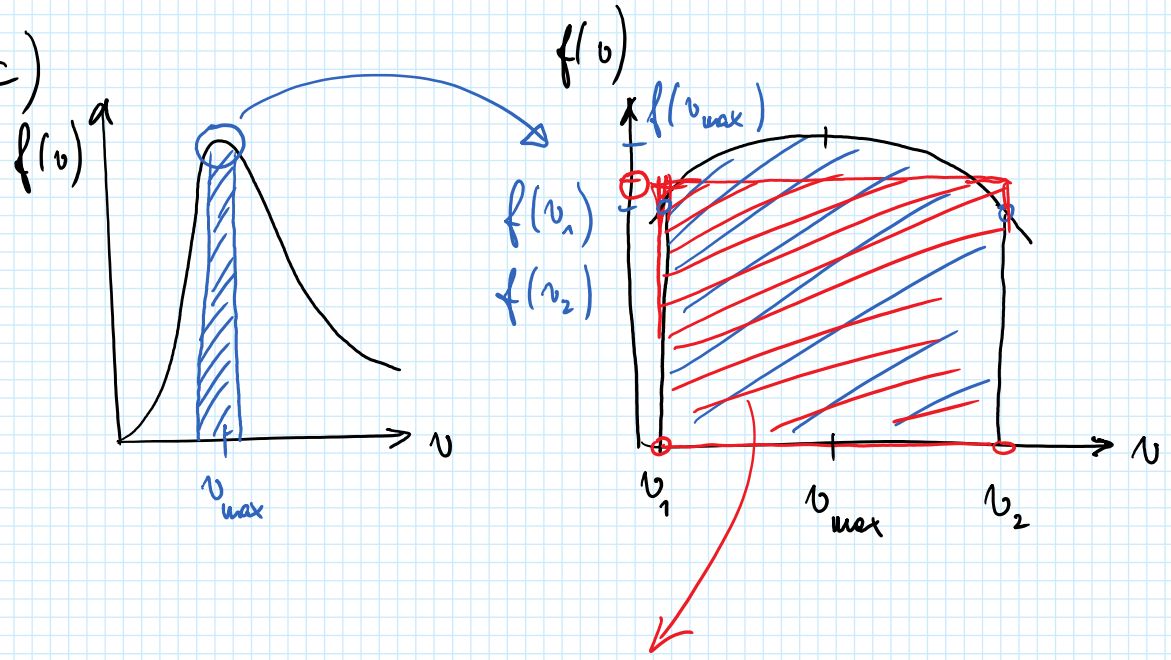
$\sqrt{\frac{2RT_2}{M}} = 3 \cdot \sqrt{\frac{2RT}{M}} \quad | ^2$

$\frac{2RT_2}{M} = 9\ \frac{2RT}{M} \quad | : \frac{2R}{M}$

$T_2 = 9T$

$T_2 = 9 \cdot 518{,}15\,K = 4663\,K$

(c)

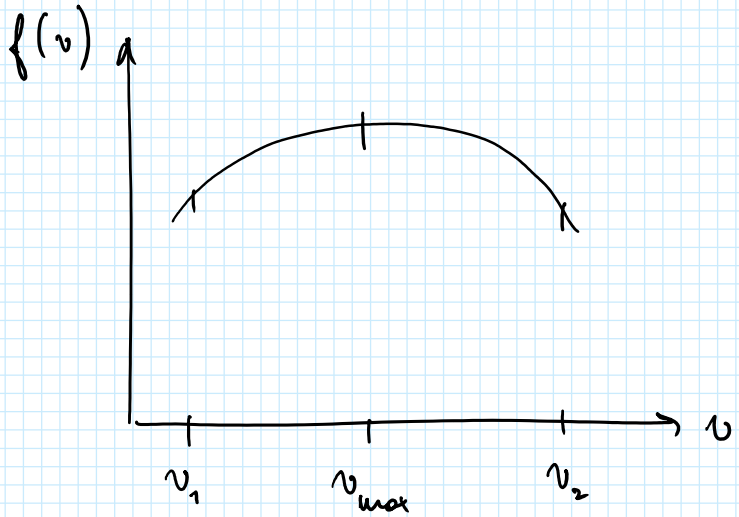


Fläche eines Rechtecks (Näherung):

$$(v_2 - v_1)\,\frac{f(v_1) + f(v_{max})}{2}$$

$$(v_2 - v_1)\,\frac{f(v_2) + f(v_{max})}{2}$$

$$|v_1 - v_{max}| = \frac{v_{max}}{100} = 4{,}64422\ K = |v_2 - v_{max}|$$



$4{,}64422\ \frac{m}{s}$ $4{,}64422\ \frac{m}{s}$

$$v_2 - v_1 = 9{,}28844 \frac{m}{s}$$

$$f(v) = 4\pi \left(\frac{M}{2\pi RT}\right)^{3/2} v^2 \cdot e^{-\frac{1}{2}\frac{M}{RT}v^2}$$

$f(v_1) = ?$ $\qquad$ $f(v_{max}) = ?$

$v_1 = 459{,}7778 \frac{m}{s}$ $\qquad$ $v_{max} = 464{,}422 \frac{m}{s}$

$f(v_1) = 0{,}00178727 1 \frac{s}{m}$ $\qquad$ $f(v_{max}) = 0{,}0017876 3 \frac{s}{m}$

$$\text{Fläche} = (v_2 - v_1)\frac{f(v_1) + f(v_{max})}{2} = 0{,}01660 26$$

1,66 % der Atome

(42) $d = 325\ pm = 325 \cdot 10^{-12}\ m = 3{,}25 \cdot 10^{-10}\ m$

$T = 145°C = 418{,}15\ K$

$V = 1250\ L = 1{,}250\ m^3$

$p = 8{,}75 \cdot 10^{-2}\ Pa = 0{,}0875\ Pa$

(a) $\lambda = \frac{kT}{\ }$

$\sqrt{2} \cdot \sigma \cdot \rho$

$$\sigma = (r_1 + r_2)^2 \pi \approx (2r)^2 \pi = d^2 \pi$$

$$\sigma \approx 3{,}25^2 \cdot 10^{-20}\ m^2$$

$$\sigma = 3{,}3183072 \cdot 10^{-19}\ m^2$$

$$\lambda = \frac{1{,}38065 \cdot 10^{-23}\ \frac{kg\ m^2}{s^2\ K} \cdot 418{,}15\ K}{\sqrt{2} \cdot 3{,}3183072 \cdot 10^{-19}\ m^2 \cdot 0{,}0875\ \frac{kg}{m\ s^2}}$$

$$\lambda = 1405{,}97 \cdot 10^{-4}\ m$$

$$\lambda = 0{,}141\ m = 14{,}1\ cm$$

(b) $\lambda \overset{!}{>} d_{Bläschen}$

$$\frac{4}{3} r_B^3 \pi = 1{,}250\ m^3$$

$$r_B^3 = \frac{3}{4\pi} \cdot 1{,}250\ m^3$$

$$r_B = 0{,}6682523\ m$$

$$d_B = 1{,}3365046\ m$$

$$\lambda \overset{!}{=} 1{,}3365047\ m$$

$$\lambda = \frac{kT}{\sqrt{2}\ \sigma\ p} \longrightarrow p = \frac{kT}{\sqrt{2}\ \sigma\ \lambda}$$

$$\lambda = \frac{kT}{\sqrt{2}\,\sigma\,p} \longrightarrow p = \frac{kT}{\sqrt{2}\cdot\sigma\cdot\lambda}$$

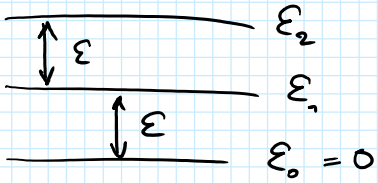
$p = 0{,}009204784\ \text{Pa}$

$p = 9{,}20\ \text{mPa}$

(43) $n = 2{,}50\ \text{mol}$

$T = 23^\circ\text{C} = 296{,}15\ \text{K}$

$\varepsilon = 10^{-22}\ \text{J}$



$$N_i = N \cdot \frac{e^{-\frac{\varepsilon_i}{kT}}}{\sum_{j=0}^{2} e^{-\frac{\varepsilon_j}{kT}}}$$

← Zustandssumme

(a) $N_0 = ?\quad N_1 = ?\quad N_2 = ?$

$e^{-\frac{\varepsilon_0}{kT}} = 1 \quad (\varepsilon_0 = 0\ \text{J})$

$e^{-\frac{\varepsilon_n}{kT}} = e^{-\frac{\varepsilon}{kT}} = 0{,}9758396$

Zustandssumme

$2{,}9281025$

$e^{\frac{\varepsilon_1}{kT}} = e^{\frac{\varepsilon}{kT}} = 0{,}9758396$

$e^{-\frac{\varepsilon_2}{kT}} = e^{-\frac{2\varepsilon}{kT}} = e^{-2\frac{\varepsilon}{kT}} = 0{,}95226286$

$2{,}9281025$

$\left(\frac{\varepsilon}{kT} = 0{,}024457083\right)$

$N_0 = N \cdot \frac{1}{\text{Nullstellensumme}} = 5{,}141555 \cdot 10^{23} = 5{,}14 \cdot 10^{23}$ Teilchen

$N = N_A \cdot n = 6{,}022 \cdot 10^{23} \frac{1}{\text{mol}} \cdot 2{,}50\ \text{mol}$

$N = 15{,}055 \cdot 10^{23}$

$N_1 = N \cdot \frac{0{,}9758396}{2S} = 5{,}017333 \cdot 10^{23} = 5{,}02 \cdot 10^{23}$ Teilchen

$N_2 = N \cdot \frac{e^{-\frac{2\varepsilon}{kT}}}{\text{Nullstellensumme}} = \frac{0{,}95226286}{2{,}9281025} = 4{,}896119 \cdot 10^{23}$

$= 4{,}90 \cdot 10^{23}$ Teilchen

(b) $\frac{N_0}{N_1} = \frac{4}{3}$ bei $T = ?$

$\frac{N_0}{N_1} = \frac{e^{-\frac{\varepsilon_0}{kT}}}{e^{-\frac{\varepsilon_1}{kT}}} = e^{-\frac{\varepsilon_0}{kT} + \frac{\varepsilon_1}{kT}} = e^{\frac{(\varepsilon_1 - \varepsilon_0)}{kT}} = e^{\frac{\varepsilon}{kT}}$

$$e^{\frac{\varepsilon}{kT}} = \frac{4}{3} \quad | \ln$$

$$\frac{\varepsilon}{kT} = \ln\left(\frac{4}{3}\right)$$

$$T = \frac{\varepsilon}{k \cdot \ln\left(\frac{4}{3}\right)} = 25{,}17698\ \mathrm{K}$$

$$T = 25{,}2\ \mathrm{K}$$