2) $S = \frac{3Nk_B}{2} \ln \frac{E}{N} + Nk_B \ln \frac{V}{N} + Nk_B \ln c$

$\lim_{E \to 0} S = c_1 \ln(E) + c_2 \to -\infty$

Bei $E \sim 0$ müssen quanteneffekte Berücksichtigt werden.

b) $E = \frac{3}{2} Nk_B T$ $\qquad N = \frac{N_a}{n}$

$C_V = \left(\frac{\partial E}{\partial T}\right)_V = \frac{3}{2} Nk_B$

$C_p = \frac{3}{2} \frac{N_a}{n} k_B + \frac{R}{n}$

	Ar	He	N_2	Methane
calculated (kJ/kg K)	0.52	5.19	0.74	1.29
NIST data (kJ/kg K)	0.52	5.19	1.04	2.22

c) $\Delta S = \frac{3Nk_B}{2}\left[\ln(2E) - \ln(E)\right] = \underline{\underline{\frac{3Nk_B}{2} \ln(2)}} \approx 8.64 \ \mathrm{J/K}$

$T = \left(\left(\frac{\partial S}{\partial E}\right)_{N,V}\right)^{-1} = \frac{3k_B N}{2E}$

$\Delta T = \frac{3kN}{2}\left(\frac{1}{E} - \frac{1}{2E}\right) = \underline{\underline{\frac{3}{4} k_B N}}$

$\Omega \propto E^{\frac{3N}{2}} \Rightarrow \Delta\Omega = \underline{\underline{2^{\frac{3N}{2}}}}$

d) $V_1 = 1\,m^3 \quad V_2 = 2\,m^3 \quad V_3 = \frac{1}{2} m^3$

$\Delta S_{1,2} = Nk_B \ln(2) \approx 5.76 \ \mathrm{J/K}$ $\qquad \Omega$ geht rauf

$\Delta S_{2,3} = -Nk_B \ln(4) \approx -11.53 \ \mathrm{J/K}$ $\qquad \Omega$ wird kleiner

3) $x_{Ar} = \frac{N_{Ar}}{N_{Ar}+N_{He}}$

$\cancel{S = S_{Ar} + S_{He} = \frac{3k}{2}(N_{Ar}+N_{He}) \ln\left(\frac{E}{N_{Ar}+N_{He}}\right) + (N_{Ar}+N_{He}) \ln\left(\frac{V_A+V_H}{N_A+N_H}\right) + (N_A+N_H) k_B \ln(c)}$

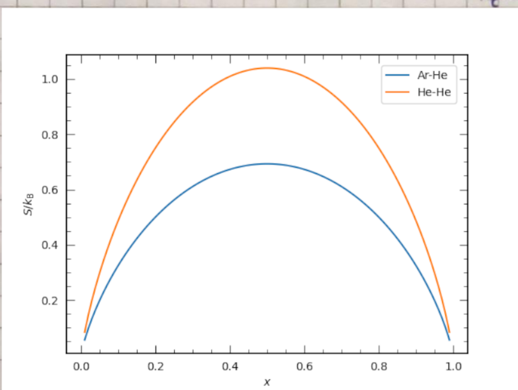
$\cancel{\Delta S = S(N_A) - S(N_A=0) = (N_A+N_H)\ln\left(\frac{V_A+V_H}{N_A+N_H}\right) - N_H \ln\left(\frac{V_H}{N_H}\right) =}$

$\cancel{= (N_A+N_H)\ln(}$

$$\Delta S_{Ar} = N_{Ar} k \ln\left(\frac{V_{Ar}+V_{He}}{N_{Ar}}\right) - N_{Ar} k \ln\left(\frac{V_{Ar}}{N_{Ar}}\right) = k N_{Ar} \ln\left(1+\frac{V_{He}}{V_{Ar}}\right) = k N_{Ar} \ln\left(\frac{N_{Ar}+N_{He}}{N_{Ar}}\right)$$

$$\Delta S_{He} = N_{He} k \left(\ln\left(\frac{V_{Ar}+V_{He}}{N_{He}}\right) - \ln\left(\frac{V_{He}}{N_{He}}\right)\right) = k N_{He} \ln\left(1+\frac{V_{Ar}}{V_{He}}\right) = k N_{He} \ln\left(\frac{N_{He}+N_{Ar}}{N_{He}}\right)$$

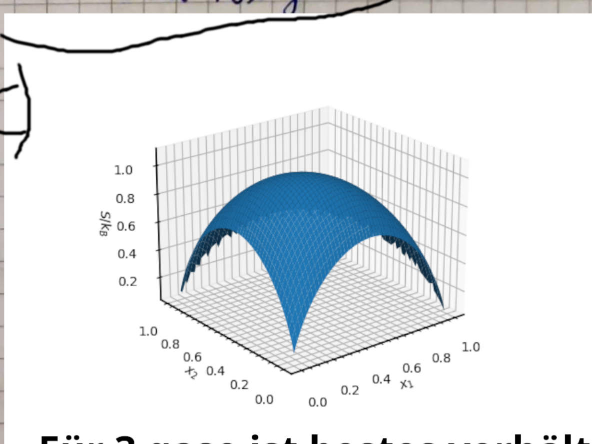
$$\Delta S = \Delta S_{Ar} + \Delta S_{He} = k\left(-N_{Ar}\ln(x_{Ar}) - N_{He}\ln(1-x_{Ar})\right) = -k\left(x_{Ar}\ln(x_{Ar}) + (1-x_{Ar})\ln(1-x_{Ar})\right)$$

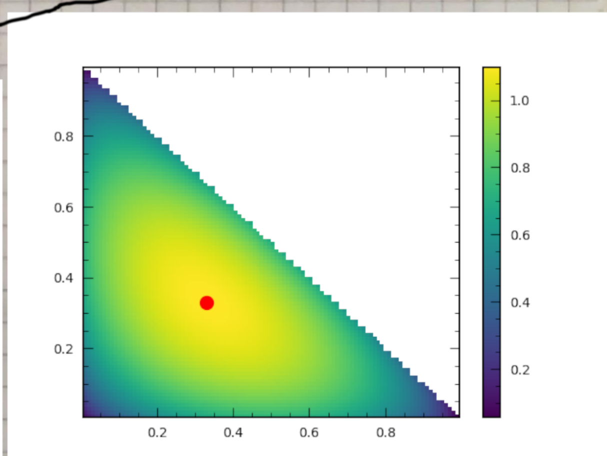


b) $\Delta S = -\frac{3}{2}(N_{H_1}+N_{H_2}) k_B \ln(N_{H_1}+N_{H_2}) + (N_{H_1}+N_{H_2}) k \ln\left(\frac{V_{H_1}+V_{H_2}}{N_{H_1}+N_{H_2}}\right) -$

⇒ Numerische Lösung

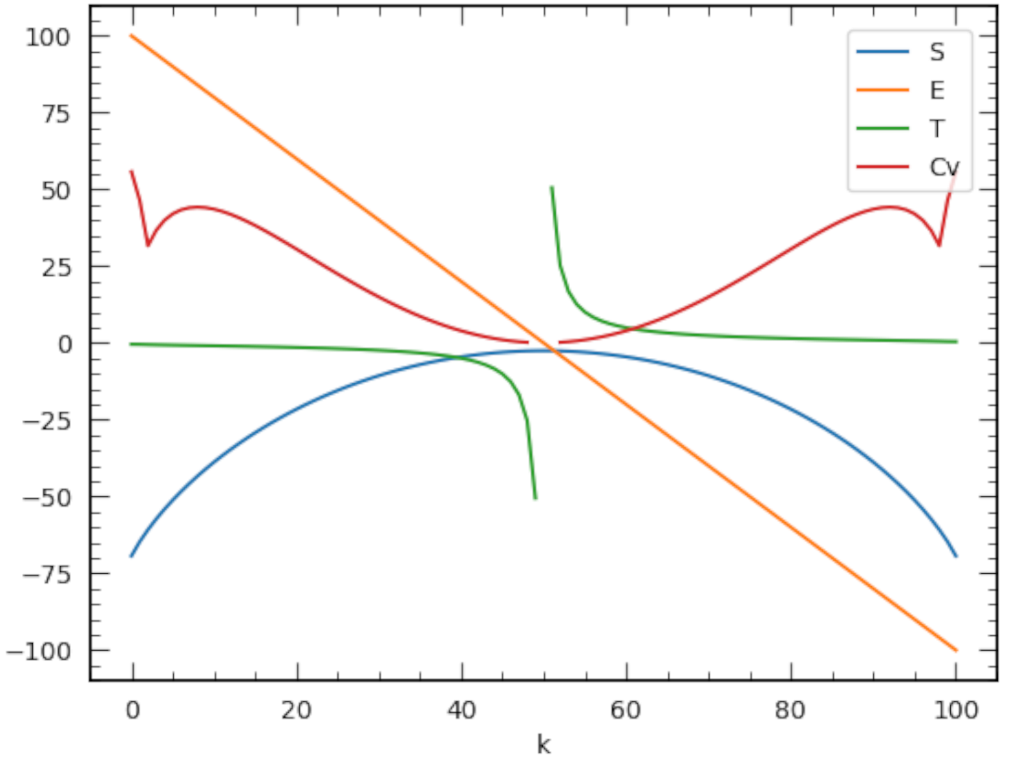
c)



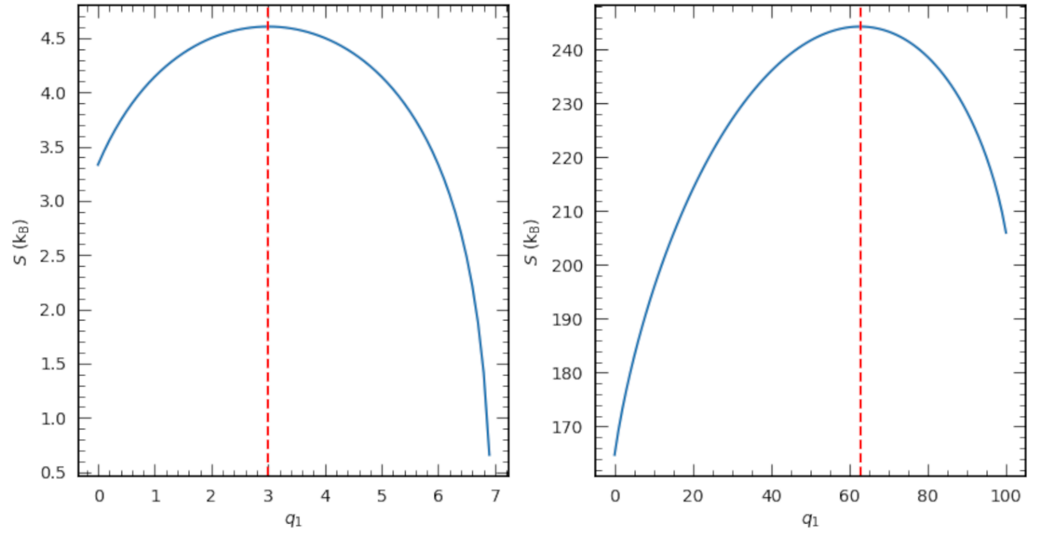


Für 3 gase ist bestes verhältnis jeweils 1/3 => für n gase dann wohl 1/n

7)



4)



3q in System 1 (mit N=3) und 63q in System 1 mit N=250