[redacted]

Aufgabe 1)

a) Energiebilanz

$\rightarrow \quad 0 = \dot{m}[h_1 - h_2] - \dot{Q}_{Aus} + Q_{12}$

$\dot{Q}_{Aus} = \dot{m}[h_1 - h_2] + \dot{Q}_{12}$

$h_1 = h_f$ at $70 C°$ $\rightarrow$ aus A-2

$h_1 = 292{,}98\ C°$

$h_2 = h_f$ at $100 C°$ $\rightarrow$ aus A-2

$h_2 = 419{,}04\ C°$

$\rightarrow Q_{aus} = 0{,}3[292{,}98 - 419{,}04] + 100$

$\dot{Q}_{aus} = 62{,}182\ kW$

b)

$\bar{T} = \dfrac{\int_e^a T\,ds}{s_a - s_e}$

$s_a \rightarrow$ aus A-2 $= 0{,}3674$

$s_e \rightarrow$ aus A-2 $= 0{,}2245$

} beide $= s_f$

$\downarrow$

$h_e \rightarrow$ aus A-2 $= 62{,}55$

$\bar{T} = \dfrac{h_a - h_e}{s_a - s_e}$

$h_a \rightarrow$ aus A-2 $= 104{,}89$

$= 293{,}21\ k$

c) Entropie-bilanz: $0 = \dot{m}[s_e - s_a] + \dfrac{\dot{Q}}{\bar{T}} + \dot{S}_{erz}$

$\dot{S}_{erz} = \dot{m}[s_a - s_e] - \dfrac{\dot{Q}_R}{T_R} - \dfrac{\dot{Q}_{aus}}{\bar{T}}$

$= 488\ J$

d) Energiebilanz: $m_2 u_2 - m_1 u_1 = \Delta m h_{ein} + \sum Q$

$(m_1 - \Delta m) u_2 - m_1 u_1 - \Delta m h_{ein} = Q_{aus,12}$

$u_2 = u_f +$ [illegible] $70c°$ → Aus A-2

$=$ [illegible] $252,55$

$u_1 = u_f + x(u_g - u_f)$ at $100c°$ → Aus A-2

$= 425,377$

$h_{ein} = h_f$ at $20c° = 83,96$ → Aus A-2

$m_1 u_2 - \Delta m u_2 - m_1 u_1 - \Delta m h_{ein} = Q$

$-\Delta m (u_2 + h_{ein}) + m_1 u_2 - m_1 u_1 = Q$

$$\Delta m = \frac{Q + m_1 u_1 - m_1 u_2}{u_2 + h_{ein}} = 2883,54\ kg$$

e) ~~$\Delta S = \frac{Q}{T} + S_{erz}$ $m(s_2 - s_1)$~~ $(\Delta m = 3600)$

$\Delta S = m_2 s_2 - m_1 s_1 = S$ $\quad m_2 = 9355$

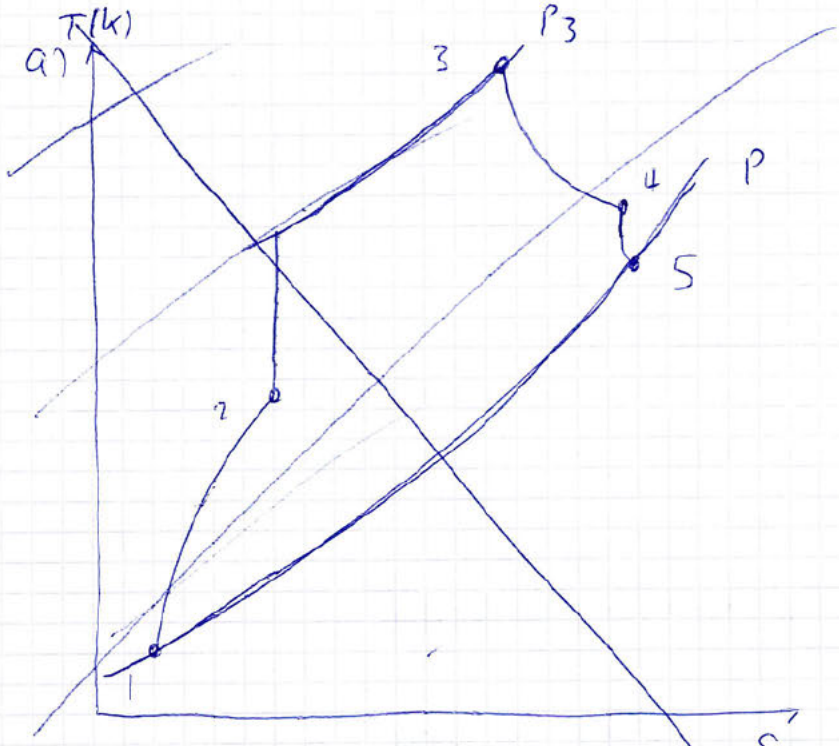
$s_1 = s_f + x(s_g - s_f) = 1,337$

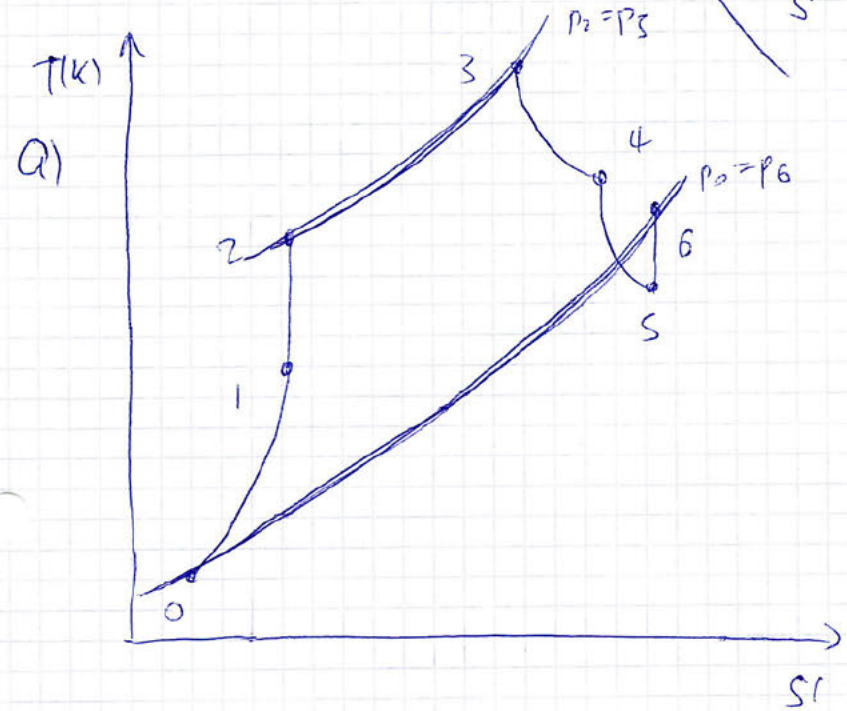
$s_2 = 0.9549$

→ $\Delta S = 1238,6\ kJ$

Aufgabe 2:

a)





b) Energiebilanz um gesamten System

$$0 = \dot{m}\left[h_0 - h_6 + \frac{w_L^2 - w_6^2}{2}\right]$$

$$h_6 - h_0 = \frac{w_L^2 + w_6^2}{2}$$

$$2(h_6 - h_0) = w_L^2 - w_6^2 \quad \rightarrow \quad w_6 = \sqrt{w_L^2 - 2(h_6 - h_0)} \quad (1)$$

$$(h_6 - h_0) = c_p (T_6 - T_0)$$

$$\frac{T_6}{T_5} = \left(\frac{p_6}{p_5}\right)^{\frac{k-1}{k}}$$

$$= 328{,}07\,K$$

$$\frac{T_6}{T_1} = \left(\frac{p_6}{p_1}\right)^{\frac{k-1}{k}}$$

$$T_6 =$$

$\rightarrow w_6 =$

c) $\Delta e_{x,str} = \dot{m}\left[h_6 - h_0 - T_0'(s_6 - s_0) + p_0'(v_6 - v_0)\right)$

$= (T_6 - T_0)c_p - T_0\left(c_p \ln\left(\frac{T_6}{T_0}\right) - ~~R\ln\left(\frac{p_6}{p_0}\right)~~\right) + p_0'(v_6 - v_0)$

$= 97{,}4 - 82{,}00 + p_0'(v_6 - v_0)$ aus A-22

~~= ...~~

$=$ $v_6 =$

d) $0 = \dot{E}_{x,str} + \sum E_{x,Q} - \sum\left(W - p_0 \frac{dV_{KV}}{dt}\right) - E_{x,v}$

~~$E_{x,Q}$~~ $= e_{v,el} = \left(1 - \frac{T_0}{T_J}\right)Q - \left[\sum W_{v,n} - ~~p_0(V_2 - V_1)~~\right)$

3) $p_{Sil} = p_{amb} + \frac{m_{Kol}}{A} + \frac{m_{EW}}{A}$

$A = \pi \cdot r^2 = 0.0314$

$\rightarrow p_{Sil} = 2\,bar$

$pV = mRT \rightarrow m = \frac{pV}{RT} = \underline{1,75}$

b) Brücke höher da mehr Wärme zugeführt wird

c) $U_{end} - U_G - U_{EW} = 0$ ~~$= U_2 - U_1 = Q - W$~~

$(m_{EW} + m_G) \cdot U_{ende} -$ ~~$U_2 =$~~

$m(u_2 - u_1) = Q$

$u_2 = u_f + x(u_g - u_f) =$

d)

~~$x = s_2 - s_f$~~ $x = \frac{\phi_2 - \phi_f}{\phi_g - \phi_f} = \frac{u_2 - u_f}{u_g - u_f}$

$u_2 = u_1 + c_v \cdot \Delta T$

$u_{11} = -0.095 + x(u_g - u_f) = -200,1168$

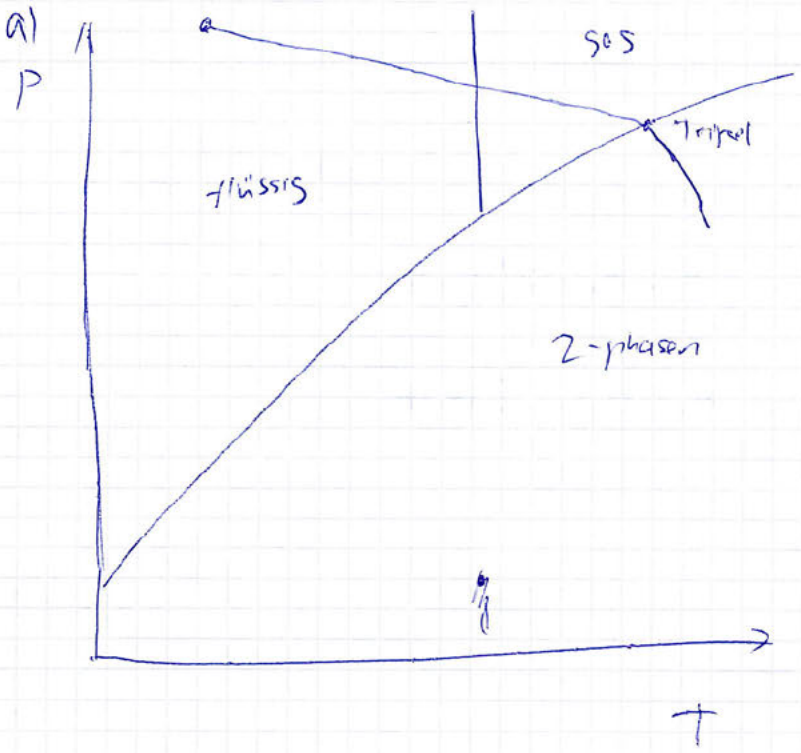
$u_2 = -200,144$

$u_f = -0.033 \qquad u_g = -333,442 \rightarrow x = 0,6003$

$\underline{0,6002}$

4)

a)



b) Energiebilanz

T_1 = Sublim. -10 K → 263,15 K

$0 = \dot{m}[h_2 - h_3] - W_K$

$\frac{W_K}{h_2 - h_3} = \dot{m}$

→ $T_1 = 263{,}15\,K$

$T_2 = 257{,}15\,K$

→ $h_2 = 237{,}74$

$h_3 = 25{,}13$

$s_2 = s_3$ → $s_3 = 0{,}5258$

→ 1,4 kg/s

c) $s_4 = s_1$ $\quad p_4 = p_1$

$X = \frac{s_3 - s_f}{s_g - s_f} = 0.96$

s_4 at 8 bar $\quad X = 0 \rightarrow 0.3455$

$X_1 = \frac{s_1 - s_f}{s_g - s_f}$ $\quad T_1 = 263{,}15$

$s_f = 0.1388 + \frac{0.1583 - 0.1388}{-12 + 8}(-12 + 12)$

$= 0.12755$

$s_g = 0.5267 + \frac{0.5235 - 0.5267}{-8 + 12}(-12 + 12)$

$= 0.5253$

→ X = 0,773

d) $\varepsilon_k = \frac{Q_{zu}}{W_t} = \frac{Q_k}{W}$

$Q = \dot{m}[h_1 - h_2] + Q$

$Q = \dot{m}[h_2 - h_1] \Rightarrow$

$h_1 = h_f + X(h_g - h_f)$ → h

$h_2 = h_g = 237{,}74$

e) Würde kälter werden bis ein Gleichgewicht entsteht