Aufgabe 1)

(a) $\frac{\partial E}{\partial t} = \sum_{i} \dot{m}_i(t) \cdot \left[h_i(t) + \cancel{u_i(t)} + \cancel{p e_i(t)}\right] + \sum_{j} \dot{Q}_j(t) - \cancel{\sum \dot{W}_n(t)}$

$0 = \dot{m}(h_e - h_a) + \dot{Q}_R - \dot{Q}_{aus} \Rightarrow \dot{Q}_{aus} = \dot{m}(h_e - h_a) + \dot{Q}_R$

$h_e[70°C] = 292{,}98 \frac{kJ}{kg}$ Aus TAB A-2

$h_a[100°C] = 419{,}04 \frac{kJ}{kg}$ Aus TAB A-2

$\dot{Q}_{Aus} = 0{,}3 \frac{kg}{s} \cdot \left[\left(292{,}98 \frac{kJ}{kg}\right) - 419{,}04 \frac{kJ}{kg}\right] + 100\,kW = \underline{62{,}182\,kW}$

(b) $\overline{T}_{LF} = \frac{\int_e^a T\,\partial s}{s_a - s_e} = \frac{h_a - h_e}{s_a - s_e} = \frac{\int_{T_1}^{T_2} c^{it}(T)\,\partial T}{\int_{T_1}^{T_2} \frac{c^{it}(T)}{T}\,\partial T} = \frac{c \cdot (T_2 - T_1)}{c \cdot \ln\left(\frac{T_2}{T_1}\right)}$

$\overline{T}_{LF} = \frac{298{,}15\,K - 288{,}15\,K}{\ln\left(\frac{298{,}15\,K}{288{,}15\,K}\right)} = \underline{293{,}12157\,K}$

(c) $\Delta S = \sum_{j} \frac{\dot{Q}_j}{\overline{T}_{LF}} + \dot{S}_{erz} \Rightarrow \dot{S}_{erz} = -\frac{\dot{Q}_{Aus}}{\overline{T}_{LF}} = \frac{62{,}182\,kW}{293{,}12157\,K} = \underline{212{,}139\,\frac{W}{K}}$

(d)

$$\frac{\partial E}{\partial t} = \sum_i \dot{m}_i(t)\left[h_i(t) + \cancel{u_{e,i}(t)}^{\,0} + \cancel{p e_i(t)}^{\,0}\right] + \sum_j \dot{Q}_j(t) - \sum_n \dot{W}_n(t)$$

$$\Delta E = m_2 u_2 - m_1 u_1 = \sum_j Q_j = Q_{aus,2} = 35\,MJ$$

$$m_2 = m_1 + \Delta m \quad / m_1 = 5755\,kg \; / \; m_{1g} = x \cdot m_1 \; / \; m_{1f} = m_1(1-x) / m_3 = \Delta m$$

$u_{1g}[200°C] = 2506{,}5 \frac{kJ}{kg}$

$u_{1f}[100°C] = 418{,}94 \frac{kJ}{kg}$ Aus TAB-A-2

$u_{2f}[70°C] = 292{,}95 \frac{kJ}{kg}$

$u_{3f}[20°C] = 83{,}95 \frac{kJ}{kg}$

$$\Delta E = m_3 \cdot u_3 + m_2 u_2 - m_1 u_1 = 35\,MJ = \Delta m\, u_3 + m_1 u_2 + \Delta m u_2 - m_1 u_1$$

$$\Delta m = \frac{m_1 u_1 - m_1 u_2}{u_3 + u_2} = \frac{m_{1g} \cdot u_{1g} + m_{1f} \cdot u_{1f} - m_1 \cdot u_{2f} + 35\,MJ}{u_{3f} + u_{2f}}$$

$$= \frac{0{,}005 \cdot 5755\,kg \cdot 2506{,}5 \frac{kJ}{kg} + 5755\,kg \cdot (1-0{,}005) \cdot 418{,}94 \frac{kJ}{kg} - 5755\,kg \cdot 292{,}95 \frac{kJ}{kg} + 35\,MJ}{83{,}95 \frac{kJ}{kg} + 292{,}95 \frac{kJ}{kg}}$$

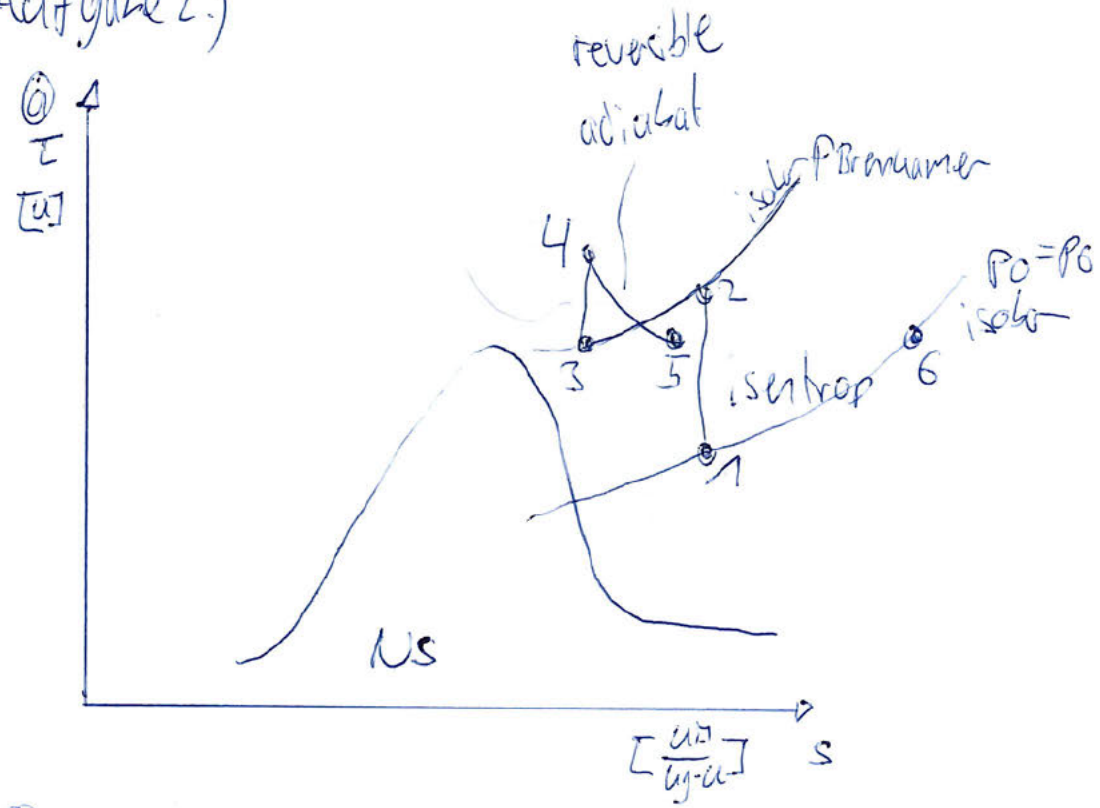
$$\Delta m_{12} = \underline{2176{,}02\,kg}$$

(e)

$$\Delta S = m_2 s_2 - m_1 s_1 = \sum \Delta m_i s_i + \sum_D \frac{\cancel{Q_D}^{\,0}}{T_D} + S_{e,z}$$

$$S_{e,z} = \Delta m_{12} \cdot s_{12} + \cancel{Q}$$

Aufgabe 2.)



(b)

$$\frac{\partial E}{\partial t} = \sum_i m_i(t)\left[h_i(t) + ke_i(t) + pe_i(t)\right] + \sum_j \dot{Q}_j(t) - \sum_n W_n(t)$$

$$0 = \dot{m}_{ges}\left[h_5 - h_6 + \frac{w_5^2}{2} - \frac{w_6^2}{2}\right] - \int_1^2 p \, \partial V$$

$$h_5 - h_6 = \int_{T_6}^{T_5} c_p^{ig}(T) \, \partial T = c_p \cdot (T_5 - T_6)$$

$\dot{m}_{ges}$

c)

$$\dot{E}_{x\,str} = \dot{m}\, e_{x\,str} = \dot{m}\,[h - h_0 - T_0 \cdot (s - s_0) + \cancel{u_e + p_e}^{\,\approx 0}]$$

d)

$$\dot{E}_{x\,verl} = T_0 \cdot \dot{S}_{er}$$

Aufgabe 3.)

(a)

$$p_{g1} = \frac{m_a \cdot g}{A} + \frac{m_{ew} \cdot g}{A} + p_{amb} = \frac{32kg \cdot 9{,}81\,m/s^2}{(0{,}05m)^2 \cdot \pi} + \frac{0{,}1kg \cdot 9{,}81\,m/s^2}{(0{,}05)^2 \cdot \pi} + 1\,bar$$

$A = r^2 \cdot \pi$

$$p_{g1} = 140094{,}4406\,Pa \approx \underline{1{,}4\,bar}$$

$$p_1 \cdot V_1 = m_1 \frac{R}{M} \cdot T_1 \Rightarrow m_1 = \frac{p_1 V_1}{T_1 \cdot \frac{R}{M}} = \frac{140kPa \cdot 0{,}00314m^3}{(773{,}15K) \cdot 8{,}314 \frac{J}{mol \cdot K}} \Big/ 50 \frac{g}{mol}$$

$$= \underline{0{,}003419431\,kg}$$

(b)

$$\Delta E = c_v \cdot m_g \cdot \Delta T =$$

$p_{g2} = p_{g1} = 1{,}4\,bar \Rightarrow$ Masse und erdbeschleunigung ändern sich nicht

$$m_{eis} = x_1 \cdot m_{EW} = 0{,}6 \cdot 0{,}1 = \underline{0{,}06\,kg} \qquad m_W = 0{,}1 \cdot (1 - 0{,}1) \cdot 0{,}6 = 0{,}054kg$$

$$\Delta E = E_2 - E_1 = \sum_i Q_i - \sum W_{vm}$$

$$c_v \cdot m_g \cdot T_{g1} + m_{eis} \cdot u_{fest} + m_W \cdot u_{flüssig} = E_1$$

$$c_v \cdot m_g \cdot \overline{T} + m_{eis} \cdot u_{fest}[\overline{T}] + m_v \cdot u[\overline{T}] = E_2$$

(2)

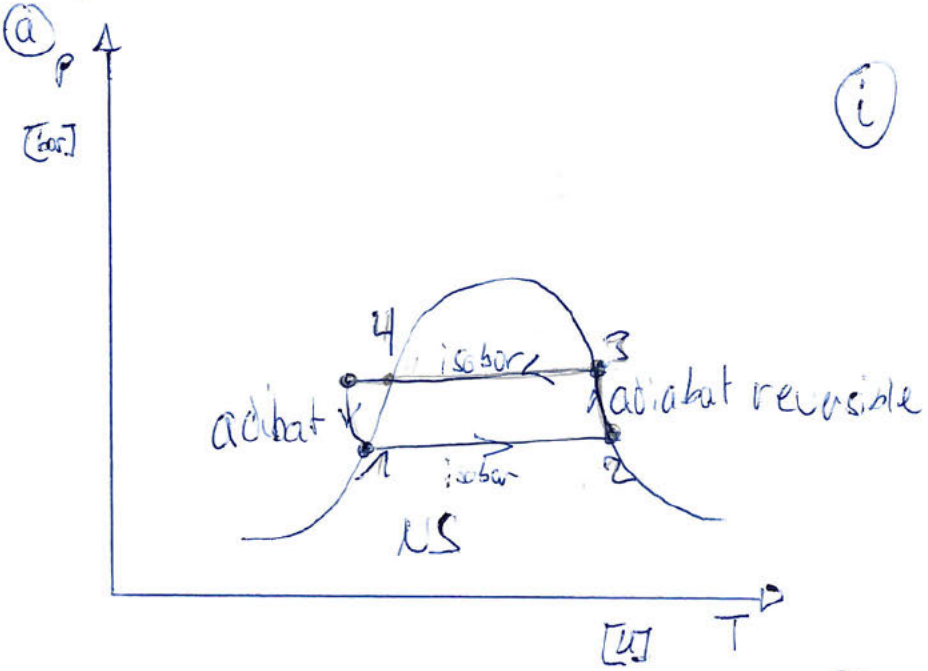
$\Delta E = m_2 c_2 - m_1 c_1 = Q_{12} = m (c_2 - c_1)$

$c_2 [0{,}103\ ^\circ C] =$

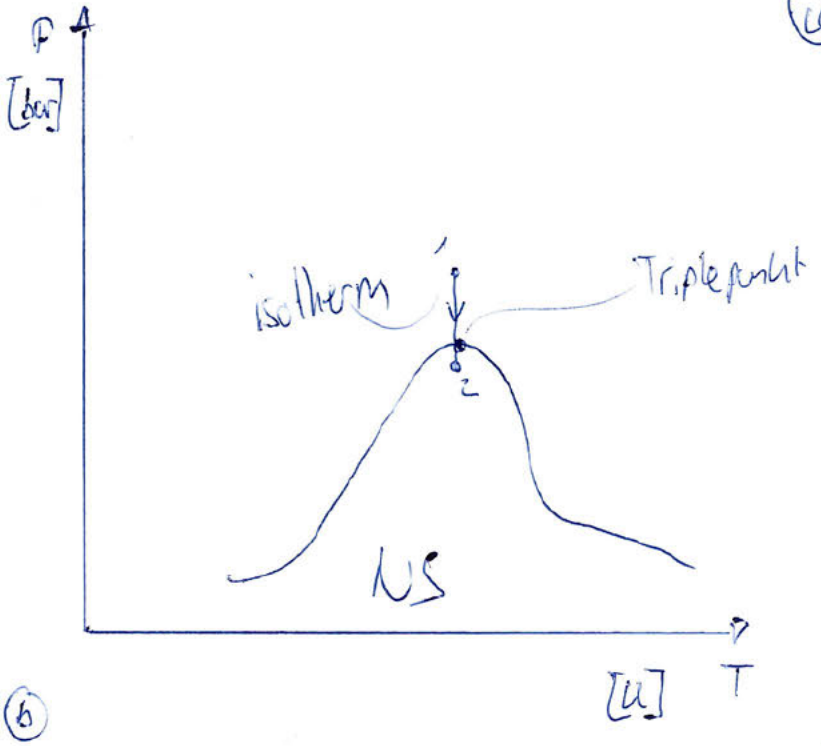
Aufgabe 4)

(a)

(i)



(ii)



(b)

$$\frac{\partial E}{\partial t} = \sum_i \dot{m}_i(t)\left[h_i(t) + k_{e,i}(t)^{\nearrow 0} + p_{e,i}\overbrace{[t]}^{\nearrow 0}\right] + \sum_j \dot{Q}_j(t)^{\nearrow 0} - \sum_n \dot{W}_n(t)$$

$\dot{W}_u = \dot{m}_i [h_2 - h_3]$ $\quad T_2 = T_1 - CU$ $\quad p_1 = p_2$

$p_3 = p_4 = 8\,bar$

(c)

$$h = h_f + x\left(h_g - h_f\right)$$

(d)

$$\varepsilon_a = \left|\frac{\dot{Q}_{zu}}{W_t}\right| = \frac{|\dot{Q}_{zu}|}{\dot{Q}_{ab} - |\dot{Q}_{zu}|}$$

(e)

T: sinkt nach dem alles Sublimiert wurde