1.a) stationärer Fliessprozess: $0 = \dot{m}_{ein}(h_{ein} - h_{aus}) + \dot{Q}_{aus}$ [redacted]

$\rightarrow \dot{Q}_{aus} = \dot{m}_{ein}(h_{aus} - h_{ein}) \xrightarrow{Tab\ A\text{-}2} 0{,}3\frac{kg}{s}\left(2257{,}0\frac{kJ}{kg} - 2333{,}8\frac{kJ}{kg}\right)$

$\rightarrow \dot{Q}_{aus} = 23{,}04\ kW$

b) $\bar{T}_{KF} = \frac{\int_e^a T\,ds}{s_a - s_e} \overset{\text{ideale Flüssigkeit}}{=} \rightarrow \frac{T_{KF,aus} + T_{KF,ein}}{2} = \frac{298{,}15K + 288{,}15K}{2}$

$= 293{,}15K$

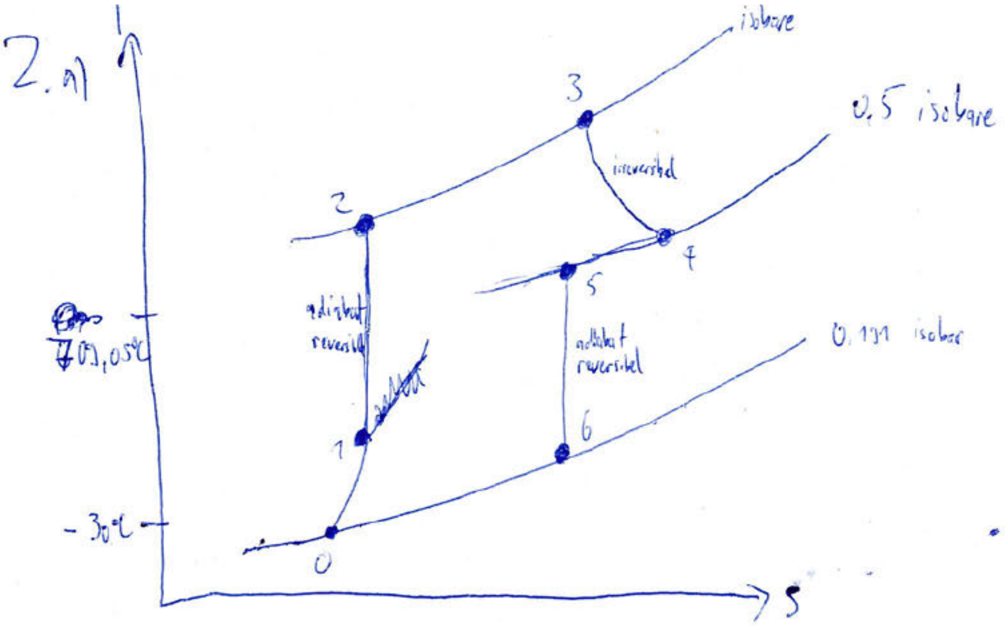
c) $\dot{E}_{x,verl} = \bar{T}_{KF}\dot{S}_{erz} \rightarrow \dot{S}_{erz} = \frac{\dot{E}_{x,verl}}{\bar{T}_{KF}}$

$\dot{E}_{x,verl} = \dot{m}\left[h_{ein} - h_{aus} - \bar{T}_{KF}(s_{ein} - s_{aus})\right] + \dot{E}_{x,Q}$

d) $\frac{dE}{dt} = \sum \Delta m_{q2}(h_i) + \sum Q_i - \sum W_n$

e) $\Delta S_{12} = \Delta m_{12} (s_2 - s_1)$

2. a)



[redacted]

b) adiabat reversible Schubdüse $\rightarrow s_5 = s_6$

ideales Gas $\rightarrow$ Polytropengleichung $\frac{T_6}{T_5} = \left(\frac{p_6}{p_5}\right)^{\frac{n-1}{n}} \rightarrow T_6 = T_5 \left(\frac{p_6}{p_5}\right)^{\frac{n-1}{n}}$

$= 431{,}9\,K \left(\frac{0{,}191\,bar}{0{,}5}\right)^{\frac{(1{,}4-1)}{1{,}4}} = \underline{328{,}07\,K = T_6}$

EB um Schubdüse $0 = \dot{m}_{ges}\left[\frac{w_5^2 - w_6^2}{2} + h_5 - h_6\right] \cancel{\dot{Q}_{56}} - \dot{W}_{56}$ 0, adiabat

c) $\Delta e_{x,str} = (h_0 - h_1 - T_0(s_0 - s_1)) + (h_1 - h_2 - T_0(s_1 - s_2)) + \dots + (h_5 - h_6 - T_0(s_5 - s_6))$

$= h_0 - h_6 - T_0(s_0 - s_6)$

d) $0 = \Delta e_{x,str} + e_{x,q} - w_t - e_{x,verl} \rightarrow e_{x,verl} = \Delta e_{x,str} + e_{x,q} - w_t$

[redacted]

3. a) $A = \left(\frac{D}{2}\right)^2 \pi = 5_{cm}^2 \pi = \cancel{78,5} \; 7{,}85 \times 10^{-3} \, m^2$

$$\frac{(m_K + m_{EW})g}{A} + p_{amb} = p_{g,1} = \frac{(0{,}1\,kg + 32\,kg)\,9{,}81\,m/s^2}{7{,}85 \times 10^{-3}\,m^2} + 1\,bar = \underline{1{,}40\,bar}$$

$pV = mRT$

$$\rightarrow m_g = \frac{p_{g,1} V_{g,1}}{R \; T_{g,1}} = \frac{1{,}40\,bar \cdot 3{,}14\,L}{0{,}17\,\frac{kJ}{kgK} \cdot 773{,}15\,K} = \underline{3{,}42\,g}$$

$$R = \frac{\bar{R}}{M_g} = \frac{8{,}314\,J/mol\,K}{50\,kg/kmol} = 0{,}17\,\frac{kJ}{kgK}$$

b) $p_{g,2} = p_{amb} = 1\,bar$ da thermodynamisches Gleichgewicht.
Das Gas breitet sich nicht mehr aus

$\cancel{pV = mRT \rightarrow T_{g,2} = p_{g,2}}$

$$\frac{T_{g,2}}{T_{g,1}} = \left(\frac{p_{g,2}}{p_{g,1}}\right)^{\frac{n-1}{n}}$$

$k = \frac{c_p}{c_v}$

$$c_p = R + c_v = 0{,}17\,\frac{kJ}{kgK} + 0{,}633\,\frac{kJ}{kgK} = 0{,}80\,\frac{kJ}{kgK} \rightarrow k = \frac{0{,}80\,\frac{kJ}{kgK}}{0{,}633\,\frac{kJ}{kgK}} = \underline{1{,}26}$$

$$T_{g,2} = T_{g,1} \left(\frac{p_{g,2}}{p_{g,1}}\right)^{\frac{n-1}{n}} = 466{,}13\,°C$$

c) $Q_{12} = m_g \cdot c_p \cdot \Delta T = 3{,}42\,g \cdot 0{,}80\,\frac{kJ}{kgK} \cdot (500\,°C - 0{,}003\,°C) = \underline{1367{,}46\,J}$

d) $T_{EW,2} = T_{g,2} = 0{,}005\,°C$

$$\frac{m_{Eis}}{m_{EW}} = 0{,}6 \rightarrow m_{Eis} = 0{,}6 \cdot 0{,}1\,kg = 0{,}06\,kg$$

$$u_1 = u_{fest} + \underbrace{x}_{x_{Eis,1}} (u_{flüssig} - u_{fest}) \rightarrow$$

Tab(0°C)

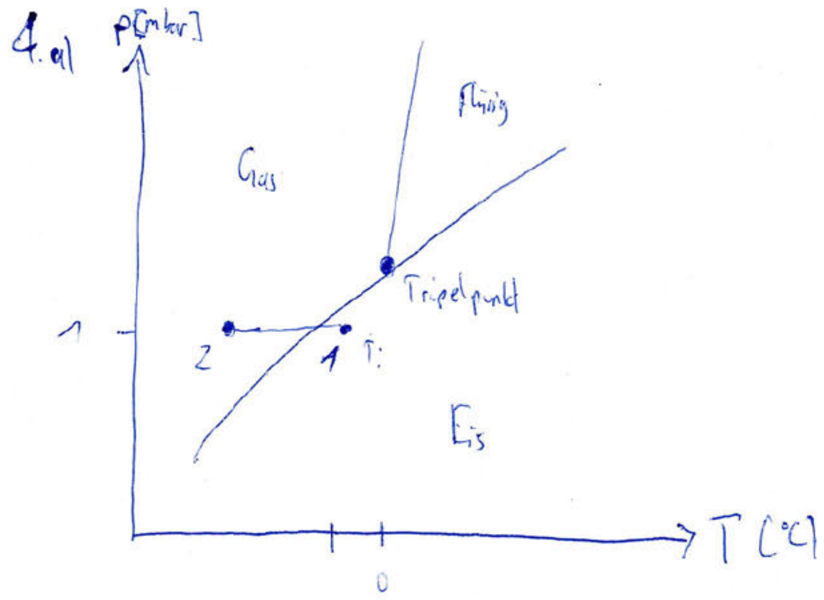
$$u_1 = -333{,}458\,kJ/kg + 0{,}6\,\left(-0{,}045\,\frac{kJ}{kg} + 333{,}458\,\frac{kJ}{kg}\right) = -133{,}41\,J$$

EB geschlossenes System: $\Delta E = Q_{12} \rightarrow \Delta U = Q_{12} = (U_2 - U_1) = Q_{12}$

$$\rightarrow U_2 = Q_{12} + U_1 = 1500\,J - 133{,}41\,J = 1366{,}58\,J$$

$$x_2 = \frac{u_2 - u_{fest}(0{,}003°C)}{u_{flüssig}(0{,}003°C) - u_{fest}(0{,}003°C)} =$$

4. a)



[redacted]

~~b) EB um Verdichter:~~

~~$0 = \dot{m}_{R134a} (h_2 - h_3) - \dot{W}_K + \dot{Q}_{23}$ adiabat~~

~~$\dot{W}_K / (h_2 - h_3) = \dot{m}_{R134a} =$~~

~~$h_3 (8 bar) \overset{T}{=}$~~

b) $p_3 = p_4 = 8 bar$ $\qquad h_4 \overset{Tab A11}{=} 93,42 \frac{kJ}{kg}$

$h_1 = h_4$

$h_2 =$

EB um Verdichter

$0 = \dot{m}_{R134a} (h_2 - h_3) - \dot{W}_K \rightarrow \dot{m}_{R134a} = \frac{\dot{W}_K}{(h_2 - h_3)}$

$\dot{Q}_K = \dot{Q}_{ab} - \dot{W}_K$

d) $\epsilon_K = \frac{|\dot{Q}_K - \dot{Q}_{ab}|}{|\dot{W}_k|}$

c) $x_1 = \frac{h_1 - h_f}{h_g - h_f} = \frac{h_4 - h_f(p_1)}{h_g(p_1) - h_f(p_1)}$

e) Die innere Temperatur würde sich nicht mehr verändern $\rightarrow$ 2. Hauptsatz