[redacted]

A1) a) 1.HS (Kühlkreislauf): $0 = \dot{m}_{KF}(h_{KF\,ein} - h_{KF\,aus}) + \dot{Q}_{aus}$

1.HS (Reaktor) $0 = \dot{m}_e h_e - \dot{m}_a h_a + \dot{Q}_R - \dot{Q}_{aus}$

$\rightarrow \dot{Q}_K = \dot{Q}_R + \dot{m}_W (h_e - h_a) = \underline{62182\ kW}$

$h_e = h_f(70°) = 292.98 \frac{kJ}{kg}$ (TAB A2)

$h_a = h_f(100°) = 419.04 \frac{kJ}{kg}$ "

b) $\bar{T}_{KF} = \frac{\int_e^a T\,ds}{s_a - s_e} \xrightarrow{\text{da reversibel}} \frac{q_{rev}}{s_a - s_e} = \frac{h_e - h_a}{s_a - s_e} = \underline{358.13\ K}$

$s_a = s_f(70°) = 0.9549 \frac{kJ}{kgK}$ TAB A2

$s_e = s_f(100°) = 1.3069 \frac{kJ}{kgK}$

c) $\bar{T}_{KF} = 295\ K$

$\dot{S}_{erz} = \left| -\frac{\dot{Q}_{aus}}{\bar{T}} \right| = \frac{-65\,kW}{295\,K} = \underline{\underline{220.3 \frac{J}{K}}}$

d) 1.HS (Reaktor): $\Delta E = m_2 u_2 - m_1 u_1 = \Delta m_{12}(h_{zu}) + \dot{Q}_{aus}$

$\rightarrow \Delta m_{12} = \frac{1}{h_{zu}}\left(\overset{0 = \Delta m_{12}}{m_2 u_2 - m_1 u_1} - \dot{Q}_{aus}\right) = \frac{\cancel{\Delta m_{12}}}{h_{zu}}(u_2 - u_1 - \dot{Q}_{aus})$

$\rightarrow \Delta m_{12}(u_2 - u_1 - h_{zu}) = \dot{Q}_{aus} \quad \rightarrow \Delta m_{12} = \frac{\dot{Q}_{aus}}{u_2 - u_1 - h_{zu}}$

$h_{zu} = h_f(\cancel{70°}\ 20°C) = \cancel{292.98 \frac{kJ}{kg}\ TAB\ A2}\ 83.96 \frac{kJ}{kg}$ (TAB A2)

$u_1 = x\, u_g(100°) + (1-x)\, u_f(100°)$

$= (1-x)(418.94) + (x)(2506.5) \frac{kJ}{kg} = \underline{430.38 \frac{kJ}{kg}}$

$u_2 = u_f(20°) = 292.95 \frac{kJ}{kg}$ (TAB-2)

$\Delta m_{12} = \underline{293.6 \frac{kg}{s}}$

e) $\Delta S_{12} = |\Delta m_{12}(s_2 - s_1)| = \underline{1'376.28 \frac{kJ}{kg}}$

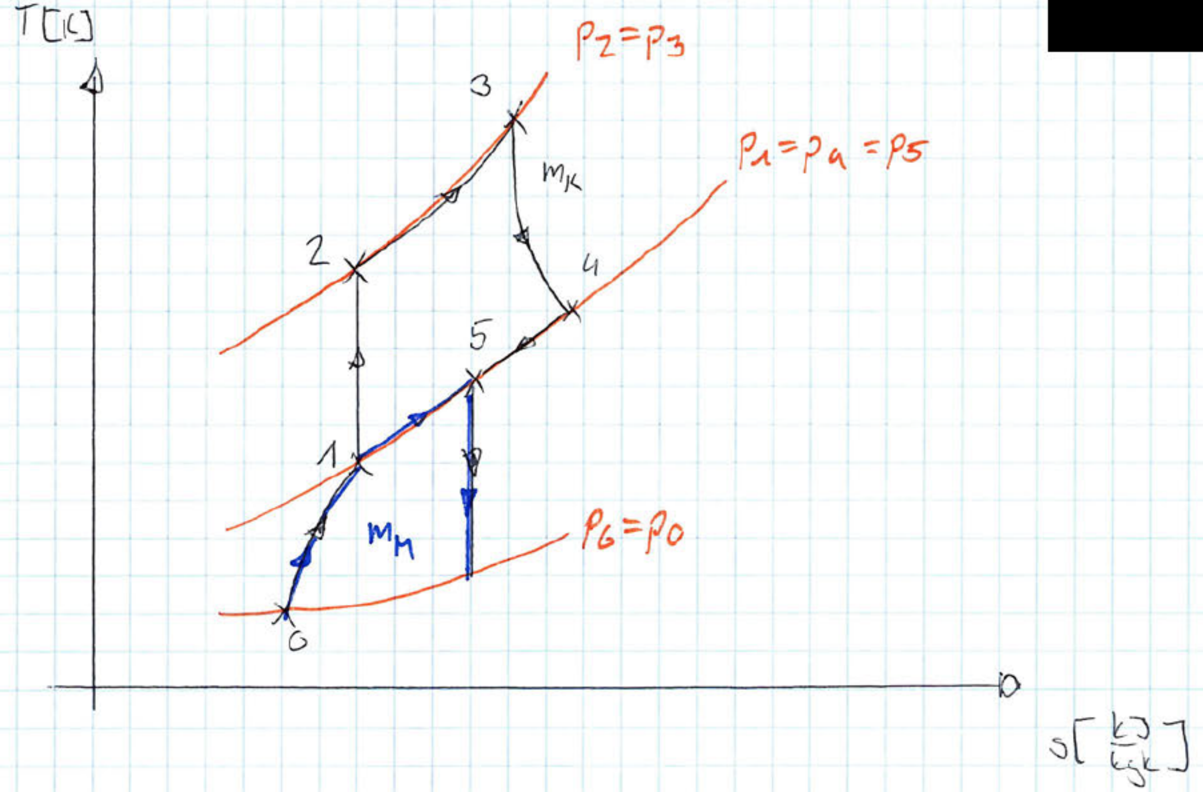
$\Delta m_{12} = 3'600\ \frac{kg}{s}$

$s_2 = s_g(70°) = 0.9549 \frac{kJ}{kgK}$ TAB A2

$s_1 = x\, s_g(100°) + (1-x)\, s_f(100°) = 1.3372 \frac{kJ}{kgK}$

[redacted]

a)



b)

	0	1	2	3	4	5	6
p [Bar]	0.191					0.5	0.191
T [K]	243.15					431.9K	
w [m/s]	200					220	
v [m³/kg]							

$R = c_p - c_v = 2.8743 \frac{kJ}{kgK} = 2874.3 \frac{J}{kgK}$

$c_{vL} = \frac{c_{pL}}{k} = 0.71857 \frac{kJ}{kgK}$

$5 \to 6$: Adiabat rev. = Isentrop: $s_5 = s_6 = s(T_5)$

$\cancel{s(T5) = 2.06533 + \frac{2.08870 - 2.06533}{440 - 430} \cdot (-430 + 431.9)}$

$\cancel{= 2.06978 \frac{kJ}{kgK}}$ $\quad T_6 = T_5 \left(\frac{p_6}{p_5}\right)^{\frac{n-1}{n}} = \underline{\underline{328.07\ K}}$

$\cancel{T_6 = T(p_6) =}$

$\cancel{\Delta S_{12} = 0 = c_p \ln\left(\frac{T_6}{T_5}\right) - R \ln\left(\frac{p_6}{p_5}\right) \to T_6 = \frac{c_p}{R}}$

1.HS (5-6): $0 = \dot{m}_g \left(h_5 - h_6 + \frac{(w_5^2 - w_6^2)}{2}\right) \to w_6 = \sqrt{2(h_5 - h_6) + w_5^2}$

$= \sqrt{2c_p(T_5 - T_6) + w_5^2} = \underline{236.755 \frac{m}{s}}$

c) $\Delta e_{x,str} = \left(h_e - h_a - T_0(s_e - s_a) + \Delta ke\right)$

$= \left(h_6 - h_0 - T_0(s_6 - s_0) + \Delta ke\right)$

(mit Werten aus Aufg.)

$= \left(c_p(T_6 - T_0) - T_0\left(c_p\left(\ln\left(\frac{T_6}{T_0}\right) - R\ln\left(\frac{p_6}{p_0}\right) + \left(\frac{w_6^2}{2} - \frac{w_0^2}{2}\right)\right.\right.$

$= 125'471.79 \frac{J}{kg} = \underline{\underline{125.47 \frac{kJ}{kg}}}$

d) $0 = \Delta e_{x,str} + \Sigma\left(1 - \frac{T_0}{T}\right)\underbrace{\dot{q}}_{=0} - \dot{w}_{t,n} - \dot{e}_{x,vel}$

$\rightarrow e_{x,vel} = \Delta e_{x,str} - \dot{w}_{t,n}$

$e_{x,vel} = T_0 \cdot \dot{S}_{erz} = T_0 \cdot \frac{-\cancel{\dot{m}_L}(s_e - s_a)}{\cancel{\dot{m}_L}} = T_0 \cdot (s_a - s_e) = T_0(s_6 - s_0)$

$= T_0\left(c_p \ln\left(\frac{T_6}{T_0}\right) - R\ln\left(\frac{p_6}{p_0}\right)\right) = 15'421.79 \frac{J}{kg} = \underline{\underline{15.422 \frac{kJ}{kg}}}$

[redacted]

A3) a) $p_g = \frac{F}{A} + p_{amb} = \frac{m_g \cdot g}{r^2 \pi} + p_{amb} = \frac{m_g \cdot g}{(\frac{d}{2})^2 \pi} + p_{amb} = \cancel{\ldots}$ $\underline{41.65 \text{ Bar}}$

$m_g = m_{EW} + m_K = 32.1 \text{ kg}$

$[p_1 = 1.5 \text{ Bar}]$ ann.

$m_g = \frac{p_1 V_1}{R T_1} = \underline{3.663 g}$

$R = \frac{\bar{R}}{M} = 0.1663 \frac{J}{gK} = \cancel{\ldots}$ $\underline{166.289 \frac{J}{kgK}}$

b) $T_{2EW} = T_{1EW} = 0°C$, da T const. ist im Zweiphasengebiet

$p_2 = p_1$ da fest + flüssig hie inkompressibel

c) $\Delta E = E_2 - E_1 = Q_{12} = m_g (\Delta u) = m_g c_p (T_{1g} - T_{2g})$

$\Delta E = m_g (\Delta u)$ $= \underline{2.225 \text{ kJ}}$

$\Delta u^{pg} = c_p (\Delta T)$

$c_p = R + c_v = \underline{0.7553 \frac{kJ}{kgK}}$

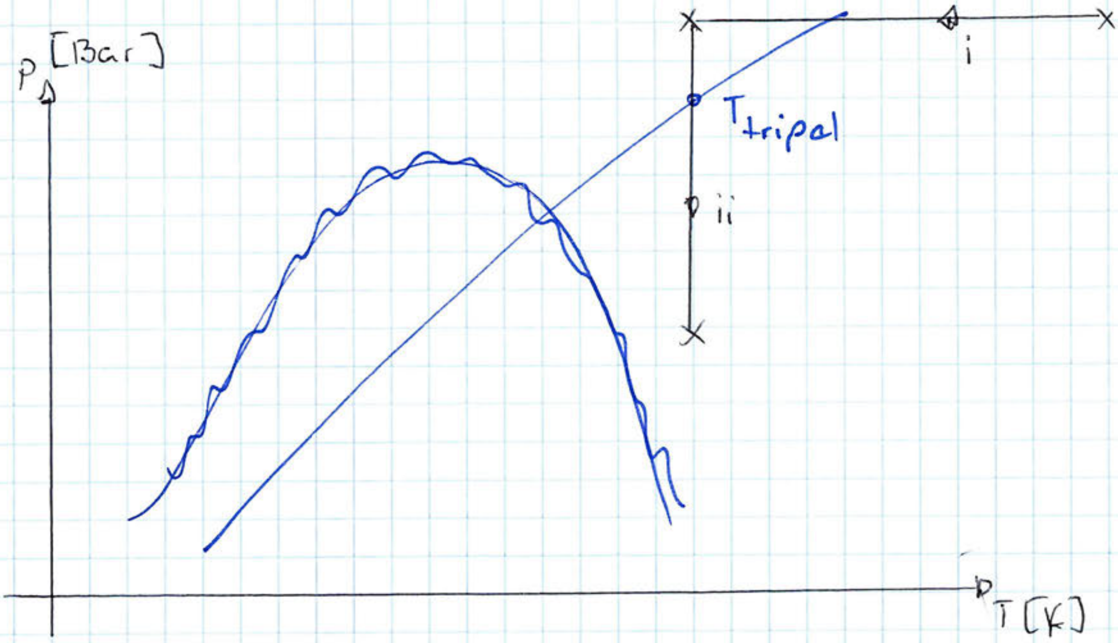
d) $x_{E2} = \frac{u_{E2} - u_f}{u_g - u_f}$

$u_{E2} = u_{E1} + \frac{Q_{12}}{m_{EW}} =$

$u_{E1} = \cancel{u_{f}(0°) + x u}$ $(1-x) u_f + x\, u_{fest}$

Nachn. Vorn.
22-924-153

A4) a)



b)

	vollst. verd. 1	ges. 2	3	g.v.k. 4	
T [C]	~~[illegible]~~	4°C	37.1°C	31.33	TAB-A11
p [Bar]	3.3765 =	3.3765	8 =	8	TAB-A10
s [$\frac{kJ}{kgK}$]	~~[illegible]~~ =	~~[illegible]~~ 0.9169	= 0.9169		
h [$\frac{kJ}{kgK}$]					

$T_1 = T_{Sub} + 10\,K = 0°C + 10° = 10°C$

$T_{verd} = T_2 = 10° - 6°K = 4°C$

$s_2 = s_g(4°C) = 0.9169 \frac{kJ}{kgK}$ TAB-A10

$T_3 = 31.33 + \frac{40 - 31.33}{(0.9374 - 0.9066)}(0.9374 - 0.9169)$

$= \underline{37.1°C}$

1\. HS (2-3): $0 = \dot{m}_{R134}(h_2 - h_3) - \dot{W}_K$

$\rightarrow \dot{m}_{R134} = \frac{\dot{W}_K}{h_2 - h_3}$

$h_2 = h_g(4°C) = 249.53 \frac{kJ}{kg}$

$h_3 = \ldots$

[redacted]

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

$h_g(T_1) =$

$h_f(T_1) =$

$h_1 =$

d) $\varepsilon_k = \frac{|\dot{Q}_{zu}|}{|\dot{W}_t|} = \frac{|\dot{Q}_{zu}|}{|\dot{Q}_{ab}| - |\dot{Q}_{zu}|}$

e) Sie würde noch etwas sinken und dann konstant bleiben, wenn die ~~sublimation~~ dissipation zu eis eintritt