1. 1. HS Reaktor:

a)

$$0 = \dot{m}_{ein}(h_{ein} - h_{aus}) + \dot{Q}_R + \dot{Q}_{aus}$$

$h_{ein} = h_f(70°C, x=0) = 292.98 \frac{kJ}{kg}$ A2

$h_{aus} = h_f(100°C) = 419.04 \frac{kJ}{kg}$ A2

$$\dot{Q}_{aus} = \dot{m}_{ein}(h_{aus} - h_{ein}) - \dot{Q}_R$$

$$= -62.182\ kW$$ ← negativ, von Reaktor abgeführt

b) 1. HS: $0 = (h_1 - h_2) + q_{rev}$

$$\overline{T}_{KF} = \frac{\int_e^a T\,ds}{s_a - s_e} = \frac{q_{rev}}{s_a - s_e} = \frac{c_p(T_{KF\,aus} - T_{KF\,ein})}{c_p \ln\left(\frac{T_{KF\,aus}}{T_{KF\,ein}}\right)}$$

$$= 233.12\ K$$

c) 2. HS Reaktor

$$0 = \dot{m}_{ein}(s_e - s_a) + \frac{\dot{Q}_{aus}}{\overline{T}_{KF}} + \frac{\dot{Q}_R}{T_{Reaktor\,1}} + \dot{s}_{erz}$$

~~2. HS Kühlmantel~~

~~$0 = \dot{m}_{KF}($~~

1. d)

	1	2	Δ12
T	100°C	70°C	20°C
m	5755 kg		Δm_{12}
x	0.005	0	

$Q_{12}=0 \quad W_{12}=0$

1. HS: $\Delta U_{12} = m_2 u_2 - m_1 u_1 = \Delta m_{12}(h_{ein})$

$u_1 = u_f(100°C) = 418.34 \frac{kJ}{kg}$ A2

$= u_f + x_1(u_g - u_f) = 418.34 + 0.005(2506.5 - 418.34)\frac{kJ}{kg}$ A2

$= 429.38 \frac{kJ}{kg}$

$u_2 = u_f(70°C) = 292.35 \frac{kJ}{kg}$ A2

$h_{ein} = h_f(20°C) = 83.36 \frac{kJ}{kg}$ A2

$m_2 = m_1 + \Delta m_{12}$

$\Delta m_{12}(h_{ein}) - (m_1 + \Delta m_{12})u_2 = m_1 u_1$

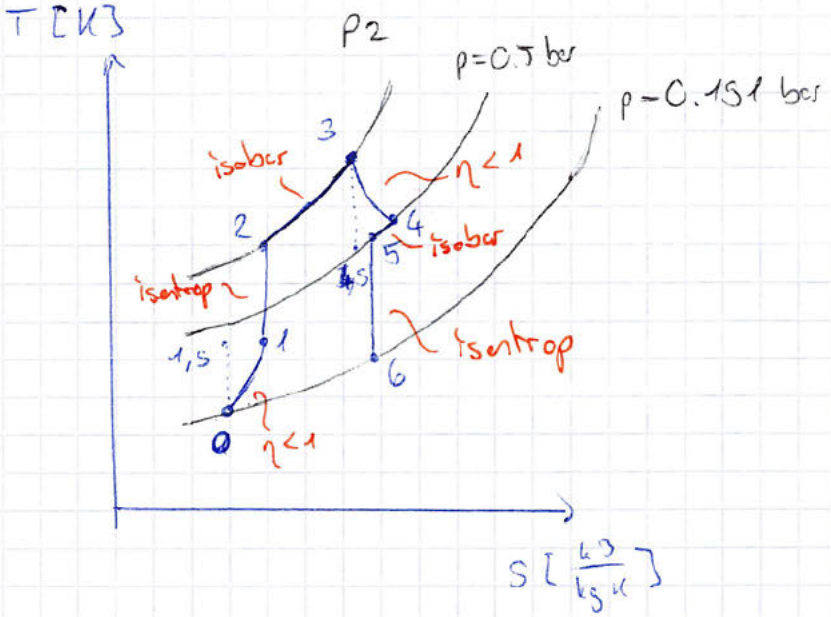
$\Leftrightarrow \Delta m_{12}(h_{ein} - u_2) = m_1 u_2 - m_1 u_1$

$\Rightarrow \Delta m_{12} = \frac{m_1 u_2 - m_1 u_1}{(h_{ein} - u_2)} = \underline{11'781 \text{ kg}}$

e) $\Delta S_{12} = m_2 s_2 - m_1 s_1 = \Delta m_{12} s_{ein} + S_{erz}$

2. 0 1 2 3 4 → 5 6

	0	1	2	3	4 → 5	6
T	-30°C				431.3K	✓
p	0.131 bar				0.5 bar	0.131 bar
w					220 m/s	



5) $T_6 = T_5 \left(\frac{p_6}{p_5}\right)^{\frac{\kappa-1}{\kappa}}$ $n = \kappa$ (isentrop)

$= 328.07\ K$

1. HS 5→6:

$0 = \dot{m}\left(h_5 - h_6 + \frac{w_5^2 - w_6^2}{2}\right)$

$\Rightarrow w_6^2 = w_5^2 + 2\, c_{p,Luft}(T_5 - T_6) = 257300\ \frac{m}{s}$

$w_6 = 507.24\ \frac{m}{s}$

c) $e_{x,str,6} = h_6 - h_0 - T_0(s_6 - s_0) + \frac{\omega_6^2}{2}$

~~$e_{x,str,5} = h_5 - h_0 - T_0(s_5 - s_0) + \frac{\omega_5^2}{2}$~~

~~$\Delta e_{x,str} = h_6 - h_5 - T_0$~~

$R = c_p - c_v$

$= c_p - \frac{c_p}{\kappa} = 0.2874 \frac{kJ}{kg\,K}$

$e_{x,str,0} = \frac{1}{2}\omega_0^2$

$\Delta e_{x,str} = h_6 - h_0 - T_0(s_6 - s_0) + \frac{\omega_6^2}{2} - \frac{\omega_0^2}{2}$

$= c_{p,Luft}(T_6 - T_0) - T_0\left(c_{p,Luft}\ln\left(\frac{T_6}{T_0}\right) - R\ln\left(\frac{p_6}{p_0}\right)^0\right) + \frac{\omega_6^2}{2} - \frac{\omega_0^2}{2}$

$= 85.43 \frac{kJ}{kg} - 73.276 \frac{kJ}{kg} + 108.65 \frac{kJ}{kg}$

$= 120.81 \frac{kJ}{kg}$

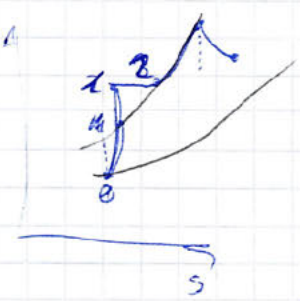
d) 2. HS: $0 = s_e - s_a + \frac{Q}{T}^{0,\ adiabat} + s_{erz}$

$\Rightarrow s_{erz} = \Delta s_{06} = c_{p,Luft}\ln\left(\frac{T_6}{T_0}\right) - R\ln\left(\frac{p_6}{p_0}\right)^0$

$= 0.3014 \frac{kJ}{kg\,K}$

$e_{x,vel} = T_0 \cdot s_{erz}$

$= 73.276 \frac{kJ}{kg}$



[redacted]

3. | | 1 | 2 |
|---|---|---|
| T_g | 500°C | 0°C |
| V_g | 3,14 L | |
| T_{EW} | 0°C | 0°C |
| x_{EIS} | 0.6 | |

a)

$$p_1 = p_0 + \frac{m_K \cdot g}{A} + \frac{m_{EW} \cdot g}{A} \qquad A = \pi \frac{D^2}{4} = 0.07854 \; m^2$$

~~$= 1.03937$ bar $= 1.021$~~

~~$= 1.0400$ bar~~ $= 1.0401$ bar

$$m_g = \frac{p_1 V_1}{R T_1} \qquad R = \frac{\bar{R}}{M_g} = \frac{8.314 \frac{J}{mol K}}{50 \cdot 10^{-3} \frac{kg}{mol}} = 166.28 \frac{J}{kg K}$$

$= 0.0025401$ kg

$= 2.5401$ g

b) $T_{EW2} = T_{g2}$ ← Dies gilt, da thermodynamisches GGW herrscht

$= 0°C$

$$\left(v_{g1} = \frac{V_{g1}}{m_g} = 1.2362 \frac{m^3}{kg} \right)$$

~~$\left(\frac{p_{g2}}{p_{g1}}\right) = \left(\frac{T_{g2}}{T_{g1}}\right)^{\frac{n}{n-1}}$~~

$p_{g2} = p_{g1}$ ← Da sich die Gewichtskraft sowie Aussendruck nicht ändern

$= 1.0401$ bar

c) 1. HS gas:

$$\Delta U = Q_{12} = \underbrace{m_s c_v (T_2 - T_1)}_{= -0.80393\ kJ} + W_{v,12}$$

$$W_{v,12} = m_s \int_1^2 p_s dv = p_s (V_2 - V_1) \qquad V_2 = \frac{m_s R T_2}{p_s}$$

$$= -211.2\ J \qquad = 0.001103\ m^3$$

$$= 1.1032\ L$$

$$\rightarrow Q_{12} = -1015.2\ J$$

d) 1. HS EW: $m_{EW}(u_2 - u_1) = Q_{12}$

~~$u_1 = u_f + x_1 (u_s - u_f) =$~~

solid

~~$u_1 = u_s + x_1 u_s$~~ ~~$u_1 = u_2 + x_1 u_s$~~

$$u_1 = u_f + x_1 (u_s - u_f) = -200.03\ \frac{kJ}{kg}$$ (0°C) TAB 1

solid

$$u_2 = \frac{Q_{12}}{m_{EW}} + u_1 = u_f + x_2 (u_s - u_f)$$

$$u_2 = -189.34\ \frac{kJ}{kg}$$

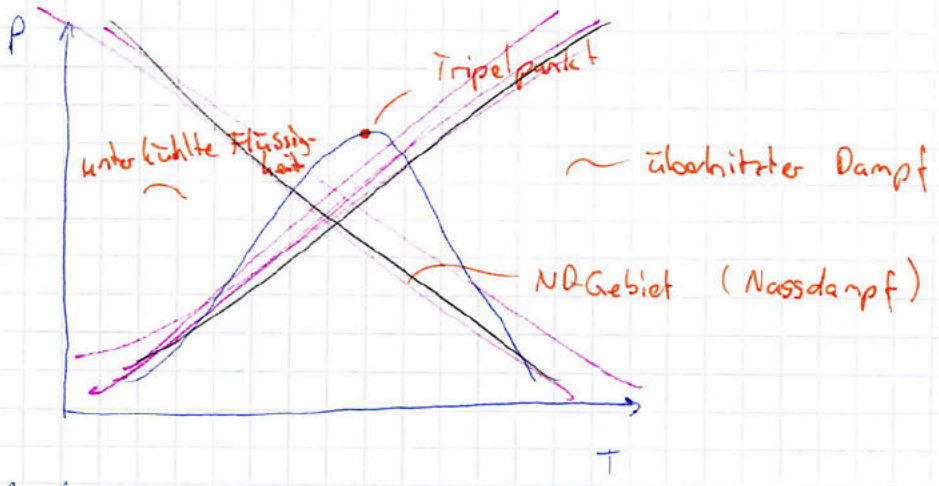
$$\Rightarrow x_2 = \frac{u_2 - u_f}{u_s - u_f} = 0.5698$$ (0°C)

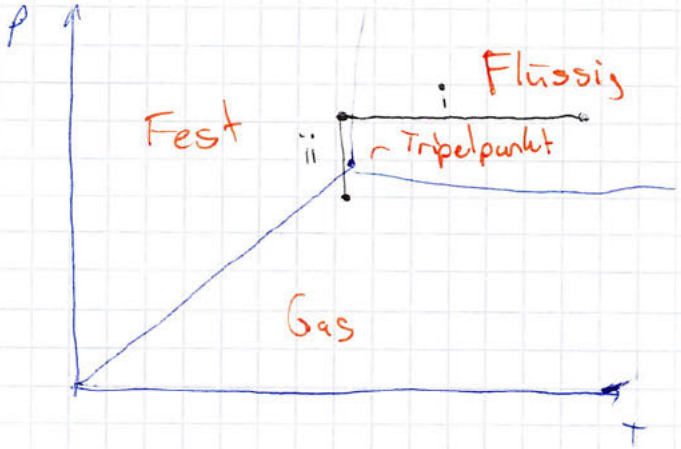
TAB 2

[redacted]

4.

	1	2	3	4
T				
p			8 bar	8 bar
x		1		0





b) 2 → 3:

$$0 = \dot{m}(h_2 - h_3) - \dot{W}_K$$

$$h_2 = h_3$$

d) $$\varepsilon_K = \frac{\dot{Q}_K}{\dot{W}_K}$$

1 → 2: $$0 = \dot{m}(h_1 - h_2) + \dot{Q}_K$$

c) $h_4 = h_1$

$$x_1 = \frac{h_4 - h_f}{h_g - h_f}$$

e) T constant