[redacted]

Aufgabe 1

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

h_{ein} (wasser 70°C sat.) A-2: $292.98\ kJ/kg$

h_{out} (wasser 100° sat) A-2: $419.04\ kJ/kg$

$Q_{aus} = 0.3\ kg/s\,(292.98\ kJ/kg - 419.04\ kJ/kg) + 100\ kW$

$= 62.182\ kW$

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

$s_2 - s_1 = \int_{T_1}^{T_2} \frac{c_{if}}{T}\,dt$

$= c\ \ln\left(\frac{T_2}{T_1}\right)$

c) $0 = \dot{m}\,[s_e - s_a] + \sum \frac{\dot{Q}}{T} + \dot{S}_{erz}$

s_1 (70°C sat) = A_2 : $0.9549\ kJ/kgK$

s_2 (100°C sat) = A_2 : $1.3069\ kJ/kgK$

$-\dot{S}_{erz} = 0.3\ kg/s\,[0.9549\ kJ/kgK - 1.3069\ kJ/kgK] + \cancel{\quad} - \frac{65\ kW}{295\ K}$

$\dot{S}_{erz} = 325.94\ J/K$

d) Im Reaktor: $\Delta U = Q_{12} - \cancel{W}$

$Q_{12} = m \cdot (u_2 - u_1)$

Z_1 ist im Reaktor Anfangszustand
~~da~~ Z2 ist ~~bei~~ 70° sieden

u_1: 100°C $x_D = 0.005$ Tab A2: $(1-x) \cdot u_f + x \cdot u_g$

$= 0.995 \cdot 418.94\,kJ/kg + 0.005 \cdot 2506.5\,kJ/kg$

$= 429.38\,kJ/kg$

u_2 70°C sat Liq Tab A2: $u_2 = 292.95\,kJ/kg$

$Q_{12} = 5755\,kg\,(292.95\,kJ/kg - 429.38\,kJ/kg)$

$= -785154\,kJ$

$\overset{!}{=}$ $-Q_{12} = \Delta m_{12}(u_2 - u_3)$

$\Delta m_{12} = \dfrac{-Q_{12}}{(u_2 - u_3)}$

~~Ausreinstrom~~
3 ist Anfangszustand Zufluss

u_3 = Siedend 20°C A-2: $83.95\,kJ/kg$

$\Delta m_{12} = \dfrac{-Q_{12}}{(292.95 - 83.95)\,kJ/kg} = \dfrac{785'154\,kJ}{209\,kJ/kg} = \underline{\underline{3756.71\,kg}}$

e) $\Delta S_{12} = \Delta S_{Reaktor} + \Delta S_{Zufluss}$

$\Delta S_{Reaktor} = \cancel{5755\,kg}\ m_R (s_2 - s_1)$

s_1 100°C $x = 0.005$ TAB A2: $s_1 = (1-x)\,s_f + x \cdot s_g$

$= 0.995 \cdot 1.3069\,kJ/kgK + 0.005 \cdot 7.3549\,kJ/kgK$

$= 1.337\,kJ/kgK$

[redacted]

e) s_2 $\cancel{100°}$ 70° sat Liq A2: $0.9549\ kJ/kgK$

s_3 20° sat Liq A2: $0.2966\ kJ/kgK$

$\Delta S_{Reaktor} = 5755kg\,(0.9549\ kJ/kgK - 1.337\ kJ/kgK)$

$= -2198\ kJ/K$

$\Delta S_{Zufluss} = m \cdot (s_2 - s_3) = 3756.71kg\,(0.9549\ kJ/kgK - 0.2966\ kJ/kgK)$

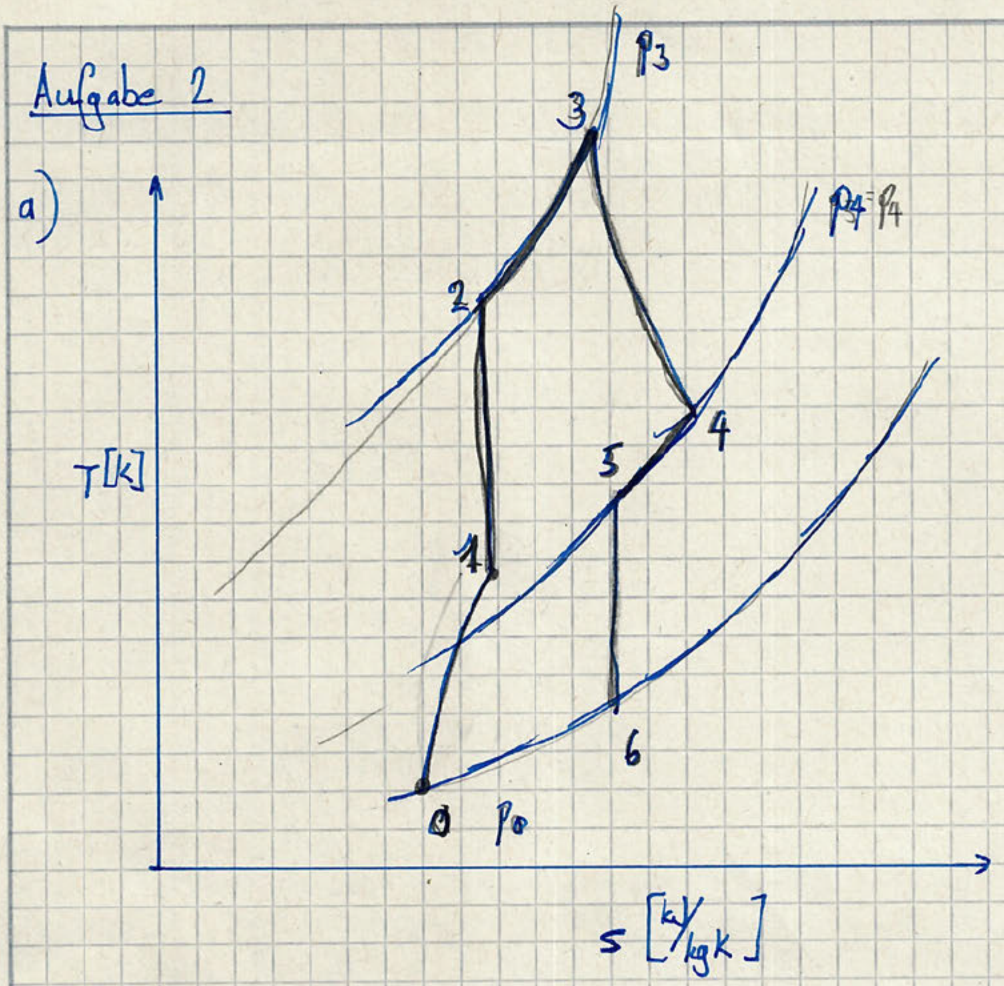
$= 2473\ kJ/K$

$\Delta S_{12} = (-2198 + 2473)\ kJ/K = \underline{\underline{275\ kJ/kg}}$

[redacted]

Aufgabe 2

a)



b) Reversibel, adiabat: Isentropengleichung $\quad n = \kappa = 1.4$

$p_6 = p_0$

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

$$T_6 = \cancel{\frac{T_5}{\left(\frac{p_6}{p_5}\right)^{\frac{n-1}{n}}}} \Rightarrow T_5 \cdot \left(\frac{p_6}{p_5}\right)^{\frac{n-1}{n}} = 431.9\,K \cdot \left(\frac{0.191}{0.5}\right)^{\frac{0.4}{1.4}} = \underline{\underline{328.07\,K}} = T_6$$

Stationäre E Bilanz: $\quad 0 = \dot{m}\left[h_e - h_a + \frac{w_e^2 - w_a^2}{2}\right] + \overset{\text{Adiabat}}{\cancel{\dot{Q}}} - \cancel{\dot{W}}$

$$(h_5 - h_6) = c_p (T_5 - T_6) = 1.006\,\mathrm{kJ/kgK} \cdot (431.9\,K - 328.07\,K) = 104.45\,\mathrm{kJ/kg}$$

$$w_a = \sqrt{104.45\,\mathrm{kJ/kg} \cdot 2 + (220\,\mathrm{m/s})^2}$$

$$\underline{\underline{w_a = 390.96\,\mathrm{m/s}}}$$

c) $e_{xstr} = h - h_0 - T_0 (s - s_0) + ke$

$\Delta e_{xstr,56} = h_6 - h_5$

d) $0 = \Delta e_{xstr} + \frac{\sum \left(1 - \frac{T_0}{\cancel{T}}\right) \dot{Q}}{\cancel{\dot{m}}} - \frac{\sum \dot{W}}{\dot{m}} - \frac{\dot{E}_{xvel}}{\dot{m}}$

[redacted]

Aufgabe 3

$A = \pi \cdot (0.05\,m)^2$
$= 0.007854\,m^2$

a) $p_{G1} = p_{amb} + \frac{m_K \cdot g}{A} + \frac{m_{EW} \cdot g}{A} =$

$= 100'000\,Pa + \frac{32\,kg \cdot 9.81\,m/s^2}{0.007854\,m^2} + \frac{0.1 \cdot 9.81\,kg\,m/s^2}{0.007854\,m^2}$

$p_{g1} = \underline{\underline{140'094\,Pa}}$

$m_G = \frac{p_G \cdot V_G}{R_G \cdot T_G}$

$R_G = \frac{\bar{R}}{M_g} = \frac{8.314\,\frac{J}{mol\,K}}{\frac{50\,kg}{1000\,mol}} = 166.28\,J/kg\,K$

$m_G = \frac{140'094\,Pa \cdot 0.00314\,m^3}{166.28\,J/kgK \cdot 773\,K}$

$3.14\,L = 0.00314\,m^3$

$\underline{\underline{m_G = 0.000003428\,kg}}$

b) $p_{g2} = p_{g1}$ da der gleiche Druck da-auf lastet.
$= \underline{\underline{140'094\,Pa}}$

Adiabat

$\Delta U = \cancel{Q} - \cancel{W}$

$0 = m_G (\Delta u) + m$

c) ~~Q_{212}~~ $\Delta U = Q - W$

$$Q_{12} = m_G (u_2 - u_1)$$

$$Q_{12} = m_G c_v \cdot (T_2 - T_1)$$

$$= 0.0000003428 kg \cdot 0.633 \, kJ/kgK \cdot (0.003°C - 500°C)$$

$$= \underline{-1.0849 J}$$

Also 1.0849 J wurden abgegeben

d) $\Delta U = Q_{12}$ ← Hier Pos wird zugeführt

$$m_{E2} \cdot u_{Fest} + m_{W2} \cdot u_{Fl} - m_{E1} \cdot u_{Fest} - m_{W1} \cdot u_F = 1.0849 J$$

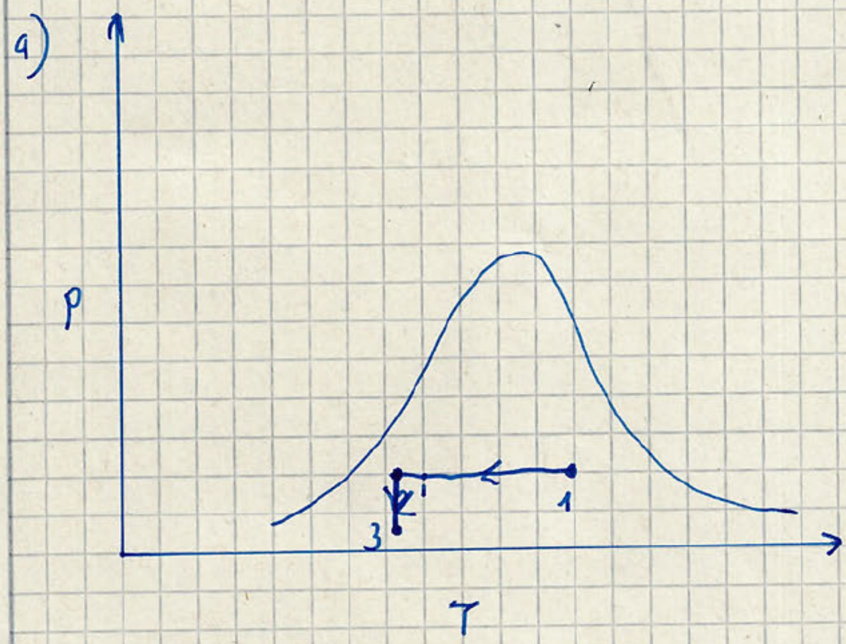
1: $x = \frac{m_E}{m_W} = 0.6$ $m_{W1} = 0.1 kg$

↳ $m_{E1} = 0.06 kg$

[redacted]

Aufgabe 4

a)



adiabat

b) $0 = \dot{m}(h_2 - h_3) + \cancel{\dot{Q}} + \dot{W}_k$

p_3 8bar T_2 ist 6K unter T_i

$T_i = 273K + 10K = 283K$

$T_2 = 283K - 6K = 277K$ (5°C)

h_2 interpoliert $y = \frac{x - x_1}{x_2 - x_1}(y_2 - y_1) + y_1$

$h\,4°C = 249.53\,^{kJ}/_{kg}$

$h\,8°C = 251.80\,^{kJ}/_{kg}$

$h_{\cancel{?}} = \frac{T_2 - 4°}{8° - 4°}(h_{8°} - h_{4°}) + h_{4°}$

$\underline{\underline{h_2 = 250.097\,^{kJ}/_{kg}}}$

$h_3 \rightarrow$ (8bar) $s_2 = s_3$ s_2 interp:

c) Z4 $8 bar$ $x_4 = 0$

Adiabate Drossel : $h_4 = h_1$

h_4 : ($8 bar$ $x = 0$) TAB A11 $93.42 \, kJ/kg$

~~h_2~~ $(1-x) \cdot h_f + x \cdot h_g = h_2$

p_2 @ $-22°C = 1.2192 \, bar$

$p_1 = p_2 = 1.2192 \, bar$

$93.42 \, kJ/kg = (1-x) \cdot$

d) $\varepsilon_K = \cancel{} \frac{\dot{Q}_K}{\dot{W}_K} = \frac{\text{Nutzen}}{\text{Aufwand}}$

[redacted]

Aufgabe 4 weiter

e)