[redacted]

1) a)

$$\dot{E} = \dot{Q} - \cancel{\dot{W}}^{\,0} = \Delta U = m_{ein}(u_{ein}) - m_{aus}\, u_{aus}$$

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

$$u_{ein} = u_f(70°C) = 292.95 \frac{kJ}{kg} \quad \underline{A2}$$

$$u_{aus} = u_f(100°C) = 418.94 \frac{kJ}{kg} \quad \underline{A2}$$

$$\hookrightarrow |\dot{Q}_{aus}| = 0.3 \frac{kg}{s}(292.95 - 418.94)\frac{kJ}{kg} + 100kW$$

$$= 62.203kW \rightarrow \underline{\underline{\dot{Q}_{aus} = -62.203kW}}$$

b)

$$\bar{T} = \frac{\int_e^a T\,ds}{s_a - s_e} = \frac{h_a - h_e}{s_a - s_e} = \frac{\cancel{c}^{if}(T_a - T_e) + \overbrace{v^{if}(p_a - p_e)}^{0}_{\;p_a = p_e} = 0}{\cancel{c}^{if}\ln\left(\frac{T_a}{T_e}\right)}$$

$$\bar{T} = \frac{T_a - T_e}{\ln\left(\frac{T_a}{T_e}\right)} = \frac{298.15k - 288.15k}{\ln\left(\frac{298.15k}{288.15k}\right)} = \underline{\underline{293.12k}}$$

c)

$$\cancel{\dot{Q}_{aus} = \dot{m}_{TKF}(}$$

$$\dot{S}_{erz} = -\frac{\dot{Q}_{aus}}{\bar{T}_{KF}} = \frac{62.203kW}{293.12k} = \underline{\underline{0.2122\frac{kW}{k}}}$$

d)

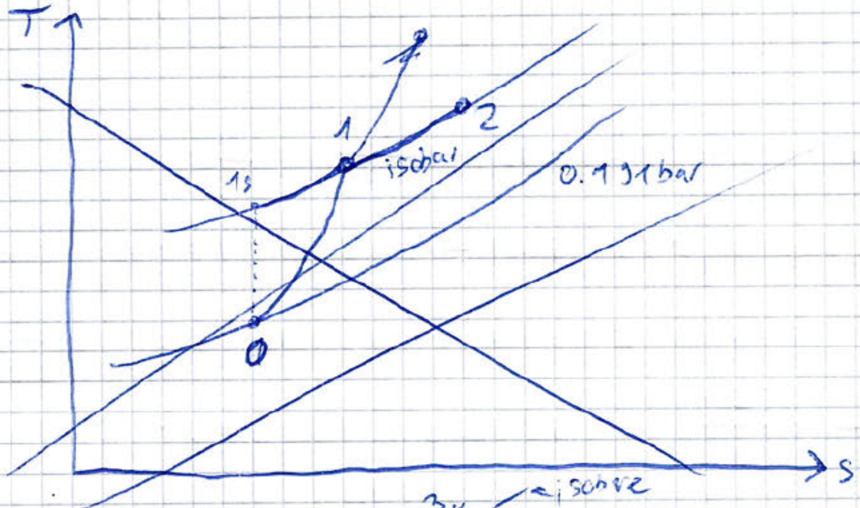
$$\frac{dE}{dt} = \Delta m_{12} h_{12} + Q_{aus12} = \Delta U$$

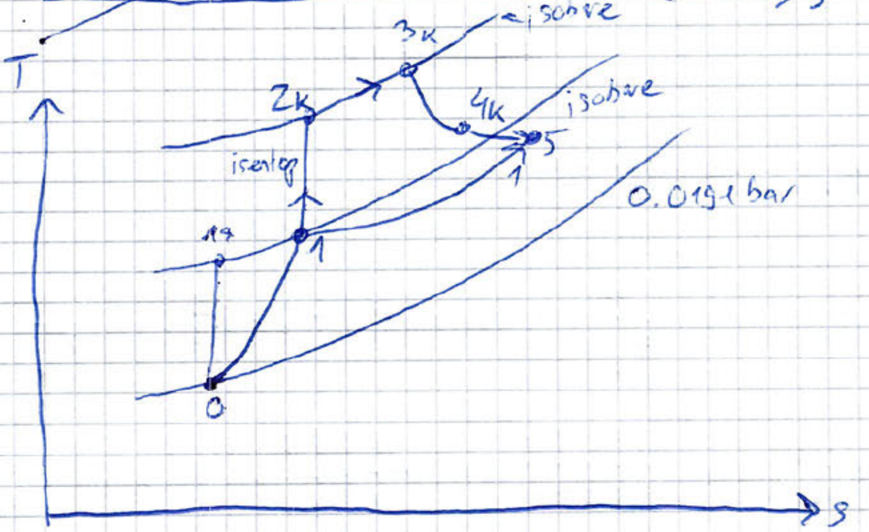
$$\hookrightarrow (m_{ges} + \Delta m_{12})u_2 - m_{ges}(u_1) - \Delta m_{12} u_{12} = Q_{aus12}$$

$$u_1 = u_f($$

[redacted]

2) a)





b)

$$h_5 + \frac{w_5^2}{2} = h_6 + \frac{w_6^2}{2}$$

Düse ist isentrop $\rightarrow s_5 = s_6 \rightarrow n = k = 1.4$

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

$$\hookrightarrow \frac{w_6^2}{2} = h_5 - h_6 + \frac{w_5^2}{2}$$

$$= c_p^{ig}\left(T_5 - T_6\right) + \frac{w_5^2}{2} = 1.006\,\frac{kJ}{kg \cdot K} \cdot (431.9 - 328.07)\,K + \frac{(220\,m/s)^2}{2}$$

$$= 104.45\,kJ + 24.2\,kJ = 128.65\,kJ$$

$$\hookrightarrow w_6 = \sqrt{2 \cdot 128.65\,kJ} = \underline{\underline{507.24\,m/s}}$$

c)

$$\Delta e_{x,str} = h_6 - h_0 - T_0(s_6 - s_0) + \frac{w_6^2}{2} - \frac{w_0^2}{2}$$

$$= c_p(T_6 - T_0) - T_0\left(c_p \ln\left(\frac{T_6}{T_0}\right) - \underbrace{\cancel{R \ln\left(\frac{p_6}{p_0}\right)}}_{0}\right) + \frac{w_6^2}{2} - \frac{w_0^2}{2}$$

$$= 1.006\frac{kJ}{kg \cdot K}(328.07K - 243.15K) - 243.15K\left(1.006\frac{kJ}{kg \cdot K}\ln\left(\frac{328.07}{243.15}\right)\right)$$

$$+ \frac{(507.24m/s)^2}{2} - \frac{220m/s^2}{2} = 12.16kJ + 128.65kJ - 24.2kJ$$

$$= \underline{\underline{116.61 kJ}}$$

d)

$$\cancel{E_{x,verl} = \Delta e_{x,str} + \left(1 - \frac{T_0}{T_B}\right) q_B}$$

$$\dot{S}_{erz} = (s_0 - s_6) + \frac{q_B}{T_B} = c_p \ln\left(\frac{T_0}{T_6}\right) - \overset{0}{\cancel{R \cdot \ln\left(\frac{p_0}{p_6}\right)}} + \frac{q_B}{T_B}$$

$$= 1.006\frac{kJ}{kg \cdot K} \cdot \ln\left(\frac{243.15K}{328.07K}\right) + \frac{1195\frac{kJ}{kg}}{1283K} = 0.6257\frac{kJ}{kg \cdot K}$$

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

$$\hookrightarrow e_{x,verl} = s_{erz} \cdot T_0 = \underline{\underline{152.14\frac{kJ}{kg}}}$$

[redacted]

3) a)

$p_{g1} = p_{amb} + p_{Kolben}$

$p_{Kolben} = \frac{32kg \cdot 9.81 \frac{m}{s^2}}{(0.05m)^2 \pi} = \underline{39.9695 kPa}$

$\hookrightarrow p_{g1} = 100kPa + 39.9695kPa = \underline{\underline{139.97 kPa}}$

$m_{g1} = \frac{V_{g1} \cdot p_{g1}}{\frac{\bar{R}}{M_g} \cdot T_{g1}} = \frac{0.00314 m^3 \cdot 139.97 kPa}{\frac{8.314 \frac{kJ}{kmol\,K}}{50 \frac{kg}{kmol}} \cdot \cancel{2}73.15K} = \underline{\underline{3.419g}}$

b) $p_{g2} = p_{G1} = 139.97kPa$

$\hookrightarrow$ bleibt gleich, weil die Masse des Kolbens und der Druck der Atmosphäre gleich bleiben.

c)

~~Q1~~ $\Delta E_{12} = Q_{12} - W_{12}$

$T_{g2} = 273.153K$

$W_{12} = p_{g1} \cdot (V_{g2} - V_{g1}) =$

$V_{g2} = \frac{m_{g1} \cdot \frac{\bar{R}}{M_g} \cdot T_{g2}}{p_{g2}} = \underline{0.001109 m^3}$

$\hookrightarrow W_{12} = 139.97kPa \cdot (0.001109m^3 - 0.00314m^3) = \underline{-0.2842 kJ}$

$\hookrightarrow \Delta E_{12} = \Delta U_{12} = \cancel{m_{EW}(T_{EW,2}} \; m_{EW}(u_{EW2} - u_{EW1}) + m_g(u_{g2} - u_{g1})$

$\Rightarrow = m$

d)

$$\cancel{Q_{12} = x_{Eis2} \cdot m_{EW}(u_{2,Eis}) - x_{Eis1} m_{EW}(u_{Eis1})}$$

$$\cancel{+ (1-x_{Eis2}) m_{EW}(u_{1,Eis}) - (1-x_{Eis1}) m_{EW}(}$$

$$0 = x_{Eis2} m_{EW} u_{Eis2} + (1-x_{Eis2}) m_{EW} u_{w2} + m_g \cdot u_{g2}$$

$$- x_{Eis1} m_{EW} u_{Eis1} - (1-x_{Eis1}) m_{EW} u_{w1} - m_g u_{g1}$$

$$\wedge\ m_{EW} = 0.1\,kg \qquad u_{Eis,2} = u_{fest}(0.003°C) = -333.442 \frac{kJ}{kg}$$

$$u_{w2} = u_{flüssig}(0.003°C) = -0.033 \frac{kJ}{kg}$$

$$u_{Eis1} = u_{fest}(0°C) = -333.458 \frac{kJ}{kg}$$

$$u_{w1} = u_{flüssig}(0°C) = -0.045 \frac{kJ}{kg}$$

$$\hookrightarrow x_{Eis} m_{EW}(u_{w2} - u_{Eis2}) = m_{EW} u_{w2} - x_{Eis1} m_{EW} u_{Eis1} - (1-x_{Eis1}) m_{EW} u_{w1}$$

$$\underbrace{+ m_g(u_{g2} - u_{g1})}_{= c_v m_g (T_{g2} - T_{g1})}$$

$$\hookrightarrow x_{Eis} = \frac{0.1kg \cdot (-0.033 \frac{kJ}{kg}) - 0.6 \cdot 0.1kg \cdot (-333.458 \frac{kJ}{kg}) - (1-0.6) 0.1kg \cdot (-0.045 \frac{kJ}{kg})}{0.1kg(-0.033 + 333.442)\frac{kJ}{kg}}$$

$$+ \frac{0.633 \frac{kJ}{kg \cdot K} \cdot 0.003419kg (273.153K - 773.15K)}{0.1kg(-0.033 + 333.442)\frac{kJ}{kg}}$$

$$\hookrightarrow Q_{12} = x_2 \cdot m_{EW} \cdot u_{Eis2} - x_1 m_{EW} \cdot u_{Eis1}$$

$$+ (1-x_2) m_{EW} \cdot u_{w2} - (1-x_1) m_{EW} \cdot u_{w1}$$

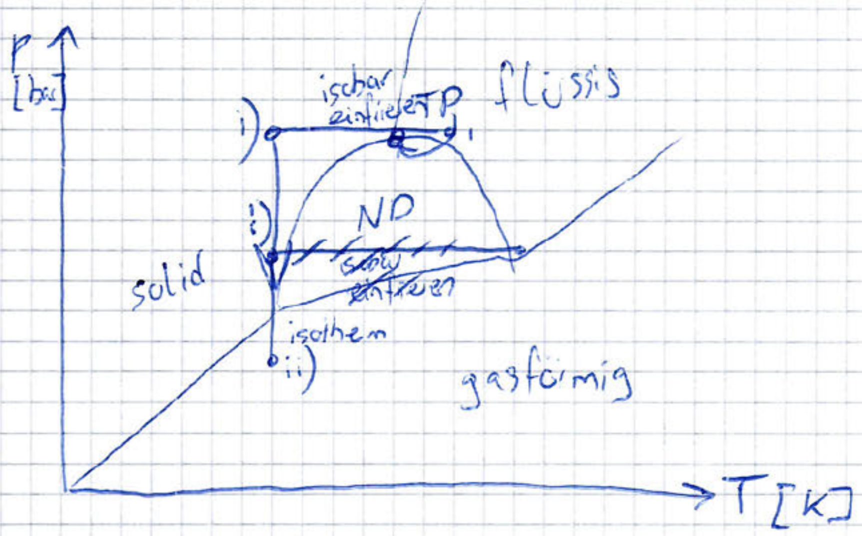
$$\hookrightarrow m_{EW} x_2 (u_{w2} - u_{Eis2}) = |Q_{12}| - x_1 m_{EW} \cdot u_{Eis1} + m_{EW} u_{w2} - (1-x_1) m_{EW} \cdot u_{w1}$$

$$\hookrightarrow x_2 = \frac{1.5kJ - 0.6 \cdot 0.1kg \cdot (-333.458 \frac{kJ}{kg}) + 0.1kg \cdot (-0.033 \frac{kJ}{kg}) - 0.4 \cdot 0.1kg \cdot (-0.045 \frac{kJ}{kg})}{0.1kg \cdot (-0.033 + 333.442)\frac{kJ}{kg}}$$

$$= \underline{\underline{0.52}}$$

[redacted]

4) a)



b) ~~$s_4 = f\, s_f(8bar) = 0.3459 \frac{kJ}{kg \cdot K}$ TaB A11~~

$\hookrightarrow = s_1$

$h_4 = h_f(8bar) = 93.42 \frac{kJ}{kg}$ TAB A-11

4-1 isenthalp $\rightarrow h_1 = h_4 = 93.42 \frac{kJ}{kg}$

c) $\dot{m}_{R134} = \frac{4kg}{h}$ $T_2 = -22°C$

$h_4 = h_1 \rightarrow h_4 = h_f(8bar) = 93.42 \frac{kJ}{kg} = h_1$

d)