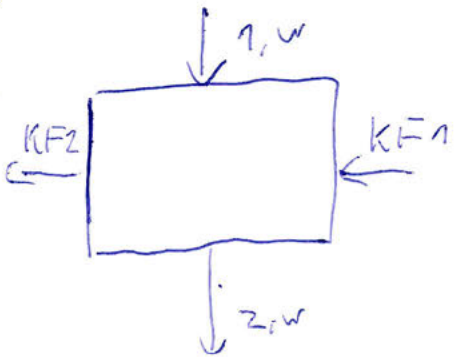
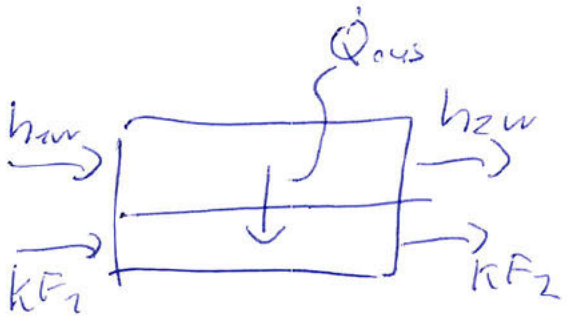
A1

a) $\dot{Q}_{aus}$





$$\frac{dE}{dt} = 0 = \dot{m}(h_{1W} - h_{2W}) + \dot{Q}_{aus} - \cancel{W}$$

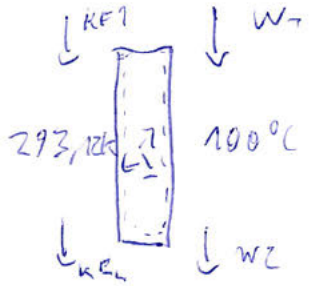
$h_{1W}(70°C, x =)$

$h_{2W}(100°C, x =)$

$$\dot{Q}_{aus} = \dot{m}(h_{2W} - h_{1W})$$

b) $$\bar{T}_{KF} = \frac{\int T ds}{s_a - s_e} = \frac{h_a - h_e}{s_a - s_e} = \frac{\cancel{c^{0}_{f}}(T_a - T_e)}{\cancel{c^{0}_{f}} \ln\left(\frac{T_a}{T_e}\right)} = 293,12\,K$$

c) $\dot{S}_{erz}$



$$\dot{S}_{erz} = \frac{\dot{Q}_{aus}}{373,15\,K} - \frac{\dot{Q}_{aus}}{293,12\,K} \quad (\dot{Q}_{aus} = 65\,kW)$$

$$= 0,047\,\frac{kW}{K} = 47,72\,\frac{W}{K}$$

d) $T_{KF} = 70°C$ Δm_{12} $T_{eintr,12} = 20°C$ $\Delta m_{12} > 0$

Z1 → Z2

$$m_2 u_2 - m_1 u_1 - \Delta m_e h_e = Q$$

$$m_2 = m_1 + \Delta m_e$$

$$(m_1 + \Delta m_e) u_2 - m_1 u_1 - \Delta m_e h_e = Q$$

A1

d) F.F. $m_1 u_2 + m_e(u_2 - h_e) - m_1 u_1 = Q$

$$m_e = \frac{Q + m_1(u_1 - u_2)}{u_2 - h_e}$$

$Q = -35\,MJ$

$m_1 = 5255\,kg$

$T_1 = 100°C$

$T_2 = 70°C$

$T_e = 20°C$

TAB2 (418,04)

$429{,}38\,\frac{kJ}{kg} = 418{,}04 + 0{,}005(2506{,}5) + u_1(100°C, s.F)$ ($x = 0{,}005$)

$u_2(70°C, s.F)$

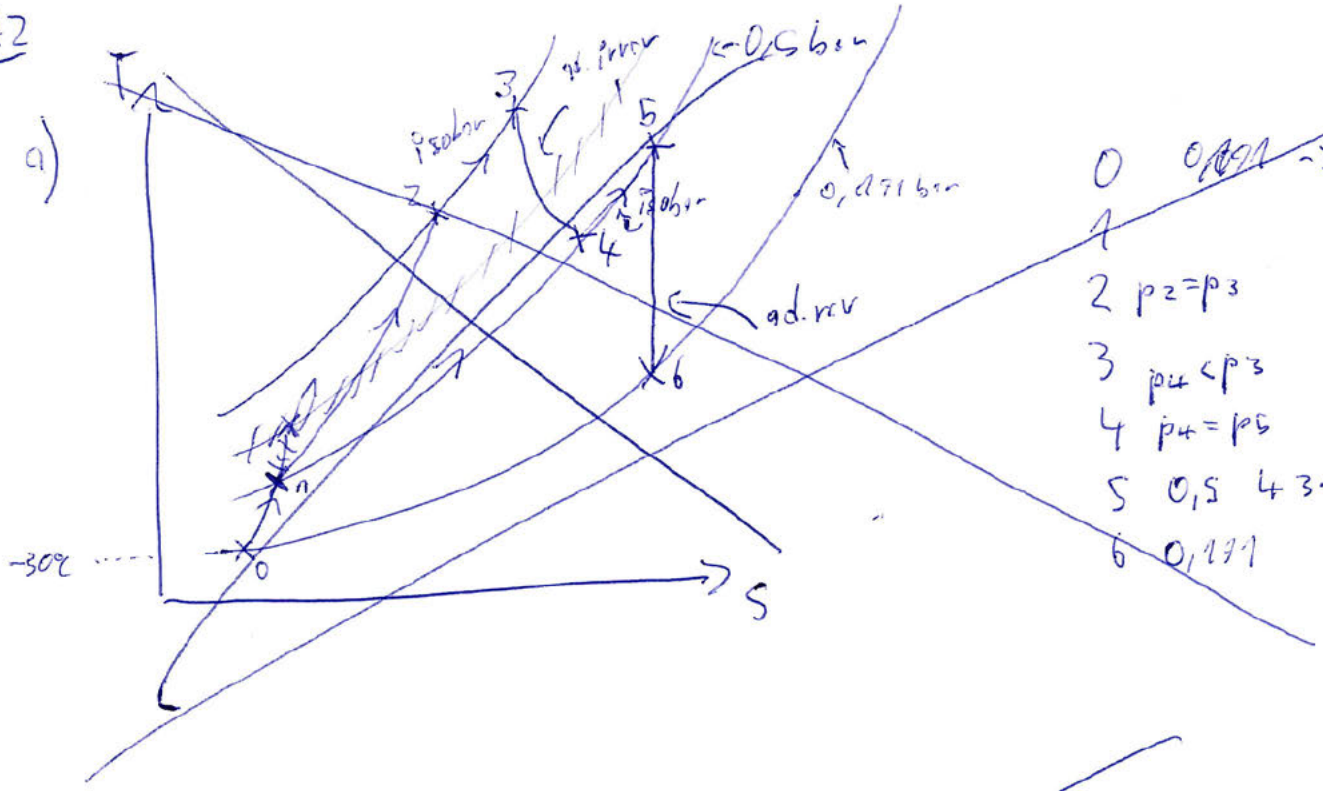
$u_e(20°C, s.F)$

$h_e(20°C, s.F)$

e) $\Delta S = m_2 s_2 - m_1 s_1 - \Delta m_e s_e = \frac{Q}{T} + S_{cr2}$

A2

a)



0 0,191 -30°C kompresor

1

2 $p_2 = p_3$

3 $p_4 < p_3$

4 $p_4 = p_5$

5 0,5 bar 431,9 K

6 0,191

b)

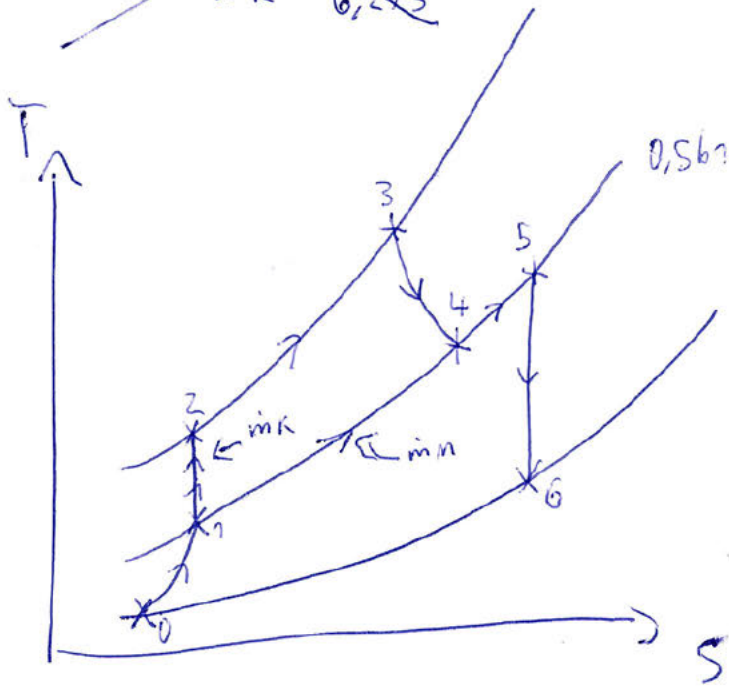
$$\frac{dE}{dt} = 0 = \dot{m}\left(h_0 - h_6 + \frac{w_0^2 - w_6^2}{2}\right) + \frac{\dot{Q}_{13}}{\dot{m}_K} + W$$

$$0 = \dot{m}\left(c_p(T_0 - T_6) + \frac{w_0^2 - w_6^2}{2}\right) = -\frac{\dot{Q}_{13}}{\dot{m}_K}$$

$$5{,}213 \cdot \dot{m}_K = \dot{m}_M = \dot{m} - \dot{m}_K$$

$$\dot{m}_K = \frac{\dot{m}}{6{,}213} =$$

c)



A2

b) $\frac{dE}{dt} = 0 = \dot{m}\left(h_0 - h_6 + \frac{w_0^2 - w_6^2}{2}\right) + q_B - W$ (W → 0)

$$0 = h_0 - h_6 + \frac{w_0^2 - w_6^2}{2} + q_B$$

$$w_6 = \sqrt{2(h_0 - h_6 + q_B) + w_0^2}$$

$$\approx \sqrt{2 \cdot [c_p (T_0 - T_6) + q_B] + w_0^2}$$

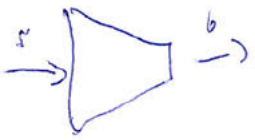
$$\approx$$

$q_B = 1195 \frac{kJ}{kg}$

$T_0 = 243{,}15\,K$

$T_6 = \ldots$

$w_0 = 200 \frac{m}{s}$



$$0 = \dot{S}_{irr} + \dot{m}(s_5 - s_6) + \frac{\dot{Q}}{T} \quad (\dot{S}_{irr} \to 0,\ \dot{Q} \to 0,\ \text{rev})$$

$$s_5 - s_6 = 0 = c_p \ln\left(\frac{T_5}{T_6}\right) - R \ln\left(\frac{p_5}{p_6}\right) = 0$$

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

$$T_6 = \frac{T_5}{\left(\frac{p_5}{p_6}\right)^{\frac{n-1}{n}}} \approx 328{,}1\,K$$

$\rightarrow w_6 = 20$

c) $\Delta e_{xstr} = e_{xstr6} - e_{xstr0} = h_6 - h_0 - T_0(s_6 - h_0) + \frac{w_6^2 - w_0^2}{2}$

$$= c_p\left[T_6 - T_0 - T_0 \ln\left(\frac{T_6}{T_0}\right)\right] + \frac{w_6^2 - w_0^2}{2}$$

$$= c_p\left[340K - 243{,}15k - 243{,}15k \ln\left|\frac{340}{243{,}15}\right|\right] + \frac{540^2 - 200^2}{2}$$

$$\approx 125{,}5 \frac{kJ}{kg}$$

d) $e_{x,verl} = e_{xstr} + e_{xQ} = T_0 \, s_{irr}$

$= -\Delta e_{xstr} + \left(1 - \frac{T_0}{T}\right) q$

$= -100 \frac{kJ}{kg} + \left(1 - \frac{243{,}15\,K}{1289\,K}\right) 1145$

$\approx 869{,}6 \frac{kJ}{kg}$

[redacted]

A3

a) p_{g1}, m_g

$$p_{g1} \cdot A = m_K g + m_{EW} \cdot g + p_{amb} \cdot A$$

$$p_{g1} = \frac{1}{A}(m_K g + m_{EW} \cdot g) + p_{amb}$$

$$= 110\,023{,}6 \ \frac{N}{m^2}$$

$$A = \pi \cdot 0{,}1^2$$

$$p_{amb} = 100\,000 \ \frac{N}{m^2}$$

$$m = \frac{pV}{RT} = 0{,}0027 \ kg$$

$$T = 273{,}15 \ K$$

$$R = \frac{8.314}{50} = 0{,}16628 \ \frac{kJ}{kg\,K}$$

$$= 166{,}28 \ \frac{J}{kg\,K}$$

$$V = 3{,}14 \cdot 10^{-3} \ m^3$$

b) T_{g2} p_{g2} Endzustand: $T_G = T_{EW}$

u_{final} ist gesucht, ~~so wie~~ dann IP bei $T = 0{,}003\,°C$

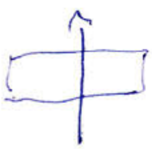
$$m(u_2 - u_1) = Q - ~~W~~$$

? Pinkompressibel = Pisochor

~~W~~ =

u_2 (

c) $x_{Eis\,2}$ $T_{W2} = 0{,}003\,°C$



$$Q = m_G(u_2 - u_1) + m_{EW}(u_2 - u_1)$$

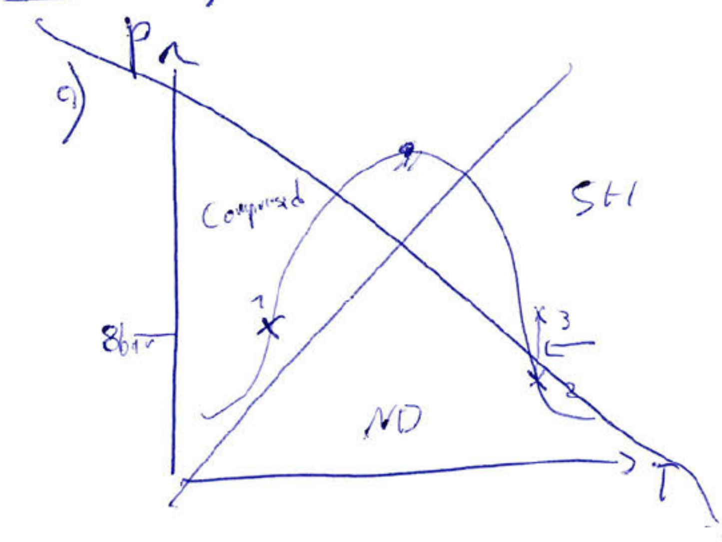
$$= m_G(c_v(T_2 - T_1)) + m_{EW}\, c\, (T_2 - T_1)$$

$$= 0{,}0027(0{,}633(273{,}153 - 773{,}15)) + 0{,}1 \cdot c($$

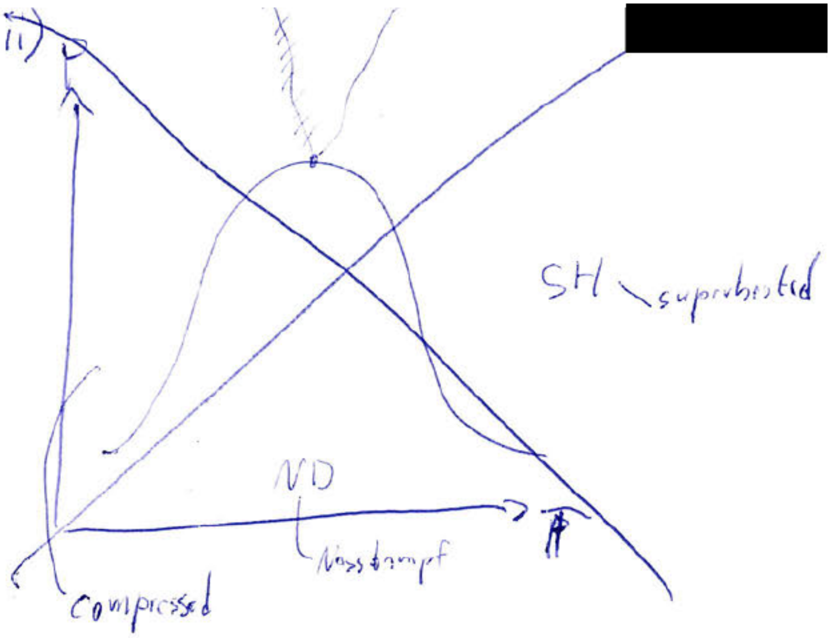
A4

a)

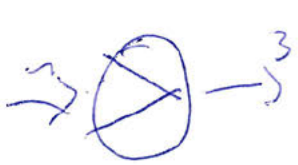
i)



ii)



b) 2->3 ad. rev $s_2 = s_3$



$$\frac{dE}{dt} = 0 = \dot{m}(h_2 - h_3) + \dot{Q} - \dot{W}$$

$\dot{Q}$: 0, ad

$\dot{W}_K = -28W$

$h_2(\quad , x=1)$

$h_3(8bar, \quad)$

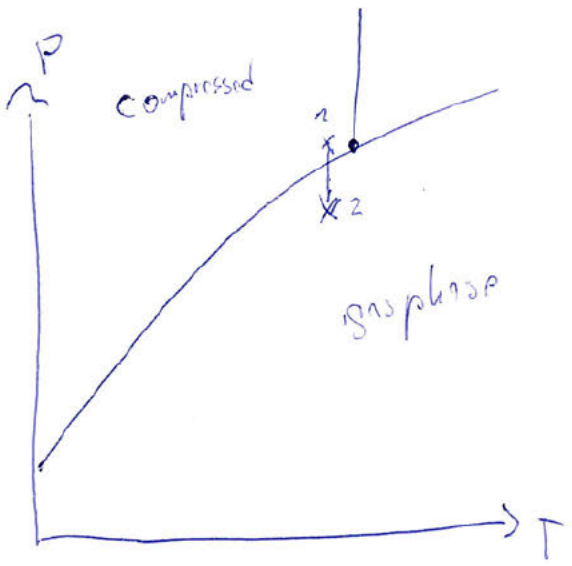
c) adiabate Drossel: isenthalp! $h_1 = h_4$

$h_4(8bar, x=0) = 93,42 \frac{kJ}{kg}$

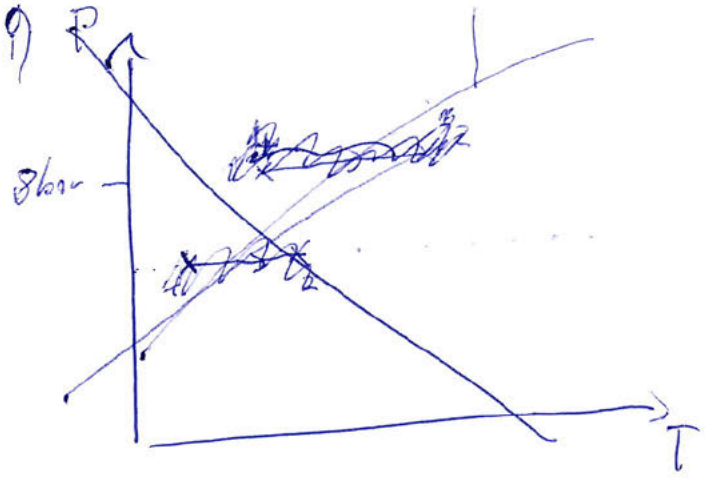
jetzt brauche ich den T_1

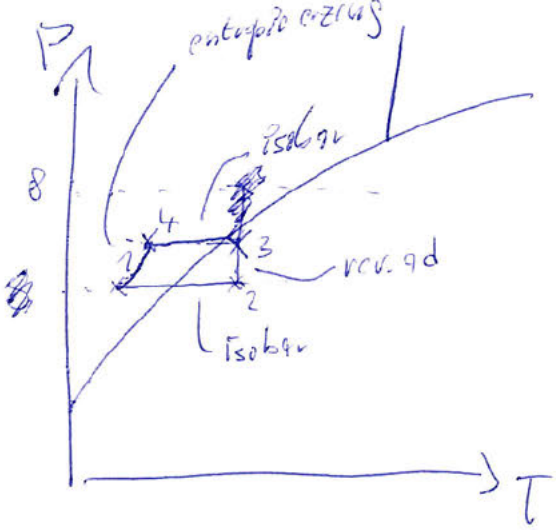
A4 FF.

9) 10) 11)



9)





d) $$\varepsilon_K = \frac{|\dot{Q}_{zu}|}{(Q_{ab}-|\dot{Q}_{zu}|} = \frac{|\dot{Q}_{zu}|}{\dot{W}_K} = \text{———}$$

$$\dot{Q}_K = \dot{m}(h_2 - h_1)$$

e) Temperatur würde fallen.