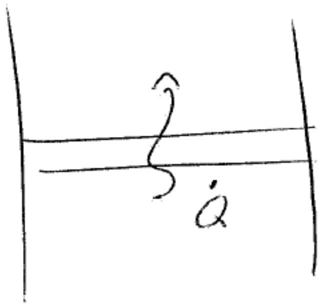
3c)

[redacted]



$$\dot{W} = R(T_2 - T_1) + p_0(v_2 - v_1)$$

$$0 = \dot{m}_w(h_1 - h_2) + \dot{Q} - \dot{W}$$

$\Uparrow$

~~$h_1 = h$~~

$$= \frac{R(T_2 - T_1)}{1-n} =$$

Druck bleibt gleich

$$\dot{m}_g(h_1 - h_2) - \dot{Q} \qquad n = 0$$

$$\underline{\underline{\dot{Q}}} = \dot{m}_g c_p(T_1 - T_2) = \underline{\underline{1{,}083\,kJ}}$$

1d) [redacted]

$u_2 = u_f(70°C) = 292.95 \frac{kJ}{kg}$

$u_1 = u_f(100°C) + x_D(u_g(100°C) - u_f(100°C)) = 303.833 \frac{kJ}{kg}$

$h_{ein} = h_f(20°C) = 83.96 \frac{kJ}{kg}$

$\underline{\underline{\Delta m_{12} = 132.275 kg}}$

1c) [redacted]

$\dot{S}_{erz}$ aufgrund von Wärmestrom (Masse der Wärme $\equiv 0$)

$$-\frac{\dot{Q}_{aus}}{T_{KF}} + \frac{\dot{Q}_{aus}}{T_W} + \dot{S}_{erz} = 0$$

$$\frac{\dot{Q}_{aus}}{T_{KF}} - \frac{\dot{Q}_{aus}}{T_W} = \dot{S}_{erz}$$

$$T_W = 100°C = 373.15 K$$

$$\underline{\underline{\dot{S}_{erz}}} = 0.095 \frac{kJ}{K} = \underline{\underline{95.5 \frac{J}{K}}}$$

1b)

[redacted]

$Q \Rightarrow U$

$$\frac{\int_1^2 c^{if} \, dT}{c^{if} \int \frac{1}{T} \, dT} = \frac{\cancel{c^{if}} \int_{T_1}^{T_2} dT}{\cancel{c^{if}} \int_2^1 \frac{1}{T} \, dT}$$

$$\underline{\underline{T_{KM}}} = \frac{T_2 - T_1}{\ln\left(\frac{T_2}{T_1}\right)} = \underline{\underline{293.12 \text{ K}}}$$

1b) [redacted]

$$\overline{T}_{KF} = \frac{\int_e^a T ds}{s_a - s_e} \Rightarrow \quad q_{aus}$$

$$\overline{T}_{KF} = \frac{\dot{m}\, q_{\cancel{aus}}}{s_a - s_e} = \frac{\dot{Q}_{aus}}{\dot{m}_{KF}(s_a - s_e)}$$

$$s_e^{if} - s_a^{if} = \int_{T_a}^{T_e} \frac{c^{if}}{T} dT$$

$$\frac{\dot{Q}}{\dot{m}}$$

$$q \quad \cancel{q} = \frac{\dot{Q}}{\dot{m}}$$

$$\Uparrow$$

$$\overline{T}_{KF} = \frac{\int_1^2 T ds}{s_a - s_e} = \frac{\int_1^2 T ds}{c^{if} \cdot \ln\left(\frac{T_e}{T_a}\right)}$$

$$\Uparrow$$

$$\frac{S}{m}$$

$$\frac{\frac{\dot{Q}}{\dot{m}}}{\frac{\Delta S}{\dot{m}}} = \frac{\dot{Q}_{aus}}{c^{if} \ln\left(\frac{T_e}{T_a}\right)}$$

1) a)

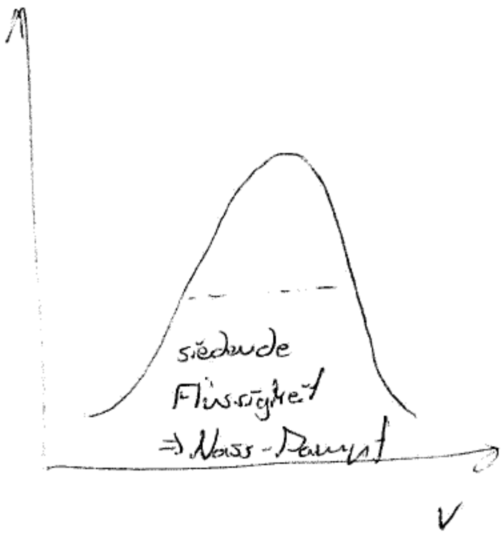
[redacted]

$\dot{Q}_{aus}$

Stationärer Fliessprozess mit

$$\dot{m}_{Wasser}(h_{1,W}-h_{2,W}) + \dot{Q}_R - \dot{Q}_{aus} + \cancel{\dot{m}(h_1-h_2)}$$

$h_{1,W} = h_f(70^\circ C)$ siedende Flüssigkeit



1-2

$h_f(70^\circ C) = 292.98 \frac{kJ}{kg}$

$\cancel{h_{2,W}(20^\circ C}$

$h_{2,W}(100^\circ C) = h_{f,W}(100^\circ C) = 419.09 \frac{kJ}{kg}$

$$\dot{m}_W(h_1-h_2) + \dot{Q}_R = \underline{\underline{\dot{Q}_{aus}}} = \underline{\underline{62.782\,kW}}$$

3a)

[redacted]

$$m_g = \frac{pV}{RT} \qquad R = \frac{\bar{R}}{M} = \frac{8.314 \frac{kJ}{\cancel{kmol}\,K}}{50 \frac{kg}{\cancel{kmol}}}$$

$$R = 0.16628 \frac{kJ}{kg\,K} = 166.28 \frac{J}{kgK}$$

$$= 0.003422\, kg$$

$$\underline{\underline{m_g = 3.422\, g}}$$

b) $T_{g,2}$, $\cancel{F}$ $u_{g,2}$

3) [redacted]

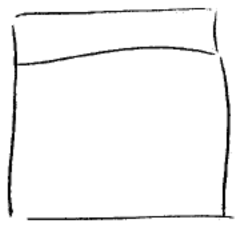
$c_v = 0.633 \frac{kJ}{kg K}$ $\quad M = 50 \frac{kg}{kmol}$

a)

$p_{g,1}, m_g = ?$

$pV = mRT$

$0.1 kg + 32 kg$



$mg = F$

$\frac{mg}{0.05^2 \pi} = p = 40.099 bar$

$\underline{\underline{p_{1,g}}} = p_{atm} + p_{Gewicht} = 1.40099 bar$

$\underline{\underline{1.40 bar}}$

3c)

$$w_6 = 570 \frac{m}{s} \qquad T_6 = 370\,K$$

$$h - h_0 - T_0(s - s_0) + ke$$

$$h_a - h_e - T_0(s_e - s_a) + \Delta ke$$

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

$$h_6 - h_1 = c_p(T_6 - T_0)$$

$$p_6 = p_0$$

$$0$$

$$s_6 - s_0 = c_p \ln\left(\frac{T_6}{T_0}\right) - \cancel{R \ln\left(\frac{p_6}{p_0}\right)}$$

$$\Delta e_{x,str} = c_p(T_6 - T_0) + {}^{T_0} c_p \ln\left(\frac{T_6}{T_0}\right) + \frac{w_6^2 - w_0^2}{2} =$$

[redacted]

2)

	p	T	
0	~~0.191 bar~~ 0.191 bar	−30°C 243.15K T_0	
1	~~[illegible]~~ 0.5 bar		
2			
3	~~0.5 bar~~		
4	0.5 bar		
5	0.5 bar	~~[illegible]~~ 431.9K	
6	0.191 bar		

T_s, p_s, w_s gegeben

8

[redacted]

$$\dot{m} c_p (T_5 - T_6) + \dot{m}\left(\frac{w_5^2 - w_6^2}{2}\right) + \cancel{\dot{Q}}^{\,0} - \dot{W}_t$$

$$W_t = -\frac{R(T_6 - T_5)}{1-n} - \Delta ke \qquad \dot{W}_t^{rev} = \quad v\,dp + ke$$

$$\text{Luft} \Rightarrow \text{Ideales Gas} \Rightarrow -\frac{R(T_6 - T_5)}{1-n}\,\dot{m}$$

$$\dot{m} c_p (T_5 - T_6) + \dot{m}(w_5^2 - w_6^2) - \dot{m}\,\frac{R(T_6 - T_5)}{1-n}$$

$$\sqrt{\left(c_p (T_5 - T_6) + w_5^2 - \frac{R(T_6 - T_5)}{1-n}\right)} = w_6 = \underline{\underline{350\ \frac{m}{s}}}$$

$$c_v = \frac{c_p}{1.4} = 0.7186\ \frac{kJ}{kgK}$$

$$R = c_p - c_v = 287\ \frac{J}{kgK}$$

2b)

[redacted]

$$0 = \dot{m}(h_e - h_a + \frac{w_e^2 - w_a^2}{2}) + \dot{Q} - \dot{W}$$

Isentrope Schubdüse

$\Rightarrow \quad n = \kappa = 1{,}4$

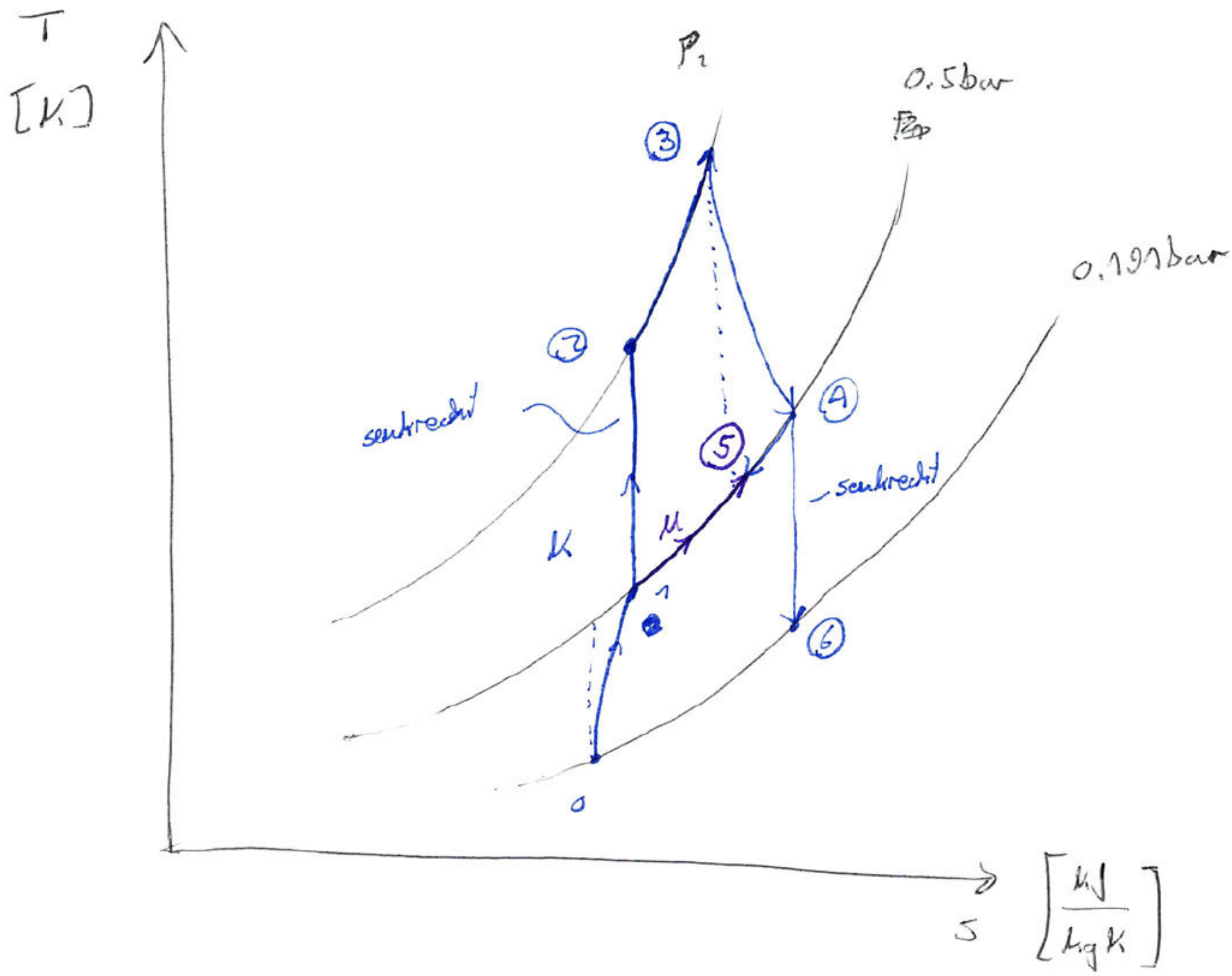
$$\frac{T_2}{T_1} = \left(\frac{p_2}{p_1}\right)^{\frac{n-1}{n}}$$

$$\text{hier} = \quad \frac{T_6}{T_5} = \left(\frac{p_6}{p_5}\right)^{\frac{\kappa-1}{\kappa}}$$

$$\underline{\underline{T_6}} = T_5\left(\frac{p_0}{p_5}\right)^{\frac{\kappa-1}{\kappa}} = \underline{\underline{328.07\,K}}$$

2) a)

[redacted]



T
[K]
p_2
0.5bar
p_0
0.191bar
3
2
4
5
1
0
6
senkrecht
senkrecht
K
M
s
[kJ/kgK]

1d)

[redacted]

$$Q_{R,12} = 35\,MJ = 35'000\,kJ$$

Halboffenes System

$$m_2 u_2 - m_1 u_1 = \Delta m_{12} h_{ein} + Q_{aus}$$

$$u_2 = u_{Wasser}(70°C) \quad \text{siedende Flüssigkeit} \quad x_D = 0$$

$$u_1 = u_{Wasser}(100°C) \Rightarrow x_D = 0.005$$

$$h_{ein} = h(20°C) \quad \text{siedende Fl.}$$

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

$$Q < 0$$

$$\Downarrow$$

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

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

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

5

3d)

$$T = 0{,}003\,°C$$

[redacted]

$$x_{E,2} =$$

$$x = \frac{m_E}{m_{ges}}$$

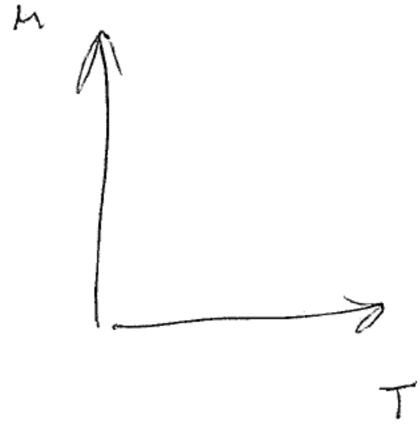
$$u = u_{fl} + x_{eis}\left(u_{fest} - u_{fl}\right)$$

$$x_{eis} = \frac{u_2 - u_{fl}}{u_{fest} - u_{fl}}$$

~~4b)~~ [redacted]

4b)

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



$x_2 = 1$

$h_2 = h_g$ bei 10°C

Interpol über 8° und 12°C

$$\frac{257.03 - 251.8}{12 - 8}(10°C - 8°C) + 251.8 =$$

$h_2 = 252.915 \frac{kJ}{kg}$

$h_3 \Rightarrow$ 8bar

$T_i = 4°$

$h_3 =$

~~$h_{3,5}$~~

$$\underline{\underline{\dot{m}_{R,134a} = \frac{\dot{W}_K}{h_2 - h_3}}}$$