[redacted]

Aufgabe 1.

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

1. HS: stationär

$$0 = \dot{m}\,[h_{ein} - h_{aus}] + \dot{Q}_R - \dot{Q}_{aus}$$

$$\dot{Q}_{aus} = \dot{m}\,[h_{ein} - h_{aus}] + 100\,kW$$

$$\dot{m} = 0.3\,\frac{kg}{s}$$

$h_{ein} \overset{A2}{\Rightarrow}$ siedende Flüssigkeit: $h_f(70°C) = 292.98\,\frac{kJ}{kg}$

$h_{aus} \overset{A2}{\Rightarrow} h_f(100°C) = 419.04$

$$\boxed{\dot{Q}_{aus} = 62.182\,kW}$$

b) $\boxed{\bar{T}_{KF} = \frac{\int_e^a T\,ds}{s_a - s_e} \overset{s.\ unten}{=} \frac{T_{aus} - T_{ein}}{\ln\left(\frac{T_{aus}}{T_{ein}}\right)} = \underline{\underline{293.12\,K}}}$

$$s_a - s_e = c_{if} \cdot \ln\left(\frac{T_{aus}}{T_{ein}}\right)$$ (ideale Flüssigkeit) (isobar)

$$\int_e^a T\,ds = q_{rev} = h_{aus} - h_{ein} \quad (1.\ HS)$$

$$= c_{if}\,[T_{aus} - T_{ein}]$$ (ideale Fl. isobar)

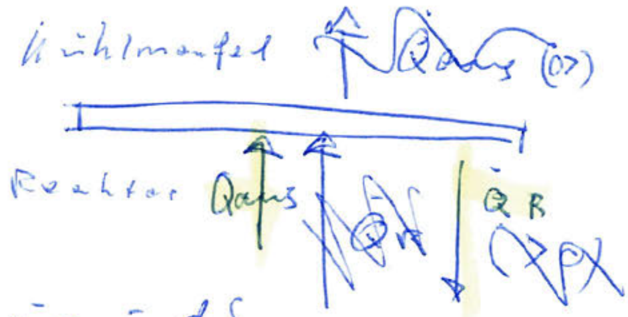
$T_{aus} = 298.15\,K$

$T_{ein} = 288.15\,K$

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

entropie entsteht in wand! [redacted]

kein Massenfluss durch wand!



bei $T_{KF} = 293.12\,K$

Stationär : $\frac{dS}{dt} = 0$

$$0 = \frac{\dot{Q}}{\overline{T}} + \dot{S}_{erz} \Rightarrow \dot{S}_{erz} = -\frac{\dot{Q}}{\overline{T}_{KF}}$$

$$+\dot{Q} = -\dot{Q}_R + \dot{Q}_{aus} = \underline{-100 + 62.182} = -37.818$$

$$\underline{\dot{S}_{erz}} = \frac{+37.818}{293.12} = \underline{\underline{0.129\ \frac{kW}{K}}}$$

d)

Halboffen:

Q_{-} Ma $Q_{R12} = Q_{aus12}$

$$m_2 u_2 - m_1 u_1 - \Delta m_{12} h_{12} = \cancel{Q} - \cancel{W}^{\,0}$$

$$\Delta m_{12} = \frac{m_2 u_2 - m_1 u_1}{h_{12}} = \frac{\Delta m_{12} u_2 + m_1 u_2 - m_1 u_1}{h_{12}}$$

$m_1 = 5755\,kg$

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

$$\Delta m_{12} - \frac{\Delta m_{12} u_2}{h_{12}} = \frac{m_1}{h_{12}}[u_2 - u_1]$$

$u_2 = h_f(70°C) = \underline{292.98}$

$$\Delta m_{12} = \frac{m_1 [u_2 - u_1]}{h_{12} \cdot \left[1 - \frac{u_2}{h_{12}}\right]}$$

$u_1 \overset{A2}{=} h_M(100°C; 0.005) = 0.005\,[2676.1] + (1 - 0.005)\,419.04 = \underline{430.3253}$

$h_{12} \overset{A2}{=} h_f(20°C) = \underline{83.96}$

$$\boxed{\Delta m_{12} = 3781.563\ kg}$$

Teil 2 Aufgabe 1

[redacted]

e) ΔS halboffen:

$$m_2 s_2 - m_1 s_1 = \Delta m_{12} s_{12} + S_{erz}$$ (keine Wärme)

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

$$= 289.61 \frac{kJ}{K}$$

$m_2 = 9536.56\underline{3}$

$s_2 = s_f(70°C) = 0.9549$

$s_1 = s(100°C, 0.005 = x) = 0.005 \cdot 7.3549 + (1 - 0.005)(1.3069)$

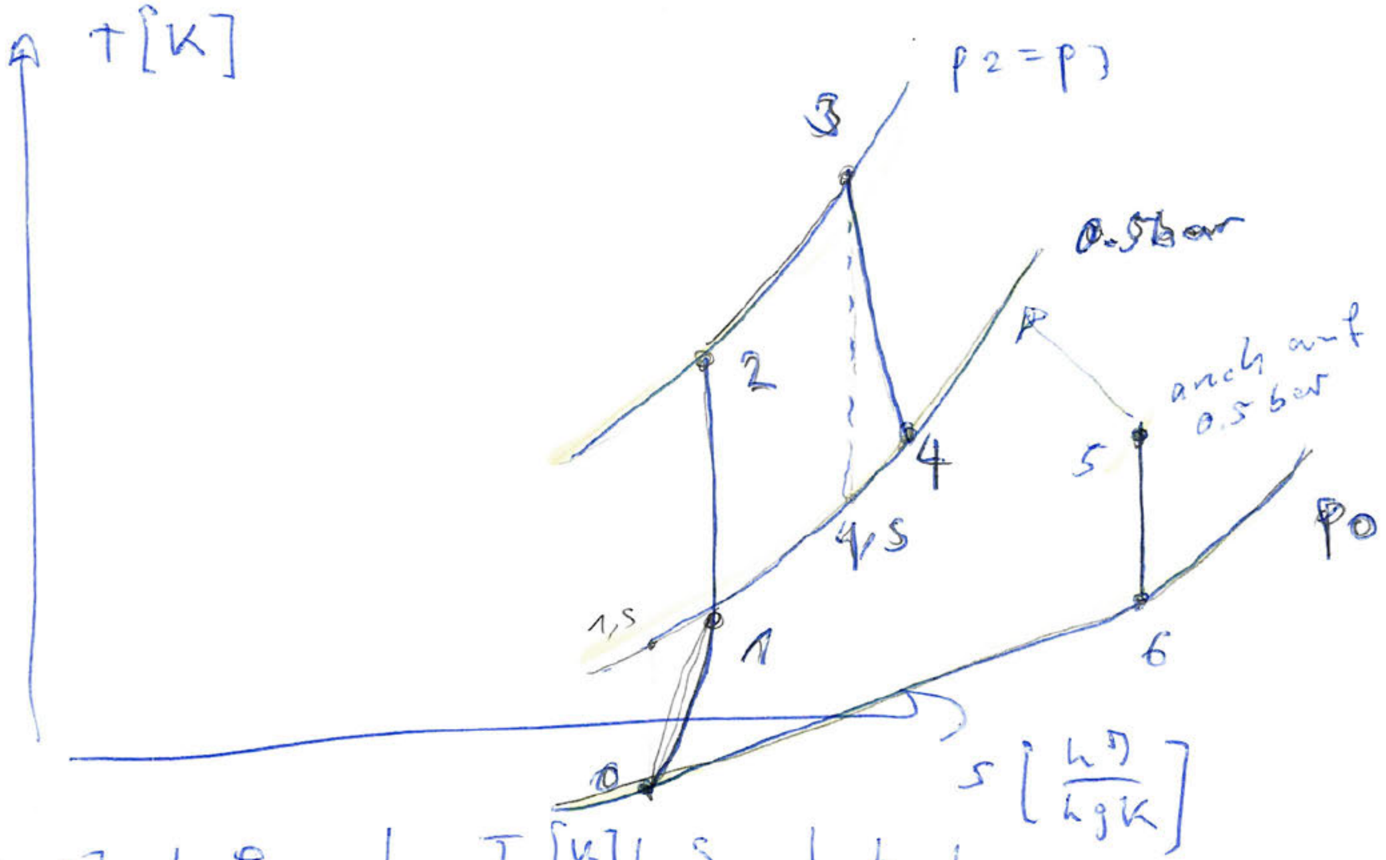
$= 1.33714$

$s_{12} = s_f(20°C) = 0.2966$

[redacted]

Aufgabe 2: [redacted]

a) T-s-diagramm



Zust.	p	T [K]	s	h
1	0.5 bar			
2			$s_1 = s_2$	
3				
4	0.5 bar			
5	0.5 bar	431.9		
6	0.191	328.075	$s_6 = s_5$	
0	0.191			

→ Ideales gas: Isentrope $\kappa = 1.4$

$$T_6 = T_5 \cdot \left(\frac{p_6}{p_5}\right)^{\frac{0.4}{1.4}}$$

b) w_6, T_6

[redacted]

1. HS um Triebwerk:

stationär: $\frac{dE}{dt} = 0$ | keine Arbeit |

adiabat $= Q = 0$

$$0 = \dot{m}\left[h_0 - h_6 + \frac{w_0^2 - w_6^2}{2}\right] \Leftrightarrow \sqrt{2(h_0 - h_6) + \frac{w_0^2}{2}} = \sqrt{w_6^2}$$

$$-2\left[h_6 - h_0\right] + w_0^2 = w_6^2$$

$$w_6 = \sqrt{+2\left[h_0 - h_6\right] + w_0^2} =$$

$h_0 =$

$h_6 =$ $\Big\}$ $h_0 - h_6 = c_p^{ig}\left[T_0 - T_6\right] = -85.43$

$T_0 = -30°$

T_6: ~~1. HS um Schubdüse~~:

$$T_6 = T_5 \cdot \left(\frac{p_6}{p_5}\right)^{\frac{0.4}{1.4}} = 328.075\,K = 54.925\,°C$$

$p_6 = 0.191\,bar$

$p_5 = 0.5\,bar$ $\qquad h_5 - h_6 = c_{ig} \cdot \left[T_5 - T_6\right] = 104.418$

b) 1 HS um Schubdüse:

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

$$h_6 - h_5 = \frac{w_5^2}{2} - \frac{w_6^2}{2} \Rightarrow w_6 = \sqrt{2(h_5 - h_6) + w_5^2}$$

$$= \underline{16.0\,\frac{m}{s}}$$

Aufg 2:

[redacted]

c) ~~an~~ $0 = h_6 - h_0 - T_0(s_6 - s_0) + \Delta he$

d) ~~$e_{x,verl}$~~ $= \Delta e_{x,str.}$

$e_{x,verl} = \Delta e_{x,str} = 100 \frac{kJ}{kg}$

[redacted]

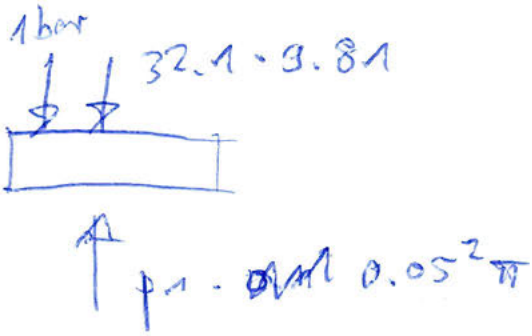
[redacted]

Aufgabe 3:

a) p_{g1}, m_g

p_{g1}: Kräfte ggw:

$A_{zyl.} = 0.05^2\pi = \frac{\pi}{400} = 7.85 \cdot 10^{-3}$



$$p_1 = \frac{32.1 \cdot 9.81}{0.05^2\pi} + 1bar = 40094.4\ Pa + 1bar$$

$$= 0.40094\ bar + 1bar$$

$$\boxed{= 1.40094\ bar}$$

Ideales gas gesetz:

$$m = \frac{pV}{RT} = \frac{1.40094 \cdot 10^5 \cdot \frac{3.14}{1000}}{\frac{8.314}{50 \cdot 10^{-3}} \cdot (500+273.15)} = 3.4 \cdot 10^{-3}\ kg$$

$0.0034 kg$

$\underline{3.4 g}$

b) der Druck bleibt, da aussendruck und Mass EW/Kolben gleich; $p_2 = \boxed{1.40094 bar}$

masse d. gases, druck, Gasconst

aber Volumen, somit auch Temperatur ~~nimmt ab~~ da $x_{Eis,2} > 0$ ist temp von EW = 0° und gas somit $\boxed{T_{g,2} = 0°}$

c) [redacted]

1 HS um Gaskammer:

geschlossen:

$m_{gas}[u_2-u_1] = Q - W \Rightarrow Q = \underline{-1361.57\ J}$

→ von gas weg (negativer wert)

$W = p_g \cdot [V_2 - V_1] = - \cancel{\dots} \ \boxed{-285.47\ J}$

$V_2 = \dfrac{0.0034 \cdot \frac{8.314}{50 \cdot 10^{-3}} \cdot 273.15}{140094} = 1.1023 \cdot 10^{-3}$

$\left[V = \dfrac{mRT}{p} \quad m = 0.0034\ kg \right.$

$V_1 = \dots [273.15 + 500] = 3.12006 \cdot 10^{-3} = \underline{3.142}$ (Aufg.)

$\left.\begin{matrix} u_2 \\ u_1 \end{matrix}\right\} u_2 - u_1 = c^v [T_2 - T_1] = 0.633 \cdot (-500)$

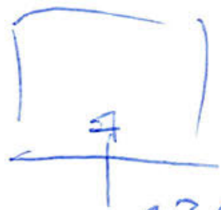
$-316.5\ \frac{kJ}{kg}$

~~[illegible]~~:

↪ ·mass $-1076.1\ J$

⇒ ~~W = ...~~

d) 1 HS Eiskammer



1361.57

$m_{eiswasser}[u_2 - u_1] = 1361.57$

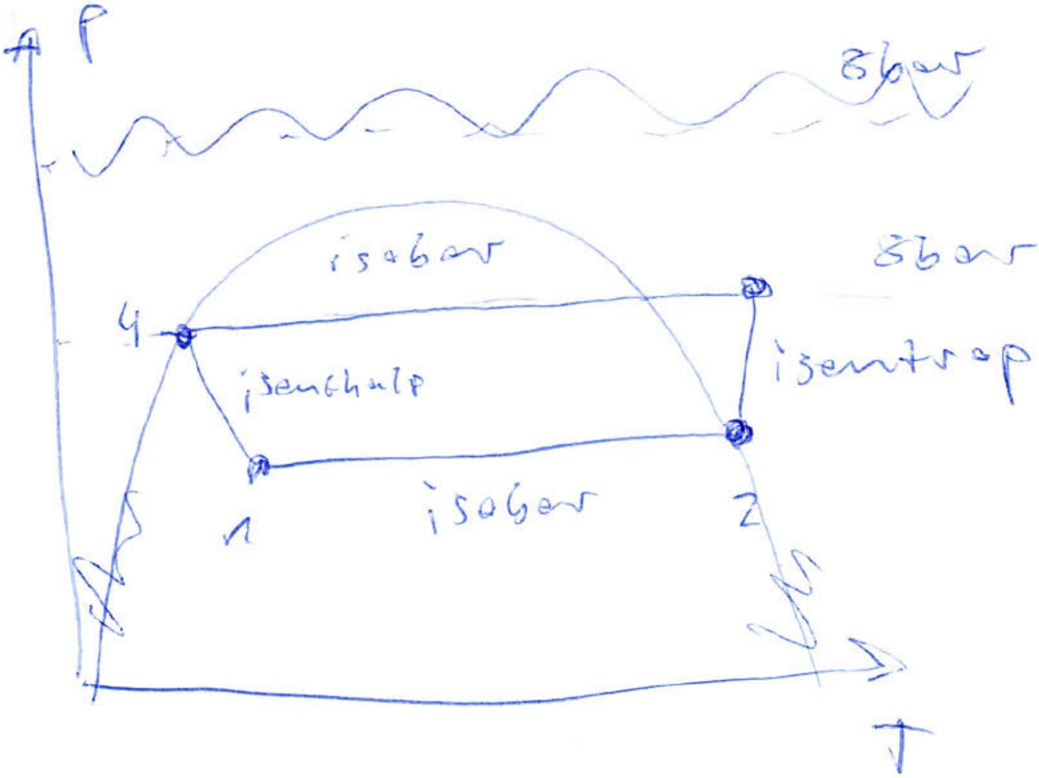
$u_1 = 0.6 \cdot (-333.458) + 0.4 \cdot (-0.045) = -200.099\ \frac{kJ}{kg}$

$u_2 = \dfrac{1361.57}{0.1 \cdot 1000} - 200.099$

$\underline{x_2} = \dfrac{-186.4771 + 0.045}{-333.48 + 0.045} = \underline{0.559}$ $= -186.4771\ \frac{kJ}{kg}$ @ 0°

Aufg 4: [redacted]

a)



b) $\dot{m}_{R134a}$

1
2
3
4

1 HS Verdichter:

$$0 = \dot{m}\left[h_2 - h_3\right] - \dot{W}_k$$

adiabat und rev: $s_2 = s_3$

$h_2 =$

$h_3 =$

$T_2 = T_i - 6K = 4K + T_{sub}$

$T_i = 10K + T_{sub}$

c) $h_1 = h_4$ [redacted]

d) $\frac{|\dot{Q}_{zu}|}{|\dot{W}_t|} = \frac{\dot{Q}_k}{28W}$

e)