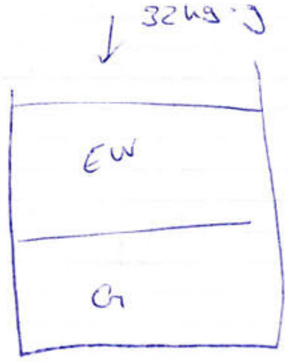
3/ [redacted]

	T_g	V_g	p_g
1	500°C	3.14 L	1.4008 bar
2			1.4008 bar



a) $p_{g1} = \frac{R_g T_1}{m_1 V_1}$

$R_g = \frac{\bar{R}}{M_g} = 0.16628944$

$\cancel{p_g = g\, p_{EW} = \frac{F}{A}}$ $p_g = p_{atm} + \frac{F_K}{A} + \frac{F_{EW}}{A}$

$F_K = \cancel{32 kg \cdot g}\; m \cdot g = 313.813\ N$

$A = \pi \cdot r^2 = \pi \cdot \frac{d^2}{4} = 0.00785\ m^2$

$\cancel{p_g}$

$F_{EW} = m_{EW} \cdot g = 0.981\ N$

$p_g = 140080.8169\ Pa = \underline{1.4008\ bar}$

$m_g = \frac{p_{g1} V_{g1}}{R_g T_1} = \underline{3.42\ g}$

b/ $p_{g2} = p_{g1} = \underline{1.4008\ bar}$, $\underline{T_{g2} = T_{EW2} = 0°C}$

Zustand 2: ~~keine Wärmeübertragung mehr~~ $\mapsto$

$x_{Eis,2} > 0 \mapsto T_{EW,2} = 0°C$

Da immernoch Eis im EW ist, ist die Temperatur immernoch = 0°C.
Der Druck verändert sich nicht im Gas, da die Kräfte des ehend bleiben,
die Temperatur des Gases nimmt die Temperatur des Wassers an,
da kein Wärmeaustausch im Zustand 2 vorliegt

c) $\Delta E = \sum Q - \sum W_v = \Delta U + \cancel{\Delta KE}^{0} + \cancel{\Delta PE}^{0} = 0$

$\Delta U_g = c_v (T_2 - T_1) \cdot m_g = 1139.4\ J$

$\sum W_v = 0$

$\Delta U_g = \sum Q = Q_{12} = 1139.4\ J$

d) $\Delta U_g = \Delta U_{EW}$ ↦ weil adiabat

$\frac{\Delta U_{EW}}{m_{EW}} = \Delta u_{EW} = \frac{1500\ J}{0.1\ kg} = 15\ \frac{kJ}{kg}$

$u_{2,EW} - u_{1,EW} = u_{f,EW,2} + x_2 (u_{g,EW,2} - u_{f,EW,2}) - (u_{f,EW,1} + x_1 (u_{g,EW1} - u_{f,EW1}))$

$u_{fEW2} = u_{fEW1}$

$u_{gEW2} = u_{gEW1}$

$u_2 - u_1 = x_2 (u_g - u_f) - x_1 (u_g - u_f)$

$\frac{u_2 - u_1}{u_g - u_f} + x_1 = x_2$

u_f = Flüssige innere Energie

u_g = Solide " "

$u_f = \text{Tab 1} (T = 0.003) = -0.033\ \frac{kJ}{kg}$

$u_g = \text{Tab 1} (T = 0.003) = -333.442\ \frac{kJ}{kg}$

$\frac{\Delta u}{\cancel{-0.033 + 333.442}\ \ -333.442 + 0.033} + x_1 = x_2 = 0.555$

[redacted]

1/
d)

	T
1	100°C
2	70°C

$T_{ein} = 20°C$

$Q_{R,12} = Q_{Aus,12} = 35\ MJ$

<u>halb offen</u>

$Q_R = Q_{aus} \Rightarrow Q = 0$

$$\Delta E = m_2 u_2 - m_1 u_1 = \Delta m_{12} (h_e) + \cancel{\sum Q} - \underbrace{\cancel{\sum W}}_{=0}$$

$h_e = Tab\ A\text{-}2\ (T = 20°C, h_f) = 83.96\ \frac{kJ}{kg}$

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

$m_1 = 5755\ kg$

$u_1 = Tab\ A\text{-}2\ (T = 100°C, u_f) = \cancel{418.94\ \frac{kJ}{kg}}\ \cancel{2506.1}\ \frac{kJ}{kg}$

$418.94\ \frac{kJ}{kg}$

$u_2 = Tab\ A\text{-}2\ (T = 100°C, u_f) = 292.95\ \frac{kJ}{kg}$

$m_1 u_2 + \Delta m_{12} u_2 - m_1 u_1 = \Delta m_{12} h_e$

$m_1 (u_2 - u_1) = \Delta m_{12} (h_e - u_2)$

$$m_1 \frac{u_2 - u_1}{h_e - u_2} = \Delta m_{12} = 3469.41\ kg$$

e) $\Delta S = m_2 s_2 - m_1 s_1$

$$= m_1(s_2 - s_1) + \Delta m_{12} s_2$$

$s_1 =$ Tab A-2 $(T = 100°, s_f) = 1.3069 \frac{kJ}{kg\,K}$

$s_2 =$ Tab A-2 $(T = 70°, s_f) = 0.9549 \frac{kJ}{kg\,K}$

$$\Delta S = 1411.88 \frac{kJ}{K}$$

[redacted]

1.) $KE = PE = 0$

Prozess: stationärer Fliessprozess mit Massestrom

$$0 = \dot{m}\,(h_{ein} - h_{aus}) + \dot{Q}_R - \dot{Q}_{Aus} - \dot{W}_t$$

~~$h_{ein} = h(T = 70°, \text{gesättigt})$ Tab~~

$$h_{aus} = h_f + x_D (h_g - h_f)$$

$$h_f = \text{Tab A-2 } (T = 100°) = 419.04 \ \frac{kJ}{kg}$$

$$h_g = \text{Tab A-2 } (T = 100°) = 2676.1 \ \frac{kJ}{kg}$$

$$h_{aus} = 430.33 \ \frac{kJ}{kg}$$

$$h_{ein} = \text{Tab A-2 } (T = 70°) \begin{bmatrix} h_f = 292.98 \ \frac{kJ}{kg} \\ h_g = 2626.8 \ \frac{kJ}{kg} \end{bmatrix}$$

a) KF

ideale Flüssigkeit $c_p^{if} = c_v^{if} = c^{if}(T) = \not c$

$$\Delta T = 10 K$$

$$h_{ein} = h_f + x_D (h_g - h_f) = 304.6491 \ \frac{kJ}{kg}$$

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

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

$$\dot{Q}_{Aus} = \dot{m}(h_{ein} - h_{aus}) + \dot{Q}_R = \underline{\underline{62.296 \ kW}}$$

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

$$s_a - s_e = \int_{T_1}^{T_2} \frac{c_{if}(T)}{T}\,dT = 0.7391693\ \frac{kJ}{kgK}$$

$$= c_{if} \cdot \ln\left(\frac{T_2}{T_1}\right)$$

$$c_{if} = \frac{\dot{Q}_{aus}}{\dot{m} \cdot \Delta T} = 21.66\ \frac{kJ}{kgK}$$

$$\cancel{s_a - s_e = 0.739\ \frac{kJ}{kgK}}$$

$$\overline{T} = \frac{\int_e^a T\,ds}{s_a - s_e} = \left(\frac{T_2 - T_1}{s_a - s_e}\right) + T_1 = 294.914\ K$$

c) $0 = \dot{m}\left(s_e - s_a\right) + \sum \frac{\dot{Q}}{T} + \dot{S}_{erz}$

$$\dot{S}_{erz} = \dot{m}(s_a - s_e) - \sum \frac{\dot{Q}}{T}$$

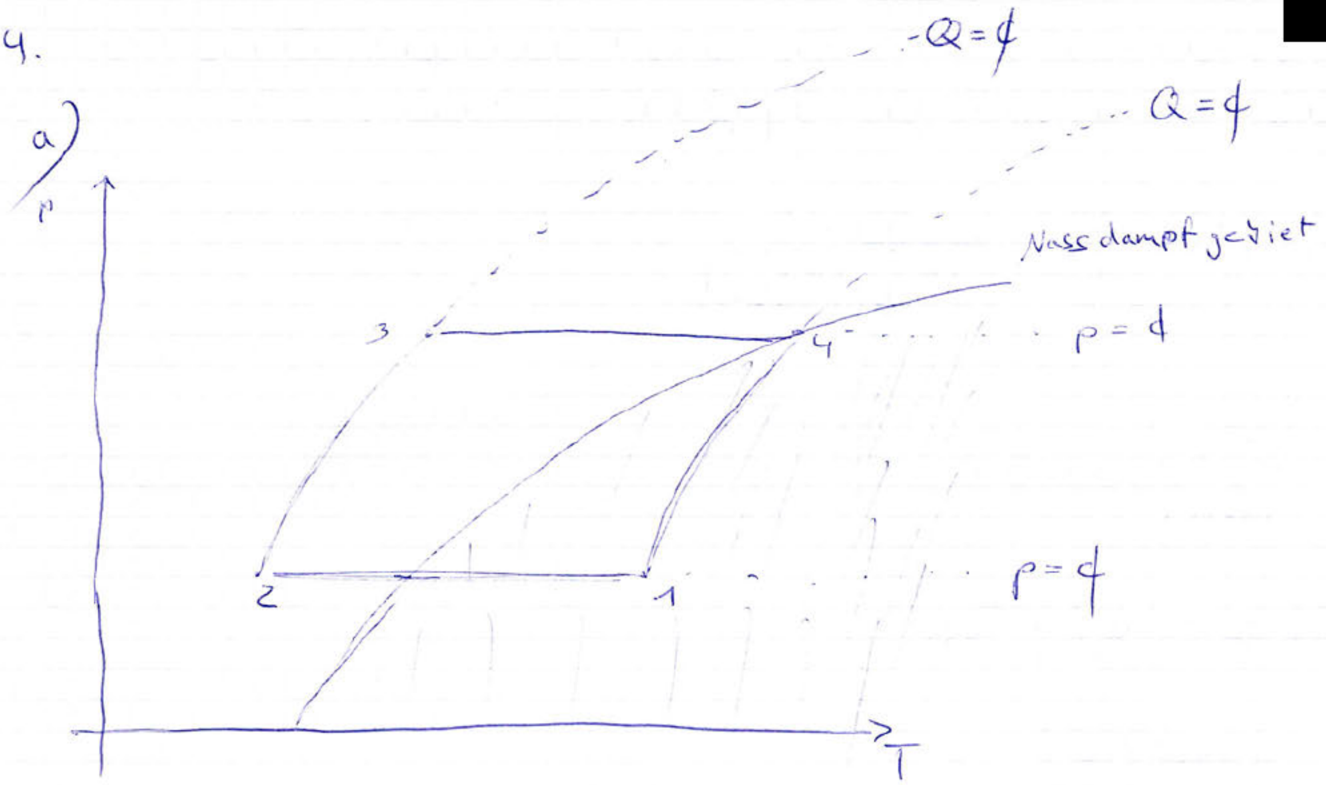
$$= \dot{m}(s_a - s_e) + \frac{\dot{Q}_{aus}}{T}$$

$$\dot{S}_{erz} = 0.44209\ \frac{kW}{K}$$

[redacted]

4.

a)



b)

	p	T	v	$\dot{W}$	$\dot{Q}$	$\dot{S}$	x
1	$p_1 = p_2$ 1.5748						
2	1.5748	−16°C		28 W	0	0	1
3	8 bar						
4	8 bar				0		0

$p_1 = p_2$

$T_2 = T_1 - 6K$; $T_1 =$ Abb 5 ($p = 1$ mbar) ↳ 10° über Subl = −10°C

$p_2 = p_4$ $\quad T_2 = -16°C$

$Q_{41} = 0$

$Q_{23} = 0$

$S_{23} \mapsto$ adiabat + Reversibel = 0

$p_2 =$ Tab A-10 ($T = -16°C$) → 1.5748 bar $= p_1$

e) Temperatur würde Fallen: Sublimation ist ein Endothermer prozess, sprich beim verdunsten nimmt das Wasser wärme auf. Hinzu kommt noch die Abgeführte wärme.

d) $\dot{\varepsilon}_K = \frac{|\dot{Q}_{zu}|}{|\dot{W}_t|} = \frac{|\dot{Q}_{zu}|}{|\dot{Q}_{ab}|-|\dot{Q}_{zu}|}$

$= \frac{|\dot{Q}_K|}{|\dot{W}_K|} = \varepsilon$

$0 = \dot{m}(h_e - h_a) + \dot{Q}_K$

$\dot{Q}_K = \dot{m}(h_a - h_e)$

$h_a =$ Tab A-10 ($T = -16°$) (rein gasförmig => h_g) $= 237.14 \frac{kJ}{kg}$

$\dot{W}_K = 28$ W

c)