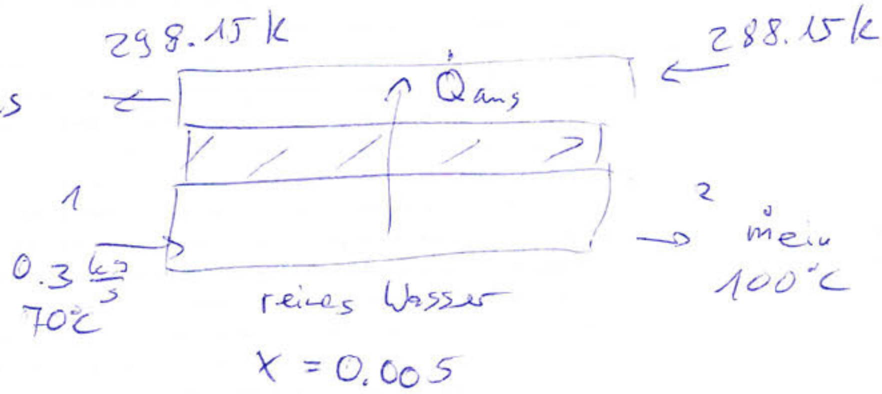
[redacted]

1. a)



$$0 = \dot{m}[h_1 - h_2] + \dot{Q}_{aus}$$

A -

$$\dot{Q}_{aus} = \dot{m}[h_2 - h_1] = \dot{m}[h(70°C) - h(100°C)]$$

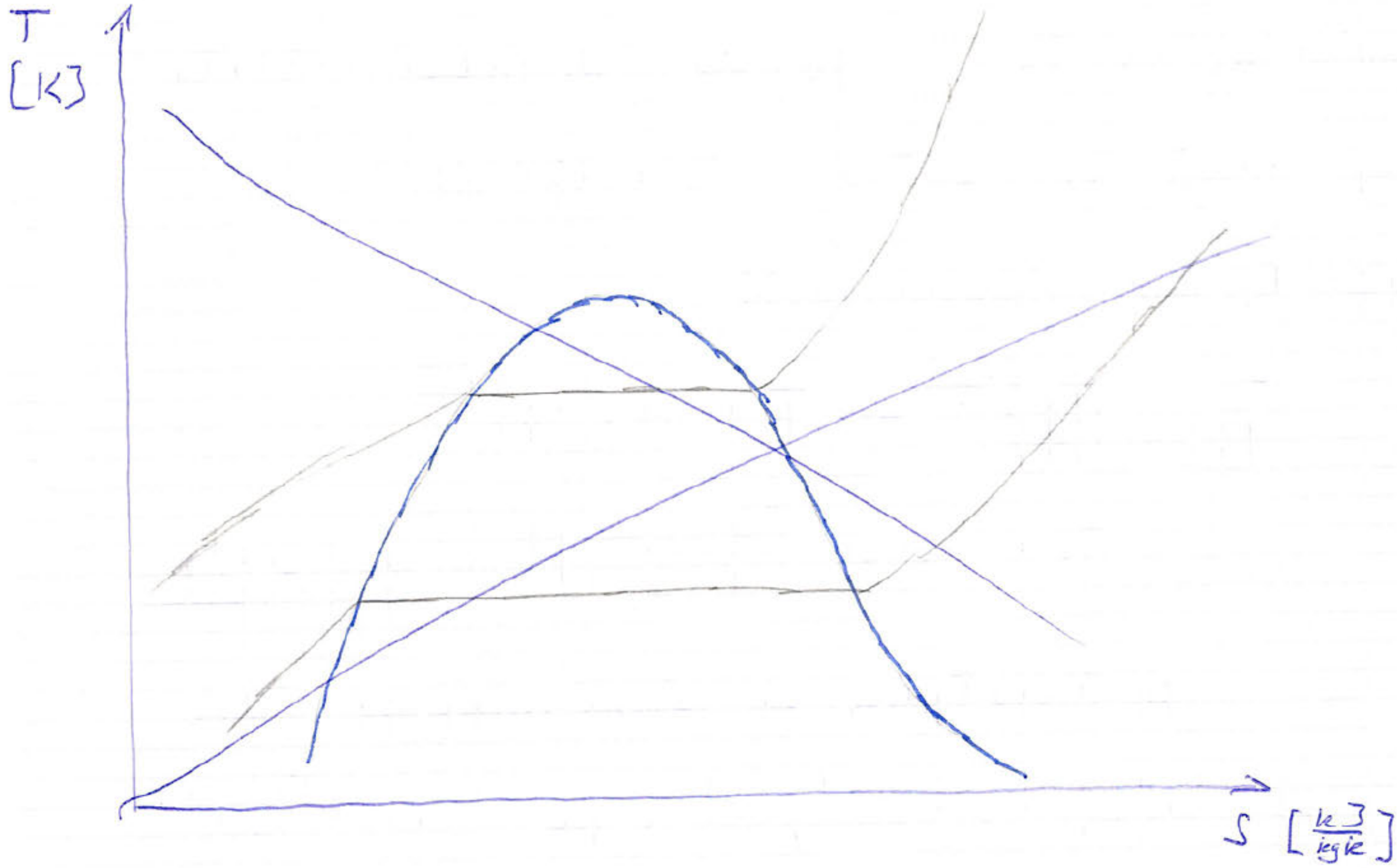
$$\dot{m}[292.98 - 419.04]\frac{kJ}{kg}$$

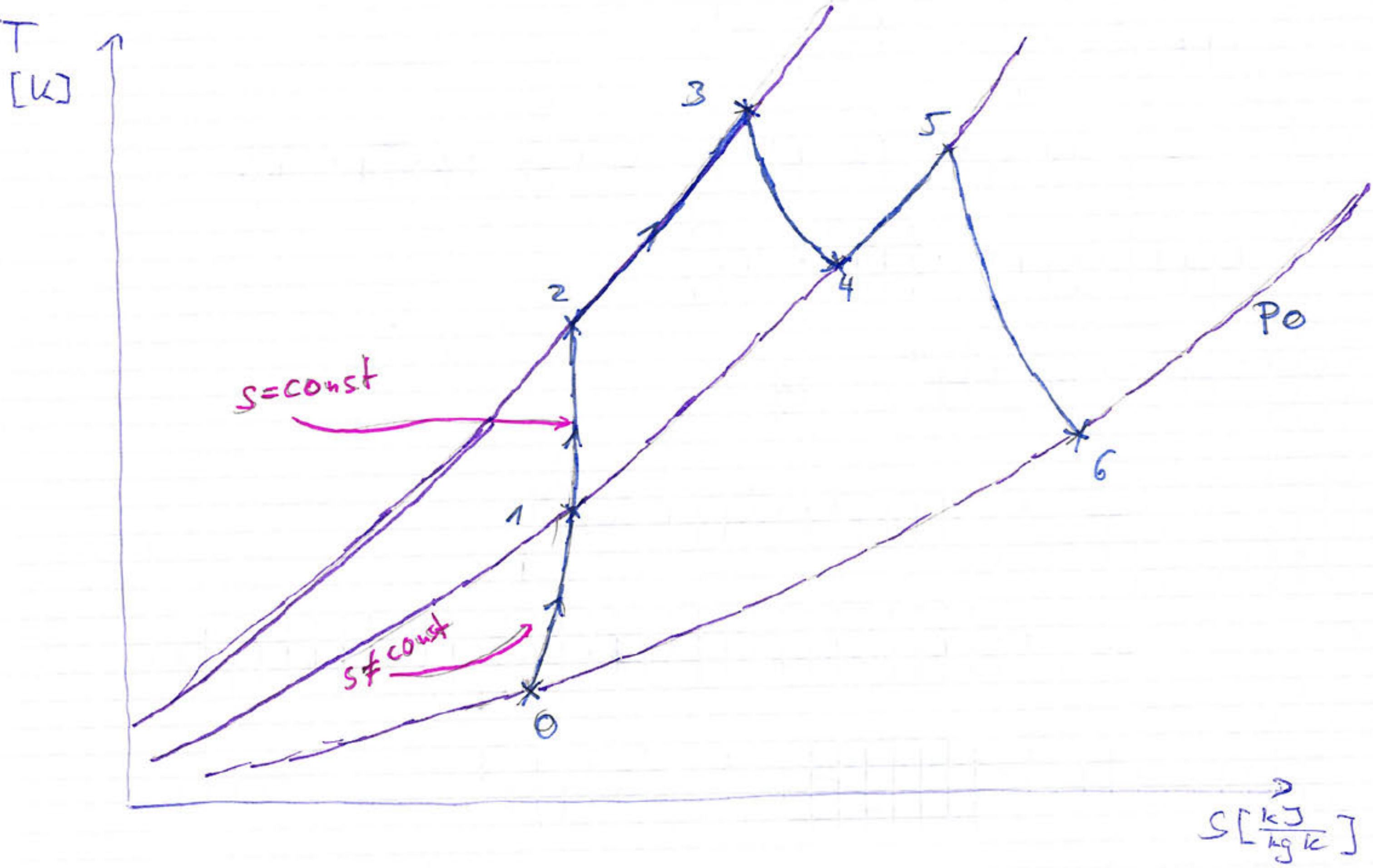
$$= -37.818 \frac{kg}{s}\frac{kJ}{s} = \underline{\underline{-37.818\ kW}}$$

b) $\frac{d\cancel{S}^{\,stFP}}{\cancel{dt}} = \sum_i \dot{m}_i s_i + \sum \frac{\dot{Q}}{T} + \dot{S}_{erz}$

[redacted]

2. a)





~~Zustand 4 liegt nicht per se auf der p_5 Isobare~~

b) IG $c_p = 1.006 \frac{kJ}{kgK}$, $n = \kappa = 1.4$

Gesucht: w_6 und T_6 $\quad p_6 = p_0 = 0.191\,bar = 19.1\,kPa$

$w_5 = 220\,\frac{m}{s}$ $\quad p_5 = 0.5\,bar$ $\quad T_5 = 431.9\,K$

$\Rightarrow$ T_6 über Adiabatenkoeff

$$\frac{T_6}{T_5} = \left(\frac{p_6}{p_5}\right)^{\frac{n-1}{n}} \rightarrow T_6 = T_5 \left(\frac{p_6}{p_5}\right)^{\frac{0.4}{1.4}}$$

$$T_6 = 431.9\,K \cdot \left(\frac{0.191\,bar}{0.5\,bar}\right)^{\frac{0.4}{1.4}} = \underline{\underline{328.075\,K}}$$

w_6: st. Fliess Prozess an adiabat reversibler Düse

$$0 = \dot{m}\left[h_5 - h_6 + \frac{(w_5)^2 - (w_6)^2}{2} + \cancel{pe}^{\,0}\right] + \cancel{\dot{Q}}^{\,0} - \cancel{\dot{W}}^{\,0}$$

$$0 = h_5 - h_6 + \frac{w_5^2 - w_6^2}{2}$$

IG: $h_5 - h_6 = c_p \cdot \Delta T = \cancel{c_p \cdot (T_5} \; c_p \cdot (T_5 - T_6)$

$$c_p(T_5 - T_6) = -\left(\frac{w_5^2}{2} - \frac{w_6^2}{2}\right)$$

$$c_p(T_5 - T_6) + \frac{(w_5)^2}{2} = \frac{w_6^2}{2}$$

$$w_6^2 = 2c_p(T_5 - T_6) + (w_5)^2$$

$$w_6 = \sqrt{2 \cdot 1.006 \cdot (431.9 - 328.1) + 220^2}\ \frac{m}{s}$$

$$w_6 \cong \cancel{220.5\,\frac{m}{s}} = \underline{\underline{507.2\,\frac{m}{s}}}$$

[redacted]

2. c)

$$\Delta e_{x\,str} = e_{x\,str6} - e_{x,str0}$$

$$\cancel{e_{x\,str6} = u_6 - u_0 - T_0 (s_6 - s_0)}$$

$$e_{x\,str6} = h_6 - h_0 - T_0 (s_6 - s_0) = \Delta e_{x\,str}$$

$$(h_6 - h_0) = c_p (T_6 - T_0)$$

$$s_6 - s_0 = c_p \cdot \ln\left(\frac{T_6}{T_0}\right) - \cancel{R \ln\left(\frac{p_6}{p_0}\right)} \quad = 0, \; p_6 = p_0$$

$$\Rightarrow \Delta e_{x\,str} = c_p \cdot \left(T_6 - T_0 - T_0 \cdot \ln\left(\frac{T_6}{T_0}\right)\right)$$

$$= 1.006 \cdot \left(340K - 243.15K - 243.15K \cdot \ln\left(\frac{340K}{243.15K}\right)\right) \frac{kJ}{kg\,K}$$

$$= \underline{\underline{15.42\ kJ/kg}}$$

d) $$e_{x\,verl} = \Delta e_{x\,str.} + \frac{\dot{E}_{x\,Q}}{\dot{m}} = \Delta e_{x\,str} + e_{x\,q}$$

~~$e_{x\,verl}$~~ $e_{x\,Q}$: an Brennkammer:

$$e_{xq} = \cancel{\dot{e}_{xq}}\ \cancel{\dot{E}_{xQ}} = \left(1 - \frac{243.15K}{1289K}\right) \cdot q_B$$

$$e_{xq} = 969.58\ \frac{kJ}{kg}$$

$$\rightarrow e_{x\,verl} = 100\,\frac{kJ}{kg} + 969.58\,\frac{kJ}{kg} = \underline{\underline{1069.58\ \frac{kJ}{kg}}}$$

~~2c) m_{ges} und Δe_x str.~~ [redacted]

3. a)

	p [bar]	T [°C]	h [kJ/kg]	s [kJ/kgK]	Anderes
1		500			$V_{g1} = 3.14L$
2					
3					

amb: $p = 1 bar$, $m_k = 32kg$

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

perfektes Gas: $m_g = \cancel{\frac{V_g}{v_g}}$

$$V_{g1} = 3.14L = 0.00314 m^3$$

P via Kräfte GGW:

$$p_{g1} \cdot A = p_{amb} \cdot A + m_k \cdot 9.81 \frac{N}{kg} + m_{EW} \cdot 9.81 \frac{N}{kg}$$

$$p_{g1} = p_{amb} + \frac{9.81 \frac{N}{kg} \cdot (m_k + m_{EW})}{A}$$

$$A = \pi \cdot \left(\frac{D}{2}\right)^2 = \pi \cdot \left(\frac{0.1m}{2}\right)^2 = 0.0079 m^2$$

$$p_{g1} = 1 bar + \frac{9.81 \frac{N}{kg} \cdot 32.1 kg}{0.0079 m^2} = 1.3986 bar$$

$$= \underline{\underline{1.4 bar}}$$

$$\rightarrow m_g = \frac{p_{1g} \cdot V_{1g}}{RT} = \frac{1.4 \cdot 10^5 Pa \cdot 0.00314 m^3}{\frac{8.314 J/molK}{50 g/mol} \cdot 773.15K}$$

$$m_g = \underline{\underline{3.42 g}}$$

~~b) $x_{Eis\,2} > 0$ $T_{g2} = ?$ $p_{g2} = ?$~~

c) ($Q = m \cdot c_v \cdot \Delta T$ für 1. HS an Gas Seite)

($Q_{12} = m_g \cdot c_v \cdot (T\ )$) $p_1 = p_2$

1 HS an Kolben: $c_p = R + c_v$

$$m \cdot (u_2 - u_1) = Q_{12} - W_{12}$$

W_{12}: da isobar: $h = 0$ + perfektes Gas:

$$R \cdot (T_2 - T_1) = \frac{8.314}{50}\,\frac{kJ}{K} \cdot (0.003\,°C - 500\,°C) \quad \text{"} -499.997\,K \text{"}$$

$$= \cancel{28}\ -83.14\ kJ$$

$\Rightarrow$ ~~$Q_{12} = m_g \cdot (c_p \cdot ($~~

$$Q_{12} = m_g \cdot (c_v \cdot (T_2 - T_1)) + W_{12}$$

~~$= 0.0036\,g \cdot (50$~~

~~$= 0.0036\,kg \cdot \left(\frac{0.633\,kJ}{kg\,K} \cdot (-499.997\,K)\right)$~~

$$Q_{12} = m_g \cdot (c_v (T_2 - T_1)) + W_{12}$$

$$= 0.0036\,kg \cdot \left(0.633 \cdot 449.997\,\frac{kJ}{kg}\right) - 83.14\,kJ$$

$Q_{12} =$

[redacted]

3c)

1. HS an ~~geschlossenen~~ Kolben

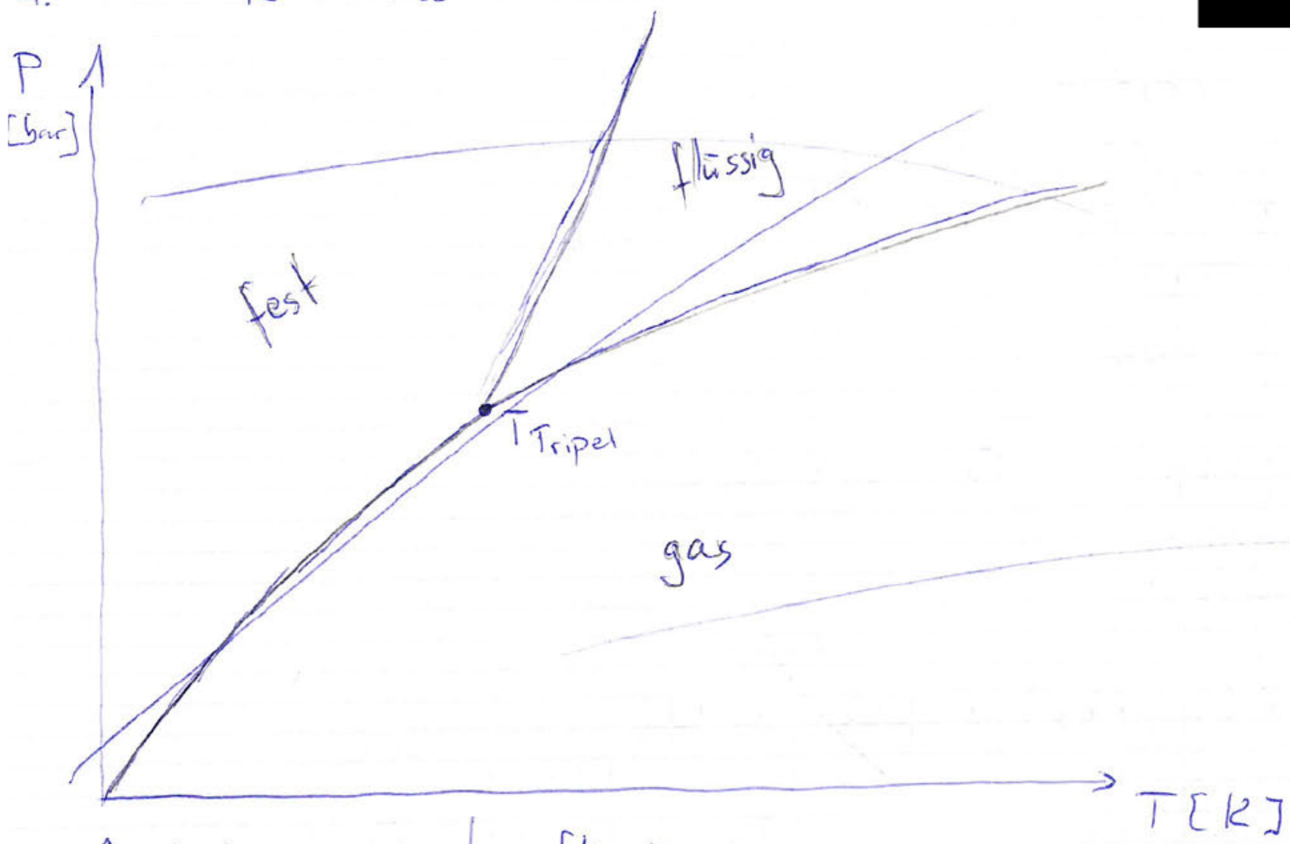
$W = 0$

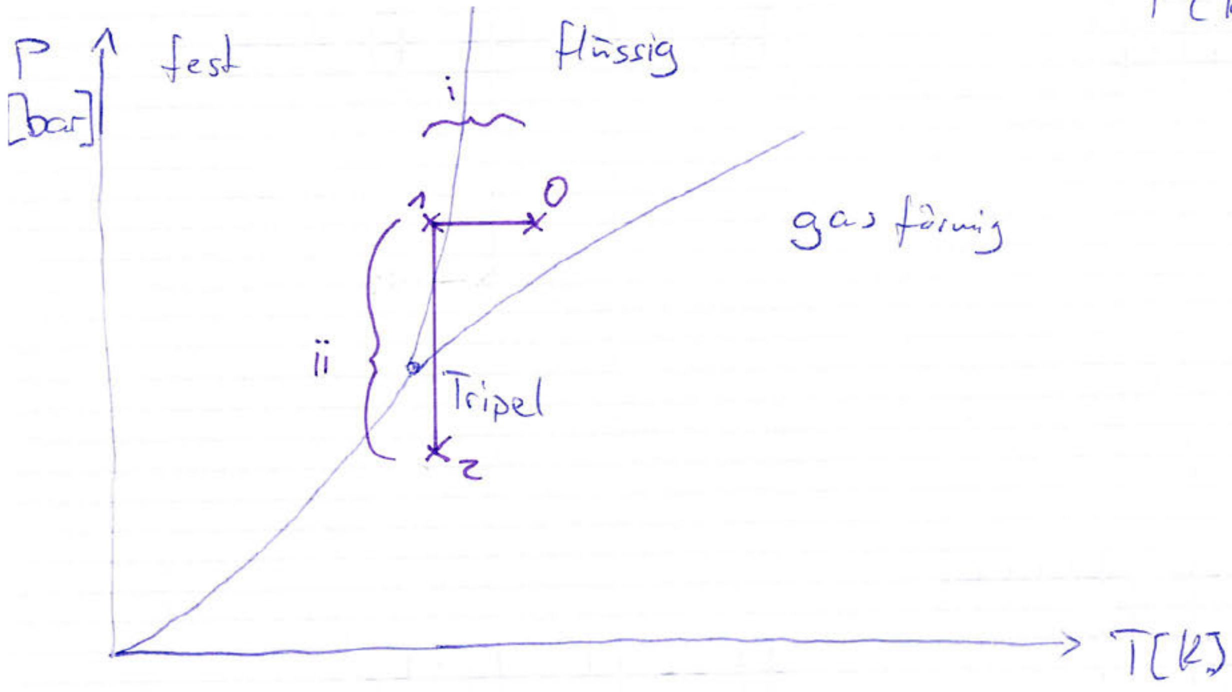
$$Q_{12} = m \cdot c_v \cdot \Delta T$$
$$= m_g \cdot c_v (T_2 - T_1)$$
$$= 0.0036\,kg \cdot 0.633\,\frac{kJ}{kg} \cdot (-449.997)$$
$$= -1.1394\,kJ = \underline{\underline{-1139.4\,J}}$$

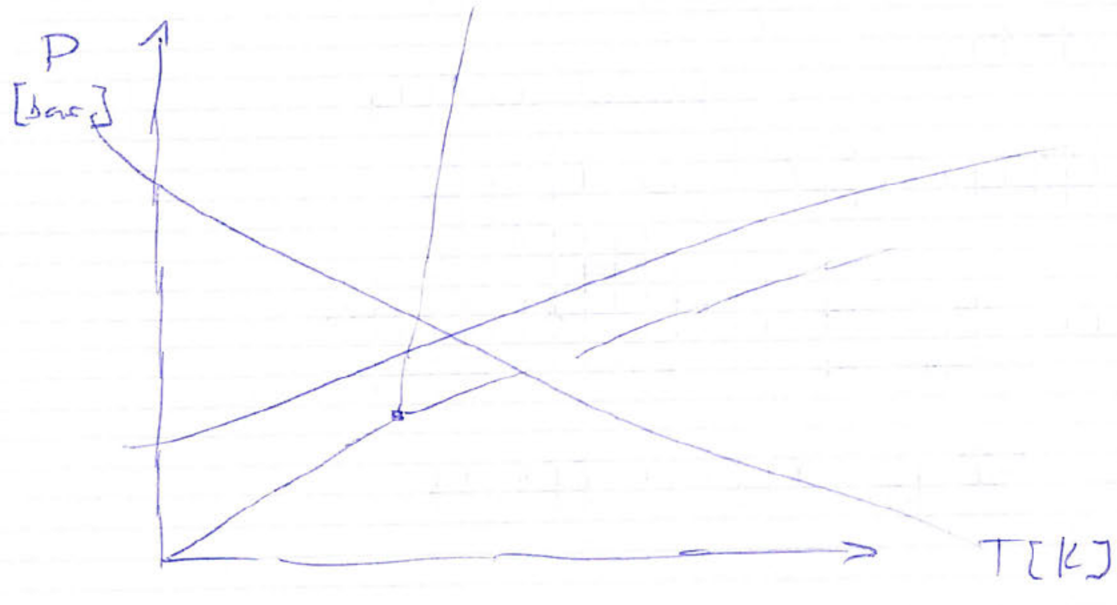
d) $x_{2\,Eis}$

4. R 134a

[redacted]

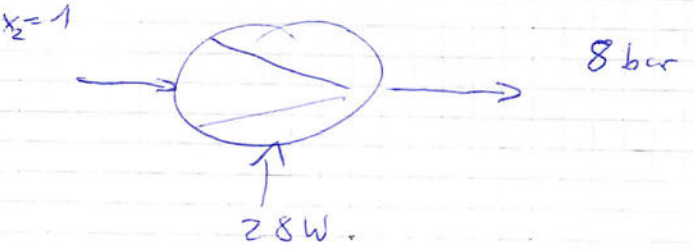






b) $\dot{m}_{R134a}$

isentrop



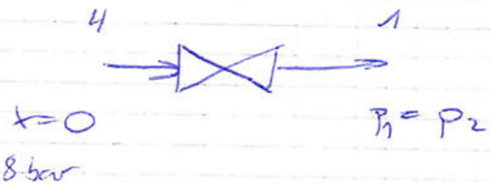
$\Rightarrow \quad s_2 = s_3 \qquad s_2 = s_g(T_2)$

1. HS st. FP.

$$0 = \dot{m}[h_2 - h_3] + \cancel{\sum \dot{Q}}^{\text{adiabat}} - \dot{W}_K$$

$$\dot{m} = \frac{\dot{W}_K}{h_2 - h_3} \qquad T_{sat} = 31.33°C \ @ \ 8 \text{ bar}$$

c) x_1 nach Drossel



$$\phi = \phi_f + x(\phi_g - \phi_f)$$

Drossel isenthalp

$$\cancel{0 = \dot{m}[h_4 - h_1]} \quad \rightarrow \quad h_4 = h_1$$

$$x = \frac{h_4 - h_{f1}}{h_{g1} - h_{1f}} = \frac{\cancel{251.02}\ \cancel{232.43}\ 264.15 - h_f(p_1)}{h_g(p_1) - h_f(p_1)}$$

h_4 aus A12 @ 8 bar = 264.15