[redacted]

A3.) a.) $p_{g,1}$, m_g

$$R = \frac{\bar{R}}{M} = 166{,}28 \frac{J}{kgK} \rightarrow x$$

$c_v \rightarrow b$

$$p_{g,1} = 1bar + \frac{32kg \cdot g}{(0{,}05)^2 \cdot \pi} + \frac{0{,}1kg \cdot g}{(0{,}05)^2 \cdot \pi} = 1{,}40015 \rightarrow a$$
$$= \cancel{1{,}04085 \rightarrow a}$$

$$m_g = \frac{pV}{RT} = \cancel{2{,}5422\,g \rightarrow b}$$

$$m_g = 3{,}421\,bar \rightarrow b$$

b) $c_v (T_2 - T_{1g}) \cdot m_g = Q$

$\cancel{T_{2g} = 0°C}$

$$p_{Eis} = 1bar + \frac{32kg \cdot g}{(0{,}05)^2 \cdot \pi}$$
$$= 1{,}39969\,bar$$
$$\approx 1{,}4\,bar$$

$c_v (T_{2,g} - T_{1,g}) \cdot m_g = Q$

$T_{2,g} \stackrel{?}{=} 0° \Rightarrow Q_{mind} = -1{,}082\,kJ$ (ohne arbeit > Q_{out})

$Q_{\cancel{max}} = m_E (u_f(1{,}45) - u_E(1{,}45)) = -20\,kJ$

$\rightarrow$ Da weniger Q benötigt wird um ~~auf~~ das Gas auf 0 grad zu kühlen als um das Eis zu schmelzen bleibt die Temp bei 0°C

$T_{g2} = 0°C$, $p_{G2} = p_{G,1} = 1{,}4015$

[redacted]

A3b.) cont.)

druck konstant weil aussendruck & masse gleich bleibt

c.) Q_{12}

~~siehe letzte aufgabe:~~ $\cancel{Q_{12}=}$

$$\Delta U = Q - W$$

$$W_{12} = \frac{R(T_2 - T_1)}{1-n} \qquad n = \frac{c_p}{c_v} = 1{,}2626 \to 6$$

$$c_p = R + c_v = 799 \,\frac{J}{kgK} \to 7$$

$$= -316{,}5 \,\frac{kJ}{kg}; \quad W_{12} = -1{,}082 \,kJ$$

$$\Delta U = c_v (T_2 - T_1) \cdot m = 866{,}38 \,kJ$$

$$\boxed{Q_{12} = 1{,}945 \,kJ}$$

d.) $x_{Eis\,2}$:

$$- m_{EW} \cdot 0{,}6\, (u_{fest}(p_2)) + m_{EW} \cdot x_{Eis2}\, u_{fest}(p_2)$$

$$+ m_{EW} (1 - x_{Eis2})\, u_{flüssig}(p_2) - 0{,}4 \cdot m_{EW}\, u_{flüssig}(p_2)$$

$$= Q_{12} \quad \cancel{-W} \; ?\; 0$$

2

A3 d) cont

$$\cancel{\frac{Q_{12} + m_{EW} \cdot 0{,}6 \cdot u_{fest} + 0{,}4\, m_{EW}\, u_{flüssig} - m_{EW}\, u_{flüssig}}{m_{EW}\, u_{fest} - m_{EW}\, u_{flüssig}}}$$

$\cancel{= x_{Eis\,2}}$? $\cancel{=}$

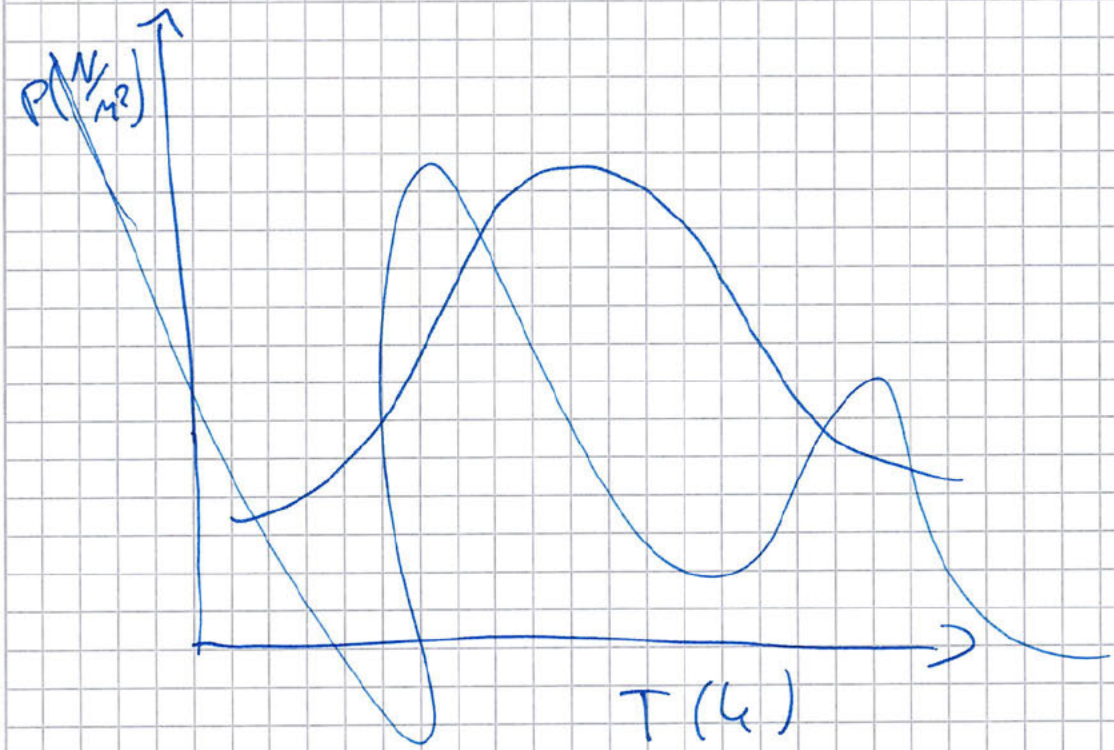
$Q_{12} = \Delta m_{Eis} (\Delta u)$

$-\Delta m_{Eis} = \dfrac{Q}{\Delta u} = -0{,}0058\,kg \Rightarrow 5{,}84\,g$

$\dfrac{0{,}6 \cdot 0{,}1\,kg - \Delta m_{Eis}}{0{,}1\,kg} = 0{,}5415 = x_{Eis\,2}$

[redacted]

4 (1.) a.)



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

$$0 = -\Delta h \dot{m} - \dot{W}_t + \cancel{\dot{Q}}^{\to 0} \qquad (2,3)$$

$p_i = 1\,mbar$

~~$T_i = 10°C$~~

$T_i = -10°C$

$\cancel{h_2^1}$ A-11

$h_4^1 = 93{,}42 \frac{kJ}{kg}$

$h_4 = 92{,}75 \frac{kJ}{kg} = h_{34}$

$h_2 = h_g(-16°C) \stackrel{A-10}{\hat{=}} 237{,}74 \frac{kJ}{kg}$

$s_2 = s_3 = 0{,}9298 \frac{kJ}{kgK}$

[redacted]

A4.) a cont

$$h_3 \overset{\text{A-12}}{=} h_{sat} + \frac{s - s_{sat}(8b)}{s(8b, 40°C) - s_{sat}(8b)} \cdot \left(h(8b, 40°) - h_{sat}(8b)\right)$$

$h_3 = 271{,}31$

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

$\dot{m}_R = \frac{\cancel{\dot{W}_k}-\dot{W}_k}{h_2 - h_3} = 0{,}834\ g/s$

c.) weiter mit gegebenen werten

x_1:

$h_1 = h_4 = 92{,}70\ \frac{kJ}{kg}$

$$x = \frac{h_1 - h_f(-22°C)}{h_g(-22°C) - h_f(-22°C)} \overset{\text{A-10}}{=} 0{,}3682$$

d.) $\varepsilon_k = \frac{\dot{Q}_k}{\dot{W}_t} = \cancel{5{,}48} = 5{,}323$

$\dot{Q}_k = \dot{m}_{R134} (h_2 - h_1) \overset{\text{A-10}}{=} \cancel{153{,}11\ \frac{kJ}{kg}} \ldots\ 149\ W$

$= 4kg/h\ (\Delta h_{12}) =$

$h_1 = h_f(-22°C) + x_1 (h_g(-22°C) - h_f(-22°C))$

$= 99.94\ \frac{kJ}{kg}$

$h_2 = 234{,}08\ kJ/kg$

5

[redacted]

A4.) e.) ~~Er würde~~ Sie würde bis

~~Th~~ zur Kondensations temperatur

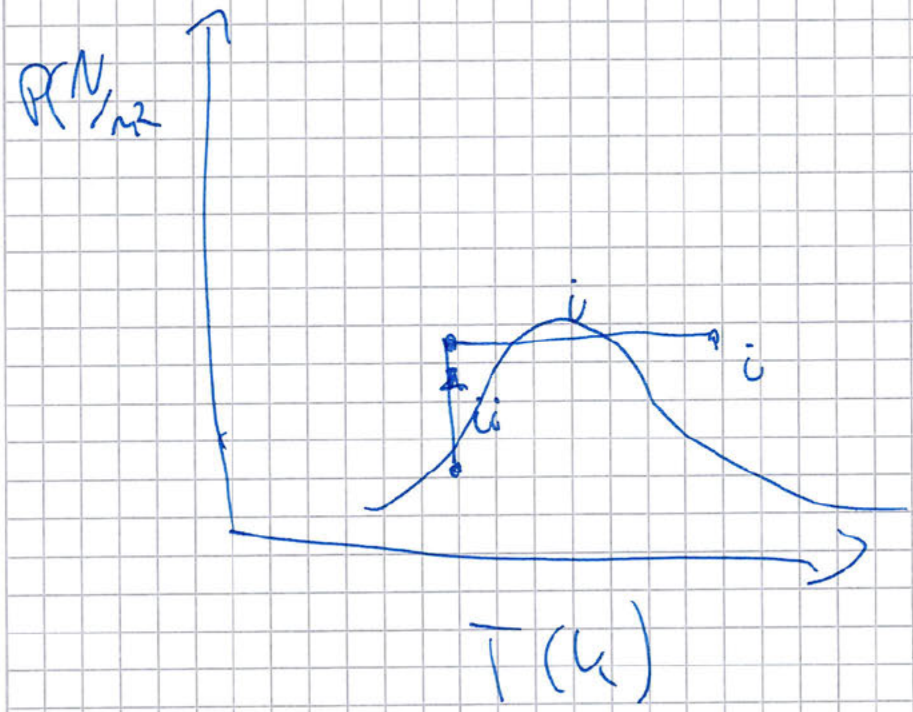
von R134a abkühlen also bis zu -22°C

bei

und dann würde keine wärme mehr abgezogen

weil ein gleich gewicht erreicht ist

A4.)



[redacted]

A1.) a)

$\dot{Q}_{aus}$

$$\dot{m}\,\Delta h = \dot{Q}_R - \dot{Q}_{Aus}$$

$$h_{aus} \overset{A\text{-}2}{\hat{=}} h_f(100°C) = 419{,}04\ \frac{kJ}{kg}$$

$$h_{ein} \overset{A\text{-}2}{\hat{=}} h_f(70°C) = 292{,}98\ \frac{kJ}{kg}$$

$$+\dot{Q}_{Aus} = \dot{Q}_R - \dot{m}\,\Delta h = +62{,}182\ kW$$

b.) $\bar{T}_{KF} = \frac{\cancel{Q_{aus}}}{s_A - s_e}\quad \frac{\dot{Q}_{aus}}{\dot{m}_v(s_A - s_e)}$

$$\dot{m} = \frac{\dot{Q}}{\Delta h} \Rightarrow \frac{\Delta h}{-\Delta s} = \bar{T}$$

$$\bar{T} \overset{A\text{-}2}{\hat{=}} \cancel{636{,}34\,K}\quad \cancel{358\,K}$$

$$= \frac{\cancel{c_p}(T_2 - T_1)}{+\cancel{c_p}\ln\left(\frac{T_2}{T_1}\right)} = 253{,}12\,K$$

7

[redacted]

c) gegebene werte weiter

$$\overline{T}_{KF} = 295\,K$$

$$S_{erz} = -\frac{\dot{Q}}{\overline{T}_{Tank}} + \frac{\dot{Q}^{65kW}}{\overline{T}_{Kühl}} = 0{,}03877\ \frac{kJ}{s}$$

siehe aufgabe (5)

$$\overline{T}_{Tank} \hat{=} \cancel{636}\ \frac{\Delta h}{\Delta s} = \cancel{636\,K}\ 358\,K$$

d.) Δm_{12}, $T_{R2} = 70°C$, $Q_{R,12} = 35\,MJ$

$$m_2 h_2 - m_1 h_1 = \Delta m\, h_f(20°C) + \cancel{Q} - \cancel{Q}$$

$$(m_1 + \Delta m) h_2 - m_1 h_1 = \Delta m\, h_f(20°C)$$

$$\Delta m = \frac{m_1 h_1 - m_1 h_2}{h_2 - h_f} = 3468{,}088\,kg$$

$h_1 = 418{,}94$

$h_2 \hat{=} \cancel{292{,}98}\ 292{,}98$

$h_f = 83{,}96$

(8)

[redacted]

e.) $\Delta S_{1,2} = m_2 s_2 - m_1 s_1 = \underline{\underline{1237{,}56 \frac{kJ}{K}}}$

$m_1 = 5755\,kg \qquad s_1 \overset{A\text{-}2}{=} 1{,}3069 + x_D(7{,}3549 - 1{,}3069)$

$= 1{,}33719 \frac{kJ}{kg\,K}$

$s_2 = s_f(70°C) = 0{,}9549 \frac{kJ}{kg\,K}$

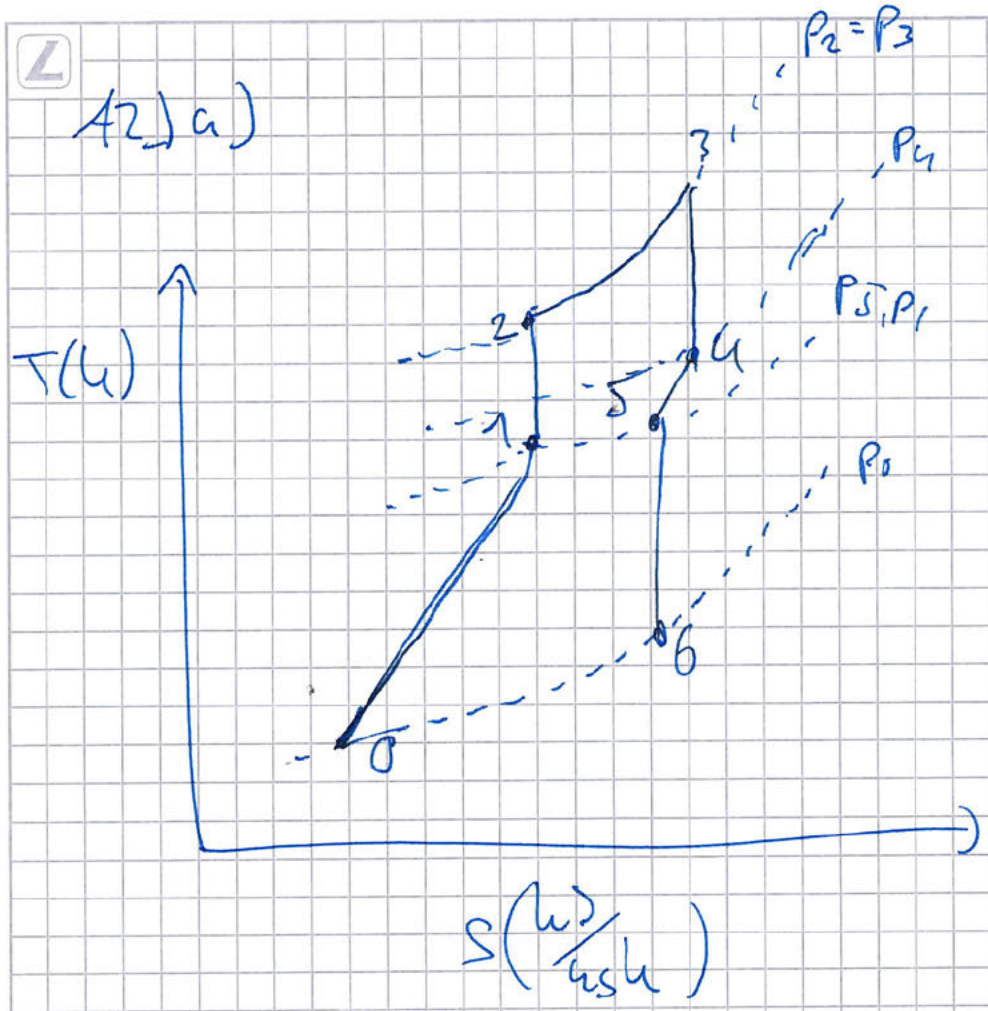
$m_2 = m_1 + 3600\,kg = 9355$

f.)

9

[redacted]

A2) a)



$$R = c_p - \frac{c_p}{1{,}4} = 288 \, \frac{J}{kg \, K}$$

b.) w_6, T_6

$$T_6 = T_5 \left(\frac{p_0}{p_5}\right)^{\frac{k-1}{k}} = \underline{\underline{328{,}07 \, K}}$$

$$w_{06} = \frac{R(T_6 - T_0)}{1-n} = -61{,}2 \, kJ$$

c.) $$\Delta e_x = \left(c_p(T_6 - T_0) - T_0\left(c_p \ln\left(\frac{T_6}{T_0}\right) - R \ln\left(\frac{p_6}{p_0}\right)\right) + \frac{w_6^2}{2} - \frac{w_0^2}{2}\right)$$

$$\Delta e_x = \underline{\underline{125 \, \frac{kJ}{kg}}}$$

10

[redacted]

$$\text{f.)}\quad e_{x\,verl} = \overline{T} e_x Q - \underbrace{\Delta e_{xsL}}_{100\,kJ/kg}$$

$$e_x Q = \left(1 - \frac{T_0}{1289K}\right) q_B$$

$$= 969{,}58\,kJ/kg$$

$$e_{x\,verl} = 869{,}58\,kJ/kg$$

21