1a) $m_a \cdot u_2 - m_1 \cdot u_1 - E_a - E_e - Q_R + Q_{aus} = 0$

$m_a = m_1 \quad m_{ein} \left(\overset{u_a}{T_{aus}} - \overset{u_{ei}}{T_{ein}} \right) - \dot{Q}_R = Q_{aus}$

b) $\bar{T} = \frac{T_{aus} + T_{ein}}{2} = \frac{298.15 + 288.15}{2} = 293.15\ K$

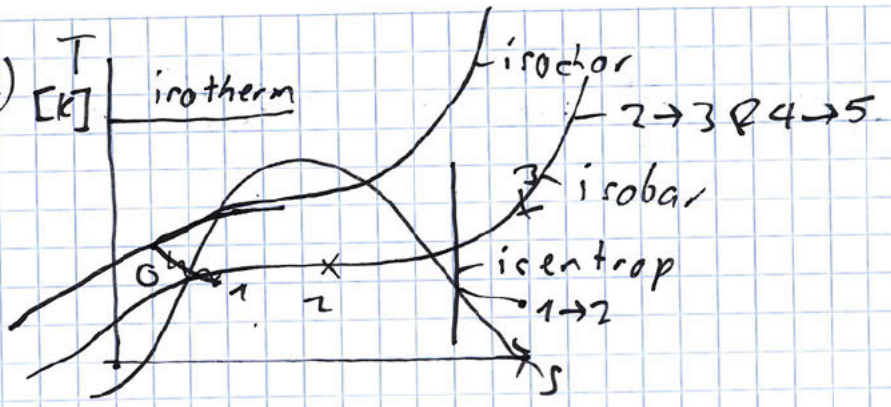
$\bar{T} = \frac{\int_e^a T\,ds}{s_a - s_e}$

c) $\Delta S = m_a \cdot s_a - m_{ei} \cdot s_e + \frac{Q_{aus}}{T} + s_{erz}$

d) ~~$\Delta E = m_e \cdot (u_a - u_e) + Q_3$~~

$\Delta E = \dot{m}_{1,2} \cdot h(20°C) + Q_{R\,1,2} - Q_{aus}$

2a)



b) $p_5 = 0.56\,bar$ $\quad T_5 = 431.91\,K$ $\quad w_6 = 270\,\frac{m}{s}$

adiabat & reversibel

$h_5 = h_6$ $\quad s_5 = s_6$

$$h_6 - h_5 = \int_{T_5}^{T_6} c_p(T)\,dT = c_p \cdot (T_6 - T_5)$$

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

$$T_6 = T_5 \cdot \left(\frac{p_6}{p_5}\right)^{\frac{0.4}{1.4}} = 328\,K$$

adiabat, reversible ⇒ isenthalp

$$0 = \dot{m}_{6\to5}\left[h_5 - h_6 + \frac{(w_e^2 - w_a^2)}{2}\right] \Rightarrow w_e = w_a \Rightarrow \sqrt{2 c_p \cdot (T_5 - T_6) + w_e^2} = w_a$$

c) $\dot{e}_{x,\dot{m}_6} = \dot{m}\cdot[h - h_0 - T_0\cdot(s - s_0) + ke]$ $\quad ke = \frac{(w_6^2 - w_0^2)}{2} = 11.10^4\,J$

$h = h_6$ $\quad s = s_6$

$h_0 = h_{\text{Ø}}$ $\quad s_0 = s_{\text{Ø}}$

$T_0 = T_{\text{Ø}}$

$h - h_0 = h_6 - h_{\text{Ø}} = c_p\,(T_6 - T_{\text{Ø}})$

$s_6 - s_{\text{Ø}} = c_p \cdot \ln\left(\frac{T_6}{T_{\text{Ø}}}\right) - R \cdot \ln\left(\frac{p_6}{p_0}\right)$

$R = c_p - c_v = c_p - \frac{c_p}{\kappa} = 0.287$

$c_v = \kappa^{-1} \cdot c_p$

d) $\dot{E}_{x,verl} = T_0 \cdot \dot{S}_{ers}$

$s_{ers} = \dots + \dot{m}\left[s_a - s_e\right] - \frac{\dot{q}_B}{T_B}$

$s_a = s_6$ $\quad s_e = s_1$

d) $E_{x,rel} = -E_{x,str} + \left(1 - \frac{T_0}{T_B}\right) \cdot q_B = 100 + \left(1 - \frac{247{,}13}{1159}\right) \cdot 1135 = 1069{,}7 \frac{\text{J}}{\text{g}}$

3a) $p_{g,1} = \frac{F}{A} + p_{amb} = \frac{314.901}{0.00785} + 1 \cdot 10^5 = 140114.8 \frac{N}{m^2}$

$A = \pi \cdot \left(\frac{D}{2}\right)^2 = 0.00785\ m^2$

$F = F_{G,K} + F_{G,EW} = (m_K + m_{EW}) \cdot g = (32\,kg + 0.1\,kg) \cdot 9.81 = 314.901$

$p \cdot V = m R T \Rightarrow m = \frac{p \cdot V}{R T} = 3.42\,g$

$T = 500°C = 773.13\,K$

$p = 146114.8\,Pa$

$V = 0.00314\,m^3$

$m = ?$

$R = \frac{\bar{R}}{\bar{M}} = \frac{8.314}{50} = 0.16628 \frac{\frac{J}{mol \cdot K}}{kg/kmol} = \frac{J}{g \cdot K}$

6) $T_{2g} = T_{2EW}$ sonst fließt noch Wärme

$p_{g,2} = p_{g,1}$ Da Masse von EW gleich bleibt

$p \cdot V = m \cdot R T$

$\Delta T_{EW} \cdot c_{p_{EW}} \cdot m_{EW} = \Delta T_G \cdot c_{p,G} \cdot m_G$

$c_p = R + c_V = 0.633 + 0.16628 = 0.799 \frac{J}{g \cdot K}$

$\Delta T_{EW} = T_{EW,1} - T$ $\quad T_{EW} \cdot c_{pEW} \cdot m_{EW} - T \cdot c_{pEW} \cdot m_{EW} =$

$\Delta T_G = T_{G,1} - T$ $\quad T_G \cdot c_{pg} \cdot m_g - T \cdot c_g \cdot m_g$

$\frac{T_{EW,1} - T}{T_{G,1} - T} = \frac{c_{pg} \cdot m_g}{c_{p,EW} \cdot m_{EW}}$ $\quad T(c_{pEW} \cdot m_{EW} - c_g \cdot m_g) = T_{EW} \cdot c_{pEW} \cdot m_{EW} - T_g \cdot c_{pg} \cdot m_g$

[redacted]

$T_{EW} = 0°C$ da sonst kein Eis übrig ist bei Gleichgewicht

also $\underline{T_{gz} = 0°C}$

c) $\Delta T_g = 500°K$ $\quad c_p = R + c_v = 0.166 + 0.633 = 0.799$

$Q = \Delta T \cdot c_g \cdot m_g = 500 \cdot \cancel{0.633} \cdot 3.42 = \underline{1366.29\,J}$

d) $p_{EW} = \frac{F_G}{A} + p_{amb} = \frac{m \cdot g}{(\frac{D}{2})^2 \cdot \pi} + 10^5\,Pa = \frac{23 \cdot 9.81}{0.00785} + 10^5 = 128742.6\,Pa$
$= 1.36\,bar$

$T_{EW} = 0°$

$U_1 = m_{Eis} \cdot u_{Fe} + m_W \cdot u_{FL} = 0.0375 \cdot -333.4468 + 0.062 = 0.0366$
$= -1353.8\,J$

$m_{eis} = 0.6 \cdot m_W$

$m_{EW} = m_{eis} + m_W = 1.6 \cdot m_W \Rightarrow m_W = \frac{m_{EW}}{1.6} = \frac{0.1}{1.6} = 0.062\,kg$

$m_{eis} = 0.6 \cdot m_W = 0.6 \cdot 0.062 = 0.0375\,kg$

$u_{Fe} = u(16ar) + \frac{1-1.3}{1.4-1.3}\left(u(1.4) - u(1)\right) = -333.442 + \frac{1-0.9}{0.1}(0.016)$
$= \cancel{-333.4808} = -333.4468$

$u_{FL} = (u(16ar) + \frac{1-1.3}{1.4-1.3}\left(u(1.4) - u(1)\right) = -0.033 + \frac{1}{3} \cdot (0.012) = -0.0366$

$\Delta E = \Delta U = Q = 1366.29 = \left(m_{eis,2} \cdot u_{Fe} + m_{wo,2} \cdot u_{FL}\right) - \left(\cancel{m_{eis,1} \cdot u_{Fe} + m} U_1\right.$

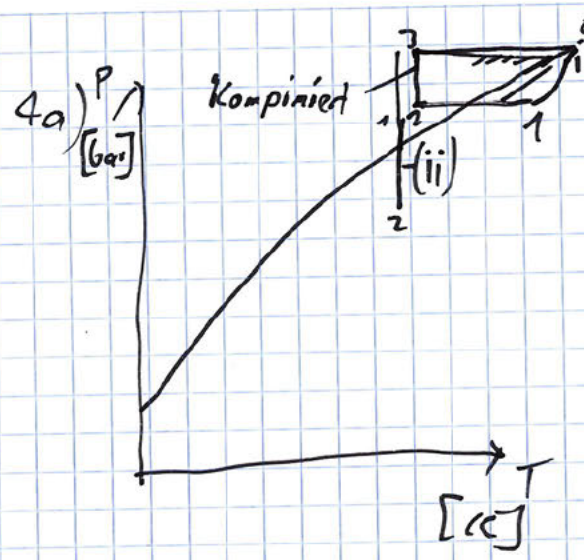
$Q - U_1 = m_{eis} \cdot u_{FE} + (0.1 - m_{eis}) \cdot u_{FL}) \Rightarrow Q - U_1 - 0.1 \cdot u_{FL} = m_{eis} \cdot (u_{FE} - u_{FL})$

$m_{eis} = \frac{Q - U_1 - 0.1 \cdot u_{FL}}{u_{FE} - u_{FL}}$

$m_W = 0.1 - m_{eis}$

$x_2 = \frac{m_{eis}}{m_{war}}$

4a)



$T_2 = T_1 - 6K = 4°C$

b) $0 = \dot{m} \cdot [h_e - h_a] + \dot{Q}_K$ $\quad p_2 = p_1$ ~~$T_1 - T_2 = 6K$~~

$\dot{Q}_K = \dot{m} [h_a - h_e]$ $\quad h_a = h_2$ $\quad h_e = h_1$ $\quad h_1 = h_3$

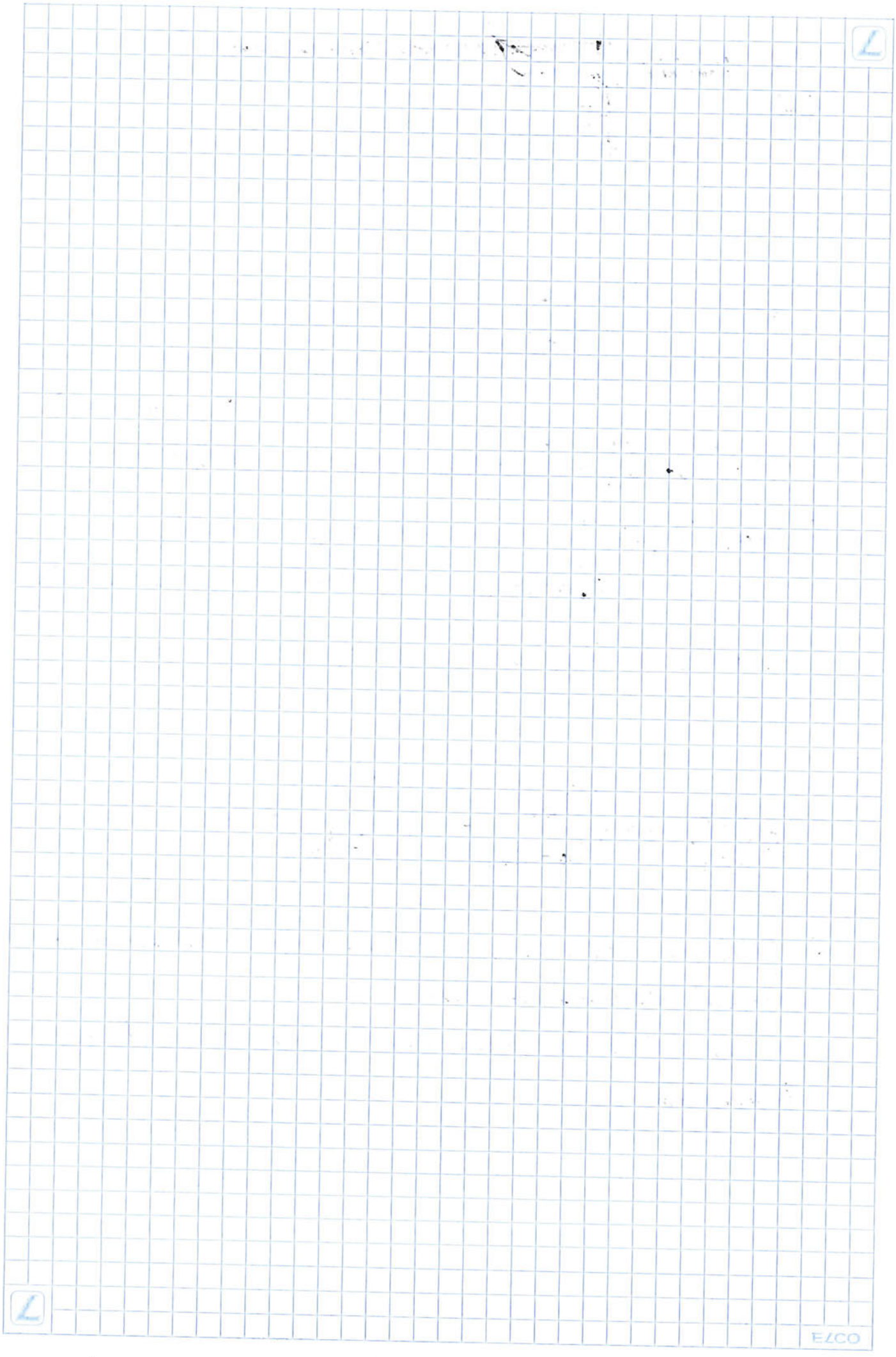
$h_g = h_1 = h_4$ $\quad x = 0$ $\quad T = 4°C \Rightarrow p_1 = p_4 = 3{,}376\ bar$

c) $x = h_f + x \cdot (h_g - h_f)$ $\quad p_4 = p_3$

d) $\varepsilon_K \dfrac{|\dot{Q}_{zu}|}{|W_t|} = \dfrac{|\dot{Q}_{zu}|}{|Q_{ab} - |\dot{Q}_{zu}|} = \dfrac{|\dot{Q}_K|}{|\dot{Q}_{ab}| - |\dot{Q}_K|} =$

e) Themperaturen sinkt da weiter Wärme abgeführt wird ~~Volumen konstant~~

~~wenn T < 20°C~~ dann nicht mehr isobar ~~da aus Verdampfer~~


ELCO