[redacted]

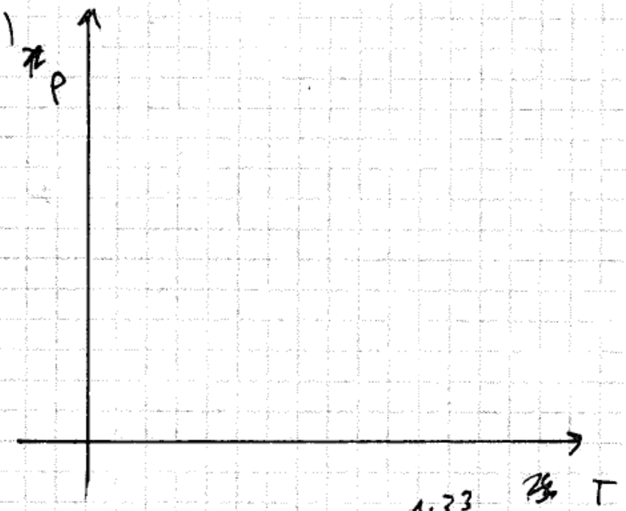
~~4.5:~~ ~~hf(94)~~

$$hf(31.33) = 94.49 + \overset{\frac{1.33}{2}}{x}\,(94.39 - 94.349)$$

$$hf = 94.4235$$

$$hg(31.33) = \text{Gleich} = 264.15$$

a)



$$4c \quad hf(31.33) = 91.45 + \overset{\frac{1.33}{2}}{x}$$

d) $\varepsilon_K = \dfrac{|\dot{Q}_{zu}|}{|\dot{W}_T|}$

$$\dot{Q}_{zu} = \dot{Q}_K$$

<u>stationär umad:</u>

$$0 = \dot{m}\,[h_1 - h_2] + \dot{Q}_K$$

$$\dot{Q}_K = \cancel{\frac{\dot{Q}_K}{h_2}}\;\dot{m}\,[h_2 - h_1]$$

Aufgabe 4:

[redacted]

Zust	p	V	T	x
1.			$T_1 = T_4$	
2.			6K	1
3.	8bar		6K ~~6K~~	
4.	8bar		$T_1 = T_4$	0

1→2: isobare Verdampfung, 6K
2→3: Verdichter, isentrop
3→4: isobar
4→1: adiabate Drossel

b) Stationär 1.HS:

$$0 = \dot{m}_R (h_2 - h_3) - \dot{W}_K \qquad \dot{W}_K = 28\,W$$

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

$h_2(6K, x=1) =$

$h_3(6K, 8bar) =$

~~T3 als Absolut 6K~~

c) Drossel ist ~~isentrop und~~ isotherm:

$T_1 = T_4$

$T_4(8bar, x=0) = 31.33°C$ Tab A-11

1.HS stationär um ~~Drossel~~: Drossel

~~dm~~ KG $0 = \dot{m}[h_4 - h_1]$

$h_4 = h_1$

Tab A-11 $h_4 = 93.42\,kJ/kg = h_f = h_1$

Zustand 1: $x = ?$ $x(31.33°C, h_4 = 93.42\,kJ/kg)$

Tab A-10: 30°C = h_f = 91.49 h_g = ~~264.48~~ 263.5

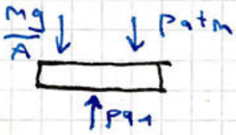
32°C = h_f = 94.39 h_g = 264.48

Aufgabe 3: Gas EW [redacted]

Zustand	p	V	T	p	V	T	x	m
1.		3.14L	500°C			0°	0.6	0.1kg
2.								

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

Da EW gemisch inkompressibel vernachlässigbar bei Druck:



$$p_{g1} = \frac{mg}{A} + p_{atm}$$

A = Fläche von Zylinder

$$A = \pi r^2$$

$$r = D/2 \qquad A = \pi \left(\frac{D}{2}\right)^2 = \pi \left(\frac{0.1}{2}\right)^2 = \frac{\pi}{400}\, m^2$$

$$p_{g1} = \frac{32\,kg \cdot 9.81\, m/s^2}{\frac{\pi}{400}\, m^2} + 100'000\, Pa = \underline{139'969.54\, Pa}$$

$$p_1 V_1 = R m_g T \qquad R = \frac{8.314\, J/mol\,K}{50\, \frac{kg}{kmol}} = \frac{\bar{R}}{M} = 166.28\, \frac{J}{kg\,K}$$

$$m_g = \frac{p_1 V_1}{R \cdot T}$$

$$m_g = \frac{139'969.54 \cdot 0.00314\, m^3}{166.28 \cdot 773.15K} = \underline{0.0034\, kg} = \underline{3.4\, g}$$

b) $p_{g,2} = p_{g,1}$ da das EW-Gemisch inkompressibel ist.

~~Gas als Da~~ Die Temperatur, wird bei 0°C bleiben, da ~~das Eises~~ nur ein Gewisser Anteil des Eises schmilzt, da $x_2 > 0$.

Aufgabe 3:

[redacted]

c) ~~Kreis~~ 1. Hs um Gasgemisch: Geschlossenes System:

$\Delta U = Q_{12} - W_{12}$

$\Delta U = \cancel{k_G} m c_v (T_2 - T_1)$

$\Delta U = 0.0034 \cdot 0.633 (0 - 500)$

$\Delta U = \underline{-1076.1\,J}$

W_{12}: isobare Kompression

$W_{12} = p_{g1} (V_{2g} - V_{1g}) = \cancel{-228.58\,J}\ \underline{-285.54\,J}$

$p_2 V_{2g} = R T m$

$V_{2g} = \frac{R T m_2}{p_2} = \underline{0.0011\,m^3}$

$T_2 = 0\,°C$

$m_1 = m_2$

$p_2 = p_1$

$Q_{12} = \Delta U + W_{12}$

$Q_{12} = -1076.1\,J - 285.54\,J = \underline{-1361.64\,J}$

d) 1. Hs um EW-Gemisch: $x_2 = ?$

$\Delta U = Q_{12} - \cancel{W_{12}}^{\,0}$ inkompressibel

~~$Q_{12} =$~~

Q_{12} wird zugeführt daher >0: $\underline{1361.64\,J}$

wenn alles Eis dann $x = 1$

$m_{EW}(u_2 - u_1) = Q_{12}$

$u_1 (T=0, x=0.6) = \cancel{u_1 = u_{Flüssig} + x(\ldots)}$

Tab. 1 Interpolieren: ~~$u_1 = u_F + x(u$~~

~~$u_1 = u_{Fest} + x(u_{Flüssig} - u_{Fest})$~~

~~Zuerst Druck interpolieren:~~

$u_2 = \frac{Q_{12}}{m_{EW}} + u_1$

$u_2 = \frac{1361.64\,J}{0.1\,kg} \cancel{+} -200$

$u_2 = \cancel{-48.63823\,kJ}/kg$

$\underline{-186.3836\,kJ/kg}$

$u_1 = u_{Flüssig} + x(u_{Fest} - u_{Flüssig})$

$u_1 = -0.045 + 0.6(-333.458 + 0.045)$

$u_1 = \cancel{-200.0938}\ -200\,kJ/kg$

~~$u_2(T=0) = -186.3836$~~

$u_2(T=0) = -186.3836 = u_{Flüssig} + x(u_{Fest} - u_{Flüssig})$

$u_{Flüssig} = -0.045\,kJ/kg$

$u_{Fest} = -333.458\,kJ/kg$

$x = \frac{u_2 - u_{Flüssig}}{u_{Fest} - u_{Flüssig}} = \cancel{0.559}\ \underline{0.559}$

[redacted]

1. $\dot{m}_{ein} = 0.3 \frac{kg}{s}$ 		Z_A

$T_{ein} = 70°C$ 		$T_{aus} = 100°C$

siedend 		siedend 		Siedende Flüssigkeit $x=1$

$m_{Rechteck,\,kasti}$ $m_{aus} = 5755\,kg$

$x_0 = 0.005$

$T = 100°C$

a) $\dot{Q}_{aus}$: stationärer Fliessprozess um Rechteck:

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

$$\dot{Q}_{aus} = \dot{m}_{ein}(h_{aus} - h_{ein})$$ 		$h_{ein} = h_g(\cancel{70°C})$

$$\dot{Q}_{aus} = 0.3 \frac{kg}{s}(2676.1 \quad -2626.8)$$ 		$h_{aus} = h_g(100°C)$

$\dot{Q}_{aus} = \cancel{14.75}\,kW$ 14.75 kW

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

$$T = \frac{q_{rev}}{s_a - s_e}$$

[redacted]

1.d) Halboffenes System:

$$m_2 u_2 - m_1 u_1 = \Delta m [h_{ein,12}] + Q_{R,12}$$

$m_1 = 5755\,kg$

$u_1(T=100°C, x_D = 0.005) = u_f + x(u_G - u_f) = \cancel{6.0088}\,?\ 429.4\,kJ/kg$

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

$u_2(70°C) = u_f = 292.95\,kJ/kg$

$h_{ein}(x=1, 20°) = 2538.1\,kJ/kg$

$$(\Delta m + m_1) u_2 - m_1 u_1 = \Delta m [h_{ein} + Q_{R,12}$$

$$\Delta m = \frac{Q_{R,12} + m_1 u_1 - m_1 u_2}{u_2 - h_{ein}}$$

$$\Delta m = \frac{35000\,kJ + 5755 \cdot 429.4 - 5755 \cdot 292.95}{292.95 - 2538.1}$$

$$\Delta m = 3600\,kg$$

e) $\Delta S_{12} = m_2 s_2 - m_1 s_1$

Aus Aufgabenstellung

$m_2 = m_1 + \Delta m_{12} = 9355\,kg$

$s_2(70°, x=1) = 0.9549 \frac{kJ}{kg\,K}$ A2

$s_1(T=100, x=0.005$

[redacted]

2b) $2(h_6 - h_5) - w_5^2 = -w_6^2$

$-208 - \frac{220^2}{2} = -w_6^2$

$\underline{w_6 = 481.87 \, m/s}$

c) $\Delta E_{str} = \dot{m}\left[h_0 - h_6 - T_0(s_0 - s_6) + \Delta ke\right]$

$\Delta E_{st} =$

$h_0 - h_6 = c_p(T_0 - T_6) = -85.36 \frac{kJ}{kg}$

$s_0 - s_6 = c_p \ln\left(\frac{T_0}{T_6}\right) - R \ln\left(\frac{p_0}{p_6}\right) = -0.3 - \cancel{286.99 \cdot \ln\left(\frac{p_0}{p_6}\right)}^{0}$

$R = \frac{\bar{R}}{M} = \frac{8314}{28.97} = 286.99$

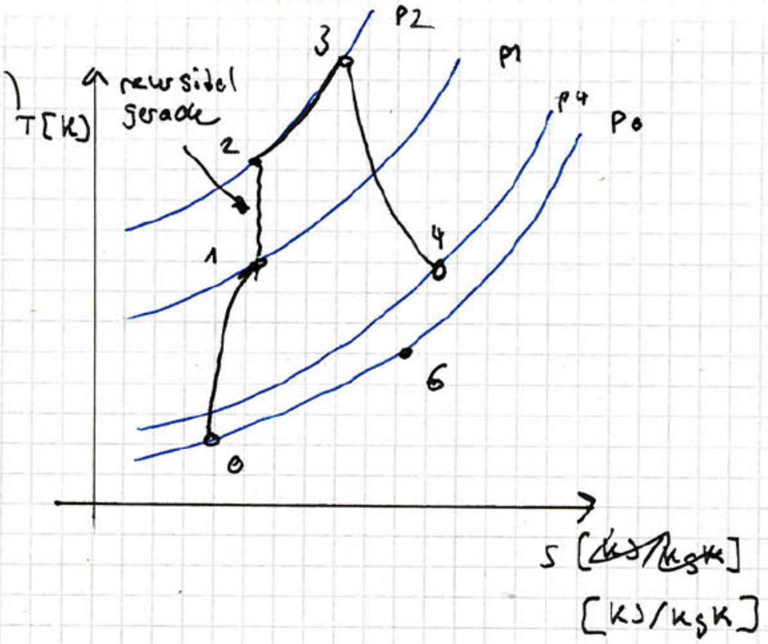
$\Delta ke \left(\frac{200^2 - 481.87^2}{2}\right)$

$\Delta E_{st} = \dot{m}\left[-85.36 - 243.15(-0.3) - \Delta ke\right]$

[redacted]

2.

a)



	p	v	T	w Luft
0	0.191 bar		-30°C	
				vorverdichter nicht $\eta < 1$
1				
				~~TB= 12 kgK~~ isentrop verdichter
2				
				Qs, TB isobare Wärmezufuhr
3				
				irreversibel Turbine
4				
5	0.5 bar		431.9 K	$w_5 = 220 \frac{m}{s}$
6	p0			

b) stationär 1. HS um Schubdrüse:

$$0 = \dot{m}_{ges}\left((h_5 - h_6) + \frac{w_5^2 - w_6^2}{2}\right)$$

reversible adiabate Schubdrüse: $\left(\frac{T_6}{T_5}\right) = \left(\frac{p_6}{p_5}\right)^{\frac{n-1}{n}}$

$n = 1.4$

$$T_6 = T_5 \cdot \left(\frac{p_6}{p_5}\right)^{\frac{n-1}{n}} = \underline{328\,K}$$

$$h_5 - h_6 = c_p(T_5 - T_6)$$

$$= 1.006\,(431.5 - 328)$$

$$= 104\ kJ/kg$$