Aufgabe 1

a) $h_e = h_f(T = 70°C) = 292.98 \frac{kJ}{kg}$

$h_a = h_f(T = 100°C) = 419.04 \frac{kJ}{kg}$

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

$= \dot{m}(h_e - h_a) + \dot{Q}_R - \dot{Q}_{aus}$

$\dot{Q}_{aus} = 0.3 \frac{kg}{s}(292.98 \frac{kJ}{kg} - 419.04 \frac{kJ}{kg}) + 100 kW$

$= \boxed{62.182 kW}$

b) da isobar $\bar{T} = \frac{T_2 - T_1}{\ln(\frac{T_2}{T_1})}$

$= \boxed{293.72 K}$

c)

$\bar{T}_2 = 293.72 K$

$\uparrow \dot{Q}_{aus}$

$\uparrow \dot{Q}_{aus}$

$\bar{T}_1 = 100°C = 373.15 K$

$\dot{S}_{erz} = \frac{\dot{Q}_{aus}}{293.72}$

$0 = \frac{\dot{Q}_{aus}}{\bar{T}_1} + \frac{\dot{Q}_{aus}}{\bar{T}_2} - \dot{S}_{erz}$

$\dot{S}_{erz} = \dot{Q}_{aus}(\frac{1}{\bar{T}_2} - \frac{1}{\bar{T}_1})$

$= 0.0455 \frac{kW}{K} = \boxed{45.497 \frac{W}{K}}$

$T = 700°C$

d)

$h_1 = x_D h_g + (1 - x_D) h_f$

$= \boxed{930.32 \frac{kJ}{kg}}$

$h_2 = h_f (T = 70°C) = \boxed{292.98 \frac{kJ}{kg}}$

halboffenes System

$m_2 u_2 - m_1 u_1 = \Delta m [h_{ein}] + Q$

$u_2 = u_f (T = 70°C) = \boxed{292.95 \frac{kJ}{kg}}$

$u_1 = x_D \cdot u_g (T = 700°C) + (1 - x_D) u_f (T = 700°C)$

$= \boxed{929.378 \frac{kJ}{kg}}$

$(m_1 + \Delta m) u_2 - m_1 u_1 = \Delta m \, h_{ein} + Q$

$\Delta m = \frac{m_1 u_2 - m_1 u_1 + Q}{h_{ein} - u_2}$

$h_{ein} = h_f (T = 20°C) = \boxed{83.96 \frac{kJ}{kg}}$

$m_1 = \boxed{5755 kg}$

$Q = \boxed{35000 kJ}$ $\boxed{\Delta m = 3589.37 kg}$

1. e)

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

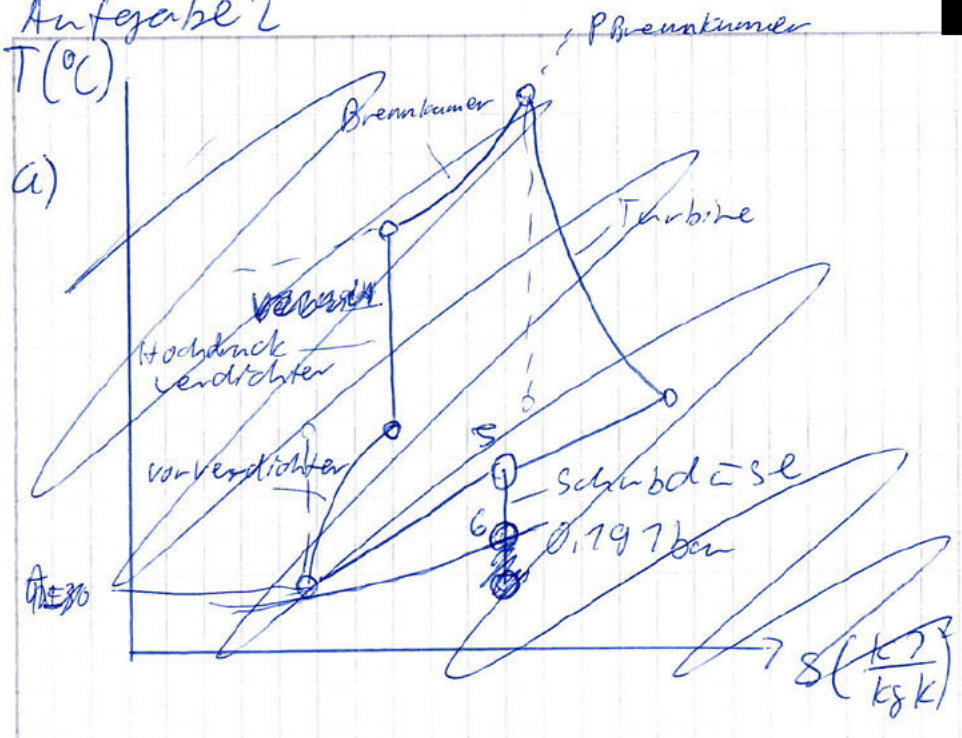
$m_2 = \Delta m + m_1 = 9349.37\,kg$

$s_2 = s_f(70°C) = 0.9559\ \frac{kJ}{kgK}$

$s_1 = x_{D\,100°C} s_g + (1 - x_D) s_f = 1.3371\ \frac{kJ}{kgK}$

$$\boxed{\Delta S_{12} = 7227.93\ \frac{kJ}{K}}$$

Aufgabe 2



a

kompression

p 0,197 bar

T −30°C

η_K

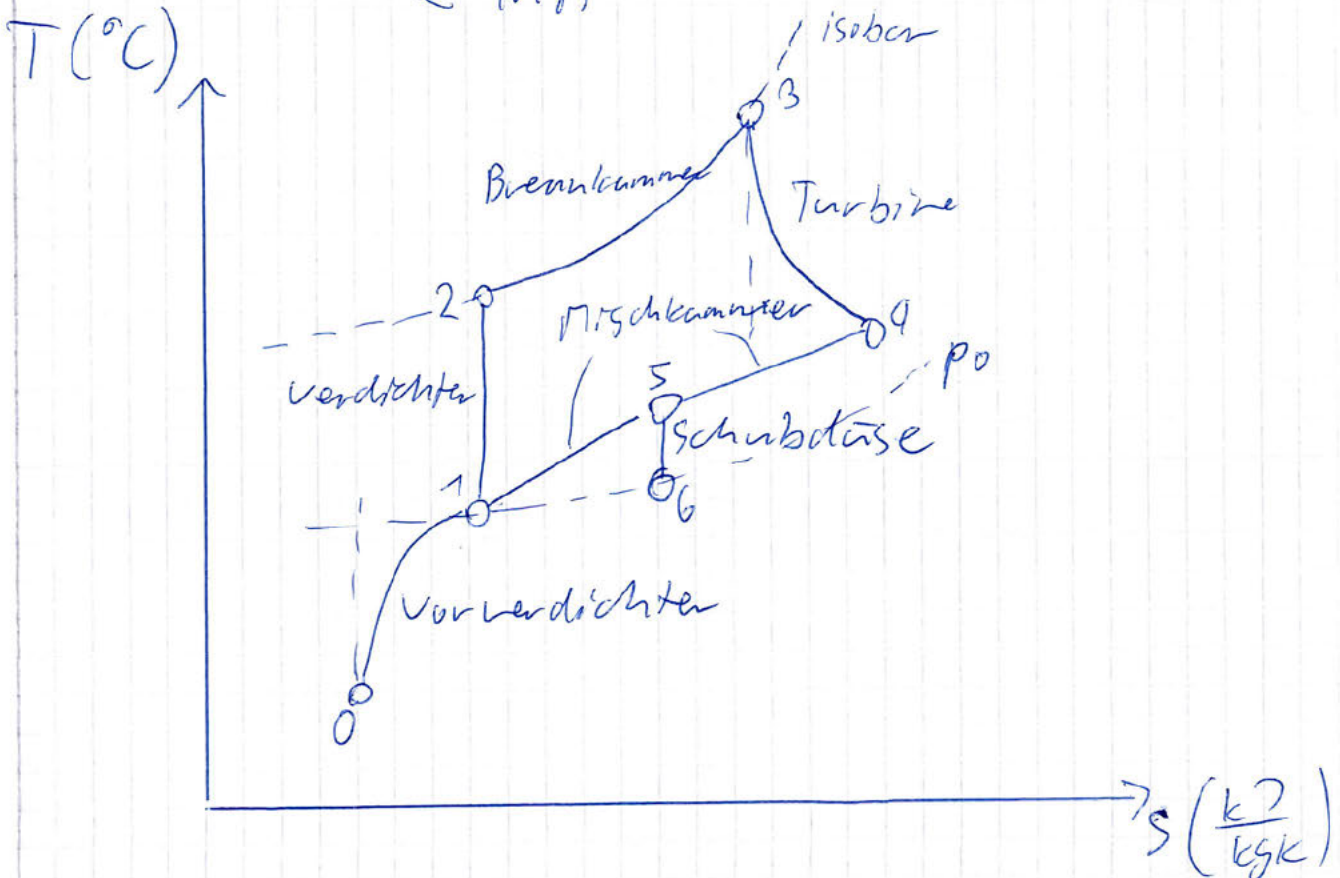
$\dot{m}$

Verdichter Brennkammer Turbine

2

Verdichter Isobare adiabat

isentrop



b) ~~$w_{ein} = 200 \frac{m}{s}$~~ $w_5 = 220 \frac{m}{s}$

$p_5 = 0.5 \text{ bar}$ $p_6 = 0.791 \text{ bar}$

$T_5 = 437.9 \text{ K}$

$s_5 = s_6$ da rev. adiabat.

$$w_{56} = \dot{m}\left(h - h_0 - T_0(s - s_0) + ke\right)$$

$$0S = 0 = c_p \ln\left(\frac{T_6}{T_5}\right) - R \ln\left(\frac{p_6}{p_5}\right)$$

c) $e_{x,stn}$

$$e_{xstr} = [h_0 - h_0 - T_0(s - s_0) + ke] - e_{xstr,6}$$

Aufgabe 3

a) $p_{g,1} = p_{amb} + (m_K + m_{EW}) g \cdot \frac{1}{A}$

$A = \frac{D^2}{4} \pi = 0{,}00785\ m^2$

$p_{g,1} = 1\ bar + (32\ kg + 0{,}1\ kg) \cdot g \cdot \frac{1}{0{,}00785\ m^2}$

$= 10^5\ Pa + 40\,719{,}78\ Pa$

$= \boxed{1{,}4\ bar}$

$m_g = \frac{p_{g,1} V_1}{R T_1}$ $\quad R = \frac{\bar{R}}{50 \frac{g}{mol}} = \boxed{0{,}7663 \frac{kJ}{kg\,K}}$

$V_1 = 3{,}719 \cdot 10^{-3}\ m^3$

$\boxed{m_g = 3{,}919\ g}$

b) der Druck wird gleich bleiben, da der Druck der Atmosphäre und das Gewicht sich nicht ändert → $p_{g,1} = p_{g,2}$
die Temperatur wird auf 0°C sinken, da sich das EW im gleichgewicht befindet. Das heißt sowohl wasser als auch Eis liegt vor, was genau bei 0°C der Fall ist.

c) ~~$\Delta E = \sum Q - \sum W_i$~~

$\Delta E = Q_{12} - W_v$

$\Delta E = \Delta u = Q_{12} - W_v$

$\Delta u = m \cdot c_v (T_2 - T_1)$

$= 3.419\,g \cdot 0.633 \frac{kJ}{kgK} \cdot (0 - 500)K$

$= \boxed{-1082\ J}$

$W_v = \int_{V_1}^{V_2} p_{1,2}\, dv = p_{g,1}(V_2 - V_1)$

$V_2 = \frac{mRT_2}{p_2} = 0.0011\,m^3 = \boxed{1.1\,L}$

$W_v = \boxed{-285.6\ J}$

~~$\Delta u + W_v = Q_{12} = \boxed{-796.4\ J}$~~

~~$\boxed{|Q_{12}| = 796.4\ J}$~~

b) $\Delta u + W_v = Q_{12} = \boxed{-1367.6\ J}$

$\boxed{|Q_{12}| = 1367.6\ J}$

d) $x_{Eis,1} = 0.6$ $\quad u_1 = 0.6(-333.458) + (1-0.6)(-0.045)\frac{kJ}{kg}$

$= \boxed{-200.1 \frac{kJ}{kg}}$

$\Delta u_{Eis} = \frac{Q_{12}}{m_{EW}}$

3.d) continued

$$\Delta u_{Eis} = \frac{Q_{12}}{m_{EW}} = \boxed{13.676 \frac{J}{g}}$$

$$\Delta u = u_2 - u_1 = 13.676 \frac{J}{g}$$

$$u_2 = 13.676 + (-200.1 \frac{J}{g})$$

$$= \boxed{-186.469 \frac{kJ}{kg}}$$

~~$x_{Eis,2} = u_2 - u$~~

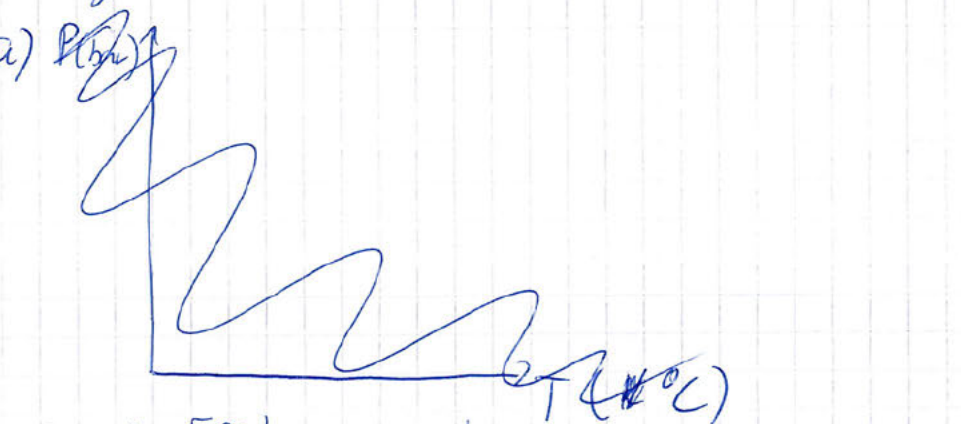
$$x_{Eis,2} \cdot u_{fest} + (1 - x_{Eis,2}) u_{flüssig} = u_2$$

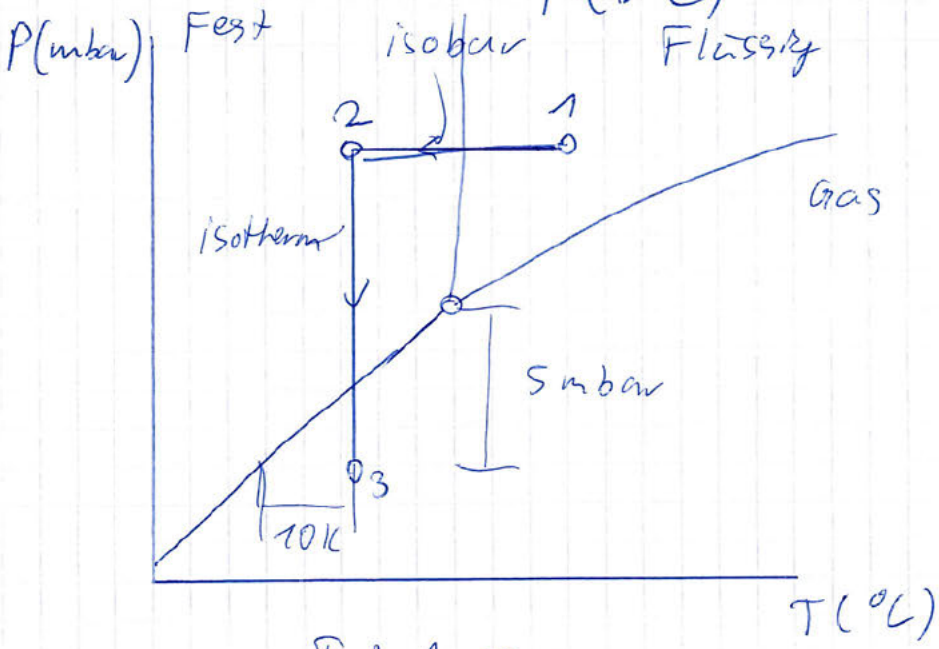
u_{fest}, $u_{flüssig}$ immer noch bei $p = 1.4$ bar da isobar.

$$x_{Eis,2} = \frac{u_2 - u_{flüssig}}{u_{fest} - u_{flüssig}} = \boxed{0.0552}$$

Aufgabe 9.

a)





b) $\dot{w}_{Rzug}$

$\dot{w}_K = \boxed{28\ W}$

$T_2 = T_1 = T_i - 6°$

$T_i = -10°C$

$T_2 = \boxed{-16°C}$

Tab A-10:

Zustand	2	3
p	1,5748 bar	8 bar
x	1	
T	-16°C	

$\dot{w}_K = 28\ W$

$s_g = 0.9298 \frac{kJ}{kgK}$ ≈ $0.9298 \frac{kJ}{kgK}$

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

$$\boxed{\frac{\dot{w}_K}{h_3 - h_2} = \dot{m}_a}$$

Zustand 3 $p = 8\,bar$ $s = 0.9298 \frac{kJ}{kgK}$

$\Rightarrow$ überhitzt

A-12 $p = 8\,bar$

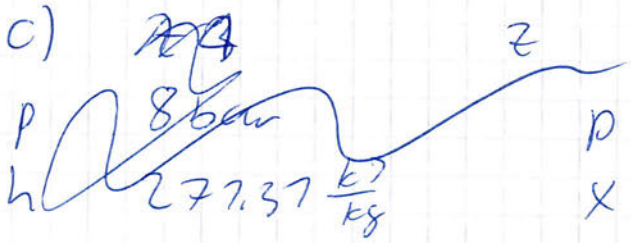
$$h_3 = \frac{264.15 - 273.66}{0.9066 - 0.9374}(0.9298 - 0.9066) + 264.15$$

$$= \boxed{271.31 \frac{kJ}{kg}}$$

$$h_2 = h_g(T = -16°C) = \boxed{237.74 \frac{kJ}{kg}}$$

$$\frac{28\,W}{h_3 - h_2} = 0.839 \frac{g}{s} = \boxed{3 \frac{kg}{h}} = \dot{m}_{R134a}$$

c)



	z_a	z_1
p	8 bar	1.5748 bar
x	0	?
h	$h_f(8\,bar) = 93.42$	93.42

→ isenthalp da Drossel

aus Tab A-10 bei $p = p_1 = 1.5748\,bar$

$$x_1 = \frac{h_1 - h_f}{h_g - h_f} = \boxed{0.308}$$

d) $\epsilon_K = \frac{|\dot{Q}_{zu}|}{|\dot{W}_{el}|} = \frac{|\dot{Q}_{zu}|}{|\dot{Q}_{ab}| - |\dot{Q}_{zu}|}$

$\dot{Q}_{zu} = \dot{m}(h_2 - h_1)$

$\dot{Q}_{ab} = \dot{m}(h_a - h_3)$

$h_1 = 93.92 \frac{kJ}{kg}$ $h_2 = 237.74 \frac{kJ}{kg}$

$h_3 = 271.31 \frac{kJ}{kg}$ $h_a = 93.92 \frac{kJ}{kg}$

$\epsilon_K = \frac{|(h_2 - h_1)|}{|(h_a - h_3)| - |(h_2 - h_1)|} = \frac{144.32}{177.89 - 144.32}$

$\boxed{\epsilon_K = 4.299}$

e) Die Temperatur würde weiter gesenkt werden und das Wasser wäre immer im Festen Zustand da die Sublimationskurve nie unterschritten wird.