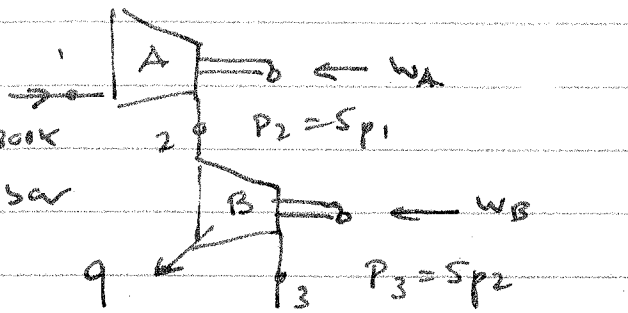
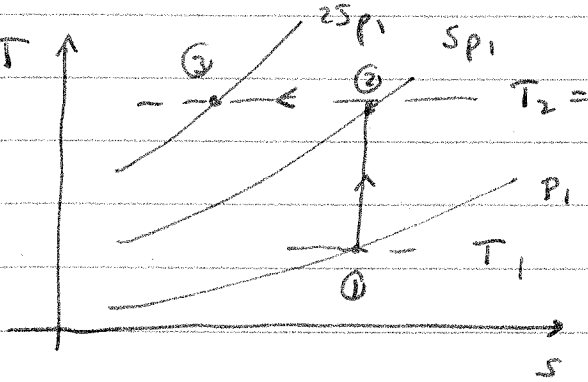
QT3



Assume:
- rev. ad. compression in A
- rev. Isothermal compr. in B
- ideal gas, const spec. heats

a)



isotherm: $dT = 0 \rightarrow T = const$

isobar: $dp = 0$

$Tds = dh - v\cancel{dp} \rightarrow \left.\frac{dT}{ds}\right|_p = \frac{1}{\varphi} T$

b) isentropic compression: $T_2 = T_1 \left(\frac{P_2}{P_1}\right)^{\frac{k-1}{k}}$, 1st law: $w_A = h_2 - h_1$

so $w_A = c_p T_1 \left(\left(\frac{P_2}{P_1}\right)^{\frac{k-1}{k}} - 1\right)$; $T_2 = 475K$, $\underline{w_A = 176 \text{ kJ/kg}}$

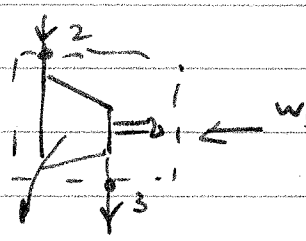
c) Gibbs: $Tds = dh - vdp$; isothermal $dT = 0$, ideal gas $\rightarrow dh = 0$

$ds = -R\frac{dp}{p}$ $\Big|\int_2^3$ $\Delta s_{23} = -R \ln\left(\frac{P_3}{P_2}\right)$, $\underline{\Delta s_{23} = -462 \text{ J/kg-K}}$

d) Gibbs: $Tds = d\tilde{q}$, $\tilde{q} = \int_2^3 Tds = T_2 \Delta s_{23}$, $\tilde{q} = RT_2 \ln\left(\frac{P_2}{P_3}\right) = -219 \frac{kJ}{kg}$

$\underline{q = -\tilde{q} = 219 \text{ kJ/kg} \text{ rejected}}$

e) 1st law CV:



$q = -\tilde{q} = 219 \frac{kJ}{kg}$

$0 = -q + w_B + h_2 - h_3$

but $T_2 = T_3 \rightarrow h_2 = h_3$

$w_B = q$, $\underline{w_B = RT_2 \ln\left(\frac{P_3}{P_2}\right) = 219 \frac{kJ}{kg}}$

Note: $w_B = -\int_2^3 v dp = +RT\int_2^3 \frac{dp}{p} = +RT_2 \ln\left(\frac{P_3}{P_2}\right)$ q.e.d.