Given sequence of processes ($C_V = 1.5R$, $C_p = 2.5R$)

(70°C, 1bar) | (150°C, P_1) | (70°C, P_2) | (70°C, 1bar)

Initial (S_0) $\xrightarrow{\text{Adi Comp}}$ S_1 $\xrightarrow{\text{Isobaric Cooling}}$ S_2 $\xrightarrow{\text{Isothermal Expansion}}$ S_3

Firstly, $P_1 = P_2$ (isobaric) $\left(\alpha = \frac{C_p}{C_V}\right)$

and since reversible adiabatic process, $P^{1-\alpha}T^{\alpha} = \text{const}$

So $(1\,bar)^{(1-\alpha)}(70+273)^{\alpha} = (P_1)^{1-\alpha}(150+273)^{\alpha}$ $\left[\alpha = \frac{2.5}{1.5} = 1.67\right.$

$\Rightarrow (1)(17137.25) = \frac{24321.39}{P_1^{0.67}}$

$\boxed{P_1 \approx 1.686 \text{ bar}}$, $\boxed{P_2 = P_1 = 1.686 \text{ bar}}$

Now, lets find out work done, heat transferred, ΔH, ΔU

For process 1, $q = 0$, $W + \Delta U = 0$ (We'll assume process 1 mole)

$\Delta H_1 = C_p \Delta T$ $\quad W_1 = \frac{P_2V_2 - P_1V_1}{1-\gamma} = \frac{R(T_2 - T_1)}{1-\gamma}$

$\boxed{\Delta H_1 = 1662.8 \text{ J}}$

~~-99.8~~

So

~~$W_1 = +992.716$ J~~

~~$\Delta U_1 = -W_1$, $\Delta U_1 = +992.716$ J~~

~~$q_1 = 0$~~

Adiabatic

$W_1 = -997.68$ J

$\Delta U_1 = -W_1 = 997.68$ J

$q_1 = 0$, $\Delta H_1 = 1662.8$ J

For process 2, isochoric cooling $(150°C, P_1) \rightarrow (70°C, P_1)$

$\boxed{P_1 = 1.686 \text{ bar}}$

~~First lets find ΔV~~

$\cancel{P_1 V_2 = RT_2} \Rightarrow \cancel{\Delta P \Delta}$

$\cancel{P_1 V_1 = RT_1}$

$q = \Delta H = C_p \Delta T \mid \Delta U = C_v \Delta T \mid W = q - \Delta U$

$\Rightarrow q_2 = 2.5R(70-150) \mid \Delta U_2 = 1.5R(70-150) \mid W_2 = q_2 - \Delta U_2$

$q_2 = -1662.8 \text{ J} \mid \Delta U_2 = -997.68 \text{ J} \mid W_2 = -665.12 \text{ J}$

$\Delta H_2 = -1662.8 \text{ J}$

For process 3, isothermal expansion $(70°C, 1.686 \text{ bar}) \rightarrow (70°C, 1 \text{ bar})$

$\boxed{\Delta U_3 = 0}$ $(n=1)$ $\boxed{\Delta H_3 = 0}$

$W_3 = RT \ln\left(\frac{V_2}{V_1}\right) = RT \ln\left(\frac{P_1}{P_2}\right)$

$\Rightarrow \boxed{W_3 = 1489.612 \text{ J}}$, $q_3 = W_3 + \Delta U_3$

$\boxed{q_3 = 1489.612 \text{ J}}$

Total $\Rightarrow$ $\Delta U_T = \Delta U_1 + \Delta U_2 + \Delta U_3$

$+997.685 - 997.685 \Rightarrow \boxed{\Delta U_T = 0}$

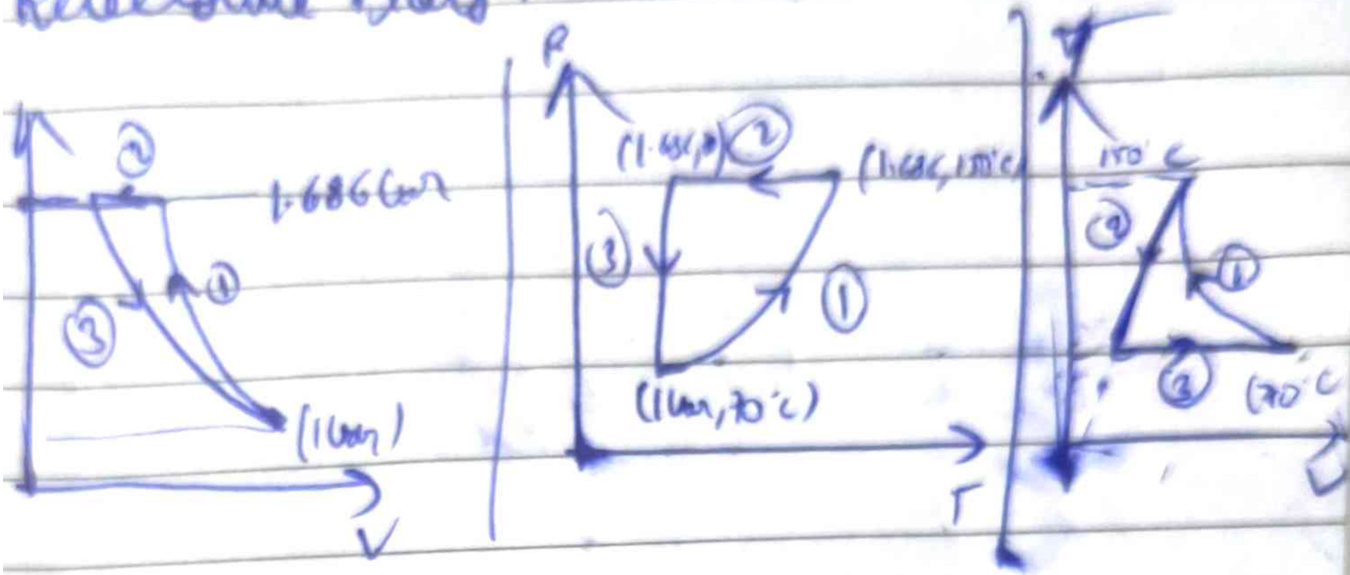
Similarly, $\boxed{\Delta H_T = 0}$

$\boxed{q_T = q_1 + q_2 + q_3 = -173.188 \text{ J}}$

$W_T = W_1 + W_2 + W_3 = -997.685 - 665.125 + 1489.612$

$\boxed{W_T = -173.188 \text{ J}}$

Reversible Plots :-



For irreversible processes, $W_i = 0.75 * q_i$

$\Rightarrow q_1 = 0$, $q_2 = C_p \Delta T$, $q_3 = nRT_2 \ln\left(\frac{P_2}{P_3}\right)$

(Adiabatic) (Isobaric) (Isothermal)

$\Rightarrow$ $q_1 = 0$, $q_2 = -1662.8\,J$, $q_3 = 1489.612\,J$

$(0.75 \times q)$ $W_1 = 0$, $W_2 = -1247.1\,J$, $W_3 = 1117.209\,J$

$\Downarrow$

Irreversible Plots