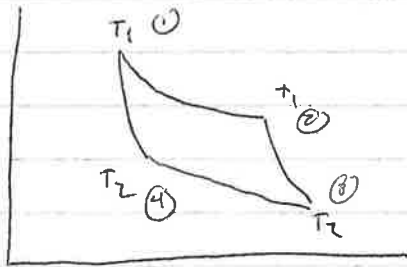


$$\int x^{-n} = \frac{-1}{n-1} x^{-n+1}$$

m98+1

find T_1, T_2 ($N, k, W, \gamma = \frac{C_p}{C_v}$, volume ratios.)



$\gamma > 1$, otherwise
 adiabats \leftrightarrow isotherms,
 no longer Carnot cycle

$$PV = NkT$$

$$W_{1 \rightarrow 2} = - \int_{V_1}^{V_2} \frac{NkT_1}{V} dV = - NkT_1 \log \left(\frac{V_2}{V_1} \right)$$

$$W_{3 \rightarrow 4} = - \int_{V_3}^{V_4} \frac{NkT_2}{V} dV = - NkT_2 \log \left(\frac{V_4}{V_3} \right)$$

$PV^\gamma = \text{constant} \Rightarrow P_2 V_2^\gamma = P_3 V_3^\gamma$

$$W_{2 \rightarrow 3} = - \int_{V_2}^{V_3} \frac{P_2 V_2^\gamma}{V^\gamma} dV = - \frac{P_2 V_2^\gamma}{1-\gamma} \left(\frac{1}{V_3^{\gamma-1}} - \frac{1}{V_2^{\gamma-1}} \right)$$

$$= - P_2 V_2^\gamma \int_{V_2}^{V_3} V^{-\gamma} dV = - P_2 V_2^\gamma \frac{1}{1-\gamma} V^{-\gamma+1}$$

$$= - \frac{P_2 V_2^\gamma}{1-\gamma} \left(\frac{1}{V_3^{\gamma-1}} - \frac{1}{V_2^{\gamma-1}} \right)$$

$$W_{4 \rightarrow 1} = - \frac{P_4 V_4^\gamma}{1-\gamma} \left(\frac{1}{V_1^{\gamma-1}} - \frac{1}{V_4^{\gamma-1}} \right)$$

$$W_{\text{tot}} = - Nk \left(T_1 \log \left(\frac{V_2}{V_1} \right) + T_2 \log \left(\frac{V_4}{V_3} \right) \right) - \frac{1}{1-\gamma} \left(P_2 V_2^\gamma \left(\frac{1}{V_3^{\gamma-1}} - \frac{1}{V_2^{\gamma-1}} \right) + P_4 V_4^\gamma \left(\frac{1}{V_1^{\gamma-1}} - \frac{1}{V_4^{\gamma-1}} \right) \right)$$

note $P_2 V_2^\gamma = P_3 V_3^\gamma$ and $P_1 V_1^\gamma = P_4 V_4^\gamma$

$$\Rightarrow P_4 = P_1 \left(\frac{V_1}{V_4} \right)^\gamma$$

and $P_1 V_1 = P_2 V_2$, $P_3 V_3 = P_4 V_4$

$$= NkT_1 \quad = NkT_2$$

note $P_4 V_4^\gamma = P_4 V_4 V_4^{\gamma-1} \left(\frac{1}{V_1^{\gamma-1}} - \frac{1}{V_4^{\gamma-1}} \right) = NkT_2 \left(\left(\frac{V_4}{V_1} \right)^{\gamma-1} - 1 \right)$

$$\rightarrow W_{\text{tot}} = - NkT_1 \log \left(\frac{V_2}{V_1} \right) - NkT_2 \log \left(\frac{V_4}{V_3} \right) - \frac{1}{1-\gamma} \left(NkT_1 \left(\left(\frac{V_2}{V_3} \right)^{\gamma-1} - 1 \right) \right) - \frac{1}{1-\gamma} \left(NkT_2 \left(\left(\frac{V_4}{V_1} \right)^{\gamma-1} - 1 \right) \right)$$

implicitly gives T_1, T_2 as function of W .