Prob: 1.6

1→2: Isócora $\quad W_{12} = 0 \quad Q_{12} = \Delta U_{12}$

$$\Delta U_{12} = \frac{nR}{\gamma - 1}(T_2 - T_1) = \frac{nR}{\gamma - 1}\left(T_0 - \frac{T_0}{2}\right) = \frac{nR}{\gamma - 1}\frac{T_0}{2} > 0$$

$$Q_{12} = \frac{nR}{\gamma - 1}\frac{T_0}{2} = \frac{3}{2}nR\frac{T_0}{2} = \frac{3}{4}nRT_0 > 0$$

2→3: Es constante $\quad T_0 V_1 = TV$

$$T_0 V_1 = \left(\frac{PV}{nR}\right) \times V \qquad p = \frac{nRT_0 V_1}{V^2}$$

$$W_{23} = \int_{V_2}^{V_3} (-p)\, dV = \int_{V_2}^{V_3} -\frac{nRT_0 V_1}{V^2}\, dV$$

$$W_{23} = (-nRT_0) V_1 \int_{V_2}^{V_3} \frac{dV}{V^2} = (-nRT_0) V_1 \left[\frac{V^{-2+1}}{(-2+1)}\right]_{V_2}^{V_3}$$

$$W_{23} = (-nRT_0) V_1 \left[\frac{-1}{V}\right]_{V_2}^{V_3} = nRT_0 V_1 \left(\frac{1}{V_3} - \frac{1}{V_2}\right) < 0$$

$(V_3 > V_2 = V_1)$

$\leftarrow V_3 = 2V_1$

$$W_{23} = nRT_0 \left(\frac{V_1}{V_3} - 1\right) = nRT_0 \left(\frac{1}{2} - 1\right) = -nR\frac{T_0}{2} < 0$$

$$Q_{23} = \Delta U_{23} - W_{23} \qquad \Delta U_{23} = \frac{nR}{\gamma - 1}(T_3 - T_2)$$

$$\Delta U_{23} = \frac{nR}{\gamma-1}\left(\frac{T_0}{2} - T_0\right) = -\frac{nR}{\gamma-1}\frac{T_0}{2}$$

$$Q_{23} = -\frac{nR}{\gamma-1}\frac{T_0}{2} - \left(-nR\frac{T_0}{2}\right)$$

$-1 = \frac{3}{2}$

$$Q_{23} = -\frac{nR}{\gamma-1}\frac{T_0}{2} + nR\frac{T_0}{2} = nR\frac{T_0}{2}\left[-\frac{1}{\gamma-1} + 1\right]$$

$$Q_{23} = nR\frac{T_0}{2}\left[\frac{-1+\gamma-1}{\gamma-1}\right] = nR\frac{\gamma-2}{\gamma-1}\frac{T_0}{2}$$

y como el gas es monoatómico $\frac{\gamma-2}{\gamma-1} = -\frac{1}{2}$

$$Q_{23} = -nR\frac{T_0}{4} < 0$$

3 → 1: Curva isoterma $\Delta U_{31} = 0 = Q_{31} + W_{31}$

$$Q_{31} = -W_{31} \qquad W_{31} = \int_{V_3}^{V_1}(-p)\,dV = \int_{V_3}^{V_1}\left(-\frac{nRT_0}{2V}\right)dV$$

$$W_{31} = -\left(\frac{nRT_0}{2}\right)\ln\left(\frac{V_1}{V_3}\right) = -\frac{nRT_0}{2}\ln\left(\frac{1}{2}\right)$$

$$W_{31} = \frac{nRT_0}{2}\ln(2) > 0$$

$$Q_{31} = -\frac{nRT_0}{2}\ln(2) < 0$$

$$\eta = \frac{\Sigma W'}{\Sigma Q_{>0}} = \frac{-W_{23} - W_{31}}{Q_{12}} = \frac{+\frac{nRT_0}{2} - \frac{nRT_0}{2}\ln 2}{\frac{3}{4}nRT_0}$$

el único calor positivo

$$\eta = \frac{nRT_0/2}{nRT_0/2}\,\frac{1-\ln(2)}{3/2} = \frac{2}{3}(1-\ln 2) < 1$$