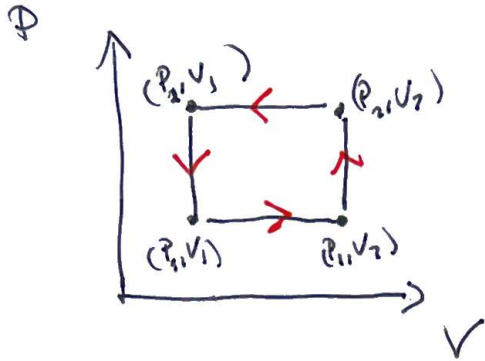


Problem 6.

Energy is a state function that only depends on what state you are in, hence $\Delta E = 0$ in a cyclic process.



The first law of thermo $\Delta E = Q + R$ gives $R = -Q$ since $\Delta E = 0$. Only the two isobaric processes contribute to the net work:

$$\begin{aligned} R &= -P_1(V_2 - V_1) + P_2(V_2 - V_1) \\ &= (V_2 - V_1)(P_2 - P_1) \end{aligned}$$

Thus, we conclude that $Q = -R = -(V_2 - V_1)(P_2 - P_1)$.