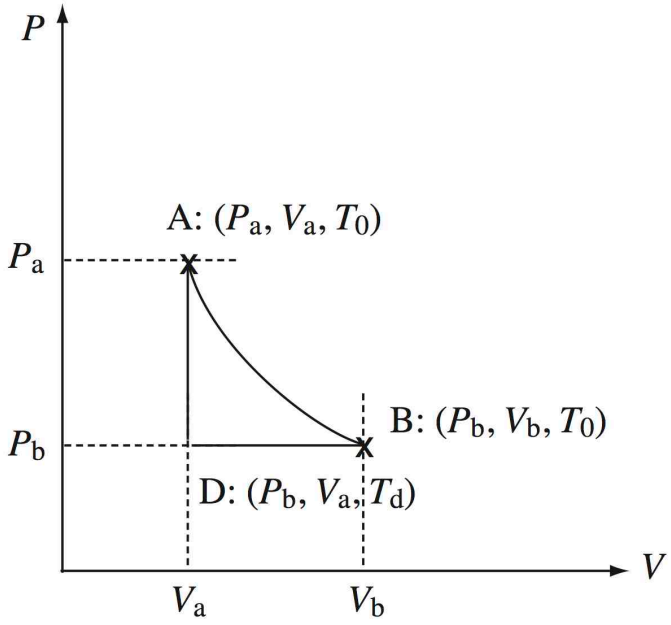
General Physics II: Tutorial Material 10

1) Let us consider an isothermal change of the state $\mathrm{A}(V_\mathrm{a}, P_\mathrm{a}, T_0) \rightarrow \mathrm{B}(V_\mathrm{b}, P_\mathrm{b}, T_0)$ in a closed system, where $V_\mathrm{a} < V_\mathrm{b}$.
   a) Calculate heat, Q, and work, W, of the system taking this path?
   b) The system now takes another path for A to B, namely an isovolumetric process from A to D$(V_\mathrm{a}, P_\mathrm{b}, T_d)$ first, followed by an isobaric process from D to B. Calculate the work and heat for the two processes. Is the total heat of the path equal to the total work of the path? Is the result what one expects?



2) Lets us considers a very large heat reservoir at a temperature T_R, and a small thermal system at T_S. The specific heat of the small system is C. By putting them into thermal contact, they reach a thermal equilibrium at T_R, since the heat reservoir has such a large heat capacity and stays at the same temperature.
   a) Calculate the entropy changes of the heat reservoir.
   b) Calculate the entropy changes of the small system.
   c) Calculate the entropy changes of the total system.
   b) Show that the change of the entropy of the total system is $\Delta S \geq 0$.

3) Show that the entropy difference of an n-mol ideal gas, ΔS, when the state $A(P_1, V_1, T_1)$ is changed to $B(P_2, V_2, T_2)$ quasi-statically, is given by

$$\Delta S = nC_\mathrm{V} \ln \frac{T_2}{T_1} + nR \ln \frac{V_2}{V_1}.$$

   Show that this leads to ΔS=0 for an adiabatic process, as expected from the definition.

4) An n-mole ideal gas with a volume V_1 expands adiabatically ($Q = 0$) into the vacuum (free expansion) and its volume becomes V_2. Is this process reversible process? Show that the entropy change is positive, i.e. $\Delta S > 0$. Is this result paradoxical? How can we explain this?