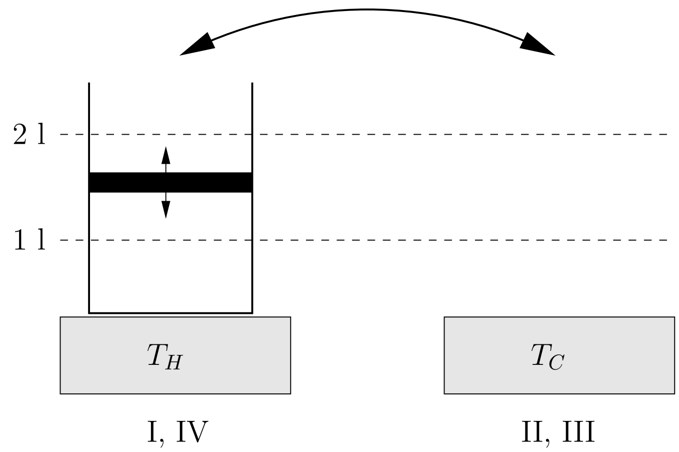
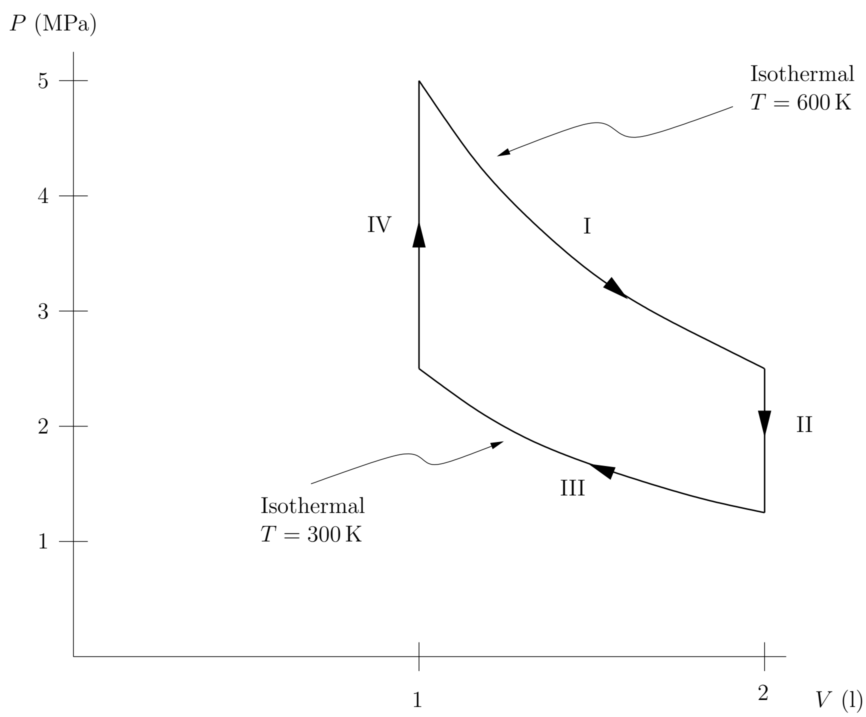
Thermodynamic Cycle Discussed on 11/10/08



Consider the following cyclic thermodynamic process with a container containing 1 mole of an ideal gas. (This discussion is meant to be a complement to the discussion of the Carnot cycle in Section 19.2 of your text. The p-V diagram for this process is on the following page. The cycle starts with the gas contained in a 1 l volume at equilibrium with a temperature bath at $T_H = 600\,\text{K}$; this is point **A** in the p-V diagram. The gas then undergoes four thermodynamic processes:

- **I**. The gas undergoes an isothermal expansion until the volume is 2 l.
- **II**. The gas is removed from the 600 K heat bath and placed on the heat bath at 300 K. The volume is held at 2 l while the gas is cooled slowly.
- **III**. While the gas is still in contact with the 300 K heat bath it is compressed back to a volume 1 l.
- **IV**. The gas is removed from the 300 K bath at returned to the600 K bath. The volume is held constant at 1 l while the gas slowly heats back up to 600 K, returning to its original state.



Path	ΔU	Q_{in}	W_{by}
I	0	3.46 kJ	3.46 kJ
II	−3.74 kJ	−3.74 kJ	0
III	0	−1.73 kJ	−1.73 kJ
IV	3.74 kJ	3.74 kJ	0

$$\begin{aligned}\text{efficiency} &= \frac{W_{\text{net}}}{(Q_{\text{in}})_H} \\ &= \frac{W_I + W_{II} + W_{III} + W_{IV}}{Q_I + Q_{IV}} \\ &= \frac{3.46 + 0 - 1.73 + 0}{3.46 + 3.74} \\ &= 0.24\end{aligned}$$

NOTE: This efficiency is *not* equal to the Carnot efficiency that is given in Eq. (19.3) of your text. It is, in fact, less than the Carnot efficiency ($e_{\text{Carnot}} = 1 - 300/600 = 0.5$). This is consistent with fact that the Carnot efficiency is the *maximum* efficiency that any cyclic heat engine that operate between T_H and T_C can have.