

In the name of God

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ADVANCED STATISTICAL MECHANICS I

Exercise Set 2

(Due Date: 1400/09/06)

1. Zero law of thermodynamics: suppose that A, B and C are in thermal equilibrium. For A and C, we have:

$$P_A V_A - n_A r_A P_A - P_C V_C = 0$$

and for B and C, we have:

$$P_B V_B - P_C V_C + \frac{n_B r_B P_C V_C}{V_B} = 0$$

Find 3 state equations of this system which are in thermal equilibrium.

2. Show that the violation of Kelvin-Planck's statement yields the violation of Clausius's statement and vice versa.
3. Show that it is impossible to have an engine possessing efficiency higher than Carnot engine.
4. Suppose that a system with T_s is contacted thermally with a reservoir with T_R .

A : Compute $\Delta S_{total} = \Delta S_{reservoir} + \Delta S_{system}$ if at the initial point $T_R > T_s$.

B : Compute $\Delta S_{total} = \Delta S_{reservoir} + \Delta S_{system}$ if at the initial point $T_R < T_s$.

C : For each cases, plot the ΔS_{total} , $\Delta S_{reservoir}$ and ΔS_{system} as a function of T_R/T_s

5. Producing a piece of ice during a night at desert. Is it possible to freeze water in a plate in the naked sky in desert? (Hint; suppose that the temperature of water is $T = 6^\circ\text{C}$ and the temperature of naked dark sky is $T = -23^\circ\text{C}$. The time for doing experiment would be sunset till sunrise.)
6. We have a refrigerator which its power equates to 100W and a heater with 100W are working in the room temperature. Which system makes more heat in the room. Explain your answer.
7. We have a box isolated from the environment with volume V . We divided it into two parts with xV and $(1-x)V$. Pressures and temperatures in both partition are equal. There are xn and $(1-x)n$ particle in left and right parts, respectively. Now we remove the partition, how much changes will be occurred in Entropy?

Good luck, Movahed
