Universität Leipzig, Fakultät für Physik und Geowissenschaften

Exercises for Experimental Physics 2 – IPSP

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Exercise Sheet 5 (SoSe 2012)

Date of Issue: May 11^{th} 2012

Date of Submission: May 18^{th} 2012

Submission Place: Marked mailbox next to room 302 (Linnestr. 5)
Submission Time: 11:00 a.m. at the submission day noted above

Please note: Write your name and matriculation number on EACH sheet of paper.
Only submit the calculations and results for exercise 1-3, exercise 4 will be discussed during the instruction classes.

Exercises:

1. The diesel cycle shown in Figure 1 approximates the behavior of a diesel engine. Process *ab* is an adiabatic compression, process *bc* is an expansion at constant pressure, process *cd* is an adiabatic expansion, and process *da* is cooling at constant volume. Find the efficiency of this cycle in terms of the volumes V_a, V_b and V_c. (7 Points)

2. Using $\Delta S = C_V \ln(T_2/T_1) + nR \ln(V_2/V_1)$ for the entropy change of an ideal gas, show explicitly that the entropy change is zero for a quasi-static adiabatic expansion from state (V_1, T_1) to state (V_2, T_2). (7 Points)

3. Suppose that two heat engines are connected in series, such that the heat released by the first engine is used as the heat absorbed by the second engine as shown in Figure 2. The efficiencies of the engines are η_1 and η_2, respectively. Show that the net efficiency of the combination is given by $\eta_{net} = \eta_1 + \eta_2 - \eta_1\eta_2$ (6 Points)

4. You are installing a heat pump, whose COP is half the COP of a reversible heat pump. You will use the pump on chilly winter nights to increase the air temperature in your bedroom. Your bedroom's dimensions are $5.00\,m \times 3.50\,m \times 2.50\,m$. The air temperature should increase from 63°F to 68°F. The outside temperature is 35°F , and the temperature at the air handler in the room is 112°F. If the pump's electric power consumption is 750 W, how long will you have to wait in order for the room's air to warm (take the specific heat of air to be 1.005 kJ/(kg·°C)? Assume you have good window draperies and good wall insulation so that you can neglect the release of heat through windows, walls, ceilings and floors. Also assume that the heat capacity of the floor, ceiling, walls and furniture are negligible.

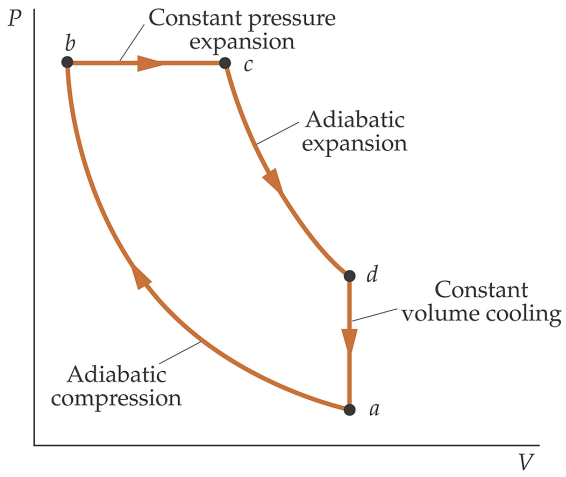

Figure 1: Exercise 1

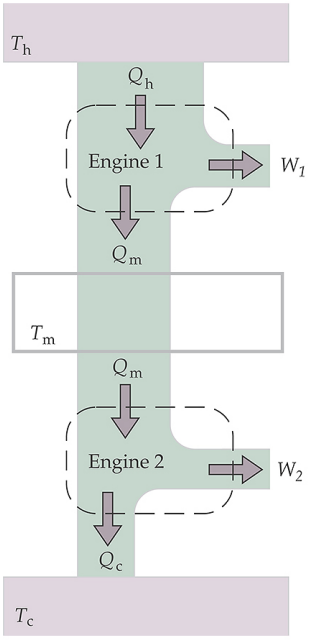

Figure 2: Exercise 3