Universität Leipzig, Fakultät für Physik und Geowissenschaften

Exercises for Experimental Physics 2 – IPSP

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Exercise Sheet 6 (SoSe 2012)

Date of Issue: May 18^{th} 2012

Date of Submission: May 25^{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. A Carnot engine works between two heat reservoirs at temperatures $T_h = 300$ K and $T_c = 77.0$ K. (a) What is its efficiency? (b) If it absorbs 100 J of heat from the hot reservoir during each cycle, how much work does it do? (c) How much heat does it release to the low-temperature reservoir during each cycle? (d) What is the coefficient of performance of this engine when it works as a refrigerator between these two reservoirs? (6 Points)

2. A copper-bottomed saucepan containing 0.800 L of boiling water boils dry in 10.0 min. Assuming that all the heat is transferred through the flat copper bottom, which has a diameter of 15.0 cm and a thickness of 3.00 mm, calculate the temperature of the outside of the copper bottom while some water is still in the pan. (6 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 1. Suppose that each engine is an ideal reversible heat engine. Engine 1 operates between temperatures T_h and T_m and Engine 2 operates between T_m and T_c, where $T_h > T_m > T_c$. Show that the net efficiency of the combination is given by $\eta_{net} = 1 - \frac{T_c}{T_h}$. Note that this result means that two reversible heat engines operating "in series" are equivalent to one reversible heat engine operating between the hottest and coldest reservoirs. (8 Points)

4. A solid disk of radius r and mass m is spinning about a frictionless axis through its center and perpendicular to the disk, with angular velocity ω_1 at temperature T_1. The temperature of the disk decreases to T_2. Express the angular velocity ω_2, rotational kinetic energy K_2, and angular momentum L_2 in terms of their values at the temperature T_1 and the linear expansion coefficient α of the disk.

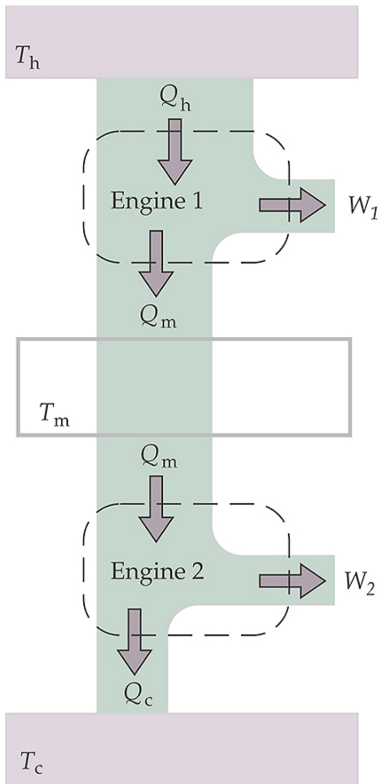

Figure 1: Exercise 3