Universität Leipzig, Fakultät für Physik und Geowissenschaften

Exercises for Experimental Physics 2 – IPSP

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Exercise Sheet 4 (SoSe 2012)

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Date of Submission: May 11^{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 gas is allowed to expand isothermally until it reaches its final volume and its pressure is 1.00 atm. It is then heated at constant volume until it reaches its final pressure. (a) Illustrate this process on a PV diagram and calculate the work done by the gas. (b) Find the heat absorbed by the gas during this process. (5 Points)

2. The working substance of an engine is 1.00 mol of a diatomic ideal gas. The engine operates in a cycle consisting of three steps: (1) an adiabatic expansion from an initial volume of 10.0 L to a pressure of 1.00 atm and a volume of 20.0 L, (2) a compression at constant pressure to its original volume of 10.0 L, and (3) heating at constant volume to its original pressure. Find the efficiency of this cycle. (7 Points)

3. Recently, an old design for a heat engine, known as the *Stirling engine* has been promoted as a means of producing power from solar energy. The cycle of a Stirling engine is as follows: (1) isothermal compression of the working gas (2) heating of the gas at constant volume, (3) an isothermal expansion of the gas, and (4) cooling of the gas at constant volume. (a) Sketch PV and ST diagrams for the Stirling cycle. (b) Find the entropy change of the gas for each step of the cycle and show that the sum of these entropy changes is equal to zero. (8 Points)

4. In this problem, 1.00 mol of an ideal gas at 300 K undergoes a free adiabatic expansion from $V_1 = 12.3\,L$ to $V_2 = 24.6\,L$. It is then compressed isothermally and reversibly back to its original state. (a) What is the entropy change of the universe for the complete cycle? (b) How much work is lost in this cycle? (c) Show that the work lost is $T\Delta S_u$.