Advanced Statistical Physics
Problem Set 1

due: 27.10.2010

Problem 1.1 One mole of an ideal gas performes a process (Figure 1) which consists of the isothermal part (AB), isochoric part (BC) and isobaric part (CA). Assuming that the volume V_A, the Pressure P_A and the pressure P_B are known, find the temperature at the point C. **[2p]**

Problem 1.2 Ideal gas performs a process shown in Fig. 2 in the PV-plane. Draw this process in TP-coordinates. **[2p]**

Problem 1.3 Find the sum of the internal energy of an ideal gas under a piston in a vertical cylinder and the potential energy of the piston.

Find the heat capacity of a column of atmosphere, i.e. a cylinder of the air of the section A open to the universe.
(Play with: c_V, T, M-mass of the piston, N-number of molecules in the cylinder, P_A-atmospheric pressure, m-molecular mass of the air, g-erdbeschleunigung.) **[2p]**

Problem 1.4 Surface tension: thermodynamic properties of the interface between two phases are described by a state function called the surface tension $\mathcal{S}$. It is defined in terms of the work required to increase the surface area by an amount ΔA through $\Delta W = \mathcal{S}\Delta A$.

(a) By considering the work done against surface tension in an infinitesimal change in radius, show that the pressure inside a spherical drop of water of radius R is larger than outside pressure by $2\mathcal{S}/R$. What is the air pressure inside a soap bubble of radius R? **[2p]**

(b) A water droplet condenses on a solid surface. There are three surface tensions involved,$\mathcal{S}_{aw}$, $\mathcal{S}_{sw}$, $\mathcal{S}_{sa}$, where a, s and w refer to air, solid, and water, respectively. Calculate the angle of contact, and find the condition for the appearance of a water film (complete wetting). **[2p]**

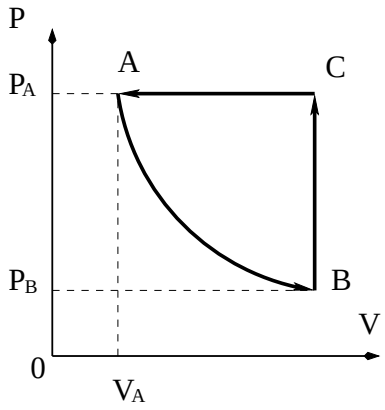

Figure 1:

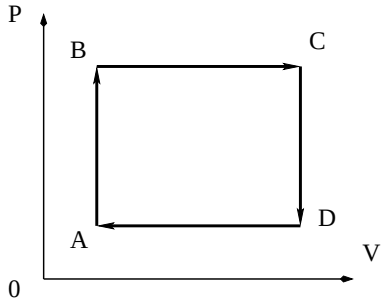

Figure 2: