Physics Department
Paderborn University

Theoretical Physics - Thermodynamics
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Sheet II
Preparation until Tuesday, 28.10.2008

4. Thermal and caloric equation of states again

In a pVT-system, the internal energy has the form

$$U = U(V,T) = \alpha T^n \ln\left(\frac{V}{V_0}\right) + f(T), \tag{7}$$

where $f(T)$ is an arbitrary function of T. Determine the constants α and n under the assumption that the thermal equation of state can be written as

$$p = T^3 V^{-1}. \tag{8}$$

5. Irreversible Gas expansion

An ideal gas expands irreversibly and adiabatically from a volume V into vacuum ΔV.

a) What are the thermal and caloric equations of state for the ideal gas?

b) Starting from these equations, show that the entropy change of the process is described by

$$\Delta S = N k_B \ln \frac{V + \Delta V}{V}. \tag{9}$$

6. Change of entropy

Show that for the heat balance between two closed systems with particle number N_1, N_2 and the temperature T_1, T_2, an entropy change appears as

$$\Delta S = C_V \ln\left[\left(n_1 + n_2\frac{T_2}{T_1}\right)^{n_1}\left(n_2 + n_1\frac{T_1}{T_2}\right)^{n_2}\right], \tag{10}$$

where $n_i = N_i/(N_1 + N_2)$, $i \in \{1,2\}$.

Which sign does ΔS have? Why?