Sheet 01

Discussion: Thursday 02.05.2024

Exercise 1 Continuity Equation

Consider a continuum of particles moving in space and derive the continuity equation for mass transport:

$$\frac{\partial \rho(\mathbf{x}, t)}{\partial t} + \nabla \cdot \mathbf{j}(\mathbf{x}, t) = 0$$

What form does the continuity equation take for energy transport and momentum transport (a qualitative argument is sufficient here)?

Exercise 2 Entropy of the ideal gas

1. Use the Gibbs fundamental form for entropy (chapter 7.2) to derive a *Gibbs-Duhem equation* (see chapter 7.3.2) for
$$\frac{\mathrm{d}\{1, P, \mu\}}{T}$$
.
2. Use 1. to obtain an expression for T/μ for the ideal gas. Check that your result is intensive.
3. Derive from 2. an expression for entropy $S(E, V, N)$ of the ideal gas. Check that it is extensive.

Exercise 3 Free Expansion of a Gas

Consider an ideal Gas composed of N particles with energy E in an isolated container with (fixed) volume V. The container is partitioned, such that at the beginning the gas can fill only the left half, while the other half is completely empty. The partition wall is removed and the gas can expand to the right half of the container. Determine the equilibrium state:

(a) using the entropy of an ideal gas.

(b) by means of the considerations about equilibrium states from chapter 8.