Exercise 08

Name:	Matriculation number:
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The exercise is due on Wednesday, June 20, 8 am.

8.1 Text book

Read sections 5.1 to 5.5 and 6.1 in G.H. Findenegg, T. Hellweg „Statistische Thermodynamik"

8.2 Translational partition function

Check if the translational partition function z_{trans} is defined for molecules in a nanoscopic volume. Take an oxygen molecule in a quadratic box with a box length $L = 1$ nm at 300 K.

8.3 Translational partition function of an one atomic ideal gas

Calculate the part of the translational partition function to the internal energy of a one atomic ideal gas that can only move on a 2D plane? What is the percentage with respect to the equipartition theorem?

8.4 Spectroscopic measurement

Molecular nitrogen is heated in a flashing arc. From spectroscopic measures the following relative occupancies are observed (for $\nu = 0$ to $\nu = 3$): $\frac{N_1}{N_0} = 0.260$, $\frac{N_2}{N_0} = 0.068$, $\frac{N_3}{N_0} = 0.018$. Show that the distribution of the molecules is in thermodynamic equilibrium and calculate the temperature of the flashing arc ($\theta_\nu = 3383$ for N_2).

8.5 Enthalpy

Consider a one atomic ideal gas. Calculate the Enthalpy. (*Hint: Apply the thermodynamic definition of the enthalpy*)

8.6 Internal energy

Calculate the temperature at which the internal energy

$$U = -nN_A \left(\frac{d}{d\beta} \ln q \right) = 1\text{kJ} \tag{1}$$

for 1 mol of particles. Consider only two energy levels as accessible with a difference $h\nu = 1 \cdot 10^{-20}$ J.

8.7 Vibrational part of the heat capacity

Calculate the vibrational part of the molar heat capacity $c_{V,vib}$ of N_2 at 1000 K. How big is the percentage compared to the classical value of $c_{V,vib}$? (The force constant of N_2 is 2239 Nm^{-1}.)