Exercise 06

NAME:	MATRICULATION NUMBER:
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RESULTS:

6.1		OF 2 P
6.2		OF 8 P
6.3		OF 3 P
TOTAL		OF 13 P

GENERAL INSTRUCTIONS

- SUBMIT YOUR SOLUTION TO OLIVER LEMKE (R. 35.17) BEFORE **WEDNESDAY 08. JUNE AT 8.15 AM**.
- FILL OUT THIS COVER SHEET AND SUBMIT IT ALONG WITH YOUR SOLUTION.
- SHOW HOW YOU ARRIVED AT YOUR ANSWER.

6.1 Distinguishable bosons (2P)

Consider a system of $N_i = 3$ distinguishable particles and $g_i = 5$ energy states.

(a) How many differnt configurations are possible?

(b) Write down a general equation for N particles and m states.

6.2 Calculation of state functions for a 3-level system (8P)

Consider a 3-level system at 400 K with

$$g_0 = g_1 = 2 \text{ and } g_2 = 4$$

and energies

$$E_0 = 0\,\text{J}\ ,\ E_1 = 4 \cdot 10^{-21}\text{J and } E_2 = 12 \cdot 10^{-21}\text{J}.$$

The partition function for this system is then defined as:

$$q = g_0 + g_1\,\exp\left(-\beta \Delta E_1\right) + g_2\,\exp\left(-\beta \Delta E_2\right) \tag{1}$$

(a) Calculate the internal energy.

(b) Calculate the entropy.

(c) Calculate the enthalpy.

(d) Calculate out of your results the Gibbs free energy.

6.3 Poisson distribution (3P)

The probability of finding k particles of an ideal gas in an volume V can be modeled by the Poisson distribution. The Poisson distribution is defined as

$$P_\lambda(k) = \frac{\lambda^k}{k!} \cdot\ \mathrm{e}^{(-\lambda)}. \tag{2}$$

λ denotes the expectation value and k the number of particles. The Poisson distribution has the curious property that the variance is equal to the expectation value. Consider an ideal gas at 1000 K with a pressure of 10^{-9} Pa.

(a) Calculate the average number of particles in a volume of 1 mm^3

(b) Caclulate the standard deviation if the particles are Poisson distributed

(c) Calculate the probability to find $k = \lambda$ particles in the volume.