Lecture Notes Thermal Physics

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1 Introduction: a short overview of important notions

The mole

A **mole** of a certain atom is equivalent to an **Avogadro number** N_a of atoms. Where $N_A = 6.022 \cdot 10^2 3$.

The ideal gas law

Suppose we have N particles in a gas, then we can relate the pressure, volume, temperature, and amount of particles as follows:

$$pV = Nk_BT \tag{1}$$

where k_B is Boltzmann's constant. In order to apply this formula one assumes that (i) there are no intermolecular forces and (ii) that the particles are point-like and have zero size.

Combinatorics

Suppose we have n atoms, and r of those atoms are for instance in an excited state. If we want to calculate the number of possible configurations Ω we apply the following formula,

$$\Omega = \frac{n!}{(n-r)!r!} \equiv {}^nC_r \tag{2}$$

Since factorials grow incredibly quick, we shall often use $\ln\Omega$ instead of Ω.

$$\ln\Omega = \ln(n!) - \ln([n-r]!) - \ln(r!) \tag{3}$$

We also have **Sterling's formula**:

$$\ln(n!) \approx n\ln n - n \tag{4}$$

2 Heat