Statistical Physics 3

1. Energy of a system of N weakly interacting harmonic oscillators has the form

$$E_M = \frac{1}{2}N\hbar\omega + M\hbar\omega\,,$$

where M is a natural number. How many possibilities are there to get a state of energy E_M? Find the relation between the energy and the temperature of the system and its heat capacity.

2. A system consists of n particles. The particles can take only two energies, $\pm\varepsilon$. The microstates are unobservable, only the total energy of the system is. Let $n_\pm$ be the number of particles with energies $\pm\varepsilon$, respectively. The macrostate of the system is fully described by two parameters only: $m = n_+ - n_-$ and $n = n_+ + n_-$, and the energy of the system is $E = m\varepsilon$. Find the entropy of the system (we can assume that m, n are large enough) and the thermodynamic temperature, defined as

$$\frac{1}{T} = \frac{\partial S}{\partial E}\,.$$

3. In a murder investigation, a corpse was found by a detective at exactly 8 P.M. Being alert, the detective also measured the body temperature and found it to be $21°$C. Two hours later, the detective measured the body temperature again and found it to be $15.5°$C. If the ambient temperature is $10°$C, and assuming that the body temperature of the person before death was $36.6°$C, at what time did the murder occur?

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