Formula sheet for Midterm II PHYS 3113

Ideal two-state paramagnet:

$$\Omega = \frac{N!}{N_1!\,(N-N_1)!} \qquad U = \mu B(N-2N_1) = -N\mu B \tanh\frac{\mu B}{kT} \qquad C_B = \left(\frac{\partial U}{\partial T}\right)_B$$

Boltzmann statistics: $Z = \sum e^{-\beta E_n}$, $\beta = \dfrac{1}{kT}$

$$\langle E\rangle = \frac{1}{Z}\sum E_n e^{-\beta E_n} = -\frac{1}{Z}\frac{\partial Z}{\partial \beta} \qquad U = N\langle E\rangle \qquad C = \frac{\partial U}{\partial T}$$

Harmonic oscillator: $E_n = n\hbar\omega$, $n = 0, 1, 2, \ldots$ $\qquad Z = \dfrac{1}{1-e^{-\beta\hbar\omega}}$

Rotation: $Z = \displaystyle\sum_{j=0}^{\infty}(2j+1)e^{-j(j+1)\beta\epsilon}$

Bohr magneton: $\mu_{\mathrm{B}} = 9.274\times10^{-24}$ J/T$= 5.788\times10^{-5}$ eV/T

Boltzmann's constant: $k = 1.38\times10^{-23}$ J/K $\qquad kT = 0.026\text{ eV}\left(\dfrac{T}{300\text{ K}}\right)$