3-1. Consider an ideal two-state electronic paramagnet DPPH (diphenyl picrylhydrazyl, a nitrogen atom with an unpaired electron in the middle of it to serve as the magnet.) with $\mu = 5.788 \times 10^{-5}$ eV/T. If the magnetic field $B = 2.06$ T (Tesla, the unit for magnetic fields) and the temperature is 2.2 K, calculate the energy and magnetization as a fraction of its maximum possible value.

3-2. Starting from $\ln \Omega(N,s) = \ln N! - \ln N_\uparrow! - \ln N_\downarrow!$, show that the entropy of a two-state paramagnet, expressed as a function of temperature, is

$$S = Nk\left[\ln(2\cosh x) - x\tanh x\right], \text{ where } x = \mu B/kT.$$

Find the value of S as $T \to 0$ and $T \to \infty$.