

1. Consider an ensemble of spin-1/2 particles trapped in a lattice configuration. Derive an expression for the entropy, heat capacity and magnetic moment of the system. Sketch the functions.
2. Explain how the second law of thermodynamics and magnetization can be used to determine the temperature of a spin-1/2 system.
Hint: Consider the magnetization at finite and zero field and their relationship to entropy.
3. Derive the expression for the demagnetization field of a uniformly in z-direction magnetized cylinder

$$B_d = -\frac{1}{3}\mu_0 \frac{M}{V}.$$

Hint: Use the magnetostatic Poisson equation.

4. In the lecture an adiabatic demagnetization refrigerator was presented, where the second cooling stage is using the paramagnetic salt FAA. How many mols FAA are needed to achieve the promised cooling power of 118 mJ at 100 mK? You can assume the high temperature approximation for E is sufficient.