Chapter 1

Chapter 3 - Problems

Problem 1

a) Given one Bohr magneton (m_b) in the Earth's field (40 μT), write a program using python that calcuates magnetostatic interaction energy (-$m_b B \cos\theta$) for angles 0$\rightarrow$ 180°. Make a plot of this with the **matplotlib** module in Python (see online PmagPy documentation).

b) Calculate the thermal energy at room temperature (300K). How does this compare with the interaction energy?

Problem 2

Fayalite (Fe_2SiO_4) is a paramagnetic solid with magnetic susceptibility $\chi =$ 4.4 x 10^{-4} (cgs units) at 0°C (= 273K). A single crystal of fayalite has a volume of 2 cm^3. This crystal is placed in a magnetic field, H = 10 oe at 0°C. What is the resulting induced magnetic moment m of this crystal?

a) Do this problem first in cgs units. Then convert your answer to SI using the conversion factors in Table 1.1 in Chapter 1 Problems.

b) Do the problem again by first converting all the parameters into SI units. Check your answer by converting the SI answer that you get back to cgs. You should get the same answer (but you would be surprised how many people do this wrong).

Problem 3

If fayalite is placed in a magnetic field H= 100 oe at a temperature of 500°C (= 773K), what is the resulting magnetization, M?

Problem 4

MnS is a paramagnetic solid. At 300K there are 4 x 10^{28} molecules of MnS per m^3. Look up the number of unpaired spins for the cationic magnetic moment of Mn^{2+} in the text and find the paramagnetic susceptibility, χ, of MnS at 300K?

Problem 5

a) Read into a Pandas DataFrame the datafile 'BMoskinBan91.txt' provided. Make a plot of magnetization versus temperature. What is the Curie temperature of the material?

b) Using this Equation 3.11 from the text:

$$\frac{M_s(T)}{M_s(T_o)} = [\frac{T_c - T}{T_c - T_o}]^{\gamma}, \tag{1.1}$$

Find the value for γ between 0.3 and 0.4 at intervals of 0.1 that fits the best. Plot the data as in Figure 3.8 in the text, i.e. $M_s(T)/Ms(T_o)$ against T/T_c.