Assignment 7.1

Question 1:

Consider a long solenoid with a core that is an iron alloy. Suppose that the diameter of the solenoid is 2 cm and the length of the solenoid is 20 cm. The number of turns on the solenoid is 200. The current is increased until the core is magnetized to saturation at about I = 2 A and the saturated magnetic field B_{sat} is 1.6 T.

a. What is the magnetic field intensity, B_0 at the center of the solenoid and the applied magnetic field, H?

b. What is the saturation magnetization M_{sat} of this iron alloy?

c. If we were to have the same magnetic field of 1.6 T inside the solenoid *without* the iron-alloy core, how much current would we need? Is there a practical way of doing this?

Question 2:

Sometimes magnetic susceptibilities are reported as molar or mass susceptibilities. **Mass susceptibility** (in $m^3\ kg^{-1}$) is χ_m/ρ where ρ is the density. **Molar susceptibility** (in $m^3\ mol^{-1}$) is $\chi_m(M_{at}/\rho)$ where M_{at} is the atomic mass. Terbium (Tb) has a magnetic molar susceptibility of 2 $cm^3\ mol^{-1}$. Tb has a density of 8.2 g cm^{-3} and an atomic mass of 158.93 g mol^{-1}. What is its susceptibility, mass susceptibility and relative permeability? What is the magnetization in the sample in an applied magnetic field of 2 T?

Question 3:

Consider bismuth with $\chi_m = -17\times10^{-5}$ and aluminum with $\chi_m = 2\times10^{-5}$. Suppose that we subject each sample to an applied magnetic field B_o of 1 T applied in the $+x$ direction. What is the magnetization **M** and the equivalent magnetic field $\mu_o M$ in each sample? Which is paramagnetic and which is diamagnetic?