Assignment 7.2

Question 1:

Consider dysprosium (Dy), which is a rare earth metal with a density of 8.54 g cm^{-3} and atomic mass of 162.50 g mol^{-1}. If the saturation magnetization of Dy near absolute zero of temperature is 2.4×10^6 Am^{-1}, what is the magnetic moment per atom in Bohr-magneton μ_B? What is the exchange energy E_{ex} in eV per atom in Dy if the Curie temperature is 85 K?

Question 2:

The energy of a domain wall depends on two main factors: the exchange energy E_{ex} (J/atom) and magnetocrystalline energy K (J m^{-3}). If a is the interatomic distance, $\delta'$is the wall thickness, then it can be shown that the potential energy per unit area of the wall is

$$U_{\text{wall}} = \frac{\pi^2 E_{\text{ex}}}{2a\delta} + K\delta \qquad \textit{Potential energy of a domain wall}$$

Show that the minimum energy occurs when the wall has the thickness

$$\delta' = \left(\frac{\pi^2 E_{\text{ex}}}{2aK} \right)^{1/2} \qquad \textit{domain wall thickness}$$

and show that when $\delta = \delta'$, the exchange and anisotropy energy contributions are *equal*.

Question 3:

Estimate the potential energy and wall thickness of a domain wall for Ni. The properties of Ni are given in Table 8.4 from lecture notes.