

23. The saturation magnetization corresponds to complete alignment of all atomic dipoles and is given by $M_{\text{sat}} = \mu n$, where n is the number of atoms per unit volume and μ is the magnetic dipole moment of an atom. The number of nickel atoms per unit volume is $n = \rho/m$, where ρ is the density of nickel. The mass of a single nickel atom is calculated using $m = M/N_A$, where M is the atomic mass of nickel and N_A is Avogadro's constant. Thus,

$$\begin{aligned} n &= \frac{\rho N_A}{M} = \frac{(8.90 \text{ g/cm}^3)(6.02 \times 10^{23} \text{ atoms/mol})}{58.71 \text{ g/mol}} \\ &= 9.126 \times 10^{22} \text{ atoms/cm}^3 = 9.126 \times 10^{28} \text{ atoms/m}^3 . \end{aligned}$$

The dipole moment of a single atom of nickel is

$$\mu = \frac{M_{\text{sat}}}{n} = \frac{4.70 \times 10^5 \text{ A/m}}{9.126 \times 10^{28} \text{ m}^3} = 5.15 \times 10^{-24} \text{ A}\cdot\text{m}^2 .$$