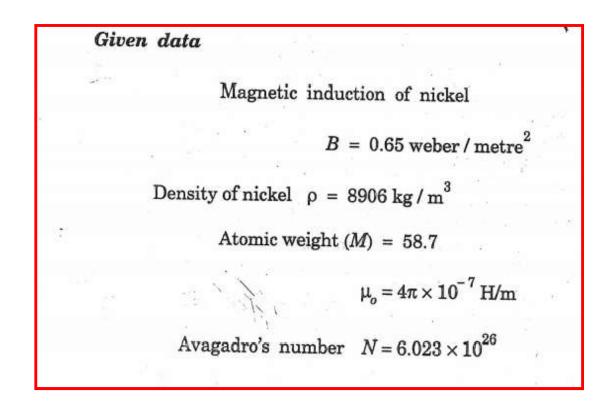
18PYB101J-Electromagnetic Theory, Quantum Mechanics, Waves and Optics

Module I Lecture-4

Solving Problems

1. The saturation magnetic induction of nickel is 0.65 weber/metre². If the density of nickel is 8906 kg/m³ and atomic weight is 58.7, calculate the magnetic moment of nickel atom in Bohr magneton.



Solution

We know that $B = N\mu_0\mu_m$

 $N=\rho N/M$

N is the number of atoms per unit volume (atoms/m³)

Substituting the given values, we have

$$N = \frac{8906 \times 6.023 \times 10^{26}}{-58.7}$$

$$N = 9.14 \times 10^{28} \text{ atoms / m}^{3}$$

$$\mu_{m} = \frac{B}{N\mu_{0}}$$

$$[: : B = N \mu_{o} \mu_{m}]$$

$$\mu_{m} = \frac{0.65}{9.14 \times 10^{28} \times 4\pi \times 10^{-7}}$$

$$\mu_{m} = 5.66 \times 10^{-24} \text{ ampere / metre}^{2}$$
We know that 1 Bohr magneton
$$= 9.27 \times 10^{-24} \text{ Am}^{2}$$

$$\mu_{m} = \frac{5.66 \times 10^{-24}}{9.27 \times 10^{-24}}$$

$$\mu_{m} = 0.61 \text{ Bohr magneton.}$$

18PYB101J Module-II Lecture- 10

2. A paramagnetic material has bcc structure with a cube edge of 2.5×10^{-10} m. If the saturation value of magnetization is 1.8×10^6 ampere/metre. Calculate the average magnetisation contributed per atom in Bohr magneton.

Given data

Interatomic distance
$$\alpha = 2.5 \text{ Å} = 2.5 \times 10^{-10} \text{ m}$$

Magnetisation
$$M = 1.8 \times 10^6 \,\mathrm{Am}^{-1}$$

Electronic charge 'e' =
$$1.6 \times 10^{-19}$$
 coulomb

Planck's constant
$$h = 6.625 \times 10^{-34} \text{ Js}$$

Solution

Number of atoms per unit volume

 $= \frac{\text{No. of atoms in an unit cell}}{\text{volume of the unit cell (a}^3)}$

$$= \frac{2}{(2.5 \times 10^{-10})^3} = 1.28 \times 10^{29} \,\mathrm{m}^3$$

Total magnetisation $M = 1.8 \times 10^6 \,\mathrm{Am}^{-1}$

Average magnetisation produced per atom

$$= \frac{1.8 \times 10^6}{1.28 \times 10^{29}} = 1.406 \times 10^{-23} \,\mathrm{Am}^{-2}$$

Bohr magneton $\mu_B = \frac{eh}{4\pi m}$

$$\mu_B = \frac{1.6 \times 10^{-19} \times 6.625 \times 10^{-34}}{4 \times 3.14 \times 9.1 \times 10^{-31}}$$

$$= 9.27 \times 10^{-24} \, \text{Am}^{-2}$$
 Average magnetisation produced per atom in Bohr magneton
$$= \frac{1.4065 \times 10^{-23}}{9.27 \times 10^{-24}}$$

$$= 1.52 \, \text{Bohr magneton}$$

3. Magnetic field intensity of a paramagnetic material is 10^4 ampere/metre. At room temperature its susceptibility is 3.7×10^{-3} . Calculate the magnetization of the material.

Hint: $M = \chi H$

Ans: 37 ampere/metre