

22. (a) The number of iron atoms in the iron bar is

$$N = \frac{(7.9 \text{ g/cm}^3) (5.0 \text{ cm}) (1.0 \text{ cm}^2)}{(55.847 \text{ g/mol}) / (6.022 \times 10^{23} / \text{mol})} = 4.3 \times 10^{23} .$$

Thus the dipole moment of the iron bar is

$$\mu = (2.1 \times 10^{-23} \text{ J/T}) (4.3 \times 10^{23}) = 8.9 \text{ A}\cdot\text{m}^2 .$$

- (b) $\tau = \mu B \sin 90^\circ = (8.9 \text{ A}\cdot\text{m}^2)(1.57 \text{ T}) = 13 \text{ N}\cdot\text{m}.$