HOMEWORK SET 10: MAGNETIC MOMENT
Due Friday, February 21, 2025

PROBLEMS FROM TZDII[1]

9.11) A typical atomic magnetic moment is of order 10^{-23} A·m^2. Assuming that this is the result of a current i circulating around a singular circular loop of radius 0.1 nm, how big is i? Comment on the reasonability of this value.

9.12) The energy of a magnetic moment $\vec{\mu}$ in a magnetic field B pointing along the z axis is $-\mu_z B$. For an electron in orbit about a proton, μ_z is given by (9.35) as

$$\mu_z = -\frac{e}{2m_e} L_z$$

If B = 10 T (a large field by the standards of most laboratories … $B_{\text{Earth, Canton}}$ = 53.27 μT) and if the electron is in a p state with $L_z = \hbar$, what is the magnetic energy due to the orbital magnetic moment (in joules and in eV)? (IN CALCULATIONS, USE THE VALUE OF THE BORN MAGNETON GIVEN ON THE INSIDE FRONT COVER AND AVAILABLE AS TZDII CONSTANTS AT THE TOP OF THE ASSIGNMENTS PAGE.)

9.14) a) Verify that the Bohr magneton, $\mu_B = e\hbar/2m_e$ has the units of the magnetic moment: namely ampere·meter^2.
b) Verify that the units of ampere·meter^2 are the same thing as joule/tesla. (Remember that the tesla is the unit of the B field defined by the Lorentz-force equation $\vec{F} = q\vec{v} \times \vec{B}$.)
c) Claculate the value of the Bohr magneton in joule/tesla, and eV/tesla.

PROBLEM FROM AOD

1) Explain the unit of energy, the electron-volt (eV). What physical situation defines the value of 1 eV? Explain how to convert 1 eV to joules.

[1] Taylor, Zafiratos, & Dubson, *Modern Physics for Scientists and Engineers*, 2nd Editon, Pearson, Prentice Hall, 2004