#5. In problem 7-40, you estimate the magnitude of the magnetic field B that an electron would be experiencing in an atom. The book claims that this field, which is responsible for the spin-orbital splitting, can be thought of as resulting from a "relative motion" of the nucleus around the electron. (Of course, the "relative motion" of the nucleus around the electron or of the electron around the nucleus is a classical analogy of an essentially quantum phenomenon.) Using this classical analogy, verify whether the value of B that you obtained is consistent with the concept that this field is generated by the nucleus charge moving around the electron.

#6. The quantization of angular momentum asserts that $L_z = \hbar m$. This requires that $\hbar m$ is the eigenvalue of the operator $\hat{L}_z$, where this operator is the z-projection of the operator for $\boldsymbol{L}=\boldsymbol{r}\times\boldsymbol{p}$ (Notice that the impossibility to determine the values of L_x and L_y implies that the corresponding operators do not produce real eigenvalues.)

a) Write down the operator $\hat{L}_z$ in Cartesian coordinates.
b) Derive or look up this operator in spherical coordinates.
c) Show that $\hbar m$ is indeed the eigenvalue of this operator, i.e.
$\hat{L}_z \Psi = \hbar m\ \Psi$, where Ψ is the hydrogen atom wavefunction.