1) The fine-structure splitting of the $2P_{3/2}$ and $2P_{1/2}$ states in hydrogen is $4.5 \times 10^{-5}$ eV. From this, estimate the magnetic field magnitude that the $2p$ electron in hydrogen experiences. Assume $B$ is parallel to the $z$ axis.

**NOTE:** The uppercase letter in spectroscopic notation is used when we include the total angular momentum value as in $2P_{3/2}$. The lowercase letter is used when total angular momentum is not included, such as $2p$.

2) Calculate the degeneracy of a given $l$ state by summing all the possible $m_l$ values for an arbitrary value of $l$.

3) Use the above result to calculate the degeneracy of a given shell (i.e., a specific value for $n$) by summing all the possible values of $l$.

4) How many different energy levels in a $3d$ electron will result from the spin-orbit interaction? Write these different states in spectroscopic notation.