HOMEWORK SET 11: ZEEMAN EFFECT
Due Monday, February 24, 2025

PROBLEMS FROM TZDII[1]

9.15) A helium atom is in an energy level with one electron occupying an s state ($\ell = 0$) and the other an f state ($\ell = 3$). The two electron spins are antiparllel so that the spin magnetic moments cancel. The atom is placed in a magnetic field B = 0.8 T.

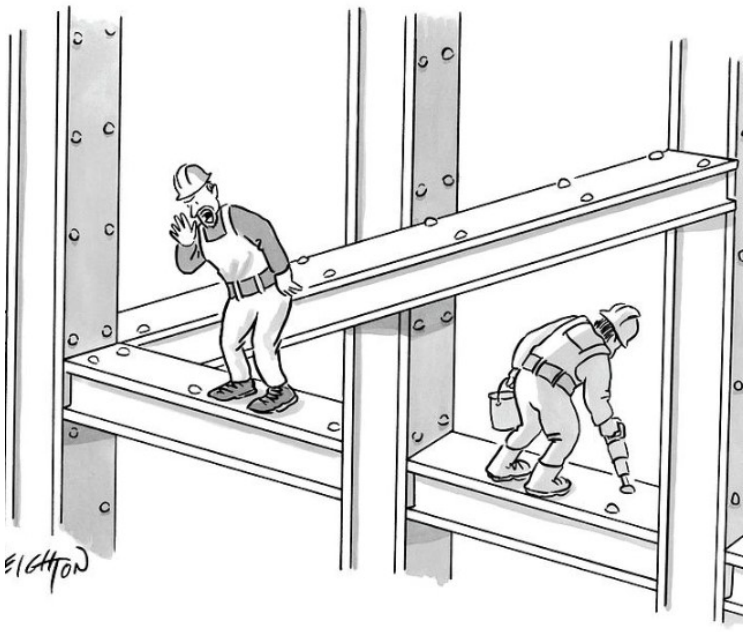
a) Sketch the resulting splitting of the original energy level. (MAKE A NEAT, SCALED SKETCH USING YOUR RULER.)

b) What is the energy difference between adjacent levels of the resulting multiplet? (THE ENERGY OF THE m^{TH} LEVEL IS $E_m = m\mu_B B$. FIND THE DIFFERENCE BETWEEN TWO ADJACENT LEVELS BY TAKING $E_m - E_{m-1}$.)

9.19) A hydrogen atom in its ground level, is placed in a magnetic field of 0.7 T along the z axis.

a) What is the energy difference between the spin-up and spin-down states?

b) An experimenter wants to excite the atom from the lower to the upper state by sending in photons of the appropriate energy. What energy is this? What is the wavelength? What is the frequency? What kind of radiation is this? (Visible? UV? IR?) (PUT VALUES IN APPROPRIATE UNITS, e.g. 1420 MHZ INSTEAD OF 1.42×10^9 HZ. AS A GENERAL RULE OF THUMB, KEEP 3 SIGNIFICANT DIGITS … DON'T ROUND DOWN TO ONE SIGNIFICANT DIGIT BECAUSE WE GIVE 0.7 T INSTEAD OF 0.700 T.)



"Escher! Get your ass up here."

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