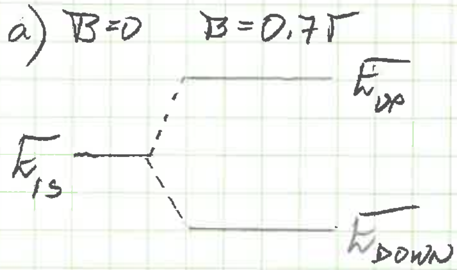
9.19) For H in the ground state in $B_z = 0.7T$, find

a) Energy difference between spin-up & spin-down states

b) E_{photon}, λ_{photon} to excite e^- from lower to upper state

a)



The energy change in $\vec{B} \neq 0$ is

$$\Delta E = \pm \frac{e\hbar}{2m_e} B = \pm \mu_B B \qquad (9.27)$$

Thus, the energy of the spin-up and spin-down states are

$$\Delta E_{up} = E_{1s} + \mu_B B \quad \text{and} \quad \Delta E_{down} = E_{1s} - \mu_B B$$

The energy difference between them is

$$\Delta E_{up\text{-}down} = E_{up} - E_{down} = 2\mu_B B$$

For $\mu_B = 5.79 \times 10^{-5} \frac{eV}{T}$ and $B = 0.7T$

$$\Delta E_{up\text{-}down} = 2(5.79 \times 10^{-5})(0.7) = \boxed{8.12 \times 10^{-5}\,eV = \Delta E_{up\text{-}down}}$$

b) A photon to excite an e^- from spin-down to spin-up is

$$\lambda = \frac{hc}{\Delta E_{up\text{-}down}} = \frac{1240}{8.12 \times 10^{-5}} = 1.53 \times 10^{7}\,nm$$

$$\lambda = 1.53\,cm \Rightarrow f = \frac{c}{\lambda} = \frac{3 \times 10^{8}}{1.53 \times 10^{-2}} = 19.6\,GHz$$

⇒ Radio K-band photon (Kurz, German for "short")

e.g. Wikipedia Radio Spectrum page, IEEE bands