Problem set "Radiation"

Due May 5, 2025

Problem I

The electron of a classical hydrogen atom is at radius equal to the Bohr radius at time $t = 0$.

(a) Derive an expression for the time it takes for the radius of the orbit of the electron to decrease to zero due to radiation. Assume that the energy loss per revolution is small compared with the remaining total energy of the atom.

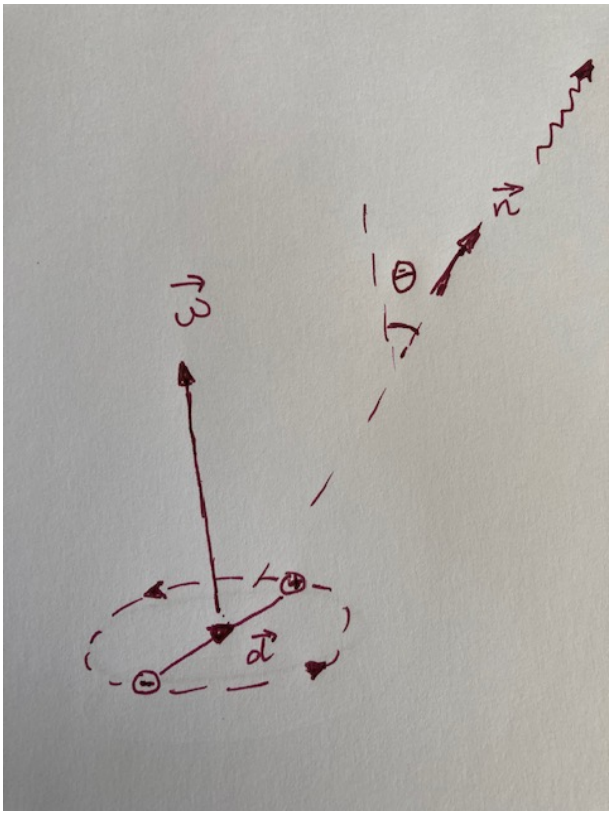
(b) Give the order of magnitude of the lifetime of the hydrogen atom in classical electrodynamics.

Every physicist should know that:

- The electron mass = 0.51 MeV/c^2
- The ground state energy of the hydrogen atom = -13.6 eV
- The Bohr radius = 0.53 Å

Problem II

A dipole $\vec{d}$ rotates in a plane with constant angular velocity $\vec{\omega}$:



(a) Find the angular distribution of the radiation averaged over a period of rotation.

(b) Determine the total radiative power.

(c) Describe the polarization of the TEM wave radiated in the direction defined by the unit vector $\vec{n}$, see figure. Under what conditions would the wave be left circularly, right circularly and linearly polarized?