PHYS306 Homework#6

(Q#1-Q#4 Due on 10Apr2022 and Q#5-Q#8 Due on 12Apr2022)

Q#1:

Check that the retarded potentials of an oscillating dipole satisfy the Lorentz gauge condition.

Q#2:

Find the radiation resistance of the wire joining the two ends of the dipole. (This is the resistance that would give the same average power loss-to heat-as the oscillating dipole in fact puts out in the form of radiation). Show that $R = 790\left(\frac{d}{\lambda}\right)^2\ \Omega$, where λ is the wavelength of the radiation. For the wires in an ordinary radio (say, d=5 cm), should we worry about the radiative contribution to the total resistance?

Q#3:

A rotating electric dipole can be thought of as the superposition of two oscillating dipoles, one along the x-axis, and the other along the y-axis, with the latter out of phase by 90°.

$$\vec{\boldsymbol{p}} = p_o[\cos(\omega t)\,\hat{x} + \sin(\omega t)\,\hat{y}]$$

(a) Using the principle of superposition and equations 11.18 and 11.19 (electric and magnetic fields of an oscillating electric dipole), find the electric and magnetic fields of a rotating dipole.
(b) Also find the pointing vector and the intensity of the radiation.
(c) Sketch the intensity profile as a function of the polar angle θ using Mathematica.
(d) Calculate the total power radiated.

Q#4:

(a) Calculate the electric and magnetic fields of an oscillating magnetic dipole without using approximation 3.
(b) Find the poynting vector and intensity of the radiation.

Q#5:

Find the radiation resistance for the oscillating magnetic dipole in the figure below. Express your answer in terms of λ and b , and compare the radiation resistance of the electric dipole in Q#2 of this homework.

Q#6:

An insulating circular ring (radius b) lies in the xy-plane, centered at the origin. It carries a linear charge density $\lambda = \lambda_o \sin\phi$, where λ_o is constant and ϕ is the azimuthal angle. The ring is now set spinning at a constant angular velocity ω about the z-axis. Calculate the power radiated.

Q#7:

An electron is released from rest and falls under the influence of gravity. In the first centimeter, what fraction of the potential energy lost is radiated away?

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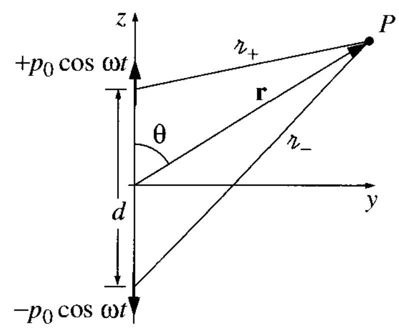
Q#8:

As a model for electric quadrupole radiation, consider two oppositely oriented oscillating electric dipoles, separated by a distance d, as shown in Fig below. Use the results of article 11.1.2 in the book (electric dipole radiation) but keep in mind that here they are not located at the origin. Keeping only the terms of first order in *d*:



(a) Find the scalar and vector potentials.
(b) Find the electric and magnetic fields.
(c) Find the Poynting vector and the power radiated. Sketch the intensity profile as a function of θ (using Mathematica).