

Physics prelim exam (Electromagnetism, Spring 2016)

Please pick two problems to complete and specify explicitly which two problems you pick.

Problem 1

At one instant, the electric and magnetic fields at one point of an EM wave are:

$$\vec{E} = (200\hat{x} + 300\hat{y} - 50\hat{z}) \text{ V/m}$$

$$\vec{B} = B_0(7.3\hat{x} - 7.3\hat{y} - a\hat{z}) \times 10^{-6} \text{ T}$$

- What are the values of a and B_0 ?
- What is the Poynting vector at this time and position?

Problem 2

You have an imaginary device to measure any parameter you wish of both electric and magnetic fields (amplitude, phase, frequency, wavelength). You have a mystery thin sheet of material (thickness of 0.1 micron) on which a 1 MHz electromagnetic field is incident - how will you determine if it is a conductor or dielectric?

Your device cannot measure anything except the above. For a comparative measure, copper has a skin depth of 1 micron at 1 MHz.

Problem 3

A positively charged particle with charge q and mass m , and with velocity $\vec{v} = v_0\hat{x}$ is injected at time $t = 0$ into a region of the x - y plane where there is a uniform magnetic field $\vec{B} = B_0\hat{z}$

Assume that $v \ll c$ and that any observer is far away.

- Find an expression for the radius R of the circular trajectory of the particle in terms of m , q , v_0 , and B_0 .
- What is the angular frequency ω of the radiation?
- What is the acceleration of the particle at time t ? Give the magnitude and direction
- Give the magnitude and direction of the electric field E detected by a distant observer at $+r_0\hat{z}$. What is the nature of the polarization? By "nature" explain if it is polarized at all, and if so, is it linearly polarized or circularly or elliptically polarized?