BIRZEIT UNIVERSITY
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Department of Physics دائرة الفيزياء

Phys332/Homework
Due on Thursday 6/12/2021

1. An electromagnetic plane wave propagating in free space is described by

$$\vec{E}(x,y,z,t) = \alpha V_0 \cos(\alpha(2x-3y)-\omega t)\hat{z}$$

Find the following in terms of c, V_0 and α

   a. The angular frequency, wave length and period of the wave.
   b. The direction of propagation.
   c. The magnetic field of the wave.
   d. The average electromagnetic energy density.
   e. If this wave from the vacuum region ($2x - 3y < 0$) approaches normally a nonmagnetic media of the refractive index $n = \frac{7}{\sqrt{13}}$ in the filled region ($2x - 3y > 0$), find the reflected electric field.

2. An electromagnetic plane wave travelling in vacuum along the x-axis. The corresponding vector potential $\tilde{\vec{A}}(x,y,z,t)$ and scalar potential $\tilde{V}$ can, in complex notation, be chosen as

$$\tilde{\vec{A}} = \left(\tilde{a}_x\hat{x} + \tilde{a}_y\hat{y} + \tilde{a}_z\hat{z}\right)e^{i(kx-\omega t)} \text{ and } \tilde{V} = c\tilde{a}_x e^{i(kx-\omega t)}$$

respectively, where $\tilde{a}_x$, $\tilde{a}_y$ *and* $\tilde{a}_z$ are constants, and c is the speed of light.

   a. Find the electric and magnetic fields.
   b. Show that both fields satisfy the electromagnetic wave equations.
   c. Find the polarization of the wave.
   d. Calculate the force on a point charge q located at the origin at time $t = 0$ moving along the x-axis with speed v.
   e. For what speed does the force vanish (irrespectively of the phases of $\tilde{a}_y$ *and* $\tilde{a}_z$)?

Additional recommended Problems (do not hand in your solution for them):

9.17

9.20

9.31

9.35