PH481 Homework 1

Due: Wednesday, 18th of January 2023

2.53 Write an expression in Cartesian coordinates for a harmonic plane wave of amplitude A and frequency ω propagating in the direction of the vector $\vec{\mathbf{k}}$, which in turn lies on a line drawn from the origin to the point (4, 2, 1). [*Hint:* First determine $\vec{\mathbf{k}}$ and then dot it with $\vec{\mathbf{r}}$.]

3.5* An electromagnetic wave is specified (in SI units) by the following function:

$$\vec{\mathbf{E}} = (-6\hat{\mathbf{i}} + 3\sqrt{5}\,\hat{\mathbf{j}})(10^4\ \mathrm{V/m})\, e^{i\left[\frac{1}{3}(\sqrt{5}x+2y)\pi\times 10^7 - 9.42\times 10^{15}t\right]}$$

Remember that $\vec{\mathbf{E}}_0$ and $\vec{\mathbf{k}}$ are perpendicular to each other.

Find (a) the direction along which the electric field oscillates, (b) the scalar value of amplitude of the electric field, (c) the direction of propagation of the wave, (d) the propagation number and wavelength, (e) the frequency and angular frequency, and (f) the speed.

3.32 A 3.0-V incandescent flashlight bulb draws 0.25 A, converting about 1.0% of the dissipated power into light ($\lambda \approx 550$ nm). If the beam has a cross-sectional area of 10 cm^2 and is approximately cylindrical,

(a) How many photons are emitted per second?

(b) How many photons occupy each meter of the beam?

(c) What is the flux density of the beam as it leaves the flashlight?

In this case, the flux density means radiant flux density (W/m^2)

3.55* A lightwave travels from point A to point B in vacuum. Suppose we introduce into its path a flat glass plate ($n_g = 1.50$) of thickness $L = 1.00$ mm. If the vacuum wavelength is 500 nm, how many waves span the space from A to B with and without the glass in place? What phase shift is introduced with the insertion of the plate?