Discussion Question 12B
P212, Week 12
Electromagnetic Waves

A laser beam travels through vacuum. The electric field of the plane electromagnetic wave produced by the laser has the form given below. The wavelength of the beam is λ = 514 nm, and the amplitude of the electric field is E_0 = 2.5 x 10^4 N/C.

$$\vec{\boldsymbol{E}}(x,y,z,t) = \hat{y}\ \ E_0 \cos(kz + \omega t - 45^\circ)$$

(a) In what direction is this wave propagating?

What does "propagating wave" mean anyway? It means that the *shape* of the wave remains the *same* as a function of time, it just moves. The shape of the wave is determined by that cosine. As time rolls forward, how do you have to change position so that the shape looks the *same*?

(b) What are the magnitudes of the wave number *k* and angular frequency ω?

(c) Make a sketch of what the E field looks like at some moment in time.

(d) Write down an expression for the magnetic field $B(x,y,z,t)$. Express your answer <u>algebraically</u> (i.e. no numbers) in terms of the symbols k, ω, and B_0 (the latter being the magnetic field amplitude). Be sure to indicate the <u>direction</u> of the magnetic field.

The $\boldsymbol{E}$ and $\boldsymbol{B}$ fields of an electromagnetic wave have a fixed relationship to the direction of propagation of the wave. You know the direction of the wave, and the direction of $\boldsymbol{E}$, so you can figure out the direction of $\boldsymbol{B}$ with the help of your sketch. Add the $\boldsymbol{B}$-field to your drawing in part (c).

(e) What is the amplitude B_0 of the magnetic field?