Discussion Question 13A
P212, Week 13
Electromagnetic Waves

This problem is a continuation of discussion question 12B from last week. Please refer to your work from last week as necessary.

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) What is the intensity *I* of the wave? Be sure to indicate the <u>units</u> of your answer.

(b) A solar cell is an example of a photo-sensitive detector that absorbs the energy of incident electromagnetic radiation and converts it into useful power (with which to operate your solar-cell calculator, for example). Suppose our electromagnetic wave is incident on a small, square photo-sensitive detector of side 2 mm. You can assume that this detector is smaller than the wave itself, and is oriented so that its surface is perpendicular to the incoming beam. You can also assume that the detector is 100% efficient at converting all the radiative energy incident on it into useful power. What, then, is the average power <*P*> that our detector would generate?

As always, <u>units</u> are an enormous help. The units of your answers to previous parts of the problem (including last week's) tell you how to determine the answer to this question!