Quiz 5

Name: _____

Total = 10 marks

1. (2 marks) Explain why the following cannot be an electromagnetic wave in vacuum. i.e. Show it does not satisfy a Maxwell equation.

$$\vec{E} = E_0(\cos(2x-\omega t), \sin(2x-\omega t), \cos(2x-\omega t))$$

$$\nabla\cdot\vec{E} = \frac{\partial E_x}{\partial x} + \frac{\partial E_y}{\partial y} + \frac{\partial E_z}{\partial z}$$

$$= -E_0 2\sin(2x-\omega t)$$

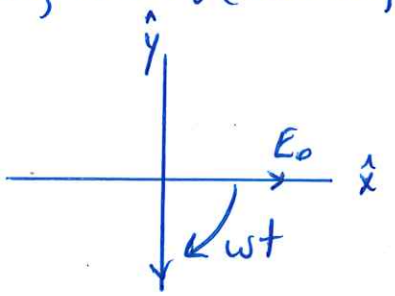
$$\neq 0.$$

2. (4 marks) The electric field of an electromagnetic wave is given by the following.

$$\vec{E} = E_0(\cos(kz-\omega t), \sin(kz-\omega t), 0)$$

a) Explain why this wave is called circularly polarized.

$$\vec{E}(z=0, t) = E_0(\cos\omega t, -\sin\omega t, 0)$$



at $t=0$ $\vec{E} = E_0\hat{x}$

$t = \frac{\pi}{2\omega}$ $\vec{E} = -E_0\hat{y}$

b) Find an expression for the magnetic field.

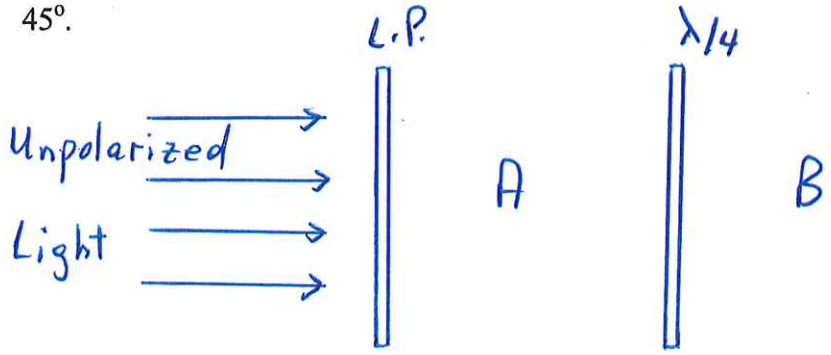
$$-\frac{1}{c}\frac{\partial\vec{B}}{\partial t} = \nabla\times\vec{E}$$

$$= (-E_0 k\cos(kz-\omega t), -E_0 k\sin(kz-\omega t), 0)$$

$$\frac{\partial\vec{B}}{\partial t} = E_0 kc(\cos(kz-\omega t), \sin(kz-\omega t), 0)$$

$$\vec{B} = \frac{E_0 kc}{\omega}(-\sin(kz-\omega t), \cos(kz-\omega t), 0)$$

3. (4 marks) Unpolarized light passes first through a linear polarizer and afterwards through a quarter waveplate as shown below. The linear polarizer transmits light aligned along the x direction. The quarter waveplate introduces a 90^{o} phase shift between light polarized along the x' and y' directions where the angle between the x and x' directions is 45^{o}.



a) What is the light polarization at locations A and B.

A: Light is linearly polarized along $\hat{x}$.

B: " " circularly polarized

b) Repeat the question if the linear polarizer and quarter waveplate are interchanged?

A: Light is unpolarized

B: Light is linearly polarized along $\hat{x}$.