Exercise 9

Introduction to Electrodynamics

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Solution Verified

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a)

Using the Eq.9.51) and 9.52) with $\hat{n} = \hat{z}$ and $\vec{k} = -k\hat{x}$ the electric and magnetic fields are:

$$\vec{E} = E_0 \cos(-kx - \omega t)\hat{z} = E_0 \cos(kx + \omega t)\hat{z}$$

$$\vec{B} = \frac{E_0}{c} \cos(-kx - \omega t)(-\hat{x} \times \hat{z}) = \frac{E_0}{c} \cos(kx + \omega t)\hat{y}$$

$$\boxed{\vec{E} = E_0 \cos(kx + \omega t)\hat{z}}$$

$$\boxed{\vec{B} = \frac{E_0}{c} \cos(kx + \omega t)\hat{y}}$$

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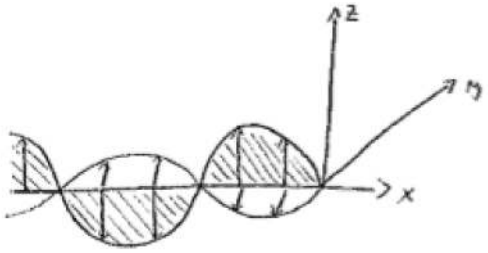
The shaded portion of the wave is the electric component of the fields.



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b)

The wave vector is:

$$\vec{k} = \frac{k}{\sqrt{3}}(\hat{x} + \hat{y} + \hat{z})$$

The vector of the electric field polarization is parallel to the xz plane, so:

$$\hat{n} = a\hat{x} + b\hat{z}$$

$$\hat{n} \cdot \hat{k} = 0 \implies \frac{a}{\sqrt{3}} + \frac{b}{\sqrt{3}} = 0 \implies b = -a$$

$$||\hat{n}|| = 1 \implies a = \frac{1}{\sqrt{2}}$$

$$\hat{n} = \frac{1}{\sqrt{2}}(\hat{x} - \hat{z})$$

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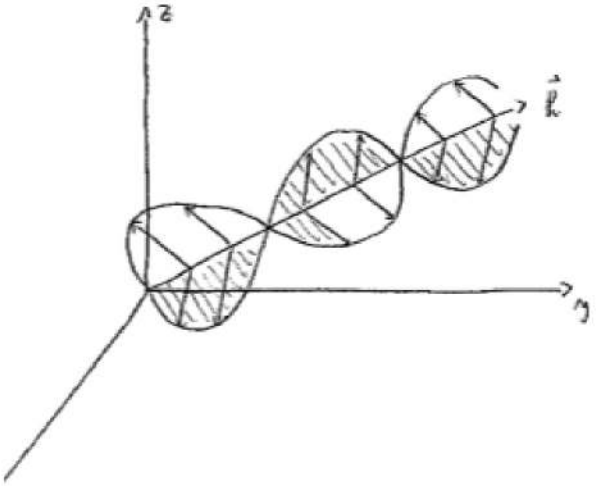
With this the electric and magnetic fields are as follows:

$$\boxed{\vec{E} = \frac{E_0}{\sqrt{2}} \cos\left(\frac{k}{\sqrt{3}}(x+y+z) - \omega t\right)(\hat{x} - \hat{z})}$$

$$\vec{B} = \frac{E_0}{c} \cos\left(\frac{k}{\sqrt{3}}(x+y+z) - \omega t\right) \frac{1}{\sqrt{3}}(\hat{x} + \hat{y} + \hat{z}) \times \frac{1}{\sqrt{2}}(\hat{x} + \hat{z})$$

$$\boxed{\vec{B} = \frac{E_0}{c\sqrt{6}} \cos\left(\frac{k}{\sqrt{3}}(x+y+z) - \omega t\right)(2\hat{y} - \hat{x} - \hat{z})}$$



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a) $\boxed{\vec{E} = E_0 \cos(kx + \omega t)\hat{z} \qquad \vec{B} = \frac{E_0}{c} \cos(kx + \omega t)\hat{y} \qquad \hat{n} = \hat{z} \qquad \hat{k} = -\hat{x}}$

b) $\boxed{\vec{E} = \frac{E_0}{\sqrt{2}} \cos\left(\frac{k}{\sqrt{3}}(x+y+z) - \omega t\right)(\hat{x} - \hat{z}) \qquad \vec{B} = \frac{E_0}{c\sqrt{6}} \cos\left(\frac{k}{\sqrt{3}}(x+y+z) - \omega t\right)(2\hat{y} - \hat{x} - \hat{z}) \qquad \hat{n} = \frac{1}{\sqrt{2}}(\hat{x} - \hat{z}) \qquad \hat{k} = \frac{1}{\sqrt{3}}(\hat{x} + \hat{y} + \hat{z})}$

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