$$E_y = (+30) \cdot \frac{\cos(\vec{k}\cdot\vec{x} - \omega t)}{\omega\mu\varepsilon} \hat{y}$$

$$E_z = -8 \cdot \frac{\cos(\vec{k}\vec{x} - \omega t)}{\omega\mu\varepsilon} \hat{z}$$

$$\boxed{\vec{E} = \cos(3x+5y-6z-\omega t)\frac{1}{\omega\mu\varepsilon}\cdot\left[-66\hat{x} + 30\hat{y} - 8\hat{z}\right]}$$

Pero $c = \frac{\omega}{k} = \frac{1}{(\mu\varepsilon)^{1/2}}$ $\Rightarrow$ $\frac{c}{2} = \frac{1}{2(\mu_0\varepsilon_0)^{1/2}}$ y $\mu\varepsilon = \frac{1}{c^2}$

velocidad general

$$\omega\mu\varepsilon = \frac{\cancel{c}}{\cancel{2}}\sqrt{70}\cdot\frac{1}{\left(\frac{c}{2}\right)^2} = \frac{2\sqrt{70}}{c}$$

$$\boxed{\vec{E} = \cos(3x+5y-6z-\omega t)\left(\frac{c}{2\sqrt{70}}\right)\left[-66\hat{x}+30\hat{y}-8\hat{z}\right]}$$

c) $\lambda = \frac{2\pi}{|\vec{k}|} = \frac{2\pi}{\sqrt{70}}\, m$ suponemos que $[k] = \text{metros}^{-1}$

$$\omega = \sqrt{70}\cdot\frac{c}{2}$$

$$f = \frac{\omega}{2\pi} = \frac{\sqrt{70}\,c}{2\pi\ 2} = \frac{\sqrt{70}\,c}{4\pi}$$

$$\tau = \frac{1}{f} = \frac{4\pi}{\sqrt{70}\cdot c}\ seg$$

$$\vec{k} = 3\hat{x} + 5\hat{y} - 6\hat{z}$$

5.3

$$\vec{E} = 3\cdot\operatorname{sen}(k_x x + k_y y - \omega t)\hat{x} + 4\cdot\operatorname{sen}(k_x x + k_y y - \omega t)\hat{y}$$

$$\vec{k} = (8.10^6, -6.10^6, 0) \qquad \omega = 2.10^{15}$$

a) $c = \frac{\omega}{k} = \frac{2.10^{15}\ 1/seg}{\sqrt{\left(\frac{8.10^6}{m^2}\right)^2 + \left(\frac{6.10^6}{m^2}\right)^2}} = \frac{2.10^{15}\ m/seg}{\sqrt{(64+36).10^{12}}} = \frac{}{1.10^{1/2}.10^{12/2}} = \frac{2.10^{15}\ m/s}{10^7}$

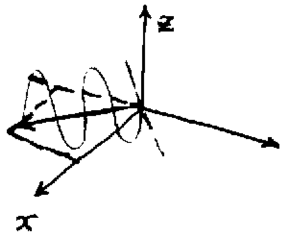
$$\boxed{c = 2.10^8\ m/seg}$$

$$\lambda = \frac{2\pi}{10^7\ 1/m} = 2\pi.10^{-7} m \cong \boxed{6.28\times10^{-7} m \cong \lambda}$$

$\omega = 2\pi f \rightarrow f = \frac{\omega}{2\pi} = \frac{\cancel{2}.10^{15}}{\cancel{2}\pi}\frac{1}{seg}$ $\boxed{\tau = \frac{1}{f} = \pi.10^{-15}\ seg}$

b) $\vec{k} = (8.10^6, -6.10^6, 0)$

$\vec{k}$ vive en el plano xy



c)

$$\vec{H} = \frac{k}{\mu\omega}\hat{k}\times\vec{E}$$, medio transparente $k=(\mu\varepsilon)^{1/2}\omega$

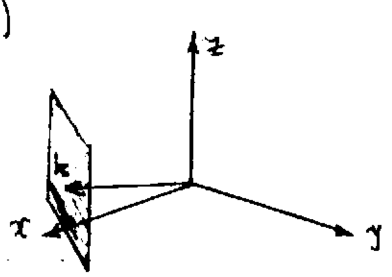
$$\vec{H} = \left(\frac{\varepsilon}{\mu}\right)^{1/2}\hat{k}\times\vec{E}$$

$$\hat{k}\times\vec{E} = \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ 1 & 1 & 0 \\ E_x & E_y & 0 \end{vmatrix} = 0\hat{x} + 0\hat{y} + E_y\hat{z} - 0\hat{x} - 0\hat{y} - E_x\hat{z}$$

$$\hat{k}\times\vec{E} = (E_y - E_x)\hat{z}$$

$$\boxed{\vec{H} = \left(\frac{\varepsilon}{\mu}\right)^{1/2}\cdot \operatorname{sen}\left(8.10^6 x - 6.10^6 y - 2.10^{15} t\right)\hat{z}}$$

d)



$A = (0,10\ m)^2$

$T = 300$ segundos

$\vec{P} = \vec{E}\times\vec{H}$

$$\vec{P} = \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ E_x & E_y & 0 \\ 0 & 0 & H_z \end{vmatrix} = (E_y H_z)\hat{x} + (-E_x H_z)\hat{y}$$

$$\vec{P} = \hat{x}\left(4\cdot\operatorname{sen}^2(\vec{k}\cdot\vec{x} - \omega t)\left(\frac{\varepsilon}{\mu}\right)^{1/2}\right)$$

$$-\hat{y}\left(3\cdot\operatorname{sen}^2(\vec{k}\cdot\vec{x} - \omega t)\left(\frac{\varepsilon}{\mu}\right)^{1/2}\right)$$

$$\vec{P}_{300} = \int_0^{300}\vec{P}\,dt = \hat{x}\,4\left(\frac{\varepsilon}{\mu}\right)^{1/2}\underbrace{\int_0^{300}\operatorname{sen}^2(-\omega t)\,dt}_{\left(-\frac{\operatorname{sen}(600\omega) - 600\omega}{4\omega}\right)} - \hat{y}\,3\left(\frac{\varepsilon}{\mu}\right)^{1/2}\int_0^{300}\operatorname{sen}^2(-\omega t)\,dt$$

$$- \underbrace{\left(-\frac{\operatorname{sen}(600\omega) - 600\omega}{4\omega}\right)}_{=U}$$

$$P_A = \int \vec{P}_{300} \cdot d\vec{S} = \int P_{300}\, dS = P_{300} \cdot A$$

$$\sqrt{\left(4\left(\varepsilon/\mu\right)^{1/2}[H]\right)^2 + \left(3\left(\varepsilon/\mu\right)^{1/2}[H]\right)^2} \cdot (0.10\,m)^2$$

$$\sqrt{(16+9)\left(\frac{\varepsilon}{\mu}\right) H^2} = 5\left(\frac{\varepsilon}{\mu}\right)^{1/2} H \cdot (0.10\,m)^2$$

$$P_A = 5\left(\frac{\varepsilon}{\mu}\right)^{1/2}\left(\frac{|\operatorname{sen}(600\omega) - 600\omega|}{4\omega}\right) 0.01\,m^2$$

$$[P_A] = \frac{W}{\cancel{m^2}}\,\cancel{m^2}\cdot seg = \text{Energía}$$

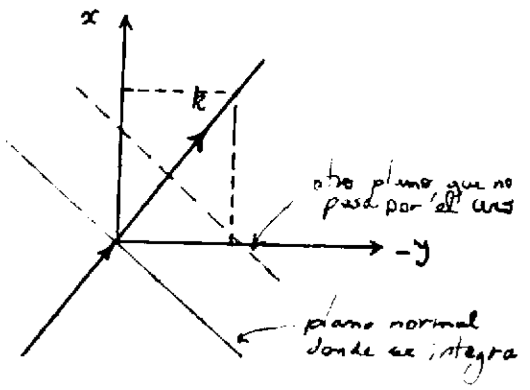
$$\varepsilon = \frac{1}{c^2\mu_0} = \frac{1}{(2\times10^8)^2\left(\frac{m}{s}\right)^2 \, 1.2566\times10^{-6}\,\frac{m.kg}{C^2}} = 1.9895\times10^{-11}\ \frac{C^2 s^2}{m^3 kg}$$

$$P_A = 5.\left(1.5832\times10^{-5}\right)^{1/2} \frac{|\operatorname{sen}(1.2\times10^{18}) - 1.2\times10^{18}|}{8.10^{15}} \cdot 0.01$$

$$\boxed{P_A = 0.029842 \ \text{Joules}}$$

NOTAS:

Para la integración temporal se elige el plano que pasa por $\vec{x} = 0$



Si elegimos otro plano

$$\int_0^{300} \operatorname{sen}^2(\vec{k}\vec{x} - \omega t)\, dt =$$

$$\frac{\operatorname{sen}(2\vec{k}\vec{x} - \omega.600) - \operatorname{sen}(2\vec{k}.\vec{x}) + 600\,\omega}{4\omega}$$

No importa cuanto oscilen los senos, $\operatorname{sen}(\text{algo}) \lll 600.\omega$

Entonces:

$$\int_0^{300} \operatorname{sen}^2(\vec{k}.\vec{x} - \omega t)\, dt \cong 150.\omega = 150\times 2.10^{15} = 3\times10^{17}\,\frac{1}{seg}$$

5.4

$\vec{E} = E_x\,\hat{x}$;

$\vec{k} = k\,\hat{z}$

$\varepsilon_r = 4 = \varepsilon/\varepsilon_0$
$\mu_r = 1 = \mu/\mu_0$
$\sigma = 0$

(a)

$$E_x = E_0 \cdot \mathrm{sen}(kz - \omega t + \varphi)$$

$$\omega = 2\pi \cdot 100 \times 10^6\ \mathrm{Hz}$$

$$10^{-4}\,\frac{V}{m} = E_0 \cdot \mathrm{sen}\left(k\,\frac{1}{8} - \omega\cdot 0 + \varphi\right)$$

Tiene valor máximo en $z = 1/8$ y $t = 0$ → debe ser fase $= \pi/2$

$$c^2 = \frac{1}{\varepsilon\mu} = \frac{1}{4\varepsilon_0\mu_0} \qquad c = \frac{\omega}{k} \rightarrow \quad k = \frac{\omega}{c} = \omega\sqrt{4\varepsilon_0\mu_0}$$

$$k = 2\omega(\varepsilon_0\mu_0)^{1/2}$$

$$10^{-4}\,\frac{V}{m} = E_0 \cdot \mathrm{sen}\left(\frac{\cancel{2}^{1}\omega(\varepsilon_0\mu_0)^{1/2}}{\cancel{8}_{4}} + \varphi\right)$$

$$k = \frac{2(2\pi)10^8\ 1/s}{3\times 10^8\ m/s}$$

$$c^2 = \frac{1}{\varepsilon_0\mu}$$

$$\varphi = \pi/2 - \pi/6 = \frac{3\pi - \pi}{6} = \frac{2\pi}{6} = \frac{\pi}{3}$$

$\varphi = \pi/3$

$$E_0 = \frac{10^{-4}\ V/m}{\mathrm{sen}\left(\omega(\varepsilon_0\mu_0)^{1/2}/4 + \varphi\right)}$$

$$k = \frac{4\pi}{3}\ 1/m$$

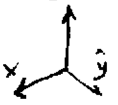
$$\boxed{\vec{E} = \frac{10^{-4}\ V/m}{\underbrace{\mathrm{sen}\left(\pi/6 + \varphi\right)}_{1}} \cdot \mathrm{sen}\left(kz - \omega t + \pi/3\right)\hat{x}}$$

$k = \frac{4\pi}{3}\ 1/m \qquad \omega = 2\pi \times 10^8\ 1/s$

(b) Expresión instantánea de $\vec{H}$

$$\vec{H} = \frac{k}{\mu\omega}\,\hat{k}\times\vec{E}$$

$$\hat{k}\times\vec{E} = \underbrace{(\hat{z}\times\hat{x})}_{\hat{y}}\ 10^{-4}\,V/m \cdot \mathrm{sen}(kz - \omega t + \pi/3)$$



$$\left(\frac{(\cancel{4}^{2}\pi/3)\ 1/m}{\underset{\downarrow\ 4\pi\times 10^{-7}}{\mu_0}\ \cancel{2\pi}\cdot 10^8\ 1/s}\right)\hat{y}\ \ 10^{-4}\ V/m \cdot \mathrm{sen}(kz - \omega t + \pi/3)\,\hat{y}$$

$$= \frac{2}{3(4\pi\times 10^{-7})10^8} \cdot 10^{-4}\ V/m \cdot \mathrm{sen}(kz - \omega t + \pi/3)\,\hat{y}$$

$$\vec{H} = \frac{10^{-4}\ V/m}{6\pi \cdot 10} \cdot \mathrm{sen}(kz - \omega t + \pi/3)\,\hat{y}$$

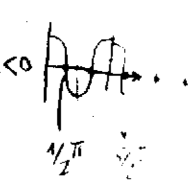
(c)

$$\frac{\partial \vec{E}}{\partial z} = 10^{-4}\,V/m \cdot \cos(kz - \omega t + \pi/3)\,k = 0$$

$$kz - \omega t + \pi/3 = (n + 1/2)\pi$$

$$(2n + 1/2)\pi$$

Máximo positivo y
Tiene que pasar de >0 a <0



$$\frac{4\pi}{3} z - 2\pi \cancel{10^{8}} \cdot \cancel{10^{-8}} + \pi/3 = (2n + 1/2)\pi$$

$$z = (2n\cancel{\pi} + \cancel{\pi}/2 - \cancel{\pi}/3 + 2\cancel{\pi})\frac{3}{4\cancel{\pi}}$$

$$(2n + 1/2 - 1/3 + 2)\,3/4$$

$$2n + \left(\frac{3-2+12}{6}\right)]\,3/4$$

$$\boxed{z = \left(2n + \frac{13}{6}\right)\frac{3}{4}}$$

$z_0 = \frac{13}{8}$ $\quad$ $z_1 = \frac{25}{8}$ $\quad$ $z_2 = \frac{37}{8}$ $\quad \ldots$