PS # 10 Sol'ns PHYS 232

34-7)a) $\vec{E} = 100 \sin(10^7 x - \omega t)\,\hat{y}$

from section, we know that $B_0 = \frac{E_0}{c} = \frac{100\ N/Coulomb}{3\times10^8\ m/s} \simeq \boxed{0.33\ \mu T}$

34-7)b) $k = 10^7\ m^{-1} = \frac{2\pi}{\lambda} \Rightarrow \boxed{\lambda \simeq 0.628\ \mu m}$

34-7)c) $c = \lambda f \Rightarrow \boxed{f \simeq 477.46\ THz}$

34-8) Just use the relation $k^2 = \frac{\omega^2}{c^2} = \mu_0 \varepsilon_0 \omega^2$ to verify the claim.

34-14)a) $u_{E,Av} = u_{B,Av} = \frac{1}{4}\varepsilon_0 E_{max}^2 = \frac{B_{max}^2}{4\mu_0}$

$$S_{Av} = \frac{\mathcal{P}_{Av}}{4\pi r^2} = \frac{E_{max}^2}{2\mu_0 c} = \frac{B_{max}^2 c}{2\mu_0}$$

$\mathcal{P}_{Av} = 100\ W$, $r = 1.0\ m \Rightarrow E_{max} = B_{max} c \simeq 77.46\ N/C$

or $E_{max}^2 = B_{max}^2 c^2 = 6000\ N^2/C^2$, C in units is Coulombs!

(c = speed of light)

$\Rightarrow \boxed{u_{E,Av} = 1.3\times10^{-8}\ J/m^3}$

34-14)b) $\boxed{u_{B,Av} = u_{E,Av} = 1.3\times10^{-8}\ J/m^3}$

34-14)c) $u_{Av} = u_{E,Av} + u_{B,Av} \simeq 2.7\times10^{-8}\ J/m^3$

$$\boxed{I = c\,u_{Av} \simeq 7.96\ W/m^2}$$

34-37)a) $\frac{\partial E}{\partial x} = -\frac{\partial B}{\partial t} = -\frac{1}{2}\mu_0 J_{max}\,\omega \sin(kx - \omega t)$

$\frac{\omega}{k} = c \Rightarrow E = \frac{1}{2}\mu_0 J_{max} c \cos(kx - \omega t) \Rightarrow$ ($\vec{v} = c\hat{x}$ & $\vec{B} = B\hat{z}$)

$$\boxed{\vec{E} = \frac{\mu_0 c J_{max}\,\hat{j}}{2}\cos(kx - \omega t)}$$

34-37)b) $\vec{S} = \frac{(\vec{E}\times\vec{B})}{\mu_0} = \boxed{\frac{\mu_0 c J_{max}^2\,\hat{i}}{4}\cos^2(kx - \omega t)}$

34-37)c) The intensity of the wave is the time-average of the Poynting vector:

$$I = S_{av} = \frac{\mu_0 c J_{max}^2}{4} \left(\cos^2(kx-\omega t)\right)_{av} = \boxed{\frac{\mu_0 c J_{max}^2}{8}}$$

34-37)d) $$J_{max} = \sqrt{\frac{8I}{\mu_0 c}} \simeq \boxed{3.48\ A/m}$$

$I = 570\ W/m^2$

34-38) See Figure 34.12 for classification.

34-40)a) my height = 1.7 m

$c = \lambda f \Rightarrow \boxed{f \approx 1.75 \times 10^8\ Hz,\ \text{Radio wave: TV, FM}}$

34-40)b) thickness $\simeq 40\ \mu m$

$\Rightarrow \boxed{f \simeq 7.5\ THz \\ \text{Infrared}}$