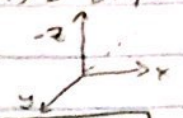
Physics 1C Chapter 32 HW

32.4) a) $\vec{E} = E\hat{i}$, $\vec{B} = -B\hat{j}$



$(0,0,-1)$

b) $\vec{E} = E\hat{j}$, $\vec{B} = B\hat{i}$

$(0,0,-1)$

c) $\vec{E} = E\hat{k}$, $\vec{B} = -B\hat{i}$

$(0,1,0)$

d) $\vec{E} = E\hat{i}$, $\vec{B} = -B\hat{k}$

$(0,1,0)$

32.10) $E = (375\ V/m)\cos[(1.99\times10^{7}\ rad/m)x + (5.97\times10^{15}\ rad/s)t]$

$E = E_{max}\cos[\omega t + kx]$

a) $v = c$

$v = 3\times10^{8}\ m/s$

b) $E_{max} = 375\ V/m$

c) $E_{max} = cB_{max}$

$B_{max} = \frac{E_{max}}{c}$

$B_{max} = 1.25\times10^{-6}\ T$

d) $\omega = 2\pi f$

$f = \frac{\omega}{2\pi}$

$f = 9.5\times10^{14}\ Hz$

e) $\lambda f = c$

$\lambda = \frac{c}{f}$

$\lambda = 3.16\times10^{-7}\ m$

f) $T = 1/f$

$T = 1.05\times10^{-15}\ s$

32.18) $|\langle S\rangle| = 1.40\ kW/m^2$

a) $I = \frac{1}{2}\varepsilon_0 c E_{max}^2$

$E_{max} = \sqrt{\frac{2I}{\varepsilon_0 c}}$

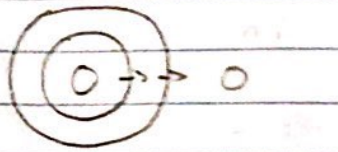
$E_{max} = 1026.9\ V/m$

b) $E_{max} = cB_{max}$

$B_{max} = \frac{E_{max}}{c}$

$B_{max} = 3.42\times10^{-6}\ T$

c) $d = 1.50\times10^{11}\ m$



$A = 4\pi r^2$, $r = d$

$I = \frac{P}{A}$

$P = IA$

$P = I(4\pi d^2)$

$P = 3.96\times10^{26}\ W$

32.19) $\frac{E_{max}}{1/r} = 40\ N/C$

$E_{max} r = 40\ N/C$

$S = \frac{P}{A}$

$P = SA$

$P = \sqrt{\frac{\varepsilon_0}{\mu_0}}E^2(4\pi r^2)$

$P = 4\pi\sqrt{\frac{\varepsilon_0}{\mu_0}}(E_r)^2$

$\langle P\rangle = P/2$

$\langle P\rangle = 2\pi\sqrt{\frac{\varepsilon_0}{\mu_0}}(E_r)^2$

$\langle P\rangle = 26.68\ W$

32.20) $\lambda = 0.361\ m$

$E_{max} = 5.5\times10^{-2}\ V/m$ @ $r = 210\ m$

a) $\lambda f = c$

$f = \frac{c}{\lambda}$

$f = 8.31\times10^{8}\ Hz$

b) $E_{max} = cB_{max}$

$B_{max} = \frac{E_{max}}{c}$

$B_{max} = 1.83\times10^{-10}\ T$

c) $S_{av} = \frac{E_{max}B_{max}}{2\mu_0}$

$S_{av} = 4.01\times10^{-6}\ W/m^2$

32.22) $P = 777000\,W$

a) $r = 4000\,m$

$P = \frac{2\langle S \rangle}{c}$

$S = \frac{P}{A}$

$P_r = \frac{2P_{av}}{cA}$

$A = 2\pi r^2$

$P_r = \frac{P_{av}}{c\pi r^2}$

$\boxed{P = 5.15\times10^{-11}\,Pa}$

b) $S_{av} = \frac{P}{A}$

$S_{av} = \frac{E_{max}B_{max}}{2\mu_0}$

$E_{max} = cB_{max}$

$\frac{P}{A} = \frac{c}{2\mu_0}B_{max}^2$

$B_{max} = \sqrt{\frac{2\mu_0 P}{c(2\pi r)^2}}$

$\boxed{B_{max} = 8.05\times10^{-9}\,T}$

$\boxed{E_{max} = 2.41\,N/C}$

c) $u = \frac{1}{2}\varepsilon_0 E^2$

$\boxed{u = 2.58\times10^{-11}\,J/m^3}$

d) $\frac{1}{2}\varepsilon_0 E^2 = \frac{1}{2\mu_0}B^2$

$\boxed{50\%}$

e) $\boxed{50\%}$

32.24) $S_{av} = 2500\,W/m^2$

a) $P = \frac{S_{av}}{c}$

$\boxed{P = 8.33\times10^{-6}\,Pa}$

$1\,atm = 101325\,Pa$

$\boxed{P = 8.22\times10^{-11}\,atm}$

b) $P_{re} = P_{al}$

$\boxed{P = 1.67\times10^{-5}\,Pa}$

$\boxed{P = 1.64\times10^{-10}\,atm}$

c) $\frac{\Delta P}{P_i} = \frac{S}{c^2}$

$\boxed{\frac{\Delta P}{P_i} = 2.78\times10^{-14}}$

32.25) $\lambda = 633\,nm$

$P = 0.550\,mW$

$d = 1.25\,mm$

a) $S = \frac{P}{A}$

$A = \pi r^2$

$S = \frac{4P}{\pi d^2}$

$\boxed{S = 448.18\,W/m^2}$

b) $S_{av} = \frac{E_{max}B_{max}}{2\mu_0}$

$S_{av} = \frac{1}{2\mu_0 c}E_{max}^2$

$E_{max} = \sqrt{2\mu_0 c S_{av}}$

$\boxed{E_{max} = 581.3\,V/m}$

c) $E_{max} = cB_{max}$

$B_{max} = \frac{E_{max}}{c}$

$\boxed{B_{max} = 1.94\,\mu T}$

d) $u_{av} = \frac{1}{2}\varepsilon_0 E^2$

$\boxed{u_{av} = 1.49\times10^{-6}\,J/m^3}$

32.27) $\lambda = 12.2\,cm$

a) $2\,1/2$ wavelengths

$L = \frac{5}{2}\lambda$

$\boxed{L = 30.5\,cm}$

b) $\lambda f = c$

$f = \frac{c}{\lambda}$

$\boxed{f = 2.46\times10^{9}\,Hz}$

c) $L = 36.5\,cm$

$\frac{2}{5}L = \lambda$

$f = \frac{5}{2}\left(\frac{c}{L}\right)$

$\boxed{f = 2.05\times10^{9}\,Hz}$

32.37) $L_{rod} = 1m$

$s = 2cm$

$m = 5g$

$F_{max} = 1.35 N/C$

$\tau = I\alpha$

$\alpha = \frac{\tau}{I}$

$I = 2mr^2$

$r = \frac{1}{2}L_{rod}$

$I = \frac{1}{2}mL_{rod}^2$

$\alpha = \frac{2\tau}{mL_{rod}^2}$

$\Sigma\tau = F_{rc}r - F_{ab}r$

$F = PA$

$A = s^2$

$\Sigma\tau = \frac{1}{2}L_{rod}(P_{rc}s^2 - P_{ab}s^2)$

$P_{rc} = \frac{2S_{av}}{c}$

$P_{ab} = \frac{S_{av}}{c}$

$\Sigma\tau = \frac{1}{2}L_{rod}s^2\left(\frac{2S_{av}}{c}\right)$

$S_{av} = \frac{E_{max}^2}{2\mu_0 c}$

$\Sigma\tau = \frac{L_{rod}s^2 E_{max}^2}{4\mu_0 c^2}$

$\alpha = \frac{s^2 E_{max}^2 L_{rod}}{2\mu_0 c m}$

$\boxed{\alpha = 6.45\times10^{-13}\ rad/s^2}$

32.38) $d = 15m$

$E = 36 N/C$

$S_{av} = \frac{P_{av}}{A}$

$\frac{E_{max}^2}{2\mu_0 c} = \frac{P_{av}}{4\pi d^2}$

$E_{max} \propto \frac{1}{d}$

$\frac{E_{max,2}}{E_{max,1}} = \frac{d_1}{d_2}$

$E_{max,2} = \frac{d_1}{d_2}E_{max,1}$

$\boxed{E_{max,2} = 180 N/C}$

32.39) a) $\Psi = \frac{F}{J}$

$F = \Psi J$

$F = \frac{\Psi I}{A}$

$\boxed{F = \frac{\Psi I}{\pi a^2}}$

b) $\boxed{\text{along current}}$

c) $\oint B\cdot ds = \mu_0 I_{encl}$

$B(2\pi a) = \mu_0 I$

$\boxed{B = \frac{\mu_0 I}{2\pi a}}$

d) $\boxed{\text{counterclockwise}}$

e) $S = \frac{1}{\mu_0}EB$

$\boxed{S = \frac{\Psi I^2}{2\pi^2 a^3}}$

f) $\boxed{\text{inward}}$

g) $P = \int S\cdot dA$

$P = S(2\pi a l)$

$\boxed{P = \frac{\Psi I^2 l}{\pi a^2}}$

h) $P_R = IV$

$V = IR$

$P_R = I^2R$

$R = \frac{\Psi l}{\pi a^2}$

$P_R = \frac{\Psi I^2 l}{\pi a^2}$

$\boxed{P/P_R = 1}$

32.41) $f = 105 MHz$

a) $d = \frac{1}{2}\lambda$

$\lambda f = c$

$\lambda = \frac{c}{f}$

$d = \frac{1}{2}\left(\frac{c}{f}\right)$

$\boxed{d = 1.43m}$

b) 8th harmonic = 9 nodes

8 nodal planes

$l = 8d$

$\boxed{l = 11.43m}$

32.42) $\vec{E} = E_{max}\cos(kz-\omega t)\hat{j}$

a) $\oint \vec{E}\cdot d\vec{s} = -\frac{d\Phi_B}{dt}$

$aE_{max}\left[\cos(\frac{1}{2}ak-\omega t)-\cos(\frac{1}{2}ak+\omega t)\right]$

$-\Phi = aE_{max}\int(\cos(\frac{1}{2}ak-\omega t)-\cos(\frac{1}{2}ak+\omega t))dt$

$\Phi = \frac{aE_{max}}{\omega}\left(\sin(\frac{1}{2}ak-\omega t)+\sin(\frac{1}{2}ak+\omega t)\right)$

$\boxed{\Phi = \frac{2aE_{max}}{\omega}\sin(\frac{1}{2}ka)\cos(\omega t)}$

b) $\mathcal{E} = -N\frac{d\Phi}{dt}$

$\boxed{\mathcal{E} = 2NaE_{max}\sin(\frac{1}{2}ka)\sin(\omega t)}$

c) $f = 4mHz$

$I = 100 W/m^2$

$N = 50$

$a = 10cm$

$L = 78\mu H$

$R = 100\Omega$

$\omega = \sqrt{\frac{1}{LC}-\frac{R^2}{4L^2}}$

$\omega = 2\pi f$

$2\pi f = \sqrt{\frac{1}{LC}-\frac{R^2}{4L^2}}$

$\boxed{C = 2.03\times10^{-11}F}$

d) $\mathcal{E}_{max} = 2N\omega E_{max}$

$I = \frac{1}{2}\varepsilon_0 c E_{max}^2$

$E_{max} = \sqrt{\frac{2I}{\varepsilon_0 c}}$

$\mathcal{E}_{max} = 2N\omega\sqrt{\frac{2I}{\varepsilon_0 c}}$

$I_{max} = \frac{\mathcal{E}_{max}}{2}$

$\mathcal{E}_{max} = 2744.6V$

$I_{max} = 27.45A$

$\boxed{I_{rms} = 17.4A}$

32.45) a) $F_a = \frac{GM_1M_2}{r^2}$

$F_a = \frac{GMm_2}{r^2}$

$\rho = \frac{M_2}{V}$

$V = \frac{4}{3}\pi R^3$

$m_2 = \frac{4}{3}\rho\pi R^3$

$\boxed{F_a = \frac{4}{3}\left(\frac{G\rho\pi R^3 m}{r^2}\right)}$

b) Force = Pressure × Area

$F = \text{Pressure}(\pi R^2)$

$P = \frac{S}{c}$

$S = \frac{\text{Power}}{A}$

$S = \frac{L}{4\pi r^2}$

$P = \frac{L}{4\pi r^2 c}$

$F = \frac{L}{4\pi r^2 c}(\pi R^2)$

$\boxed{F = \frac{LR^2}{4r^2c}}$

c) $F_g = F$

$\frac{4}{3}\left(\frac{GM\rho\pi R^3}{r^2}\right) = \frac{LR^2}{4r^2c}$

$\frac{4}{3}(GM\rho\pi R) = \frac{L}{4c}$

$R = \frac{3}{16}\left(\frac{L}{GM\rho\pi c}\right)$

$\boxed{R = 1.75\times10^{-7}m}$

32.49) a) $e=0 \Rightarrow \frac{2I_0}{c}$

$e=1 \rightarrow \frac{I_0}{c}$

$\boxed{\frac{(2-e)I_0}{c}}$

b) $F_{rad} = PA$

$F_{rad} = \frac{(2-e)I_0}{c}\left(\frac{1}{4}\pi d^2\right)$

$I_0 = \frac{1}{r^2}I_{sun}$

$F_{rad} = \frac{(2-e)I_{sun}}{c}\left(\frac{1}{4}\pi d^2\right)$

$\boxed{F_{rad} = 1.83\times10^{-16}N}$

c) $F_g = \frac{GM_1m_2}{r^2}$

$F_g = 5.89\times10^{-16}N$

$\boxed{0.305}$