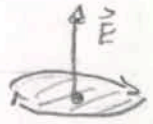
Ch. 24 solutions

#11 $\Phi_E = AE = (\pi R^2)E$; $\frac{d\Phi_E}{dt} = (\pi R^2)\frac{dE}{dt} \Rightarrow \oint \vec{B}\cdot d\vec{s} = B 2\pi s = \mu_0 \varepsilon_0 \pi R^2 \frac{dE}{dt}$

$\Rightarrow$ $B = 1.9 \times 10^{-18}$ T. $\uparrow |\vec{E}|$ by $|\vec{B}|$ being CCW.

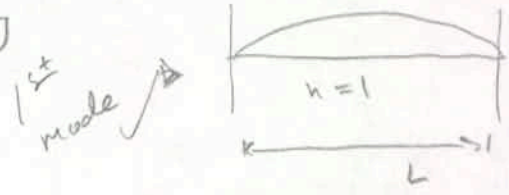


#13 $\vec{F} = m\vec{a} = q\vec{E} + q\vec{v}\times\vec{B}$ w/ $\vec{v}\times\vec{B} = \begin{vmatrix} x & y & z \\ 200 & 0 & 0 \\ 0.2 & 0.3 & 0.4 \end{vmatrix} = -200(0.4)\hat{x} + 200(0.3)\hat{y} \Rightarrow$

$\vec{a} = 2.87\times10^{-9}(-\hat{y} + 2\hat{x}) = (-2.8\times10^{9}\,\hat{y} + 5.8\times10^{9}\,\hat{z})$ m/s²

#7 $f\lambda = c \Rightarrow f = 6$ MHz w/ $c = 3\times10^8$ m/s.

#10



$L = \frac{\lambda}{2} \Rightarrow \lambda = 2L \Rightarrow f = \frac{c}{\lambda} = 75$ MHz

#13 (A) f_c = frequ. seen by car; $f_c = f_s\left(\frac{c+v}{c-v}\right)^{1/2}$ & f = frequ. of reflected wave, $f = f_c\left(\frac{c+v}{c-v}\right)^{1/2} \Rightarrow f = f_s\left(\frac{c+v}{c-v}\right)$ w/ f_s = source frequ.

(B) $f(c-v) = f_s(c+v) \Rightarrow (f - f_s)c = (f + f_s)v \simeq 2f_s v \Rightarrow$

$f_{beat} = f - f_s = \frac{2f_s v}{c} = \frac{2v}{\lambda}$

(C) $f_b = 2$ KHz

(D) $v = \frac{f_{beat}\lambda}{2} \Rightarrow \Delta v = \Delta f_{beat}\frac{\lambda}{2} \simeq$ 0.2 mi/h

#15 light observed: $f_{obs} = \frac{c}{\lambda_{obs}} = \left(\frac{1+v/c}{1-v/c}\right)^{1/2} f_{sour} = \left(\frac{1+v/c}{1-v/c}\right)^{1/2}\frac{c}{\lambda_{src}}$

$\left(\frac{1+v/c}{1-v/c}\right)^{1/2} = \frac{\lambda_{src}}{\lambda_{obs}} = \frac{650}{520}$ w/ $\frac{1+v/c}{1-v/c} = 1.56$.

B $v/c = 0.22 \Rightarrow \boxed{v = 0.22c}$.

#18 $f = \frac{1}{2\pi\sqrt{LC}} \Rightarrow L = \frac{1}{(2\pi f)^2 C} = \boxed{0.22\,H}$

#20 $S = I = \frac{U}{At} = \frac{uc}{v} = uc \Rightarrow u = \frac{E}{V} = \frac{I}{c} = \frac{1\,W/m^2}{3\times10^8\,m/s^2} = \boxed{3.3\,\mu J/m^3}$

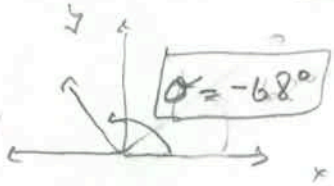
w/ E = energy & V = volume.

#22 $\bar{S} = S_{avg} = \frac{\bar{P}}{4\pi r^2} = \boxed{307\,\mu W/m^2}$

#26 (A) $\vec{E}\cdot\vec{B} = 0$

(B) $\vec{S} = \frac{1}{\mu_0}\vec{E}\times\vec{B} = \boxed{(11.5\,\hat{x} - 28.6\,\hat{y})\frac{W}{m^2}}$

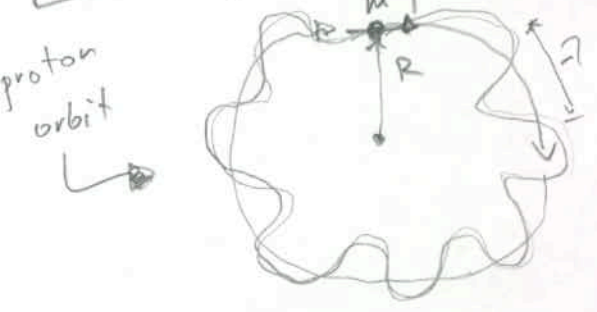
$\Rightarrow \boxed{|\vec{S}| = 30.9\,W/cm^2}$



#27 $P = SA = \frac{E_{max}^2}{2\mu_0 c}(4\pi r^2) = 1\,W \Rightarrow \boxed{r = 5.16\,m}$

#33 $f = \frac{c}{\lambda} = \boxed{5.45\times10^{14}\,Hz}$

#37 For a proton: $F = \frac{mv^2}{R} = qvB\sin(90°)$ w/ $T = \frac{2\pi R}{v}$.



$\Rightarrow T = \frac{2\pi m}{qB} = \boxed{1.87\times10^{-7}\,sec}$

$f = 1/T = \boxed{5.3\times10^6\,Hz}$

$\lambda = \frac{c}{f} = \boxed{56.2\,cm}$

#50 $f = \frac{E}{h} = \boxed{2.82 \times 10^{13} \text{ /sec}}$ & $\lambda = c/f = \boxed{10\,\mu\text{m, IR}}$

#52 (A) $\lambda = c/f = \boxed{4\text{ mm}}$

(B) $E = \frac{hc}{\lambda}$ & $E_N = NE \Rightarrow N = \frac{E_N}{E} = \frac{3\text{ J}}{3 \times 10^{-19}\text{ J}} \simeq \boxed{10^{19}\text{ photons}}$

(C) $V = \lambda \cdot \pi R^2 = 119\text{ mm}^3$ & so $n = \frac{N}{V} = \boxed{8.82 \times 10^{16}\text{ mm}^{-3}}$
