Phys 2120-4   11/7/12

Note Title   11/7/2012

Maxwell equations in vacuum:

$\rho = 0$

$J = 0$

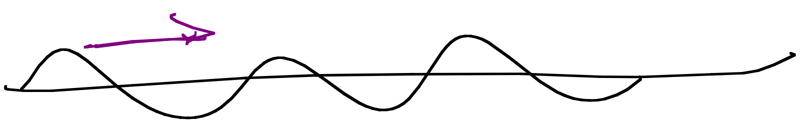
$I = 0$

$$\oint \vec{E} \cdot d\vec{A} = 0 \qquad \oint \vec{E} \cdot d\vec{r} = -\frac{d\Phi_B}{dt}$$

$$\oint \vec{B} \cdot d\vec{A} = 0 \qquad \oint \vec{B} \cdot d\vec{r} = \mu_0 \epsilon_0 \frac{d\Phi_E}{dt}$$

$v = \frac{\omega}{k}$

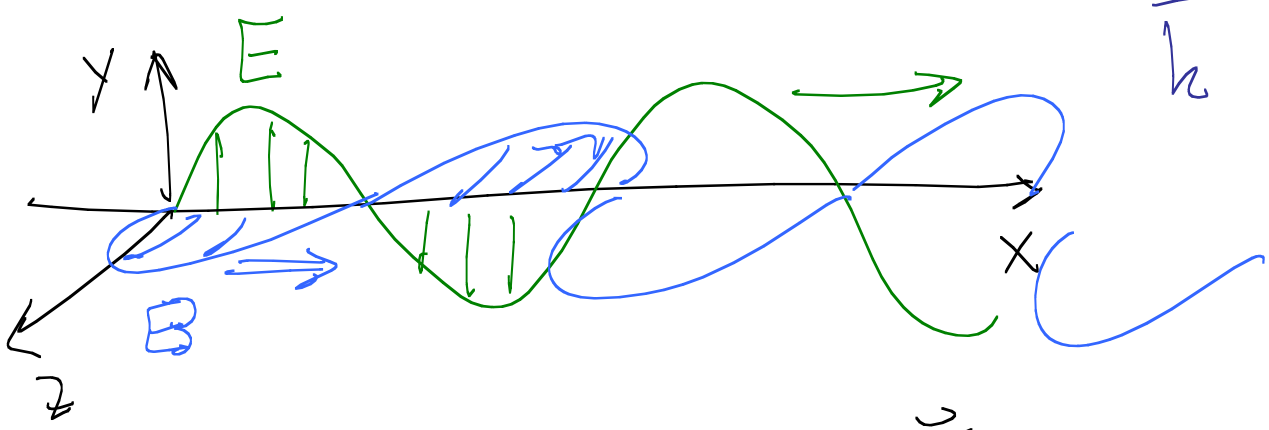
Wave



$y(x,t) = A\cos(kx - \omega t + \phi)$

Wave of electricity & magnetism

$v = c = 3.0 \times 10^8 \ m/s$




$\vec{k}$

$\vec{E}(x,t) = E_p \sin(kx - \omega t)\,\hat{j}$

$\vec{B}(x,t) = B_p \sin(kx - \omega t)\,\hat{k}$

where $\frac{\omega}{k} = c = \frac{1}{\sqrt{\epsilon_0 \mu_0}}$

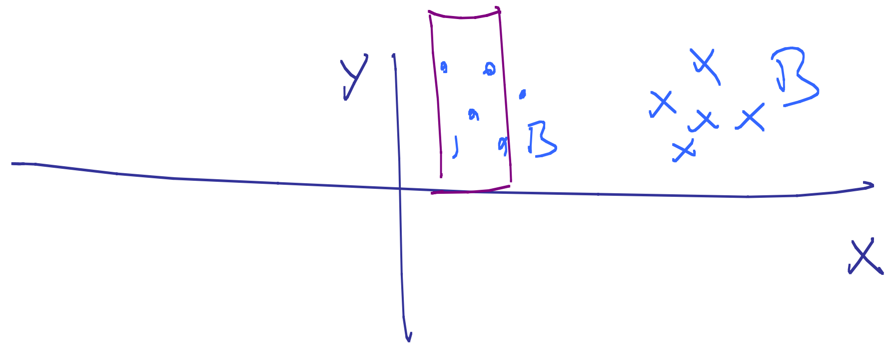
See book

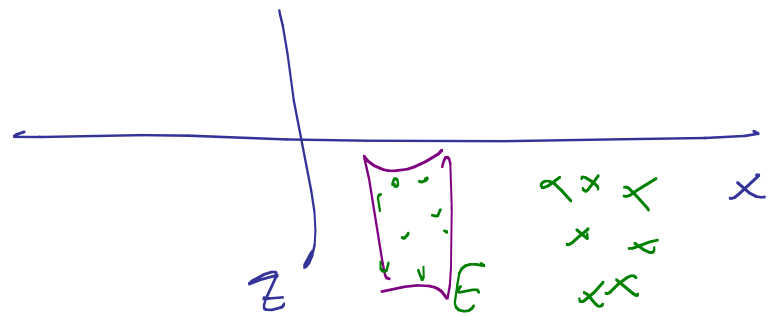
$$\oint \bar{E}\cdot d\bar{r} = -\frac{d\Phi_B}{dt}$$

$$\boxed{\frac{\partial E}{\partial x} = -\frac{\partial B}{\partial t}}$$

$$\oint \bar{B}\cdot d\bar{r} = \mu_0 \epsilon_0 \frac{\partial E}{\partial t}$$

$$\boxed{\frac{\partial B}{\partial x} = -\epsilon_0 \mu_0 \frac{\partial E}{\partial t}}$$



Combine &

$$\frac{\partial}{\partial t}\frac{\partial E}{\partial x} = \boxed{-\frac{\partial^2 B}{\partial t^2}}$$

$$= \frac{\partial}{\partial x}\frac{\partial E}{\partial t} = -\frac{1}{\epsilon_0\mu_0}\frac{\partial}{\partial x}\frac{\partial B}{\partial x} = \boxed{-\frac{1}{\epsilon_0\mu_0}\frac{\partial^2 B}{\partial x^2}}$$

$$\boxed{\frac{\partial^2 B}{\partial t^2} = \frac{1}{\epsilon_0\mu_0}\frac{\partial^2 B}{\partial x^2}}$$

$$\boxed{\frac{\partial^2 E}{\partial t^2} = \frac{1}{\epsilon_0\mu_0}\frac{\partial^2 E}{\partial x^2}}$$

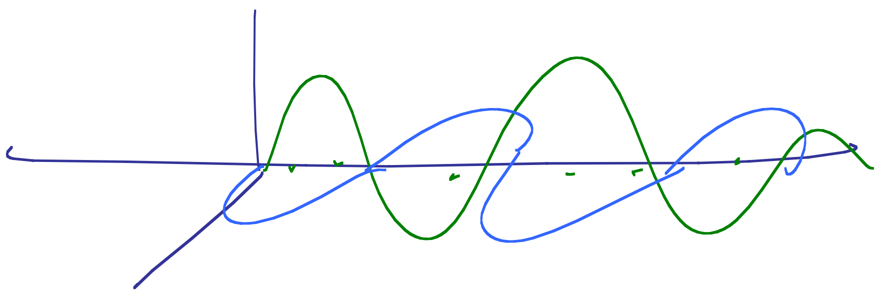
Wave equation. $f(x-vt)$

predicts: $v = \frac{1}{\sqrt{\epsilon_0\mu_0}} = c$

$= \omega/k$

Predicts EM waves w/ speed $c = 2.998 \times 10^8 \frac{m}{s}$

$\lambda f = v = c$ $3.00 \times 10^8 \frac{m}{s}$



Instantaneously related

$E = \frac{\omega}{k} B = c B$

Dir's of $\vec{E}$, $\vec{B}$ prop dir $\vec{k}$

$\vec{k}$ in dir of $\vec{E} \times \vec{B}$

29.22 What are wavelengths of

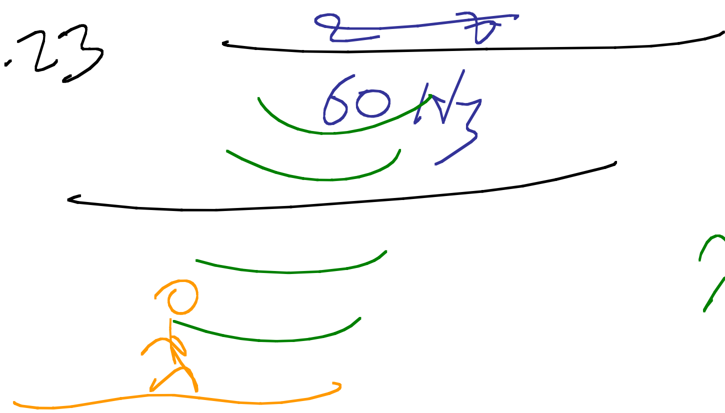
a) 100 MHz FM radio wave

$$\lambda = \frac{c}{f} = \frac{3.00 \times 10^8 \ \frac{m}{s}}{100 \times 10^6 \ \frac{1}{s}} = 3.0 \ m$$

b) 5.0 GHz WiFi signal

$$\lambda = \frac{c}{f} = \frac{3.0 \times 10^8 \ \frac{m}{s}}{5.0 \times 10^9 \ \frac{1}{s}} = 6 \ cm$$

29.23




$f = 60\ \mathrm{Hz}$

$$\lambda = c/f = \frac{3.0\times10^{8}\ \frac{m}{s}}{60} = 5.0\times10^{6}\ m \approx \text{size of earth}$$

p. 519 Waves in Matter

In transparent medium, EM waves also propagates

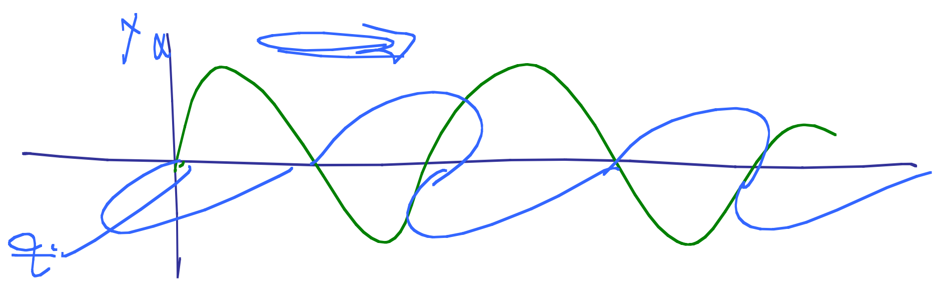
$\vec{E}$, $\vec{B}$ still in phase $\Rightarrow$ $\vec{k} \perp \vec{E}$ $\quad \vec{k} \perp \vec{B}$

Speed is different, slower

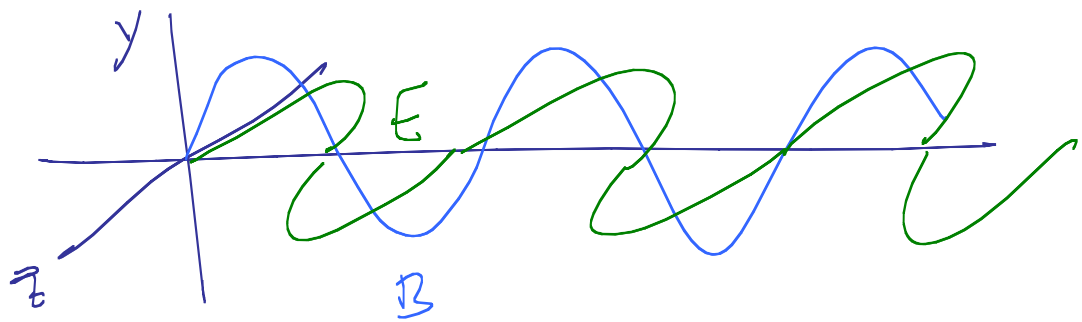
In vacuum $c$, In a trans medium $v = \frac{c}{n}$

$n > 1.0$

For some substances interesting effect involving polarization.

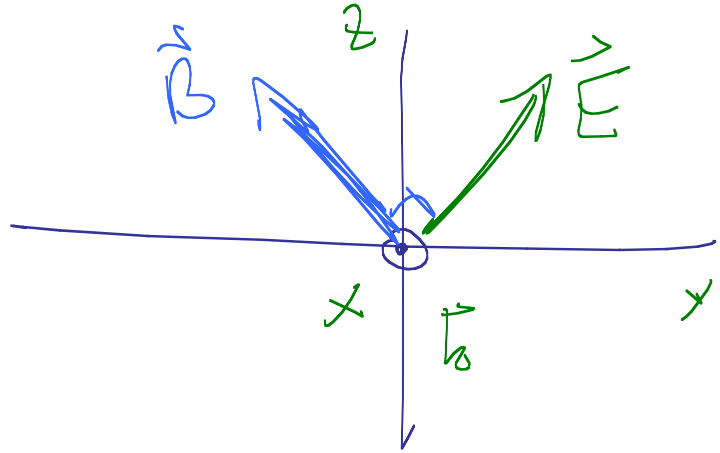



$\vec{E}$ polarized along $y$.

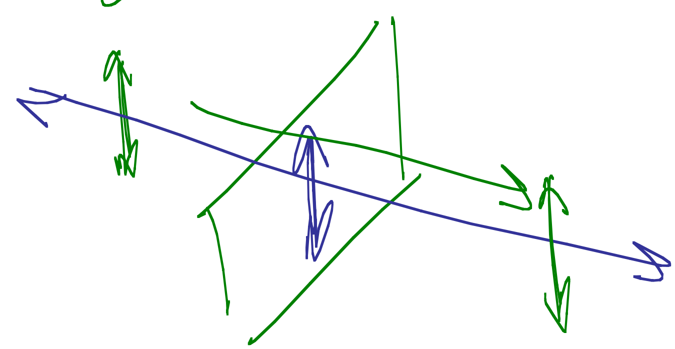


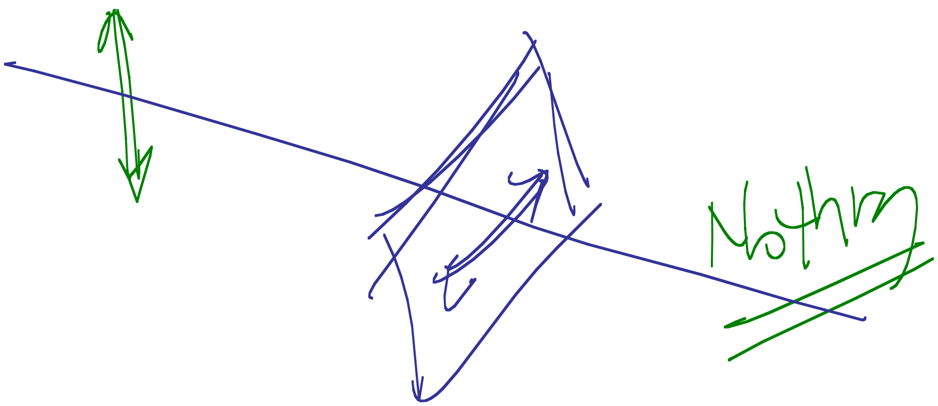

$\vec{E}$ pol'd along z

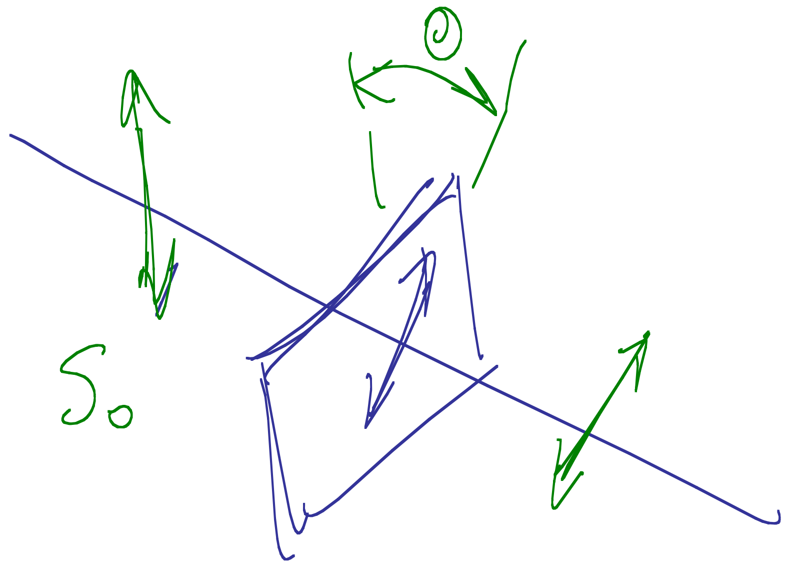
"Polarization" refers to dir of $\vec{E}$ field.



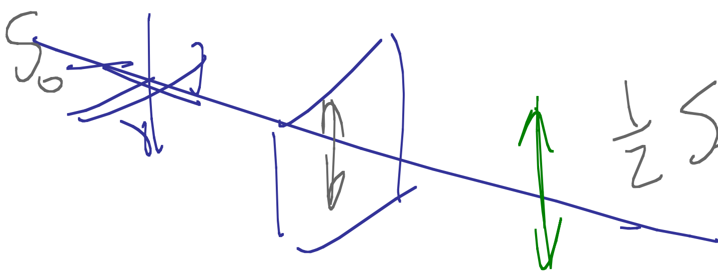

Polarizers:






$S$ intensity $\frac{W}{m^2}$



$\frac{1}{2} S_0$

$S = \cos^2\theta \, S_0$

Law of Malus

for polarized light.