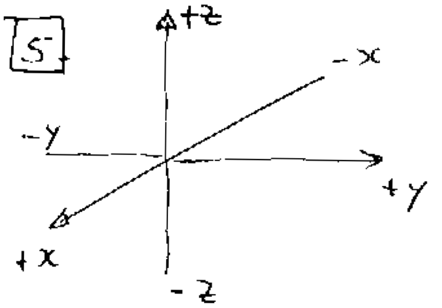
Phys 116, Autumn 07
OE Vilches

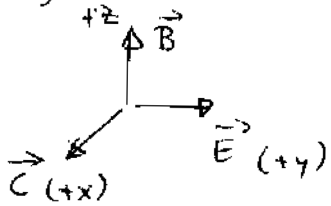
Some Problems from Walker's Ch. 25 [3rd Edition]

[5]



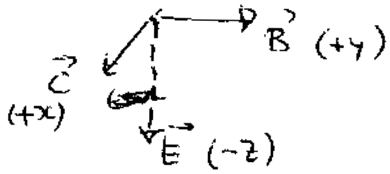
Right handed coordinate system
x goes (or curves) into y, thumb points in +z

First line

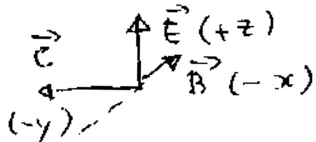


Use right hand rule
With $\vec{E}$ fingers, bend them
perpendicular to $\vec{B}$, thumb
points in direction $\vec{C}$

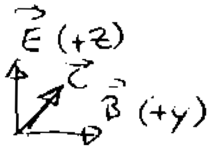
2nd line



3rd line



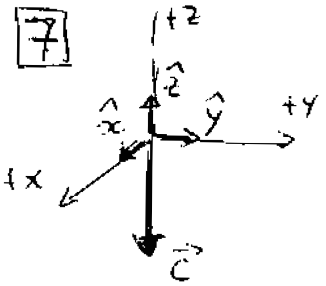
4th line



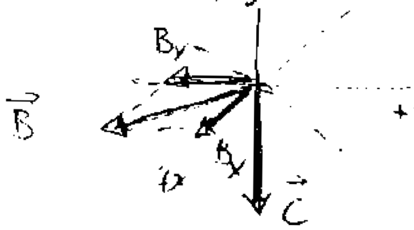
$\vec{C}$ in −x direction.

---

[7]



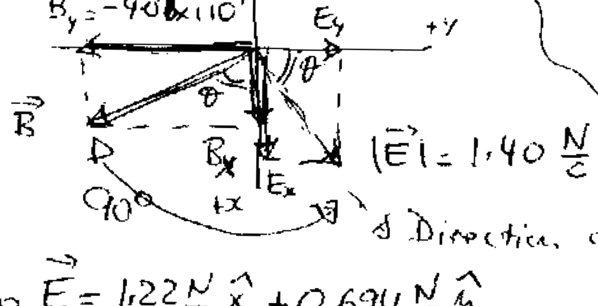
$\vec{B} = B_x\hat{x} + B_y\hat{y} = 2.32\times10^{-9}\,\hat{x} - 4.06\times10^{-9}\,\hat{y}$



B_y is in the negative y-direction
and B_x is in the positive x-direction
$\vec{B}$ is in the x-y plane

(a) $\vec{E}$ has to be perpendicular to both $\vec{B}$ and $\vec{C}$, so it is in the x-y plane – The vector $\vec{E}$ does not have a z-component.

(b) If we look in the x-y plane



$|\vec{E}| = 1.40\ \frac{N}{C}$

Direction of $\vec{E}$

$\tan\theta = \frac{B_y}{B_x} = \frac{4.06}{2.32} = 1.75$

$\theta = 60.3°$

So $E_y = E\cos 60.3° =$
$= 1.40\frac{N}{C}\cos 60.3° =$
$= 0.694\ N/C$

$E_x = E\sin 60.3° =$
$= 1.22\ N/C$

So $\vec{E} = 1.22\frac{N}{C}\,\hat{x} + 0.694\frac{N}{C}\,\hat{y}$

11 Factor change in wavelength is the same as in frequency

$$f \cong f_0\left(1-\frac{v}{c}\right) = f_0\left(1 - \frac{3.6\times10^7\,\mathrm{m/s}}{3.0\times10^8\,\mathrm{m/s}}\right) = f_0(1-0.12) = 0.88 f_0$$

So the wavelength increases by the inverse $\lambda = \frac{1}{0.88}\lambda_0 = 1.14\,\lambda_0$

---

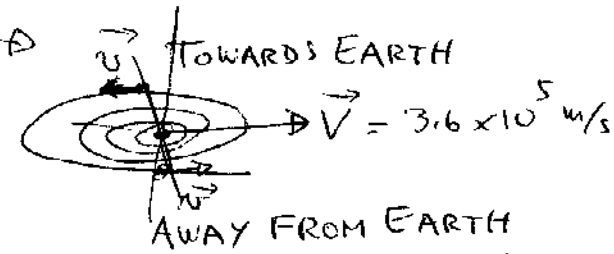
15 The speed measured, $v = \frac{\Delta \ell}{\Delta t} = \frac{2\times 35.5\times10^3\,\mathrm{m}}{\frac{1}{8}\,\mathrm{rev}\times\frac{1\,\mathrm{s}}{528\,\mathrm{rev}}}$ ← goes and comes back

$= 2.999\times10^8\,\mathrm{m/s}$

---

23 $|v| > |V|$ →

Earth



$f_0 = 8.230\times10^{14}\,\mathrm{Hz}$

a) Towards $f = f_0\left(1 + \frac{6.4\times10^5 - 3.6\times10^5}{3\times10^8}\right) = 8.238\times10^{14}\,\mathrm{Hz}$

b) Away $f = f_0\left(1 - \frac{3.6\times10^5 + 6.4\times10^5}{3\times10^8}\right) = 8.211\times10^{14}\,\mathrm{Hz}$

Note: One would have to measure wavelengths to better than $\frac{1}{3}\%$, which is easy to do –

---

29 $\lambda = \frac{c}{f} = \frac{3\times10^8\,\mathrm{m/s}}{1.25\times10^8\,1/\mathrm{s}} = 2.4$ meters

---

37 $H = \frac{\lambda}{4} = \frac{c}{4f} = \frac{3\times10^8\,\mathrm{m/s}}{4\times8.80\times10^5\,1/\mathrm{s}} = 85.2\,\mathrm{m}$

---

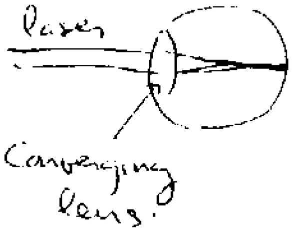
43 $B = 2.7\times10^{-6}\,\mathrm{T}$ (a) $E = cB = 3\times10^8\,\frac{\mathrm{m}}{\mathrm{s}}\times2.7\times10^{-6}\,\mathrm{T} = 810\,\frac{\mathrm{N}}{\mathrm{C}}$

(b) $I_{peak} = \epsilon_0 c E^2_{peak} = 8.85\times10^{-12}\,\frac{\mathrm{Coul}^2}{\mathrm{m^2 N}}\times3\times10^8\,\frac{\mathrm{m}}{\mathrm{s}}\times\left(810\,\frac{\mathrm{N}}{\mathrm{C}}\right)^2 = 1.74\times10^3\,\underbrace{\frac{\mathrm{Nm}}{\mathrm{m^2 s}}}_{\frac{\mathrm{Watts}}{\mathrm{m^2}}}$

(c) $I_{average} = \frac{1}{2} I_{peak} = 0.87\times10^3\,\frac{\mathrm{Watts}}{\mathrm{m^2}}$

3

57 This is like example I did in class!



$P = 0.75\ mW = 0.75 \times 10^{-3}$ Watts.

(a) $\text{Energy} = \text{Power} \times \text{time} = 0.75 \times 10^{-3} \frac{J}{s} \times 0.2\ s = 1.5 \times 10^{-4}$ Joules

(b) $I = \frac{\text{Power}}{\text{Area}} = \frac{0.75 \times 10^{-3}\ \text{Watts}}{\pi (2.5 \times 10^{-6}\ m)^2} = 3.82 \times 10^{7}\ \frac{\text{Watts}}{m^2}$

$= 3.82 \times 10^{4}\ \frac{\text{kWatts}}{m^2} = 3.82\ \text{kWatts}/cm^2$

(c) $\frac{3.82 \times 10^{3}\ \text{Watts}/cm^2}{1 \times 10^{-2}\ W/cm^2} = 3.8 \times 10^{5}$

69

Case A $\quad I_A = I_o \cos^2 45^\circ \cos^2 45^\circ = \frac{1}{4} I_o$

Case B $\quad I_B = I_o \cos^2 45^\circ \cos^2 45^\circ = \frac{1}{4} I_o$

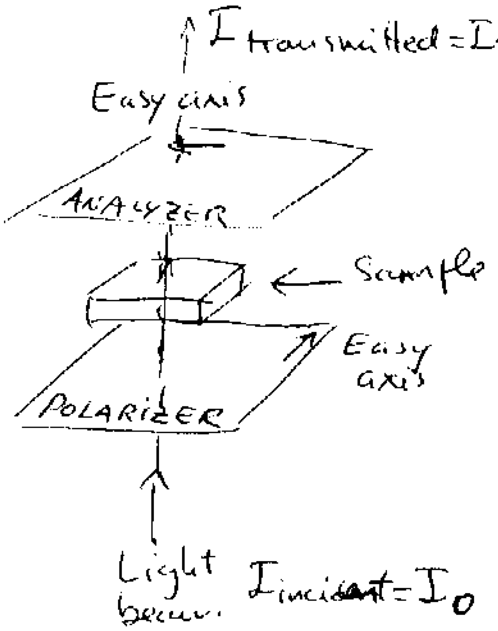
Case C $\quad I_c = I_o \cos^2 45^\circ \cos^2 90^\circ = 0$

$I_A = I_B > I_C$

$I_A = I_B = \frac{1}{4} \times 37.0 \frac{W}{m^2} = 9.25\ \frac{\text{Watts}}{m^2}$

---

71 This is like the demo done in class with corn syrup.



(a) If no sample in the holder, $I_{\text{transmitted}} = I_2 = 0$ since easy axis (of analyzer) is crossed with respect to easy axis of Polarizer.

Solution 1

$I_2 = \left(\frac{1}{2} I_o\right) \cos^2 (90^\circ - 0.550^\circ) =$

$= 4.61 \times 10^{-5}\ I_o \equiv 5.76 \times 10^{-4}\ \frac{\text{Watts}}{m^2}$

Solution 2

$I_2 = \left(\frac{1}{2} I_o\right) \cos^2 (90^\circ + 0.620^\circ)$

$= 0.732 \times 10^{-3}\ \frac{\text{Watts}}{m^2}$

$\boxed{\text{So } I_{22} > I_{21}}$