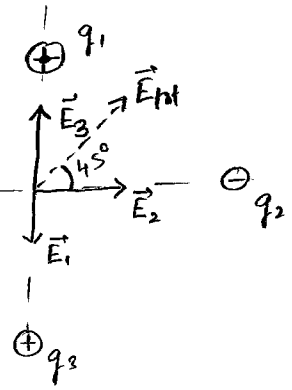
Solution PHYS-203B, Final Exam, Fall 2016

## Prob. 1

$$|\vec{E}_1| = \frac{k|q_1|}{L^2} = \frac{8.99\times10^9 \times 1.0\times10^{-6}}{(0.20)^2} = 4.50\times10^5 \frac{N}{C}$$

$$|\vec{E}_2| = \frac{k|q_2|}{L^2} = 8.99\times10^5 \frac{N}{C}$$

$$|\vec{E}_3| = \frac{k|q_3|}{L^2} = 13.5\times10^5 \frac{N}{C}$$




$$\vec{E}_1 = 0\,\hat{i} - \hat{j}\,4.50\times10^5 \frac{N}{C}$$

$$\vec{E}_2 = +\hat{i}\,8.99\times10^5 \frac{N}{C} + 0\,\hat{j}$$

$$\vec{E}_3 = 0\,\hat{i} + \hat{j}\,13.5\times10^5 \frac{N}{C}$$

$$\vec{E}_{tot} = \hat{i}\,8.99\times10^5 \frac{N}{C} + \hat{j}\,8.99\times10^5 \frac{N}{C}$$

Magnitude:

$$|\vec{E}_{tot}| = \sqrt{(8.99\times10^5)^2 + (8.99\times10^5)^2} = 1.27\times10^6 \frac{N}{C}$$

Direction: 45° counter clockwise w.r.t. $q_2$.

## Prob. 2

$$V_1 + V_2 = 0$$

$$-\frac{kq}{y} + \frac{2kq}{\sqrt{y^2+a^2}} = 0$$

$$\frac{2kq}{\sqrt{y^2+a^2}} = \frac{kq}{y}$$

(squaring on both sides)

$$\frac{4}{y^2+a^2} = \frac{1}{y^2}$$

$$4y^2 = y^2 + a^2$$

$$3y^2 = a^2$$

$$y = \pm\frac{a}{\sqrt{3}} = \pm\frac{2.0\ m}{\sqrt{3}} = \pm 1.15\ m$$

## Prob. 3

$$\frac{U_1}{U_2} = \frac{\left(\frac{1}{2} C_1 V_1^2\right)}{\left(\frac{1}{2} C_2 V_2^2\right)} = \frac{C_1}{C_2} \qquad (\text{using } V_1 = V_2)$$

$$= \frac{10.0\,\text{nF}}{20.0\,\text{nF}}$$

$$= 0.500$$

## Problem 4

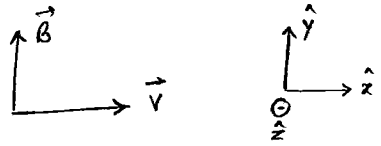
$$\vec{F} = q\,\vec{v} \times \vec{B}$$

$$= q\,v\,B\,(\hat{x} \times \hat{y})$$

$$= q\,v\,B\,\hat{z}$$

$$= 1.6 \times 10^{-19} \times 3.0 \times 10^{6} \times 0.100\,\hat{z}$$

$$= \hat{z}\,4.8 \times 10^{-14}\,\text{N}$$




Magnitude : $4.8 \times 10^{-14}$ N

Direction : along $\hat{z}$

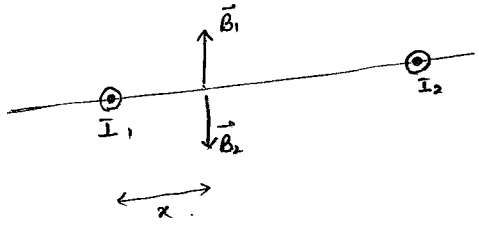
## Prob. 5

$$|\vec{B}_1| = |\vec{B}_2|$$

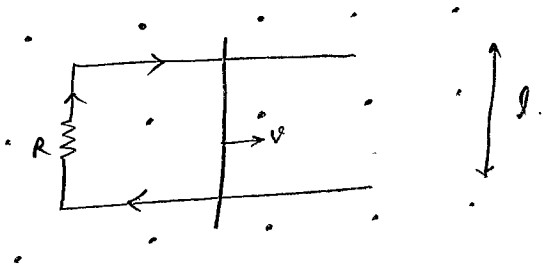
$$\frac{\mu_0 I_1}{2\pi x} = \frac{\mu_0 I_2}{2\pi (D - x)}$$

$$D - x = \frac{I_2}{I_1}\,x$$

$$x = \frac{D}{\left(1 + \frac{I_2}{I_1}\right)} = \left(\frac{I_1}{I_1 + I_2}\right) D$$



## Prob. 6




(a) increasing

(b) clockwise.

(c) $I = \frac{Blv}{R}$

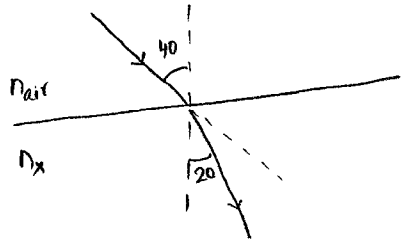
$= \frac{2.0 \times 0.10 \times 3.0}{0.40}$

$= 1.5\ A$

## Prob. 7

$1054 - 6500 = -5446 \longrightarrow$ in 5446 B.C.

## Prob. 8



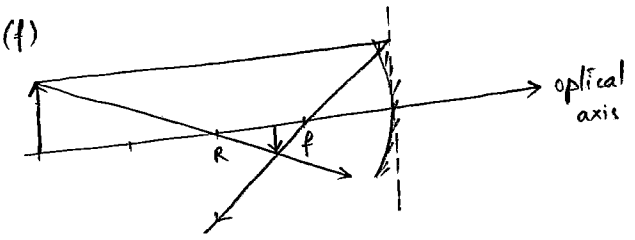

$n_{air} \sin 40 = n_x \sin 20$

$n_x = n_{air} \frac{\sin 40}{\sin 20}$

$= 1.00 \frac{\sin 40}{\sin 20} = 1.88$

## Prob. 9

(f)




(a) $\frac{1}{di} = \frac{1}{f} - \frac{1}{do} = \frac{1}{10} - \frac{1}{40} = \frac{3}{40}$

$di = \frac{40}{3} = +13.3\ cm$

(b) $m = -\frac{di}{do} = -\frac{13.3\ cm}{40.0\ cm} = -0.33$

(c) real

(d) inverted

(e) $h_i = m h_o = -0.33 \times 1.00\ cm = -0.33\ cm$

## Prob. 10

(a) $\frac{1}{d_i} = \frac{1}{f} - \frac{1}{d_o} = \frac{1}{-10} - \frac{1}{40} = -\frac{5}{40}$

$d_i = -\frac{40}{5} = -8.0\,\text{cm}$

(b) $m = -\frac{d_i}{d_o} = -\frac{(-8.0\,\text{cm})}{(+40.0\,\text{cm})}$

$= +0.20$

(c) virtual

(d) upright

(e) $h_i = m\,h_o = +0.20 \times 1.00\,\text{cm}$

$= +0.20\,\text{cm}$

(f)