Solutions

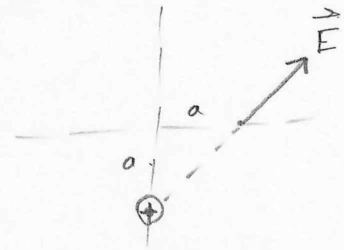
PHYS-205B-002 (Final Exam) Spring 2025

Problem 1

$$\vec{E} = \frac{kq}{(\sqrt{2}a)^2}\left[\cos 45\,\hat{i} + \sin 45\,\hat{j}\right]$$

$$= \frac{(9.0\times10^{9})(2.0\times10^{-9})}{(\sqrt{2}\;3.0\times10^{-2})^2}\left[\frac{1}{\sqrt{2}}\hat{i} + \frac{1}{\sqrt{2}}\hat{j}\right]$$

$$= \left(1.0\times10^{4}\,\frac{N}{C}\right)\left[\frac{1}{\sqrt{2}}\hat{i} + \frac{1}{\sqrt{2}}\hat{j}\right]$$



direction: 45° CCW w.r.t. $+x$.

magnitude: $|\vec{E}| = 1.0\times10^{4}\,\frac{N}{C}$

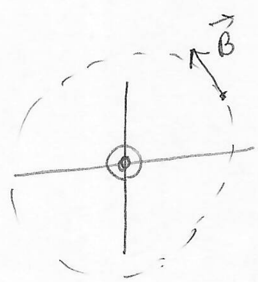
Problem 2

$$E = Pt = 12\,\frac{J}{s}\,(1\text{ year})$$

$$= 12\,(365\times24\times60\times60)$$

$$= 3.8\times10^{8}\,J$$

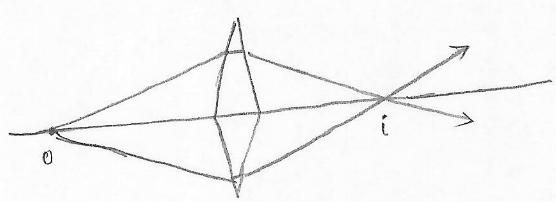
Problem 3



Problem 4

o - object

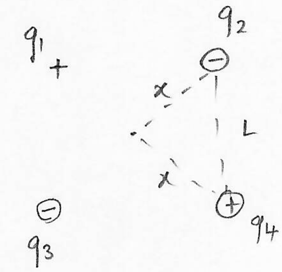
i - image.



optical axis

rays converge towards the optical axis.

Problem 5



$$\vec{E}_1 + \vec{E}_4 = 0$$

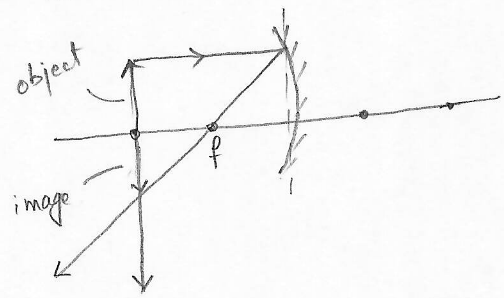
$$\vec{E}_2 + \vec{E}_3 = \frac{kq}{x^2}\left[\frac{1}{\sqrt{2}}\hat{i} + \frac{1}{\sqrt{2}}\hat{j}\right]$$

$$\vec{E}_{tot} = \vec{E}_1 + \vec{E}_2 + \vec{E}_3 + \vec{E}_4 = \frac{2kq}{L^2}\left[\frac{1}{\sqrt{2}}\hat{i} + \frac{1}{\sqrt{2}}\hat{j}\right]$$

$$x = \frac{L}{\sqrt{2}}$$

magnitude: $|\vec{E}_{tot}| = \frac{2kq}{L^2}$ direction: 45° ccw w.r.t. $+x$.

Problem 6



$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$$

$$\frac{1}{20.0} + \frac{1}{d_i} = \frac{1}{10.0}$$

$$\frac{1}{d_i} = \frac{1}{10.0} - \frac{1}{20.0} = \frac{1}{20.0}$$

$$d_i = +20.\,\text{cm}$$

$$m = -\frac{d_i}{d_o} = -\frac{(+20.0)}{(+20.0)} = -1.00$$

(a) +20.0cm

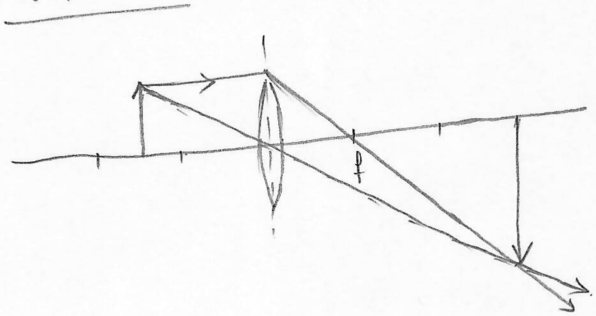
(b) $d_i = +20.0$ cm, real

(c) $m = -1.00$, $h_i = -1.0$ cm.

(d) inverted.

(e) see diagram.

Problem 7



$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$$

$$\frac{1}{15} + \frac{1}{d_i} = \frac{1}{10.0}$$

$$\frac{1}{d_i} = \frac{1}{10.0} - \frac{1}{15} = \frac{1}{30.0}$$

$$d_i = +30.\,\text{cm}$$

$$m = -\frac{d_i}{d_o} = -\frac{(+30.0)}{(+15)} = -2.0$$

(a) $d_i = +30.$ cm, real

(b) $m = -2.0$, $h_i = -2.0$cm

(c) inverted

(d) see diagram.