Solution

Final Exam, PHYS-2038-001, Spring 2017

Prob. 1

$$a = \frac{q}{m} E \qquad y = \frac{1}{2} a t^2 = \frac{1}{2} \frac{q}{m} E t^2$$

$y_1 = y_2$

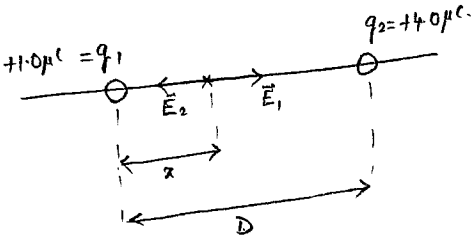
$E_1 = E_2$

$m_1 = m_2$

$$\frac{y_1}{y_2} = \frac{\frac{1}{2}\frac{q_1}{m_1} E_1 t_1^2}{\frac{1}{2}\frac{q_2}{m_2} E_2 t_2^2}$$

$$1 = \frac{q_1}{q_2} \frac{t_1^2}{t_2^2} \Rightarrow \frac{t_1}{t_2} = \sqrt{\frac{q_2}{q_1}} = \sqrt{2} = 1.41$$

Prob. 2



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

$$\frac{k|q_1|}{x^2} = \frac{k|q_2|}{(D-x)^2}$$

$$\frac{1}{x^2} = \frac{4.0}{(D-x)^2}$$

$$D - x = \pm 2x$$

$$x = \frac{D}{1 \pm 2} = +\frac{D}{3} \text{ or } -D \rightarrow \text{not compatible with } x > 0.$$

Answer: $x = +\frac{D}{3} = \frac{10.0\,cm}{3} = 1.33\,m$

Prob 3

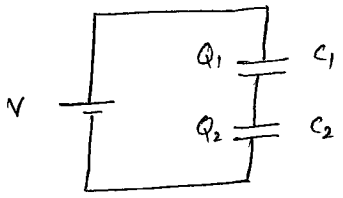
$$V_A = \frac{kq_1}{a} + \frac{kq_2}{a\sqrt{2}} = \frac{8.99\times10^9 \times 1.0\times10^{-6}}{0.100}\left(1 + \frac{2}{\sqrt{2}}\right)$$

$$V_B = \frac{kq_1}{a\sqrt{2}} + \frac{kq_2}{a} = \frac{8.99\times10^9 \times 1.0\times10^{-6}}{0.100}\left(\frac{1}{\sqrt{2}} + 1\right)$$

$$V_A - V_B = 8.99\times10^4 \left(1 + \frac{2}{\sqrt{2}} - \frac{1}{\sqrt{2}} - 1\right)$$

$$= \frac{8.99\times10^4}{\sqrt{2}} = 6.4\times10^4\ V.$$

Prob. 4

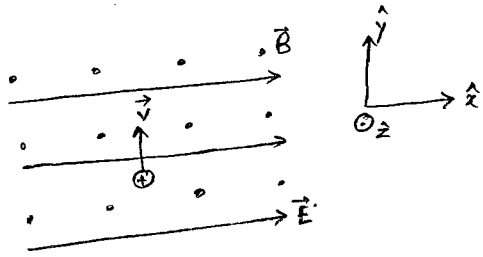


$$Q_1 = Q_2$$

$$C_1 V_1 = C_2 V_2$$

$$\frac{V_1}{V_2} = \frac{C_2}{C_1} = 2.0$$

Prob. 5



$$\vec{F}_E = \hat{x}\, qE$$

$$= \hat{x}\,(1.0\times10^{-6}\,C)\ 6.00\times10^{3}\ \frac{N}{C}$$

$$= \hat{x}\ 6.0\ mN$$

$$\vec{F}_B = \hat{x}\, qvB$$

$$= \hat{x}\,(1.0\times10^{-6}\,C)\times\left(2.00\times10^{6}\ \frac{m}{s}\right)\left(1.50\times10^{-3}\,T\right)$$

$$= \hat{x}\ 3.0\ mN$$

$$\vec{F}_E + \vec{F}_B = \hat{x}\ 6.0 + \hat{x}\ 3.0 = \hat{x}\ 9.0\ mN$$

magnitude: 9.0 mN

Prob. 6

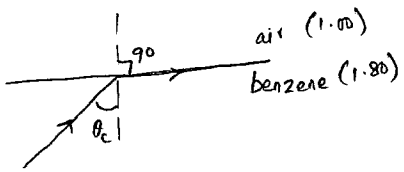
$$\lambda = \frac{c}{f} = \frac{3.00\times10^{8}\ \frac{m}{s}}{9.00\times10^{18}\ Hz} = 3.33\times10^{-11}\ m$$

Prob. 7

$$1\ \text{light-year} = 1\times\left(3.00\times10^{8}\ \frac{m}{s}\right)\times\left(365\times24\times60\times60\ s\right)$$

$$= 9.46\times10^{15}\ m$$

Prob. 8



$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

$$1.80\sin\theta_c = 1.00\sin 90$$

$$\theta_c = \sin^{-1}\left(\frac{1.00}{1.80}\right) = 33.8^\circ$$

Prob. 9

(a) $R = 2f = 2 \times 10.0\,cm = 20.0\,cm$

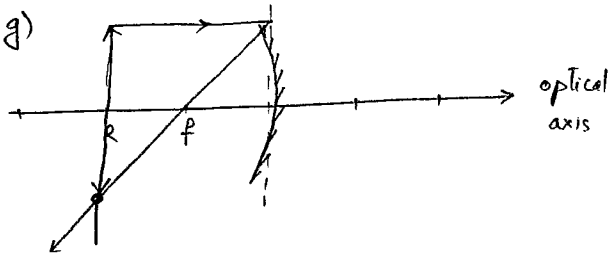
(b) $\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$

$\frac{1}{+20} + \frac{1}{d_i} = \frac{1}{+10} \Rightarrow d_i = +20.0\,cm$

(c) $m = -\frac{d_i}{d_o} = -\frac{(+20.0\,cm)}{(+20.0\,cm)} = -1.0$

(d) real

(g)



(e) inverted

(f) $h_i = m h_o = -1.0 \times 1.0\,cm = -1.0\,cm$

Prob. 10

(a) $\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$

$\frac{1}{+5.0} + \frac{1}{d_i} = \frac{1}{+10} \Rightarrow d_i = -10.0\,cm$

(b) $m = -\frac{d_i}{d_o} = -\frac{(-10.0\,cm)}{(+5.0\,cm)} = +2.0$

(c) virtual

(d) upright

(e) $h_i = m h_o = +2.0 \times 1.0\,cm = +2.0\,cm$

(f)