PHYS 203B (2017 Spring) Midterm Exam 1

Prob. 1

	A	C	B
initial	$+Q$	0	$-Q$
step 1:	$+\frac{Q}{2}$	$+\frac{Q}{2}$	$-Q$
step 2:	$+\frac{Q}{2}$	$-\frac{Q}{4}$	$-\frac{Q}{4}$

(a) $+\frac{Q}{2}$

(b) $-\frac{Q}{4}$

(c) $|\vec{F}| = \frac{k\,|+Q|\,|-Q|}{R^2} = \frac{kQ^2}{R^2}$

$|\vec{F}'| = \frac{k\,|+\frac{Q}{2}|\,|-\frac{Q}{4}|}{R^2} = \frac{1}{8}\frac{kQ^2}{R^2} = \frac{1}{8}F$

Prob. 2

$\vec{F}_{12} = F_{12}\cos 60\,\hat{i} + F_{12}\sin 60\,\hat{j}$

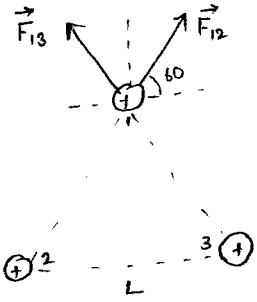
$\vec{F}_{13} = -F_{13}\cos 60\,\hat{i} + F_{13}\sin 60\,\hat{j}$

$\vec{F}_{tot} = 0\,\hat{i} + 2F_{12}\sin 60\,\hat{j}$

$= 0\,\hat{i} + 2\times(4.0\times10^{1})\sin 60\,\hat{j}$

$= 0\,\hat{i} + \hat{j}\ 69\ N$

magnitude : 69 N



$F_{12} = F_{13} = \frac{kq^2}{L^2}$

$= \frac{8.99\times10^{9}\ (2.0\times10^{-6})^2}{(3.0\times10^{-2})^2}$

$= 4.0\times10^{1}\ N$

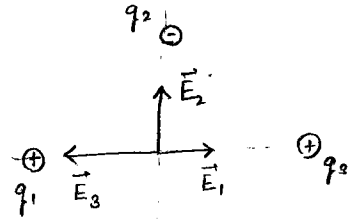
Prob. 3

$$\vec{E}_1 = 8.99\times10^5\,\hat{i} + 0\,\hat{j}$$

$$\vec{E}_2 = 0\,\hat{i} + 18.0\times10^5\,\hat{j}$$

$$\vec{E}_3 = -27.0\times10^5\,\hat{i} + 0\,\hat{j}$$

$$\vec{E} = -18.0\times10^5\,\hat{i} + 18.0\times10^5\,\hat{j}$$



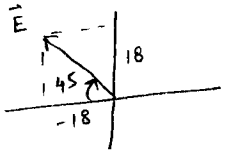
$$|\vec{E}_1| = \frac{kq_1}{L^2} = \frac{8.99\times10^9\times(1.0\times10^{-6})}{(1.0\times10^{-1})^2} = 8.99\times10^5\ \frac{N}{C}$$

$$|\vec{E}_2| = 2|\vec{E}_1| = 18.0\times10^5\ \frac{N}{C}$$

$$|\vec{E}_3| = 3|\vec{E}_1| = 27.0\times10^5\ \frac{N}{C}$$

magnitude: $|\vec{E}| = \sqrt{(18.0\times10^5)^2 + (18.0\times10^5)^2}$

$= 26\times10^5\ \frac{N}{C}$



direction: $\theta = \tan^{-1}\left(\frac{18.0\times10^5}{18.0\times10^5}\right) = 45^\circ$

45° clockwise $\omega\cdot x\cdot t$ $-\hat{x}$

Prob. 4

$q_e = q_p = e$

$$\frac{a_e}{a_p} = \frac{\left(\frac{q_e}{m_e}E\right)}{\left(\frac{q_p}{m_p}E\right)} = \frac{m_p}{m_e}$$

$$= \frac{1.67\times10^{-27}\ kg}{9.1\times10^{-31}\ kg}$$

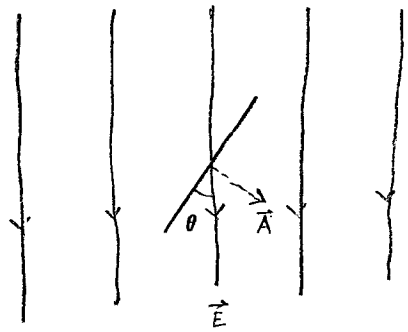
$$= 1835$$

$$= 1800 \quad \text{(upto 2 significant digits)}$$

Prob. 5

$\theta = 30^\circ$

$90 - \theta = 60^\circ$



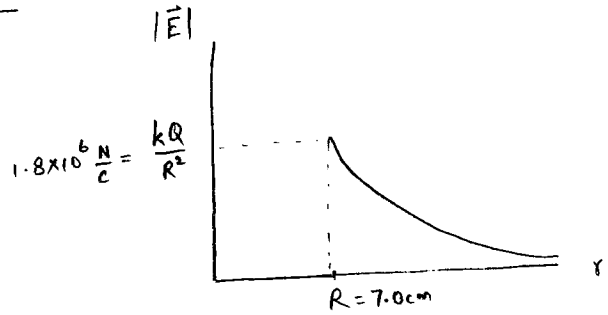
$$\Phi_E = \vec{E} \cdot \vec{A}$$

$$= E A \cos(90-\theta)$$

$$= \left(3.0\times10^2 \frac{N}{C}\right)(2.0\ m^2)\cos 60$$

$$= 3.0\times10^2 \frac{N\,m^2}{C}$$

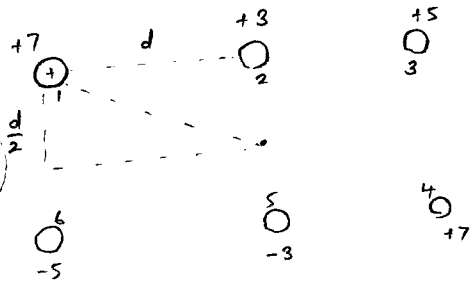
Prob. 6



$$\frac{kQ}{R^2} = \frac{8.99\times10^9 \times 1.0\times10^{-6}}{(7.0\times10^{-2})^2}$$

$$= 1.8\times10^6 \frac{N}{C}$$

Prob. 7



$$V = V_1 + V_2 + V_3 + V_4 + V_5 + V_6$$

$$= + \frac{k7q}{\sqrt{d^2+\left(\frac{d}{2}\right)^2}} + \frac{k3q}{d/2} + \frac{k5q}{\sqrt{d^2+\left(\frac{d}{2}\right)^2}} + \frac{k7q}{\sqrt{d^2+\left(\frac{d}{2}\right)^2}} - \frac{k3q}{d/2} - \frac{k5q}{\sqrt{d^2+\left(\frac{d}{2}\right)^2}}$$

$$= \frac{14\,kq}{d\sqrt{1+\frac{1}{4}}}$$

$$= \frac{14\times8.99\times10^9\times9.0\times10^{-6}}{0.10\times\sqrt{\frac{5}{4}}}$$

$$= 1.0\times10^7\ V$$

Prob. 8

$$\Delta U = \frac{k q_1 q_2}{b} + \frac{k q_2 q_3}{a} + \frac{k q_3 q_1}{\sqrt{a^2 + b^2}}$$

$$= + \frac{8.99\times10^{9} \times 1.0\times10^{-6} \times 2.0\times10^{-6}}{1.0\,m} - \frac{8.99\times10^{9} \times 2.0\times10^{-6} \times 3.0\times10^{-6}}{2.0\,m} - \frac{8.99\times10^{9}\ 3.0\times10^{-6}\ 1.0\times1}{\sqrt{1.0^2 + 2.0^2}}$$

$$= + 0.018 - 0.027 - 0.012$$

$$= - 0.021 \text{ Joules.}$$