Solutions PHYS-203B (Midterm Exam 01) Fall 2025

Problem 1

$q_A = q$ $\quad q_B = q$ $\quad q_C = 0$

$q'_A = \frac{q+0}{2} = \frac{q}{2}$ $\quad q'_B = q$ $\quad q'_C = \frac{q+0}{2} = \frac{q}{2}$

$q''_A = \frac{q}{2}$ $\quad q''_B = \frac{q+\frac{q}{2}}{2} = \frac{3}{4}q$ $\quad q''_C = \frac{q+\frac{q}{2}}{2} = \frac{3}{4}q$

Answer: $q''_C = \frac{3}{4}q$

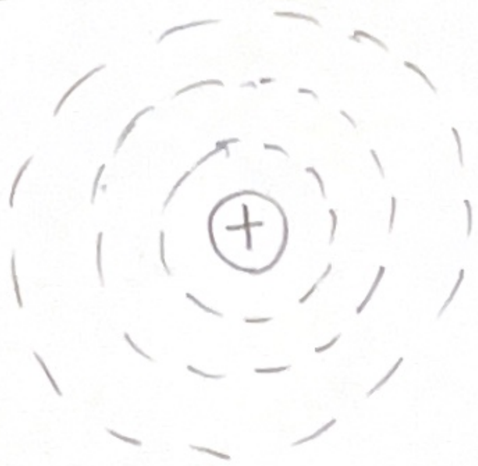
Problem 2

zero.

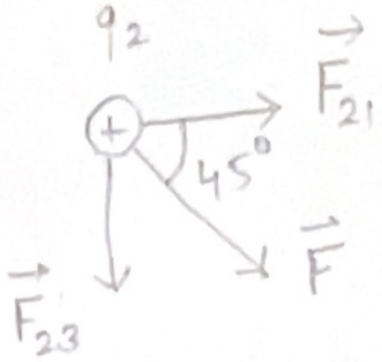
Problem 3

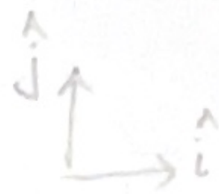
$$\Phi_E = \frac{Q_{enclosed}}{\epsilon_0} = \frac{+8.9\times10^{-9}\,C}{8.9\times10^{-12}\,\frac{C^2}{Nm^2}} = 1.0\times10^{3}\,\frac{N}{C}m^2$$

Problem 4



Problem 5





$$\vec{F}_{21} = \frac{k|q|^2}{L^2}[\hat{i} + 0\hat{j}]$$

$$\vec{F}_{23} = \frac{k|q|^2}{L^2}[0\hat{i} - \hat{j}]$$

$$\vec{F} = \frac{k|q|^2}{L^2}[\hat{i} - \hat{j}]$$

$$= 10.\ \mu N\,(\hat{i} - \hat{j})$$

magnitude: $|\vec{F}| = 10. \times 10^{-6}\sqrt{1^2 + (-1)^2}$

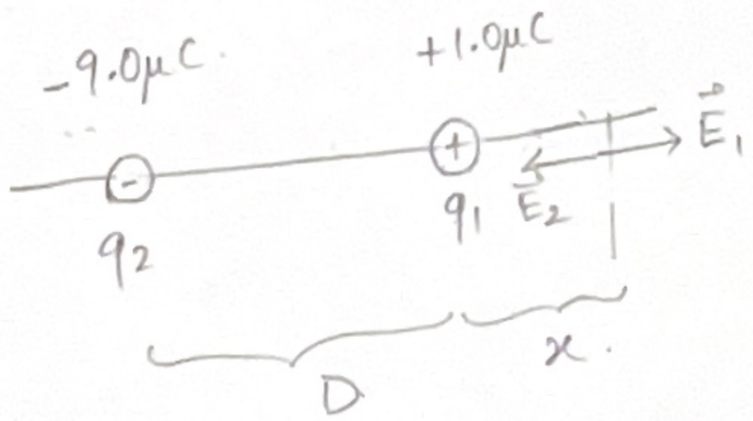
$= 14 \times 10^{-6} = 14\ \mu N$

direction: 45° cw w.r.t. $\hat{i}$

$$\frac{k|q|^2}{L^2} = \frac{(9.0\times10^{9})(1.0\times10^{-9})^2}{(3.0\times10^{-2})^2} = 1.0\times10^{-5}\ N$$

$= 10.\ \mu N$

Problem 6



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

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

$$\frac{1.0}{x^2} = \frac{9.0}{(D+x)^2}$$

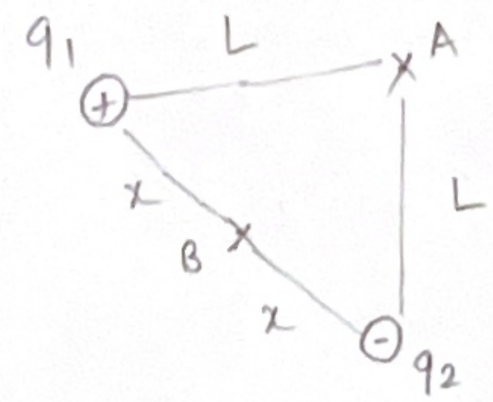
$$\frac{1.0}{x} = \frac{3.0}{D+x}$$

$$D + x = 3.0\,x.$$

$$x = \frac{D}{2.0} = 5.0\,cm$$

$x = 5.0\,cm$ to right of q_1.

Problem 7



$$V_A = \frac{kq_1}{L} + \frac{kq_2}{L}$$

$$= +\frac{k|q|}{L} - \frac{k|q|}{L} = 0$$

$$V_B = \frac{kq_1}{x} + \frac{kq_2}{x}$$

$$= +\frac{k|q|}{x} - \frac{k|q|}{x} = 0$$

$$V_A - V_B = 0$$