

# Solutions

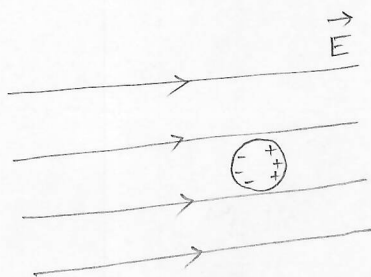
PHYS-205B

(Midterm Exam 01)

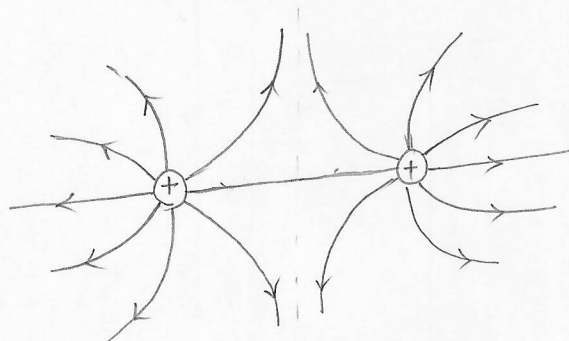
Fall 2024

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Problem 1



Problem 2

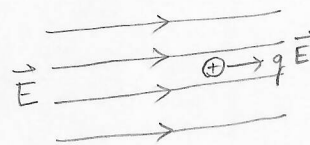


Problem 3

$$m\vec{a} = q\vec{E}$$

$$a = \frac{q}{m} E = \frac{(8.2 \times 10^{-6})(1.0 \times 10^3)}{(1.0 \times 10^{-3})}$$

$$= 8.2 \frac{\text{m}}{\text{s}^2}$$



Problem 4

$$\phi_E = \oint \vec{E} \cdot d\vec{a} = \frac{Q_{\text{enclosed}}}{\epsilon_0} \quad (\text{using Gauss's law})$$

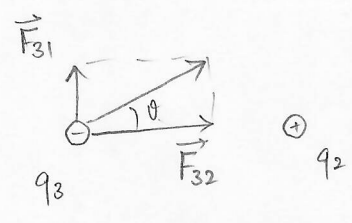
$$= \frac{Q_a + Q_b}{\epsilon_0}$$

$$= \frac{-3.5 \times 10^{-9} - 5.4 \times 10^{-9}}{8.85 \times 10^{-12}}$$

$$= -1.0 \times 10^3 \frac{\text{N}}{\text{C}} \text{m}^2$$

### Problem 5

$q_1 \oplus$

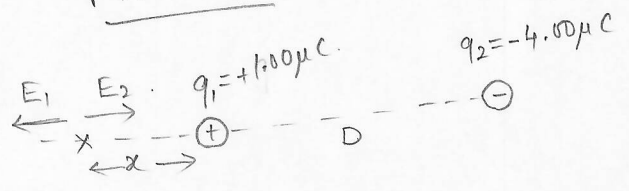


$$\begin{aligned} \vec{F}_{32} &= \frac{k|q_3|q_2}{L^2} \hat{i} \\ &= \frac{(9.0 \times 10^9)(1.0 \times 10^{-9})(2.0 \times 10^{-9})}{(3.0 \times 10^{-2})^2} \hat{i} \\ &= 2.0 \times 10^{-5} \hat{i} \\ &= \hat{i} 20. \mu\text{N} \\ \vec{F}_{31} &= \frac{k|q_3|q_1}{L^2} \hat{j} \\ &= \hat{j} 10. \mu\text{N} \end{aligned}$$

$$\begin{aligned} \vec{F}_{\text{tot}} &= \vec{F}_{32} + \vec{F}_{31} \\ &= (\hat{i} 20. + \hat{j} 10.) \mu\text{N} \end{aligned}$$

magnitude:  $|\vec{F}_{\text{tot}}| = \sqrt{20^2 + 10^2} = 22 \mu\text{N}$   
 direction  $\theta = \tan^{-1} \frac{10}{20} = 27^\circ \text{ ccw } \hat{i}$

### Problem 6



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

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

$$\frac{1.00}{x^2} = \frac{4.00}{(D+x)^2}$$

$$\frac{1.00}{x} = \frac{2.00}{D+x}$$

$$D+x = 2.00x$$

$$x = D$$

$\vec{E} = 0$  at  $D$  distance to the left of  $q_1$ .

Problem 7

$$\Delta V = V_A - V_B$$

$$r_A = s$$

$$r_B = t$$

$$= \frac{kq}{r_A} - \frac{kq}{r_B}$$

$$= \frac{(9.0 \times 10^9)(1.0 \times 10^{-9})}{(3.0 \times 10^{-2})} - \frac{(9.0 \times 10^9)(1.0 \times 10^{-9})}{(6.0 \times 10^{-2})}$$

$$= 3.0 \times 10^2 - 1.5 \times 10^2$$

$$= 150 \text{ Volt}$$