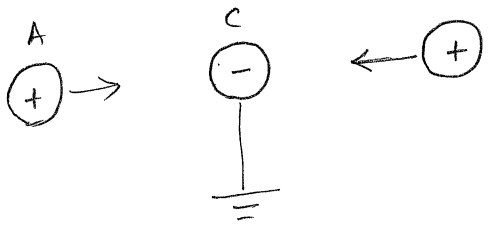
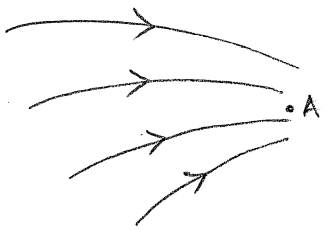
Solutions PHYS-205B (Midterm Exam 01) Fall 2025

Problem 1

Sphere C gets polarized. It will attract A and B.



Problem 2



Force is proportional to electric field. Magnitude of electric field is represented by density of field lines. Thus, point A will experience a larger force.

Problem 3

$$v = v_i + a\Delta t \quad (v_i = 0)$$

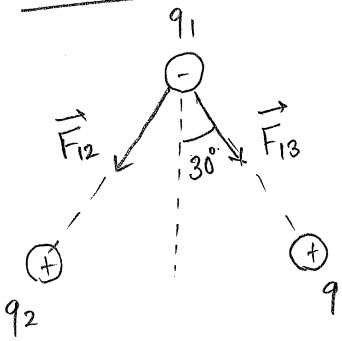
$$\frac{|v_e|}{|v_p|} = \frac{|a_e|\Delta t}{|a_p|\Delta t} = \frac{\frac{eE}{m_e}\Delta t}{\frac{eE}{m_p}\Delta t} = \frac{m_p}{m_e}$$

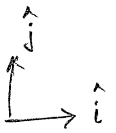
$$\Rightarrow v_e > v_p.$$

Problem 4

$$\oint \vec{E}\cdot d\vec{a} = \frac{Q_{enclosed}}{\epsilon_0} = 0.$$

Problem 5





$$\vec{F}_{12} = \frac{k|q|^2}{L^2}\left[-\sin 30\,\hat{i} - \cos 30\,\hat{j}\right]$$

$$\vec{F}_{13} = \frac{k|q|^2}{L^2}\left[+\sin 30\,\hat{i} - \cos 30\,\hat{j}\right]$$

$$\vec{F}_{tot} = -\hat{j}\,\frac{k|q|^2}{L^2}\,2\cos 30$$

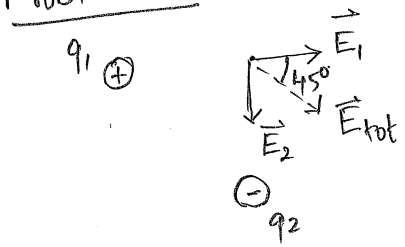
$$= -\hat{j}\,\frac{(9.0\times10^{9})(1.0\times10^{-9})^2}{(3.0\times10^{-2})^2}\,2\,\frac{\sqrt{3}}{2}$$

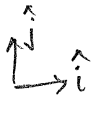
$$= -\hat{j}\;17\;\mu N$$

magnitude : $17\ \mu N$

direction : downwards along $-\hat{j}$.

Problem 6





$$\vec{E}_1 = \frac{k|q|}{L^2}\left[+\hat{i} + 0\,\hat{j}\right]$$

$$\vec{E}_2 = \frac{k|q|}{L^2}\left[0\,\hat{i} - \hat{j}\right]$$

$$\vec{E}_{tot} = \frac{k|q|}{L^2}\left[+\hat{i} - \hat{j}\right]$$

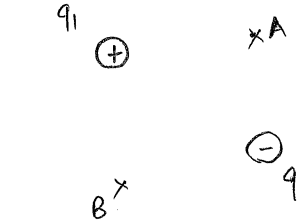
$\sqrt{1^2+1^2} = \sqrt{2}$.

magnitude : $|\vec{E}_{tot}| = \frac{k|q|}{L^2}\sqrt{2} = 1.4\times10^{4}\ \frac{N}{C}$.

direction : 45° cw w.r.t. $\hat{i}$.

$$\frac{kq}{L^2} = \frac{(9.0\times10^{9})(1.0\times10^{-9})}{(3.0\times10^{-2})^2} = 1.0\times10^{4}\ \frac{N}{C}$$

Problem 7



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

$$= +\frac{kq}{L} - 2\,\frac{kq}{L} = -\frac{kq}{L}$$

$$V_B = \frac{kq_1}{L} + \frac{kq_2}{L} = -\frac{kq}{L}$$

$$V_A - V_B = 0.$$