

# Solution

## Problem 1

In Move 2 all charges move to A and D.

$$Q'_A = \frac{+1+2+3+4}{2} = 5.0\mu\text{C}$$

$$Q'_B = 0$$

$$Q'_C = 0 \text{ charges}$$

$$Q'_D = 5.0\mu\text{C}$$

## Problem 2

0.

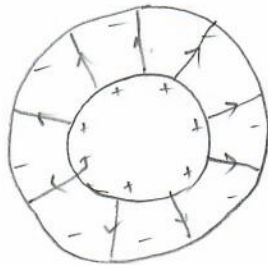
## Problem 3

$$|\vec{E}| = \frac{kq}{r^2} = \frac{(9.0 \times 10^9)(+1.0 \times 10^{-9})}{(2\sqrt{2} \times 10^2)^2} = 1.1 \times 10^4 \frac{\text{N}}{\text{C}}$$



$$r = \sqrt{2^2 + 2^2} = 2\sqrt{2} \text{ cm}$$

## Problem 4



### Problem 5

Let  $F = \frac{kq^2}{L^2}$

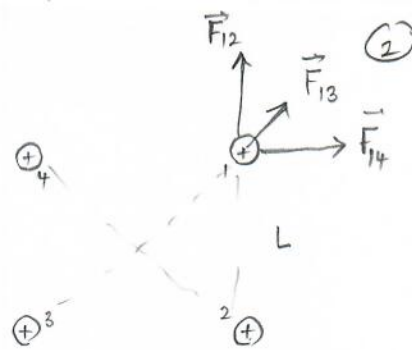
$$\vec{F}_{12} = +0 \hat{i} + F \hat{j}$$

$$\begin{aligned} \vec{F}_{13} &= \frac{F}{2} \cos 45^\circ \hat{i} + \frac{F}{2} \sin 45^\circ \hat{j} \\ &= \frac{F}{2\sqrt{2}} \hat{i} + \frac{F}{2\sqrt{2}} \hat{j} \end{aligned}$$

$$\vec{F}_{14} = F \hat{i} + 0 \hat{j}$$

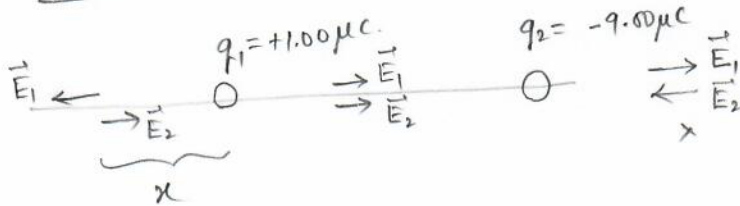
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$$\vec{F}_{tot} = F \left(1 + \frac{1}{2\sqrt{2}}\right) \hat{i} + F \left(1 + \frac{1}{2\sqrt{2}}\right) \hat{j}$$



$$\begin{aligned} |\vec{F}_{tot}| &= \sqrt{2} F \left(1 + \frac{1}{2\sqrt{2}}\right) \\ &= \frac{kq^2}{L^2} \left(\sqrt{2} + \frac{1}{2}\right) \end{aligned}$$

### Problem 6



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

$$D = 10.00 \text{ cm.}$$

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

$$\frac{\sqrt{1.00}}{x} = \frac{\sqrt{9.00}}{D+x}$$

$$\frac{1.00}{x} = \frac{3.00}{10.0 + x}$$

$$10.0 + 1.00x = 3.00x$$

$$10.0 \text{ cm} = 2.00x$$

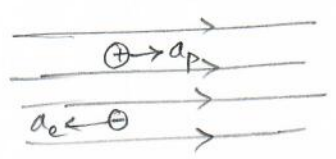
$$x = 5.00 \text{ cm. to the left of } q_1.$$

Problem 7

$$a_e = -\frac{q_e E}{m_e}$$

$$a_p = +\frac{q_p E}{m_p}$$

$$\frac{a_e}{a_p} = -\frac{m_p}{m_e} = -\frac{1.7 \times 10^{-27} \text{ kg}}{9.1 \times 10^{-31} \text{ kg}} = -1900$$



Problem 8

$\vec{E} = 0$  inside

