NUML
National University of Modern Languages

<u>BS-Software Engineering 1ST-E</u>

Assignment # 1

Physics

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<u>Title:Numerical Problems</u>

Submitted to

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-: Applied physics

-: Assignment 01

Example 21.30

A point Charge is placed at each Corner of a Square w
Side Length a. The Charges all have the Same magnit
Two of the Charges are positive .... what is the m
in terms of q and a.

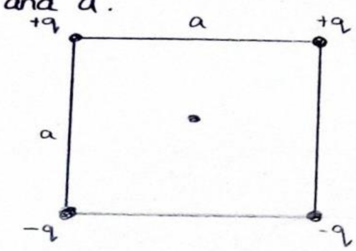


Figure 21.30

★ **To Find:**

- Magnitude of Charges in term of q and a.
- direction of net electric field at Centre O
  Square.

★ **Identify:**

The net electric Field is the Sum of individu
fields.

As we Know:

The distance from corner to centre of Square i

$r = \sqrt{(a/2)^2 + (a/2)^2} = a/\sqrt{2}$

The magnitude of electric field due to each Charge is the Same and equal to

$$E_q = \frac{Kq}{r^2} = \frac{2Kq}{a^2}$$ (all four y and x Components Cancel each other)

★ Executing:

Each y-Component is equal to $= E_{qy} = -E_q \cos 45°$

$$= -\frac{E_q}{\sqrt{2}} = -\frac{2Kq}{\sqrt{2}a^2} = -\frac{\sqrt{2}\,Kq}{a^2}$$

The resultant field is $\frac{4\sqrt{2}\,Kq}{a^2}$ in the y-direction.

★ Evaluate:

We must add y-Components of the fields, not their magnitudes.

★ **Example 21.34**

Point Charge $q_1 = -500nC$ is at the origin and point Charge $q_2 = +3.00$ is on the x-axis and $x = 3.00cm$. Point P is on the y-axis at $y = 4.00cm$ . . . . . . unit Vector form.

- **To Find:**

(a) The electric fields E_1 and E_2 at point P due to Charges q_1 and q_2.

(b) Use the results to find the resultant field at P.

- **Set up:**

For q_1, $\hat{r} = \hat{j}$ For q_2, $\hat{r} = \cos\theta\hat{i} + \sin\theta\hat{j}$ where θ is the angle between E_2 and x-axis.

- **Execute:**

(a) $$E_1 = \frac{q_1}{4\pi\epsilon_0 r_1^2}\hat{j} = \frac{(9.0\times10^9 N\cdot m^2/C^2)(-500\times10^{-9}C)}{(0.400m^2)}\hat{j}$$

$= (-2.813 \times 10^4 \, N/C)\hat{j}$

$$|\vec{E_2}| = \frac{(9.0\times10^9 \, N\cdot m^2/C^2)(3.00\times10^{-9} C)}{(0.0300m)^2+(0.400m)^2} = 1.080\times10^4 \, N/C$$

The angle of $\vec{E_2}$ measured from the x-axis is

$$180^\circ - \tan^{-1}\left(\frac{4.00cm}{3.00cm}\right) = 126.9 \, cm$$

Thus

$$E_2 = (1.080\times10^4 \, N/C)(\hat{i}\cos 126.9^\circ + \hat{j}\sin 126.9^\circ)$$

$$= (-6.485\times10^3 N/C)\hat{i} + (8.64\times10^3 N/C)\hat{j}$$

(b)

The resultant field is $\vec{E_1}+\vec{E_2} = (-6.485\times10^3 N/C)\hat{i} + (-2.813\times10^4 N/C + 8.64\times10^3 N/C)\hat{j}$.

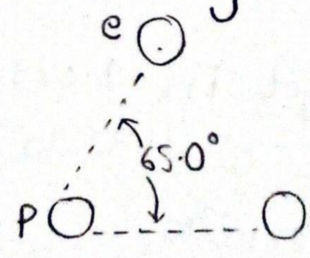
$$\vec{E_1}+\vec{E_2} = (-6.485\times10^3 N/C)\hat{i} - (1.95\times10^4 N/C)\hat{j}$$

Evaluate:

$\vec{E_1}$ is toward q_1, Since q_1 is negative. $\vec{E_2}$ is directed away from q_2. Since q_2 is positive.

★ **Example 21.37:**

If two electrons are each 1.50×10^{-10} m from a proton.... they will exert on the proton.



- **Identify:**

The forces the Charges exert on each other are given by Coloumb's law. The net force on the proton is the vector Sum of forces due to electrons.

- **Set up:**

$q_e = -1.60 \times 10^{-19} C$, $q_P = +1.60 \times 10^{-19} C$. The net force is the Sum of forces extended by each electron. Each force has magnitude $F = K\frac{|q_1 q_2|}{r^2} = K\frac{e^2}{r^2}$ and is attractive So directed toward the electron that exerts it.

- **Execute:**

Each force has magnitude

$$F_1 = k_2 \frac{|q_1 q_2|}{r^2} = K\frac{e^2}{r^2} = \frac{(8.988\times10^{9})(1.60\times10^{-19})^2}{(1.50\times10^{-10}m)^2}$$

$$= 1.023\times10^{-8} N$$

The Vector Force diagram

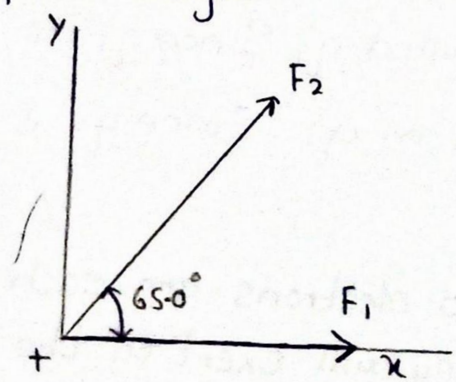


Figure 21.37

Taking Components, we get $F_{1x} = 1.023\times10^{-8} N$;

$F_{1y} = 0$ $F_{2x} = F_2 \cos 65.0° = 4.32\times10^{-9} N$;

$F_{2y} = F_2 \sin 65.0° = 9.27\times10^{-9} N$

$F_x = F_{1x} + F_{2x}$ $F_y = F_{1y} + F_{2y}$

$= 1.46\times10^{-8} N$; $= 9.27\times10^{-9} N$

$$F = \sqrt{F_x^2 + F_y^2}$$

$$= 1.73 \times 10^{-8} N \text{ (Magnitude)}$$

$$\tan\theta = \frac{F_y}{F_x}$$

$$= \frac{9.27 \times 10^{-9} N}{1.46 \times 10^{-8} N}$$

$$= 0.6349 \text{ which gives } \theta = 32.4°.$$

The net force is $1.73 \times 10^{-8} N$ and is directed toward a point midway between two electrons.

Evaluate:

The net force is less than the algebric Sum of individual forces.