Pir Mehr Ali Shah
Arid Agriculture University, Rawalpindi

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(EXTRA SHEET) S.No: ....

Continuous Sheet No : .... Regd. No : ....

Solution paper section (A) P# 1

Q 1 Given:

(a) $\vec{E} = 2x\hat{i} + 2\hat{j}$ N/C

$x = 0$ meters (for left face)

$x = 3$ meters (for right face)

$\vec{d} = dx\hat{i} + dy\hat{j} + dz\hat{k}$ | $d\hat{i} + d\hat{j} + d\hat{k}$

To Find:

$\Phi_R, \Phi_L, \Phi_T =$ electric flux through right, lef, and top face?

Solution: we know that

$$\Phi = \oint \vec{E}\cdot d\vec{A}$$

$$\Phi_R = \int (2x\hat{i}+2\hat{j})\cdot dA\hat{i}$$
$$= 2x\int dA(\hat{i}\cdot\hat{i}) + 2\int dA(\hat{j}\cdot\hat{i})$$

$$= 2x\int dA + 0$$ $\because \hat{i}\cdot\hat{i} = \hat{j}\cdot\hat{j} = \hat{k}\cdot\hat{k} = 1$

$$= 2x\cdot A \longrightarrow (a)$$ $\therefore \hat{i}\cdot\hat{j} = \hat{j}\cdot\hat{k} = \hat{k}\cdot\hat{i} = 0$

$$= 2(3)\cdot(3\times 3)$$

$$\boxed{\Phi_R = 54 \ N\cdot m^2/C}$$ $\because$ Area $= A = 3\times 3 \ m^2$

$$\Phi_L = -2x\cdot A$$ from eqn. (a

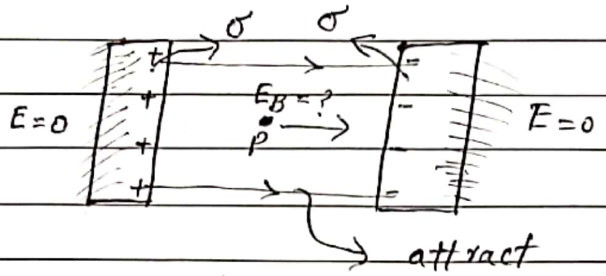
$$= -2(0)\cdot 9$$

$$\boxed{\Phi_L = 0 \ N\cdot m^2/C}$$

$$\Phi_T \Rightarrow \int(2x\hat{i}+2\hat{j})\cdot dA\hat{j} = \cancelto{0}{2x\int dA(\hat{i}\cdot\hat{j})} + 2\int dA(\hat{j}\cdot\hat{j}) = 2\cdot A$$

$$\boxed{\Phi_T = 2\times 9 = 18 \ N\cdot m^2/C}$$

Q.1 (b) Since Two plates are conducting so we have this situation:



Both plates attract each other due to opposit equal and opposite charges.

we know that

$E_+ = \frac{\sigma_1}{\epsilon_0}$ (Due to +ive plate)

$E_- = \frac{\sigma_2}{\epsilon_0}$ (Due to -ive plate) ∴ $\sigma_1 = \sigma_2$ (plates are placed parallel with equal charges).

$E_B = \frac{1(\sigma_1+\sigma_2)}{\epsilon_0} = \frac{2\sigma_1}{\epsilon_0}$ or $\frac{\sigma}{\epsilon_0}$ ∵ $\sigma_1 = \sigma$

$$\boxed{\vec{E}_B = \frac{\sigma}{\epsilon_0}\hat{r}}$$

⇒ This field is directed away from +ively charged plate and toward the −ively charged plate.

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S.No: ....
Continuous Sheet No : ....
Regd. No : ....

Q.3

(a) Data -:

$q_1 = 6\,C$

$q_2 = 4\,C$

$r = 2\,cm$

Find -: $\vec{F} = ?$

Solution -: we know that

$$\vec{F} = \frac{k\, q_1 q_2}{r^2}$$

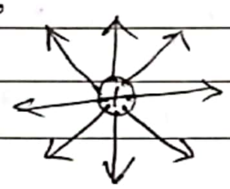
$$= 9\times10^9 \times \frac{6\times4}{(2)^2}$$

$$\vec{F} = \frac{24\times9\times10^9}{4}\,N$$

$$\boxed{\vec{F} = 54\times10^9\,N}$$

(b) Because electric field lines are unidirectional, so they can't cross each other even at far field.

i.e



(c) (i) spherical charge distrib

(ii hold only for pointcharg

(iii hold when distance is not of infinite value betwee the charges.

Q.2

(a) Data -: $a = 2\,cm$

$q_1 = 5\,C$, $q_2 = 10\,C$, $q_3 = 10\,C$, $q_4 = 5\,C$

To Find -:

net electric field at the square's center $= \vec{E} = ?$

Solution -:

using superposition priciple for four charges

$$\vec{E} = \sum_{i=1}^{4} E_i = \sum_{i=1}^{4} \frac{k\, q_i}{r_i^2} \longrightarrow (A)$$

where $k = \frac{1}{4\pi\epsilon_0}$ (common)

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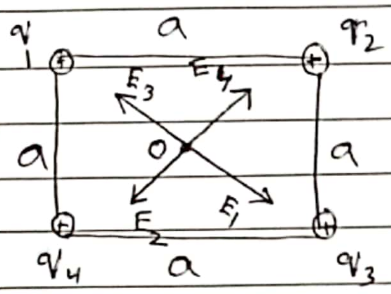
Continuous Sheet No : .... Regd. No : ....

Q.2 (a) Since all four charges are +ive so the electric field will be directed away from each charge.



Since $\vec{E_1}$ and $\vec{E_3}$ has same magnitude and are opposite in direction so cancels each other's effect. Similarly, $\vec{E_2}$ and $\vec{E_4}$ has same magnitude and opposite in direction, so cancels each other affect.

So at center O, net electric field is zero.

$$\boxed{\vec{E}_{net} = 0}$$