Sheet(3)-Prob 1

A 2mC positive charge is isolated in a Vaccum at $P_1(3,-2,-4)$ and $5\mu C$ negative charge at $P_2(1,-4,2)$

ⓐ Find the vector force on negative charge

ⓑ " " magnetiude of Force on charge at P_1

Sol

$$\overline{F_{12}} = 9\times10^9 \times \frac{q_1 q_2}{r^2}\, \overline{a_{R12}}$$

$$= 9\times10^9 \times \frac{(2\times10^{-3})(-5\times10^{-3})}{r^2}\, \overline{a_{R12}} \qquad \therefore r = |\overline{R_{12}}|$$

$$\overline{R_{12}} = \overline{R_2} - \overline{R_1} = (1,-4,2) - (3,-2,-4)$$

$$= (-2,-2,6) = -2\hat{a_x} - 2\hat{a_y} + 6\hat{a_z}$$

$$|\overline{R_{12}}| = r = \sqrt{(-2)^2+(-2)^2+(6)^2} = \sqrt{44}$$

$$\therefore \overline{a_R} = \frac{\overline{R_{12}}}{|\overline{R_{12}}|}$$

$$\therefore \overline{F_{12}} = \frac{9\times10^9 \times 2\times10^{-3} \times -5\times10^{-3}}{(\sqrt{44})^2} \cdot \frac{(-2\hat{a_x} - 2\hat{a_y} + 6\hat{a_z})}{\sqrt{44}}$$

$$\overline{F_{12}} = 0.616\hat{a_x} + 0.616\hat{a_y} - 1.84\hat{a_z}$$

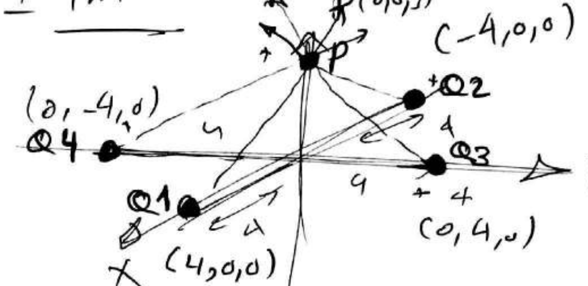
ⓑ Magnitude $= |\overline{F_{12}}| = \sqrt{(0.616)^2 + (0.616)^2 + (-1.84)^2}$

$= 2.04\ N$

EX(3)
Sheet(3 - Prob(2)

Find Force on 100 μC charge at (0,0,3) m of Four like charges of 20 μC are located on x and y axis at ± 4m

Sol



$$\vec{F}_t = \frac{Q_1 Q_p}{r_1^2} \times 9\times10^9 \hat{a}_{R_1} + \frac{Q_2 Q_p}{r_2^2} \times 9\times10^9 \hat{a}_{R_2} + \frac{Q_3 Q_p}{r_3^2} \times 9\times10^9 \hat{a}_{R_3} + \frac{Q_4 Q_p}{r_4^2} \times 9\times10^9 \hat{a}_{R_4}$$

$\because Q_1 = Q_2 = Q_3 = Q_4 = 20\times10^{-6}$

$$\therefore \vec{F}_t = 20\times10^{-6} \times 100\times10^{-6} \times 9\times10^9 \left[\frac{\hat{a}_{R_1}}{r_1^2} + \frac{\hat{a}_{R_2}}{r_2^2} + \frac{\hat{a}_{R_3}}{r_3^3} + \frac{\hat{a}_{R_4}}{r_4^2} \right]$$

$* \ \hat{R}_1 = \hat{R}_p - \hat{R}_1 = (-4, 0, +3) = -4\hat{a}_x + 3\hat{a}_z$

$|R_1| = r_1 = \sqrt{(-4)^2 + (3)^2} = 5 \ \ \& \ \hat{a}_{R_1} = -\frac{4}{5}\hat{a}_x + \frac{3}{5}\hat{a}_z$ → I

$* \ \hat{R}_2 = R_p - \hat{R}_2 = (4, 0, 3) = 4\hat{a}_x + 3\hat{a}_z$

$r_2 = 5 \ \ \& \ \hat{a}_{R_2} = \frac{4}{5}\hat{a}_x + \frac{3}{5}\hat{a}_z$ → II

$* \ \hat{R}_3 = \hat{R}_p - \hat{R}_3 = (0, -4, 3) = -4\hat{a}_y + 3\hat{a}_z$

$r_3 = 5 \ \ \& \ \hat{a}_{R_3} = -\frac{4}{5}\hat{a}_y + \frac{3}{5}\hat{a}_z$ → III

$* \ \hat{R}_4 = \hat{R}_p - \hat{R}_4 = (0, 4, 3) = 4\hat{a}_y + 3\hat{a}_z$

$r_4 = 5 \ \ \& \ \hat{a}_{R_4} = \frac{4}{5}\hat{a}_y + \frac{3}{5}\hat{a}_z$ → IV

$$\vec{F}_t = \frac{9\times10^9 \times 20\times10^{-6} \times 100\times10^{-6}}{(5)^2} \left[4 \times \frac{3}{5}\hat{a}_z \right] = 1.73\,\hat{a}_z \ \ (N)$$

EX(4)

sheet(3) Prob(3)

Two point charges, $Q_1 = 50\,\mu C$, $Q_2 = -10\,\mu C$ located at $P_1(-1, 1, -3)$ & $P_2(3, 1, 0)$ find Force on Q_1

Report

EX(5) sheet(3) Prob(4) Quiz مهم

Point charge $Q_1 = 300\,\mu C$, located at $(1, -1, -3)$ m experiences (exerts) a Force $\vec{F}_{1\,on\,Q_1} = 8\hat{a}_x - 8\hat{a}_y + 4\hat{a}_z$ N due to Q_2 located at $(3, -3, -2)$, Find Q_2

Sol

$$\bar{F}_{21} = \frac{Q_1 Q_2}{r^2} \cdot 9\times10^9 \times \hat{a}_R = 8\hat{a}_x - 8\hat{a}_y + 4\hat{a}_z$$

$$\Rightarrow \bar{R}_{21} = \bar{R}_1 - \bar{R}_2 = (-2, 2, -1)$$

$$= -2\hat{a}_x + 2\hat{a}_y - \hat{a}_z$$

$$\therefore |\bar{R}_{21}| = \sqrt{(-2)^2 + (2)^2 + (-1)^2} = 3$$

$$\therefore \hat{a}_{R21} = -\frac{2}{3}\hat{a}_x + \frac{2}{3}\hat{a}_y - \frac{1}{3}\hat{a}_z$$

$$\therefore 8\hat{a}_x - 8\hat{a}_y + 4\hat{a}_z = \frac{9\times10^{9}\times 300\times10^{-6}\times Q}{(3)^2}\cdot\left[-\frac{2}{3}\hat{a}_x + \frac{2}{3}\hat{a}_y + \frac{1}{3}\hat{a}_z\right)$$

الأسهل اساوي طرف $\hat{a}_x$ مع ما يقابل طرف a_x مع التحقيق (مع الواحد) وكفاية

$$\therefore 8\cancel{a_x} = \frac{9\times10^{9}\times 300\times10^{-6}\,Q}{9}\cdot\times -\frac{2}{3}\,\cancel{a_x}$$

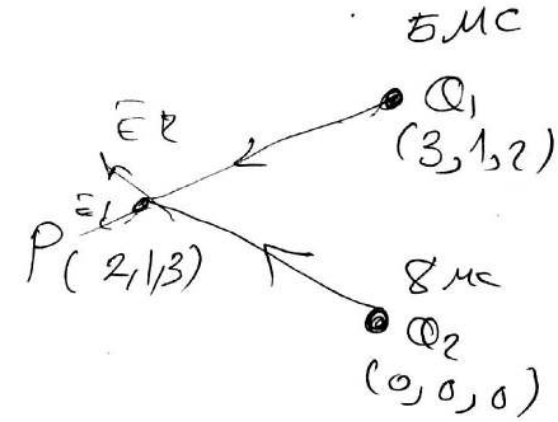
$$\therefore Q = -\,\_\_$$

حل مسائل شيت ٣ الشيت وشيت ٤

Sheet(3) Prob(5) → Point charge :

Find Electric Field intensity at Point (2,1,3) due to 2 charges of $Q_1 = 5\mu C$ and $Q_2 = 8\mu C$ at points (3,1,2) and origin

Sol



$$\bar{E} = \bar{E}_1 + \bar{E}_2$$

$$= \frac{Q_1}{4\pi\epsilon R_1^2}\hat{a}_{R_1} + \frac{Q_2}{4\pi\epsilon R_2^2}\hat{a}_{R_2}$$

$$= \frac{Q_1}{4\pi\epsilon R_1^3}\bar{R}_1 + \frac{Q_2}{4\pi\epsilon R_2^3}\bar{R}_2$$

$$= \frac{5\times10^{-6}}{R_1^3}\times9\times10^{9}\bar{R}_1 + \frac{9\times10^{9}\times8\times10^{-6}}{R_2^3}\bar{R}_2$$

$* \ \bar{R}_1 = (2-3, 1-1, 3-2) = -\hat{a_x} + \hat{a_z}$

$|\bar{R}_1| = r_1 = \sqrt{2}$

$* \ \bar{R}_2 = (2-0, 1-0, 3-0) = 2\hat{a_x} + 2\hat{a_y} + 3\hat{a_z}$

$|\bar{R}_2| = r_2 = \sqrt{14}$

$$\therefore \bar{E}_p = \frac{9\times10^9 \times 5\times10^{-6}}{(\sqrt{2})^3}\left[-\hat{a_x} + \hat{a_z}\right] + \frac{9\times10^9 \times 8\times10^{-6}}{(\sqrt{14})^3}\left[2\hat{a_x} + 2\hat{a_y} + 3\hat{a_z}\right]$$

$$= (\quad)\hat{a_x} + (\quad)\hat{a_y} + (\quad)\hat{a_z}$$

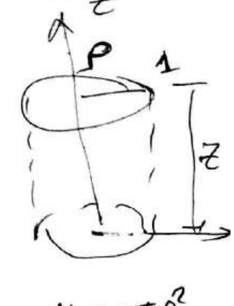
[illegible]

---

sheet(3) → No (6)

An electron Beam may be Approximated by a right circular cylinder of Random (R) that contains a volume charge density $\rho_v = \frac{k}{c+r^2}$ C/m³. Evaluate the total charge per unit length of beam

Sol / $(r = \rho)$



$Q = \int \rho_v \, dv$

For cylindrical $dv = \rho \, d\rho \, d\phi \, dz$

$$\therefore Q = \int_0^{\rho}\int_0^{2\pi}\int_0^{1} \frac{k}{c+r^2} \cdot \rho \, d\rho \, d\phi \, dz$$

$z=1$

$A_{base} = \pi\rho^2$

$A_l = 2\pi\rho z$

$$= (2\pi)(z)k\int_0^{\rho}\frac{\rho}{c+\rho^2}\,d\rho = \pi z k\int_0^{\rho}\frac{2\rho}{c+\rho^2}\,d\rho$$

$2\pi\rho$

$V = \pi\rho^2 z$

$$= \pi z k\left[\ln(c+\rho^2)\right]_0^{\rho} =$$

$$2\pi z k \rho \left[\ln(c+\rho^2) - \ln c\right]$$

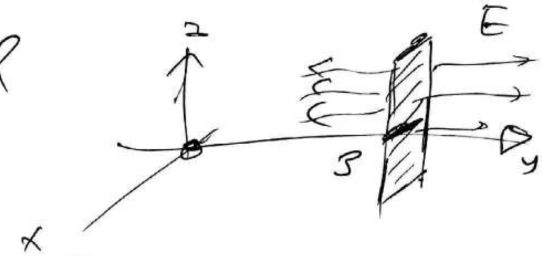
$$Q = \pi K \ln \frac{c+r^2}{c}$$

$$Q = \pi K \ln \frac{c+r^2}{c}$$

sheet(3) No(7)

7 A plane $y = 3m$, contains a uniform charge destribution of density $\rho_s = (\frac{10^{-8}}{6\pi})\ C/m^2$, Determine $\bar{E}$ at all points

Sol



Sol

$E(y > 3)$

$$= \frac{\rho_s}{2\epsilon_0} \cdot \hat{a}_n \quad \hat{a}_n \rightarrow \hat{a}_y \qquad = \frac{10^{-8}/6\pi}{2 \times 8.85 \times 10^{-12}} \hat{a}_y = 30\,\hat{a}_y$$

$8.85 \times 10^{-12} \rightarrow 1/36\pi$

$E(y < 3)$

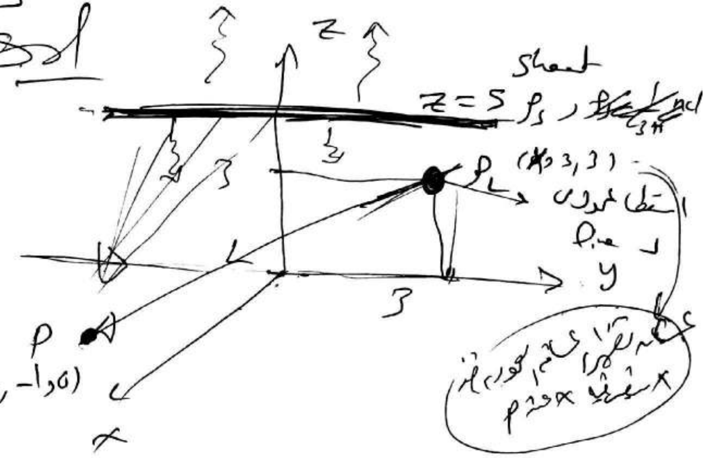
$$= \frac{\rho_s}{2\epsilon_0} \cdot \hat{a}_n \quad \hat{a}_n \rightarrow -\hat{a}_y \qquad = -30\,\hat{a}_y$$

Sheet(3) – No(8)

determine $\bar{E}$ at $(x,-1,0)$ due to uniform sheet charge with $\rho_s = \frac{1}{3\pi}\ nC/m^2$, is located at $z = 5m$ & Uniform line charge with $\rho_L = -\frac{25}{9}\ nC/m$ at $z = +3$, $y = 3$, (هنا الـ x مجهول يبقى خط x)

يعني x متغيرة

Sol



$\bar{E} = \bar{E}_{line} + \bar{E}_{sheet}$

$\bar{E}_{sh} = \frac{\rho_s}{2\epsilon}\hat{a}_n$

عشان النقطة p تقع تحت الشيت ∴ اتجاهها $= -\hat{a}_z$

$\therefore \bar{E}_s = \frac{\left(\frac{1}{3\pi}\times 10^{-9}\right)}{2\times 8.85\times 10^{-12}}\cdot[-\hat{a}_z] \longrightarrow (1)$

$\bar{E}_l = \frac{\rho_L}{2\pi\epsilon r}\cdot\hat{a}_r \longrightarrow$

$\bar{R} = (x,-1,0) - (x,3,3) = (0,-4,-3)$

$= -4\hat{a}_y + 3\hat{a}_z$

$|\bar{R}| = \sqrt{(-4)^2+(3)^2} = 5$

$\bar{E}_l = \frac{\left(-\frac{25}{9}\times 10^{-9}\right)}{2\pi\times 8.85\times 10^{-12}}\cdot\frac{(-4\hat{a}_z + 3\hat{a}_z)}{5} \longrightarrow (2)$

$\bar{E} = -8a_y - 12\hat{a}_z$