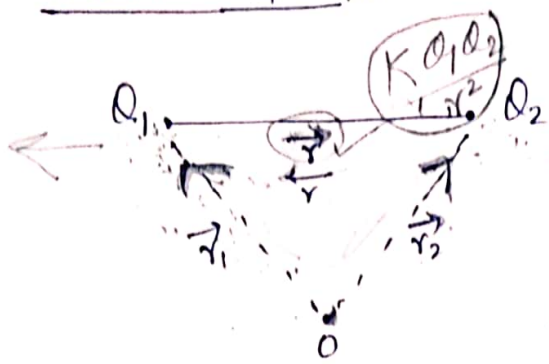
[for ECE-6th & 4th sem students] Date 05/04/20

Q_1 & Q_2 are two charge & +ve value.
Q_1 & Q_2 की distance assume करते हैं origin से, इसलिए $\vec{r_1}$, $\vec{r_2}$ vector-form में हैं।

Force in vector-form :→



Q_2 पर force Q_1 के कारण, क्योंकि दोनों Positive हैं तो Rightward direction में लगेगा। (Repulsive)
{इसी तरह से Q_1 पर force Q_2 की वजह से Leftward direction में लगेगा}

$F = \frac{1}{4\pi\varepsilon}\frac{Q_1Q_2}{r^2}(\hat{r})$ → direction बताता है कि किस direction में force लग रहा है।
Vector

$F(\text{on } Q_2 \text{ due-to } Q_1) = \frac{1}{4\pi\varepsilon}\frac{Q_1Q_2}{r^2}(\hat{r})$

$\hat{r} = \frac{\vec{r}}{|\vec{r}|}$

$\hat{r} = \frac{\vec{r_2}-\vec{r_1}}{|\vec{r_2}-\vec{r_1}|}$

जहाँ Put किजिए तो direction पता चला जायेगी।

on triangular law

$\vec{r_1}+\vec{r} = \vec{r_2}$

$\vec{r} = \vec{r_2}-\vec{r_1}$

$F(\text{on } Q_1 \text{ due-to } Q_2) = \frac{1}{4\pi\varepsilon}\frac{Q_1Q_2}{r^2}\hat{r}$

$\vec{r_2}+\vec{r} = \vec{r_1}$

$\vec{r} = \vec{r_1}-\vec{r_2}$ (Put it like wise)

ε → is know as Permittivity

$\varepsilon = \varepsilon_0\varepsilon_r$

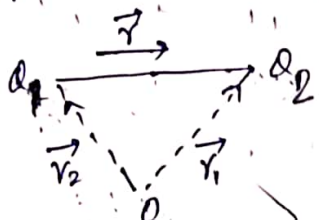
$\frac{1}{36\pi}\times10^{-9}$ F/m

then Put it

$\frac{1}{4\pi\varepsilon} = \frac{1}{4\pi\frac{1}{36\pi}\times10^{-9}} = 9\times10^9$ m/F

Qu $Q_1(1,3,2)$ & $Q_2(-1,2,3)$ if $Q_1 = 2C$, $Q_2 = -3C$ then determine the force on Q_2 due to Q_1 in vector-form. ($\varepsilon_r = 2$ & $\varepsilon_0 = \frac{1}{36\pi}\times10^{-9}$ F/m)

medium Air, glass = 1
ε_r 1



$|\vec{r}| = \sqrt{(x_2-x_1)^2+(y_2-y_1)^2+(z_2-z_1)^2}$

$= \sqrt{4+1+1} = \sqrt{6}$

$\vec{r_2}+\vec{r} = \vec{r_1}$

$\vec{r} = \vec{r_1}-\vec{r_2}$

(Point given है तो) $\vec{r_1} = \hat{i}_x + 3\hat{i}_y + 2\hat{i}_z$

$\vec{r_2} = -\hat{i}_x + 2\hat{i}_y + 3\hat{i}_z$

$\vec{r} = \vec{r_1}-\vec{r_2} = 2\hat{i}_x + \hat{i}_y - \hat{i}_z$

also $|\vec{r}| = \sqrt{6}$, $\hat{r} = \frac{2}{\sqrt{6}}\hat{i}_x + \frac{1}{\sqrt{6}}\hat{i}_y - \frac{1}{\sqrt{6}}\hat{i}_z$

$F = \frac{1}{4\pi\varepsilon_0\varepsilon_r}\frac{Q_1Q_2}{r^2}\hat{r}$ only Put mag.

$\hat{r} = \frac{\vec{r}}{|\vec{r}|}$ =

$F = \frac{5\times10^9}{2}\times\frac{2\times3}{(\sqrt{6})^2}\hat{r}$

$\vec{F} = 4.5\pi\times10^9\left(\frac{2}{\sqrt{6}}\hat{i}_x + \frac{1}{\sqrt{6}}\hat{i}_y - \frac{1}{\sqrt{6}}\hat{i}_z\right)$ Coulomb.

← force in vector-form

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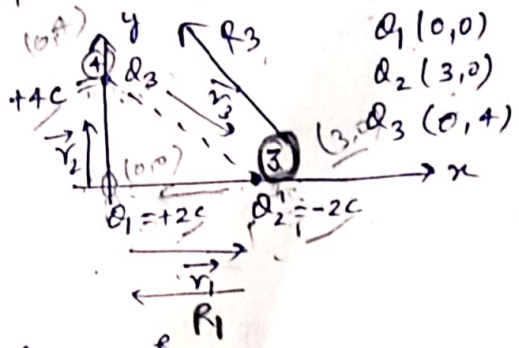
→ if asked force in x-direction then

$$\vec{F} = 4.5\pi \times 10^{9}\left(\frac{2}{\sqrt{6}}\hat{i}_x\right)C$$

$$\vec{F} = 4.5\pi \times 10^{9}\left(\frac{1}{\sqrt{6}}\hat{i}_y\right)C \rightarrow \text{in } y \text{ direction}$$

$$\vec{F} = 4.5\pi \times 10^{9}\left(-\frac{1}{\sqrt{6}}\hat{i}_z\right)C \rightarrow \text{in } z\text{-direction}$$

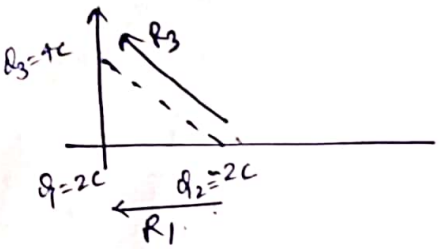
Q.1 find force F on Q_2 = ?



Soln

$Q_1 \rightarrow$ +ve ई
$Q_2 \rightarrow$ +ve दो
$Q_3 \rightarrow$ +ve ई

⇒ तो Q_2 पर force Q_3 की वजह से R_3 direction में लगेगा (attractive लगेगा)
और Q_2 पर Q_1 की वजह से R_1 direction में लगेगा (")



$$\vec{R}_3 = -\vec{r}_3 = -3\hat{i}_x + 4\hat{i}_y$$

(3-0) $\hat{i}_x$ + (0-4) $\hat{i}_y$
$3\hat{i}_x + (-4)\hat{i}_y$
$3\hat{i}_x - 4\hat{i}_y$

$\vec{r}_3 = 3\hat{i}_x - 4\hat{i}_y$

$|\vec{r}_1| = 3$
$\vec{r}_1 = 3\hat{i}_x$
$\vec{r}_2 = 4\hat{i}_y$

$\vec{r}_2 + \vec{r}_3 = \vec{r}_1$
$\vec{r}_3 = \vec{r}_1 - \vec{r}_2$

$\vec{R}_1 = -\vec{r}_1 = -3\hat{i}_x$ ⇒ $|\vec{R}_1| = |\vec{r}_1| = 3$ (magnitude same here)

then $F_{12} = \frac{1}{4\pi\varepsilon}\frac{Q_1 Q_2}{r^2}\hat{R}_1$

$\hat{R}_1 = \frac{\vec{R}_1}{|\vec{R}_1|} = \frac{-3\hat{i}_x}{3} = -\hat{i}_x$ ⇒ it shows force in -ve x-direction, → जो कि पहले से आपको दिख रहा है attractive होगा और -ve direction में होगा।

$F_{12} = 9\times10^{9} \times \frac{2\times2}{9} \times (-\hat{i}_x)$

$$\boxed{F_{12} = -4\times10^{9}\,\hat{i}_x}$$

Q_2 पर Q_1 के वजह से

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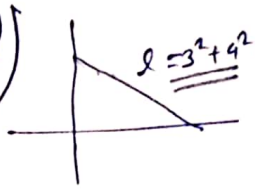
$$\vec{F}_{32} = 9\times10^{9} \times \frac{4\times2}{25} \times \left(\frac{-3\hat{i}+4\hat{j}}{5}\right)$$



$$l = 3^2+4^2 = 9+16 = 25 = 5$$

$$|\vec{R}_3| = 5$$

$$\vec{R}_3 = -3\hat{i}+4\hat{j}$$

$$\vec{F}_{32} = \frac{72}{25}\times10^{9}\left[\frac{-3}{5}\hat{i}+\frac{4}{5}\hat{j}\right]$$

Then Total $F = F_{32} + F_{12}$