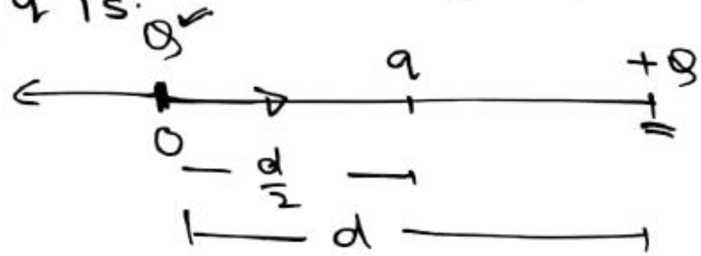
JEE(Mains) 2019 Three charges +Q, q, +Q are placed respectively at ~~x~~ distance, 0, $\frac{d}{2}$, & d from the origin, on the x-axis. If the Net force experienced by Q placed at x=0 is zero then value of q is:

(a) $+Q/4$

(b) $-Q/2$

(c) $+Q/2$

(d) $-Q/4$



$$F_{Q,Q} = \frac{1}{4\pi\varepsilon_0}\frac{QQ}{d^2}$$

$$F_{Qq} = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{(d/2)^2} = \frac{1}{4\pi\varepsilon_0}\frac{4Qq}{d^2}$$

$$F_{QQ} + F_{Qq} = 0$$

$$\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{d^2} + \frac{1}{4\pi\varepsilon_0}\frac{4Qq}{d^2} = 0$$

$$\cancel{\frac{1}{4\pi\varepsilon_0}}\frac{Q^{\cancel{2}}}{\cancel{d^2}} = -\cancel{\frac{1}{4\pi\varepsilon_0}}\frac{4\cancel{Q}q}{\cancel{d^2}}$$

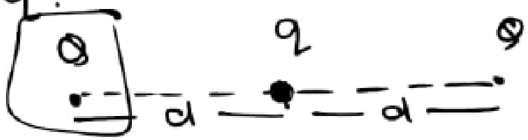
$$Q = -4q$$

$$q = -\frac{Q}{4}$$

AIEEE : 2002

Q) If a charge q is placed at the centre of the line joining two equal charges Q such that the system is in equilibrium then the value of q.

(a) Q/2.



(b) −Q/2.

$$F_{Qq} + F_{Q,Q} = 0$$

(c) Q/4.

$$\frac{1}{4\pi\varepsilon_0}\frac{Qq}{d^2} + \frac{1}{4\pi\varepsilon_0}\frac{Q\cdot Q}{(2d)^2} = 0$$

(d) −Q/4.

$$\frac{\cancel{Q}q}{\cancel{4\pi\varepsilon_0}\cancel{d^2}} = -\frac{1}{\cancel{4\pi\varepsilon_0}}\frac{\cancel{Q}\cdot Q}{4\cancel{d^2}}$$

$$q = -\frac{Q}{4}$$

JEE(main) 2018, 2007

q_A (A) — (B) q_B ; (A) $\frac{q_A+q_B}{2}$; (B) $\frac{q_A+q_B}{2}$

Q) Two identical conducting spheres A & B, carry equal charge. They are seperated much distance, larger than their diameter & the Force b/w them is F. A third identical conducting sphere C is uncharged. Sphere C is First touch with A, then to B & then removed. As a result, the Force b/w A & B would be equal to.

(a) 3F/8

(b) F/2

(c) $\frac{3F}{4}$

(d) F.

q (A) —— r —— (B) q

$$F = \frac{1}{4\pi\varepsilon_0}\frac{q\times q}{r^2} = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{r^2}$$

q (B) — (C) $q/2$

$\frac{q+q/2}{2}$; $\frac{q+q/2}{2}$

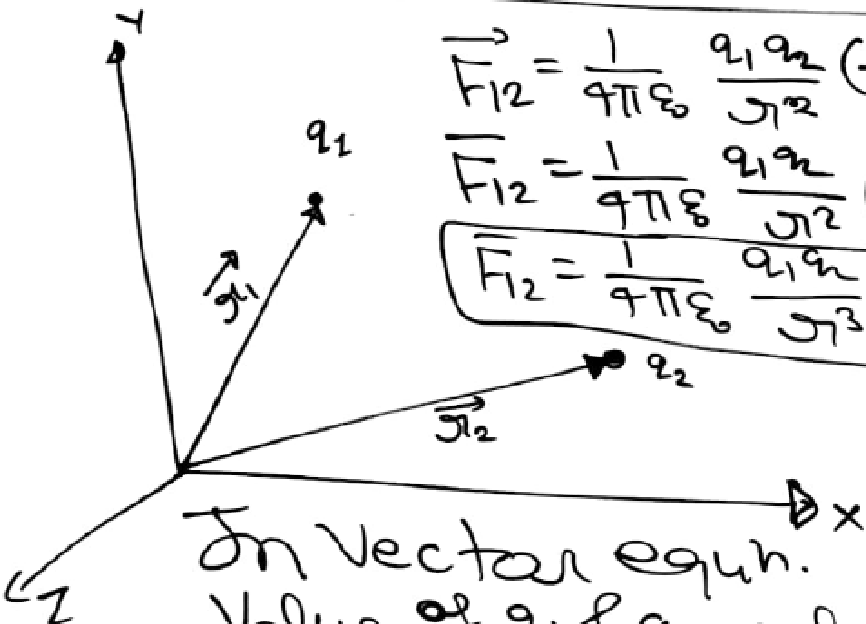
$\frac{3q}{4}$

$$F' = \frac{1}{4\pi\varepsilon_0}\frac{(q/2)(3q/4)}{r^2}$$

$q/2$ (A) —— r —— (B) $3q/4$

$$F' = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{r^2} \times \frac{3}{8} \Rightarrow F' = \frac{3}{8}F$$

Vector form of Coulomb's Law:-



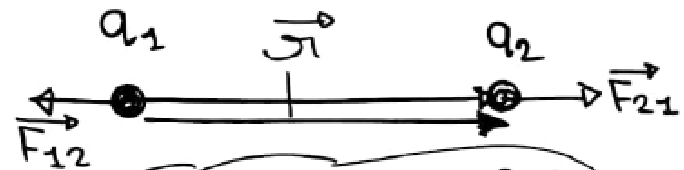
$$\vec{F}_{12} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}(-\hat{r})$$

$$\vec{F}_{12} = \frac{1}{4\pi\varepsilon}\frac{q_1 q_2}{r^2}\left(\frac{-\vec{r}}{r}\right)$$

$$\boxed{\vec{F}_{12} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^3}(-\vec{r})}$$

In vector equn. Value of q_1 & q_2 put with sign

⇒ Vector form



$$|\vec{F}_{12}| = |\vec{F}_{21}| = \frac{1}{4\pi\varepsilon}\frac{q_1 q_2}{r^2}$$

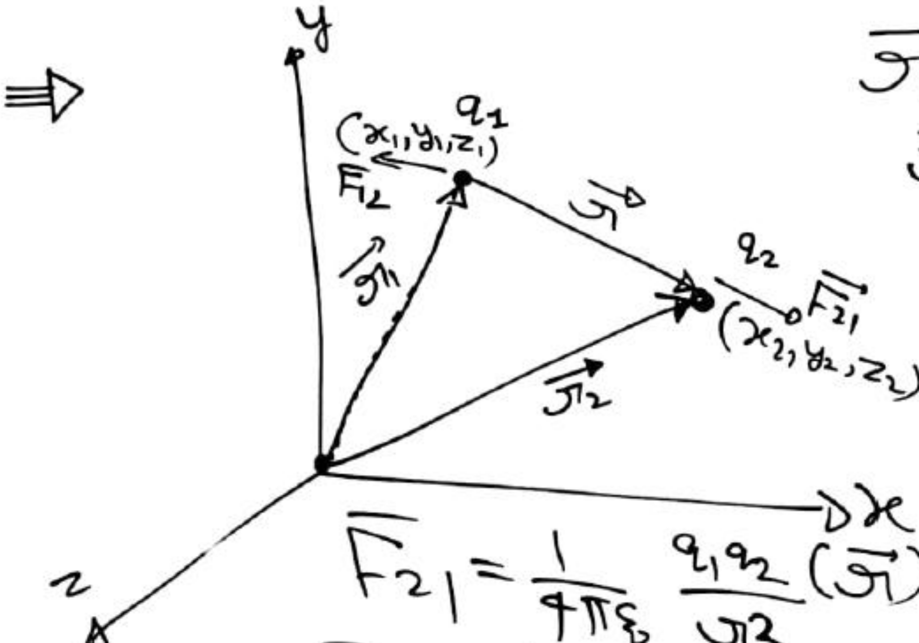
$$\boxed{\vec{F}_{21} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}\cdot\hat{r}} \quad \left[\hat{r} = \frac{\vec{r}}{r}\right]$$

$$\vec{F}_{21} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}\times\frac{\vec{r}}{r}$$

$$\boxed{\vec{F}_{21} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^3}(\vec{r})}$$

Vector form of Coulomb's Law:

$\Rightarrow$



$$\vec{r}_1 + \vec{r} + (-\vec{r}_2) = 0$$

$$\vec{r}_1 + \vec{r} - \vec{r}_2 = 0$$

$$\boxed{(\vec{r} = \vec{r}_2 - \vec{r}_1)}$$

$$\vec{r}_1 = x_1 \hat{i} + y_1 \hat{j} + z_1 \hat{k}$$

$$\vec{r}_2 = x_2 \hat{i} + y_2 \hat{j} + z_2 \hat{k}$$

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

$$\boxed{\vec{r} = (x_2 - x_1)\hat{i} + (y_2 - y_1)\hat{j} + (z_2 - z_1)\hat{k}}$$

$$\vec{F}_{21} = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r^3} (\vec{r})$$

$$\vec{F}_{12} = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r^3} (-\vec{r})$$

two point charges 2c & −4 c placed at (2, 3, 4) & (4, 2, 1) respectively. find Force on 2c & −4c in vector form.

$\boxed{q_1 = 2c}$ $\boxed{q_2 = -4c}$

$\vec{r}_1 = 2i + 3j + 4k$

$\vec{r}_2 = 4i + 2j + 1k$

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

$= (4-2)i + (2-3)j + (1-4)k$

$\vec{r} = 2i - j - 3k$

$|\vec{r}| = \sqrt{(2)^2 + (-1)^2 + (-3)^2}$

$|\vec{r}| = \sqrt{4+1+9}$

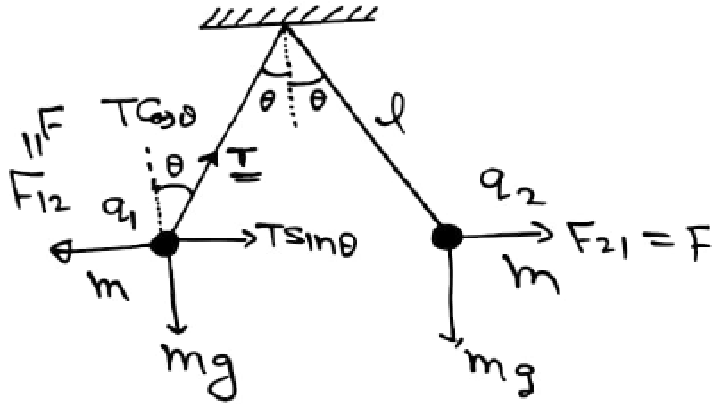
$r = \sqrt{14}$

$\vec{F}_{2,-4}$ = Force on 2c

$$\vec{F}_{2,-4} = \frac{1}{4\pi\varepsilon_0} \frac{2\times(-4)}{(\sqrt{14})^3} \cdot \vec{r}$$

$$\boxed{(\vec{F}_{2,-4}) = \frac{1}{4\pi\varepsilon_0} \frac{(-8)}{14\sqrt{14}} (2i - j - 3k)}$$

⇒ String, bob problem



$$\theta = \tan^{-1}\left(\frac{F_e}{mg}\right)$$

Angle of String with vertical

⇒ In equilibrium condition

$$T\sin\theta = F_e \quad \text{—(i)}$$

$$T\cos\theta = mg \quad \text{—(ii)}$$

$$\frac{\cancel{T}\sin\theta}{\cancel{T}\cos\theta} = \frac{F_e}{mg}$$

$$\tan\theta = \frac{F_e}{mg}$$

H.W

Ex#2

Q, 12, 22, 26