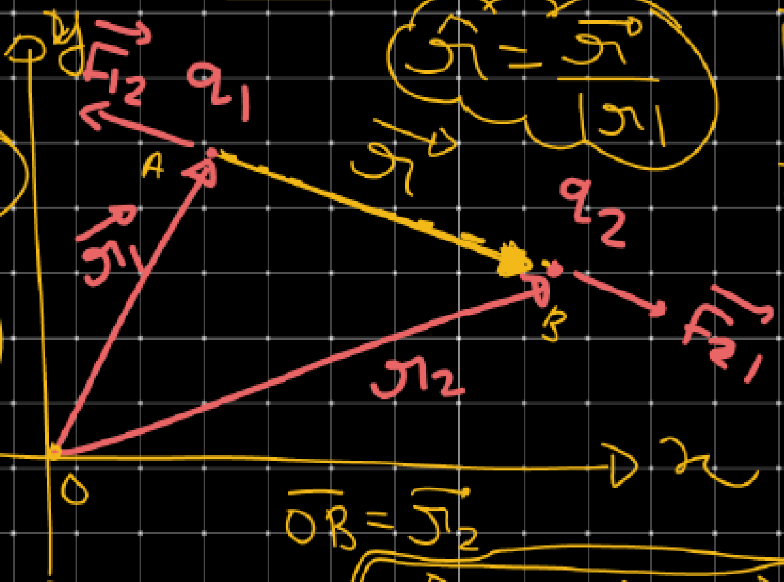
Vector form of Coulomb's law:

$$\vec F_{21} = \frac{Kq_1q_2}{r^3}(\vec r)$$

$$\vec F_{12} = \frac{Kq_1q_2}{r^2}\left(-\frac{\vec r}{r}\right)$$

$$= \frac{Kq_1q_2}{r^3}(-\vec r)$$

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



$\vec F_{12}$ = Force on 1 due to (2)

$\vec F_{21}$ = Force on 2 due to one.

$$\vec F_{21} = \frac{Kq_1q_2}{r^2}(\hat r)$$

$$\vec F_{12} = \frac{Kq_1q_2}{r^2}(-\hat r)$$

$$\boxed{\vec F_{12} = -\vec F_{21}}$$

$$\vec{OB} = \vec r_2$$

$$\vec{OA} + \vec{AB} + \vec{BO} = 0$$

$$\vec r_1 + \vec r + (-\vec r_2) = 0$$

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

In Vector form q_1 & q_2 put with sign

$\overset{2C}{\overset{\shortparallel}{q_1}} \to (2,3)$ $\overset{4C}{\overset{\shortparallel}{q_2}}(5,7)$ $\vec{F}_{21} = \frac{k q_1 q_2}{r^3}(\vec{r})$

$\vec{r} = \vec{r}_2 - \vec{r}_1$ $\vec{r}_2 = 5i + 7j$ $\vec{F}_{12} = \frac{k q_1 q_2}{r^3}(-\vec{r})$

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

$\vec{F}_{21} = \frac{9 \times 10^9 \times 2 \times 4}{5^3}(3i + 4j)$

$\vec{r} = \vec{r}_2 - \vec{r}_1 = 3i + 4j$

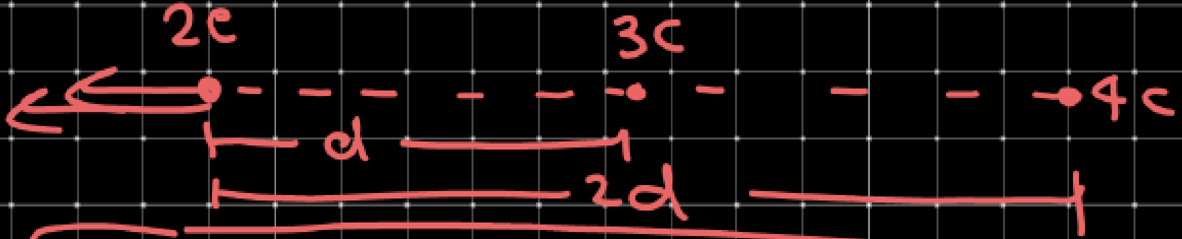
$\vec{F}_{12} = \frac{9 \times 10^9 \times 2 \times 4}{5^3}(-3i - 4j)$

$|\vec{r}| = \sqrt{9+16} = 5\,m$

Superposition principle for Electric forces -

$$\vec{F}_{net} \text{ on } q_0 = \vec{F}_{01} + \vec{F}_{02} + \vec{F}_{03} + \cdots + \vec{F}_{0n}$$

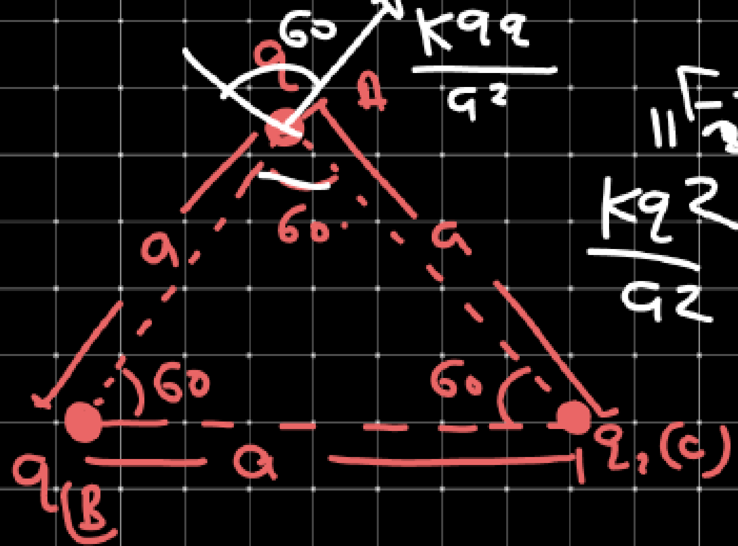
Find Force on 2C charge.



$$\boxed{\vec{F}_{net} = \frac{K(2)(3)}{d^2} + \frac{K\,2\times 4}{4d^2}}$$

Q2)

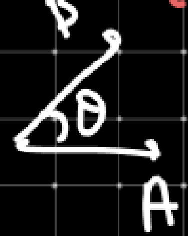
Find Net Force on q placed at position $\boxed{A}$.



$$\frac{Kq^2}{a^2} = \frac{Kqq}{a^2}$$

$$F_1 = F_2 = F$$

$$\frac{Kqq}{a^2} = \frac{Kq^2}{a^2} = F_1 = F$$



$$R = \sqrt{A^2 + B^2 + 2AB\cos\theta}$$

$$F_{net} = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos 60}$$

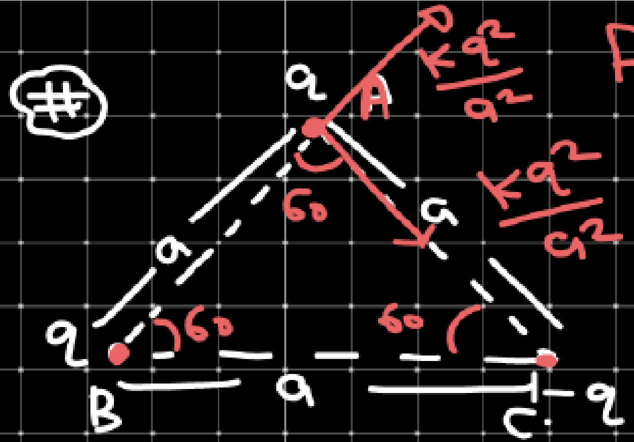
$$F_{net} = \sqrt{F^2 + F^2 + 2F^2 \times \frac{1}{2}}$$

$$F_{net} = \sqrt{3F^2}$$

$$F_{net} = F\sqrt{3}$$

$$F_{net} = \frac{Kq^2}{a^2}\sqrt{3}$$

#



Find F_{net} on q [Placed at Point A]

A

120

60

$\frac{kq^2}{a^2} = F = F_1$

$\boxed{F_{net} = \frac{kq^2}{a^2}}$

$\frac{kq^2}{a^2} = F = F_2$

$\cos 120$

$= \cos(90+30)$

$= -\sin 30 = -\frac{1}{2}$

$$F_{net} = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos\theta}$$

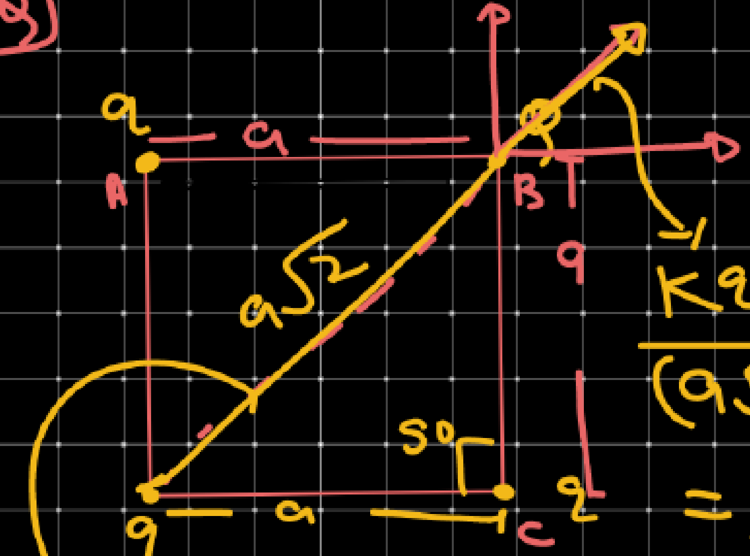
$$= \sqrt{F^2 + F^2 + 2F^2\cos 120}$$

$$= \sqrt{F^2 + F^2 + 2F^2 \times \left(-\frac{1}{2}\right)}$$

$$= \sqrt{F^2 + \cancel{F^2} - \cancel{F^2}} = \sqrt{F^2} = \underline{\underline{F}}$$

$$F_{net} = \frac{kq^2}{a^2}$$

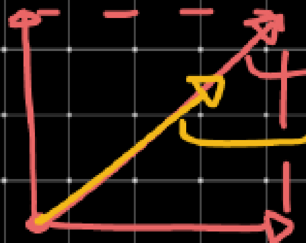
Q) Find Force on Q placed at Point B.



$F = \frac{KqQ}{a^2}$

$\frac{KqQ}{(a\sqrt{2})^2} = \frac{KqQ}{a^2\times 2}$

$= \frac{KqQ}{2a^2}$



$F_{net} = \frac{KqQ}{a^2}\sqrt{2}$

$\frac{KqQ}{2a^2}$

$\frac{KqQ}{a^2} = F$

$\sqrt{a^2+a^2}$

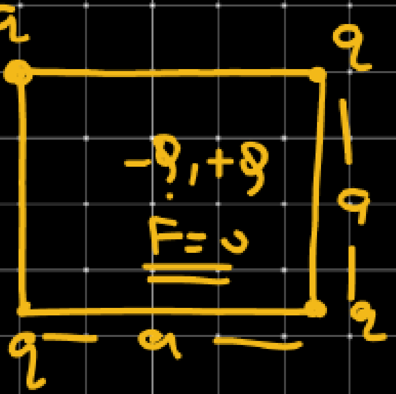
$= \sqrt{2a^2}$

$= a\sqrt{2}$

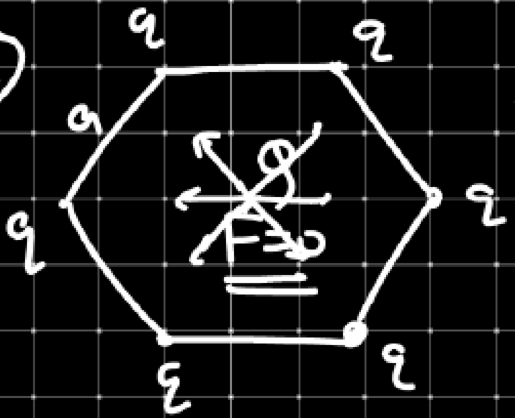
$F_{net} = \frac{KqQ}{a^2}\sqrt{2} + \frac{KqQ}{2a^2}$

$$\boxed{F_{net} = \frac{KqQ}{a^2}\left(\sqrt{2}+\frac{1}{2}\right)}$$

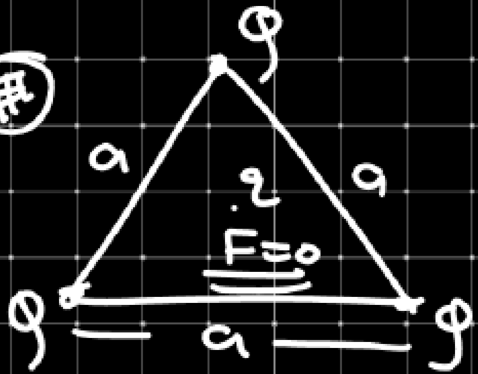
#


q
q
a
q
q
a
−q, +q
F = 0

#


q
q
a
q
q
q
q
q
F = 0

#

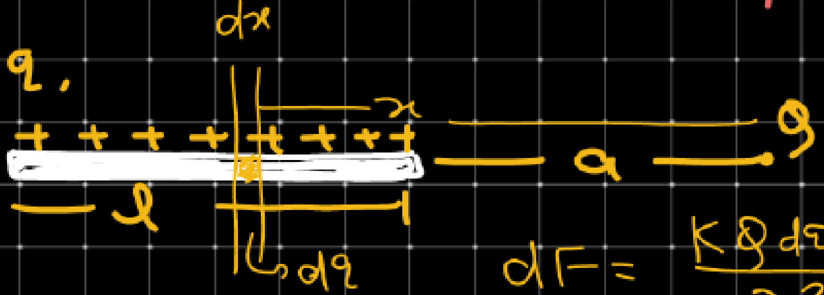

q
a
a
q
q
a
q
F = 0

Q1)

$$\int x^n dx = \frac{x^{n+1}}{n+1}$$

Find Force on Q due to rod.

⊕ Force on rod due to Q.



$$dF = \frac{KQ\,dq}{x^2}$$

⊕ $l \longrightarrow q$

$1 \longrightarrow \frac{q}{l}$

$$dq = \frac{q}{l}dx$$

$$dF = \frac{KQ}{x^2} \times \frac{q}{l}dx$$

$$\int dF = \frac{KQq}{l}\int_a^{a+l}\frac{dx}{x^2}$$

$$\int dF = \frac{KQq}{l}\int_a^{a+l}\frac{dx}{x^2}$$

$$\int \frac{dx}{x^2} = \int x^{-2}dx = \frac{x^{-2+1}}{-2+1} = \frac{x^{-1}}{-1} = -\frac{1}{x}$$

$$F = \frac{KqQ}{l}\left[-\frac{1}{x}\right]_a^{a+l}$$

$$F = \frac{KqQ}{l}\left[\frac{1}{x}\right]_a^{a+l}$$

$$F = -\frac{KqQ}{l}\left[\frac{1}{a+l} - \frac{1}{a}\right]$$

q, l

$l \longrightarrow q$

$1 \longrightarrow \frac{q}{l}$

$$\boxed{dx \rightarrow dq = \frac{q}{l}\,dx}$$

$5m,\ 20C$

$5m \rightarrow 20C$

$1m \rightarrow \frac{20}{5}$

$dq = \frac{20}{5}\,dx.$

$$F = -\frac{Kq\mathcal{Q}}{l}\left[\frac{1}{a+l} - \frac{1}{a}\right]$$

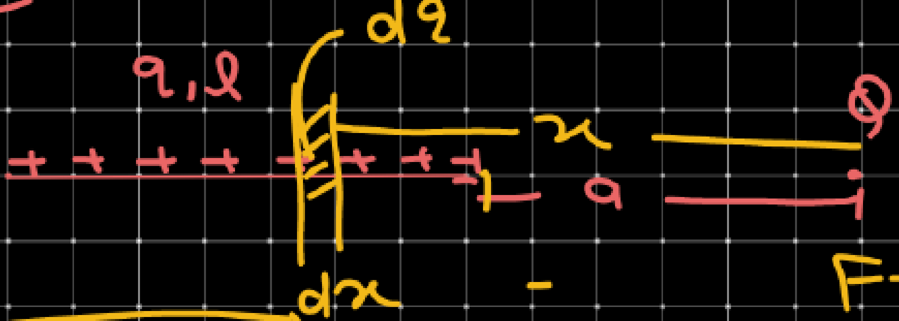
$$F = \frac{Kq\mathcal{Q}}{a(a+l)}$$

$$F = -\frac{Kq\mathcal{Q}}{l}\left[\frac{\cancel{a} - \cancel{a} - l}{a(a+l)}\right]$$

$$F = -\frac{Kq\mathcal{Q}}{\cancel{l}}\left[\frac{+\cancel{l}}{a(a+l)}\right] = \boxed{\frac{Kq\mathcal{Q}}{a(a+l)}}$$

JEE(M)

Force on rod due to Q?



$$\boxed{dq = \frac{q}{l}dx}$$

$$dF = \frac{KQ\,dq}{x^2} = \frac{KQ\frac{q}{l}dx}{x^2}$$

$$\int dF = \frac{KQq}{l}\int_a^{a+l}\frac{dx}{x^2}$$

$$F = -\frac{KQq}{l}\left[\frac{1}{x}\right]_a^{a+l}$$

$$F = -\frac{KQq}{l}\left[\frac{1}{a+l}-\frac{1}{a}\right]$$

$$F = -\frac{KQq}{l}\left[\frac{\cancel{a}-\cancel{a}-l}{a(a+l)}\right]$$

$$= \frac{KQq\cancel{l}}{\cancel{l}a(a+l)} = \boxed{\frac{KQq}{a(a+l)}}$$