given

$q_1 \cdot q_2 > 0$

both charges are same nature.

$$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{d^2}$$

F_{12} = Force on q_1 due to q_2.

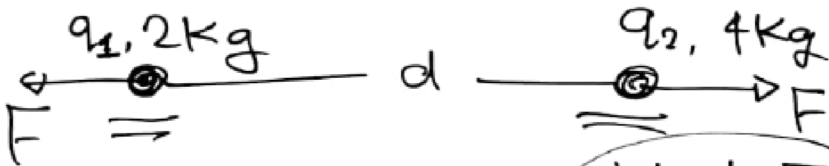
F_{21} = Force on q_2 due to q_1

$$|\vec{F}_{12}| = |\vec{F}_{21}|$$

$$\vec{F}_{12} = -\vec{F}_{21}$$

If q_1 & q_2 treat as a System then Net force on System is zero.

$$P_i = P_f$$



$q_1 q_2 > 0$

After Some time

Net Force on System = 0

$P = mv$

Find Value of v ?

(a) 8 m/s

(b) 16 m/s

(c) 4 m/s

(d) 2 m/s

$\vec{P}_i = \vec{P}_f$

$0 + 0 = 4 \times 8\hat{i} + 2kg * v$

$0 = 32 + 2v$

$-32\hat{i} = 2v$

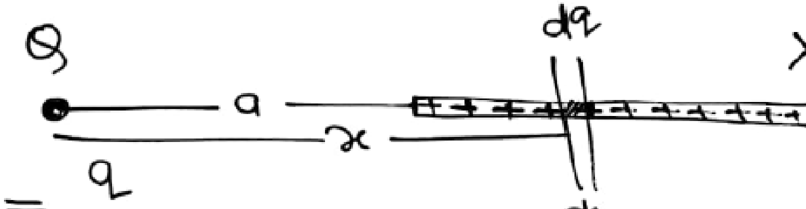
$v = -16\hat{i}$

$v = 16 \, m/s$

⇒ Force on body due to point charge:-

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

$$\int x^5 dx = \frac{x^{5+1}}{5+1}$$



$$\lambda = \frac{q}{l}$$

$l \longrightarrow q$

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

$$dq = \lambda dx$$

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

$$dF = \frac{1}{4\pi\varepsilon_0} \frac{Q\,dq}{x^2}$$

$$dF = \frac{1}{4\pi\varepsilon_0} \frac{Q\lambda\,dx}{x^2}$$

$$\int dF = \left(\frac{1}{4\pi\varepsilon_0} Q\lambda\right) \int_a^{a+l} \frac{dx}{x^2}$$

$$F = \frac{1}{4\pi\varepsilon_0} Q\lambda \left[-\frac{1}{x}\right]_a^{a+l} = \frac{1}{4\pi\varepsilon_0} Q\lambda \left[-\frac{1}{a+l} - \left(-\frac{1}{a}\right)\right]$$

$$\frac{1}{4\pi\varepsilon_0} \frac{Qq}{l} \left[-\frac{1}{a+l} + \frac{1}{a}\right]$$

$$F = \frac{1}{4\pi\varepsilon_0} \frac{Qq}{l} \left[\frac{1}{a} - \frac{1}{a+l}\right]$$

$$F = \frac{1}{4\pi\varepsilon_0} \frac{Qq}{l} \left[\frac{a+l-a}{a(a+l)}\right]$$

$$F = \frac{1}{4\pi\varepsilon_0} \frac{Qq}{l} \left[\frac{l}{a(a+l)}\right] = \frac{1}{4\pi\varepsilon_0} \frac{Qq}{a(a+l)}$$

Electric field Strength (E) :- It is basically Force on test charge divide by test charge.

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

(OR) Around the charge where a test charge feel force,

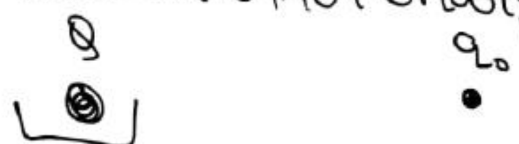
q $\bullet$ - - - - - - - - r - - - - - - - - $\bullet$ q_0 $\longrightarrow$ E

$$E = \frac{F \text{ on test charge}}{q_0}$$

$$F_{q_0 q} = \frac{1}{4\pi\varepsilon_0}\frac{q q_0}{r^2}$$

$$E = \frac{F_{q q_0}}{q_0} = \frac{1}{4\pi\varepsilon_0}\frac{q q_0}{r^2 q_0} = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$$

Test charge (q_0) :- Small positive charge, which does not apply any effective force on other charge.



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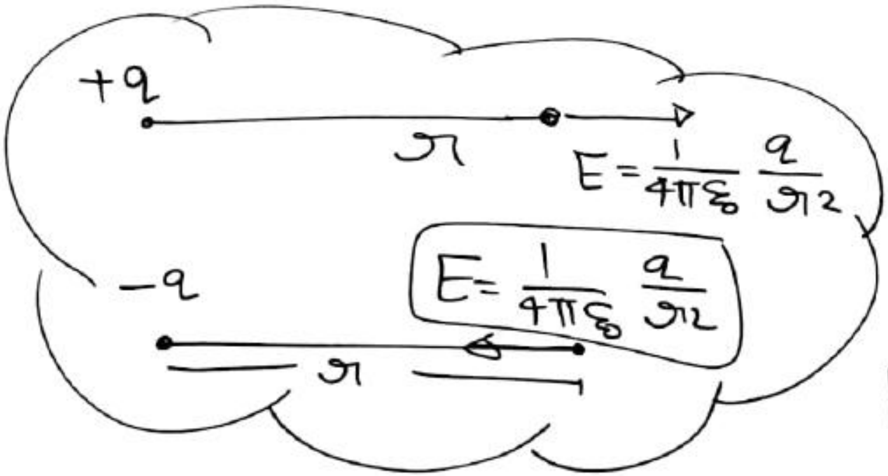


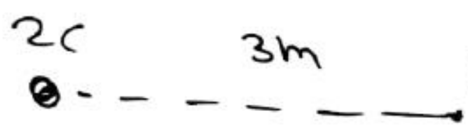
$$E = \frac{F}{q_0} = \frac{N}{C}$$

SI Unit = N/C

$$[E] = \frac{[MLT^{-2}]}{[AT]}$$

$$[E] = [MLT^{-3}A^{-1}]$$

Q1:- Find Electric field strength due to 2C charge At 3m distance.



$E = ?$

$$E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2} = \frac{9\times10^9\times2}{3^2}$$

$$E = \frac{9\times10^9\times2}{9} = 2\times10^9\ N/C$$

Vector form of Electric field due to point charge at distance r.

$$E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2} \Rightarrow \vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}(\hat{r})$$

$$\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}\left(\frac{\vec{r}}{r}\right)$$

$$\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^3}\vec{r}$$

→ "In vector formula Charges always put with sign"

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⇒ A charge 2C placed at (2, 4, 6). find Electric field at (1, −1, 2).

$$\vec{r} = \vec{r}_f - \vec{r}_i$$ = [Final position − initial position]

$\vec{r}_i = (2i + 4j + 6k)$

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

$\vec{r} = \vec{r}_f - \vec{r}_i$

$= (i - j + 2k) - (2i + 4j + 6k)$

$= ((i - 2i) + (-j - 4j) + (2k - 6k))$

$\vec{r} = -i - 5j - 4k$

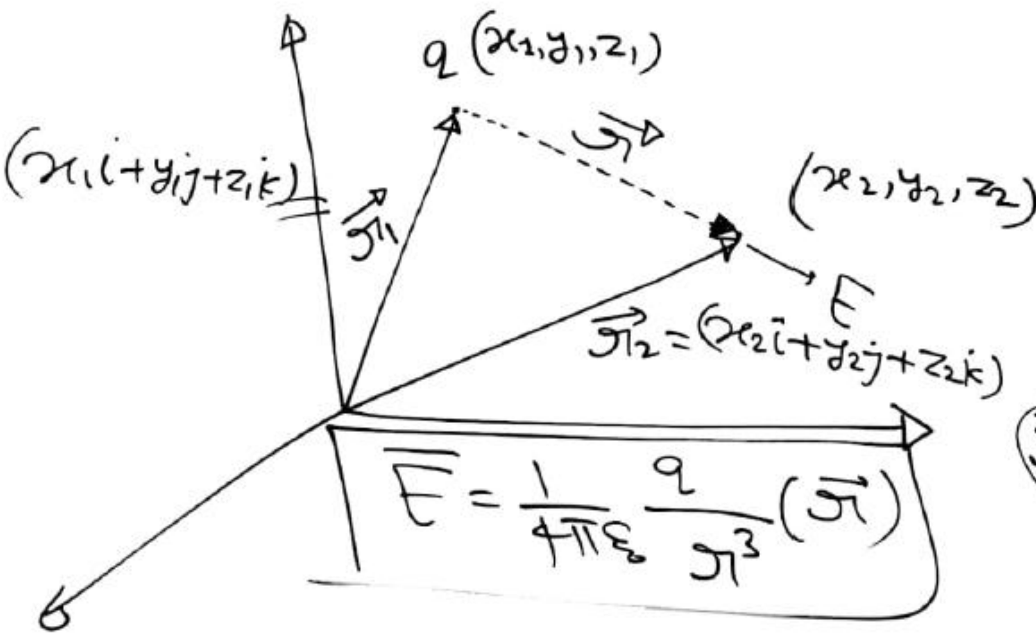
$|\vec{r}| = \sqrt{(-1)^2 + (-5)^2 + (-4)^2}$

$= \sqrt{1 + 25 + 16} = \sqrt{42}$

$$\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^3}(\vec{r})$$

$$= \frac{9 \times 10^9 \times 2 \times (-i - 5j - 4k)}{(\sqrt{42})^3}$$

⇒ Vector form of Electric field :-



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

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

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

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

$$\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^3}(\vec{r})$$

Q1) 2C Charge placed at (1, 2)m. find electric field at (4, 6)m.

$\vec{r}_1 = 1i + 2j$

$\vec{r}_2 = 4i + 6j$

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

$= (4i + 6j) - (i + 2j)$

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

$|\vec{r}| = r = \sqrt{3^2 + 4^2}$

$= \sqrt{9 + 16} = 5m$

$\vec{E} = \frac{1}{4\pi\varepsilon_0} \frac{q}{r^3} (\vec{r})$

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

$\vec{E} = \frac{16 \times 10^{9}}{125} (3i + 4j)$

$|\vec{E}| = \frac{9 \times 10^9 \times 2}{25}$