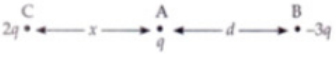
QUES 05:-

Two charges q and $-3q$ are placed fixed on x-axis separated by distance 'd'. Where should a third charge '$2q$' be placed such that it will not experience any force?

Ans. 

(i) If we place the third charge 2q between A and B the direction of the force on 2q due to A and B on C will be same.

So the net force cannot be zero, so the charge q cannot be placed between A and B.

(ii) If 2q is placed the right side of A then $r_{AC} > r_{BC}$ as $q_A < q_B$.So $F_{CA}<F_{CB}$ always as the direction of F_{CA} is towards right and F_{CB} is left so, $F_{CA}+F_{CB} \neq 0$ we can not obtain required condition.

(iii) Now consider 2q at the C to left of q at distance x from q.

Force on 2q at C (left of q) is in opposite direction so net force will be zero if magnitude is equal so,

$\Rightarrow F_{CA}+F_{CB}=0 \text{ or } F_{CA}=-F_{CB}$

$\Rightarrow \frac{Kq_C q_A}{r_{CA}^2}=\frac{-Kq_C q_A}{r_{CB}^2}$

$\Rightarrow \frac{2q\,q}{x^2}=\frac{-2q(-3q)}{(x+d)^2}$

$\Rightarrow \frac{2q^2}{x^2}=\frac{6q^2}{(x+d)^2} \Rightarrow \frac{1}{x^2}=\frac{3}{(x+d)^2}$

$\Rightarrow 3x^2=x^2+d^2+2xd$

$3x^2-x^2-2xd-d^2=0$

$2x^2-2xd-d^2=0$

$x=\frac{+2d\pm\sqrt{(-2d)^2-4.2.(-d^2)}}{2.2}$

$\Rightarrow x=\frac{+2d\pm\sqrt{4d^2+8d^2}}{4}=\frac{2d\pm 2d\sqrt{3}}{4}$

$\rightarrow x=\frac{\cancel{2}(d\pm d(\sqrt{3}))}{\cancel{4}2}=\frac{d(1\pm\sqrt{3})}{2}$

So, $x=\frac{d}{2}\left(1+\sqrt{3}\right)$ m to the left of q.