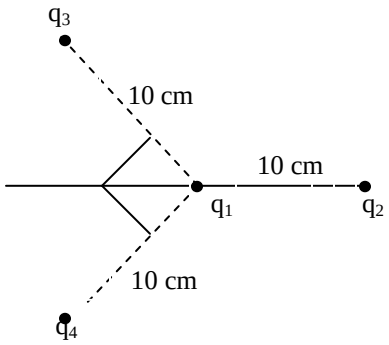
Q- In the figure $q_1 = 4\mu C$, $q_2 = -3\mu C$ and $q_3 = q_4 = -2\mu C$.
a. What is the magnitude of force exerted on charge q_1 by charge q_2?
b. What is the magnitude of force exerted on charge q_1 by charge q_3?
c. What is the horizontal component of force exerted on q_1 by q_3?
d. What is the resultant force exerted on charge q_1 by the other three charges?
e. q_1 were replaced by a charge of -4 μ C, what would be the resultant force exerted on it by the other three charges?

a. The force of electric interaction between two point charges q_1 and q_2 placed at a distance r is given by Coulomb's law as

$$F = \frac{q_1 q_2}{4\pi \in_0 r^2} \qquad \left[\frac{1}{4\pi \in_0} = 9*10^9\right]$$



Substituting the values we get the magnitude of the force between q_1 and q_2 as

$$F = \frac{9*10^9 * 4*10^{-6} * (-3*10^{-6})}{(10*10^{-2})^2} = -10.8\,\text{N}$$

The negative sign is showing that the force is attractive.

b. $$F = \frac{q_1 q_3}{4\pi \in_0 r^2}$$

Substituting the values we get the magnitude of the force between q_1 and q_2 as

$$F = \frac{9*10^9*4*10^{-6}*(-2*10^{-6})}{(10*10^{-2})^2} = -7.2\ N$$

c. As the force is attractive and on q_1 is in the direction from q_1 to q_3, which makes 135^0 from the x axis hence its component in the x direction will be F*cos 135^0

Or 7.2*cos 135^0 = 7.2*(-0.707) = - 5.09 N

The negative sign shows that the component is in negative x direction.

d. The force due to two charges q_3 and q_4 are equal in magnitude and as they are making same angle with x axis (45^0) their x components and y components are equal. The x components are in same direction (negative x) but y components are opposite and hence cancel each other's effect. Thus the resultant force on q_1 is the resultant of the force due to q_2 and the x components of the force due to q_3 and q_4 and which is equal to

$F = F_{12x} + F_{13x} + F_{14x}$

Or F = 10.8 + (-5.09) + (-5.09) = 0.62 N (positive x direction)

e. If q_1 is replaced by -4mC means the charge is same in magnitude but opposite in sign. Thus the magnitude of the force will remain same and its direction will be reversed. Hence the force will be 0.62 N in negative x direction.