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Seatwork # 1

1. Two point charges have a Coulomb force of magnitude of 5N. If distance r is halved, what will be the magnitude of the new force?

Solution 1: Coulomb Force with Changed Distance

According to Coulomb's Law, the force between two point charges is: $F = k \times (q_1q_2)/r^2$

If we change only the distance (r), the force will change as follows:

- Original force $F_1 = 5$ N at distance r
- New distance $r_2 = r/2$ (half the original distance)

When r is halved, the r^2 term in the denominator becomes $(r/2)^2 = r^2/4$ Therefore, the new force $F_2 = k \times (q_1q_2)/(r^2/4) = 4 \times k \times (q_1q_2)/r^2 = 4 \times F_1$

$F_2 = 4 \times 5$ N $= 20$ N

2. Find the magnitude of the force between two charges ($q_1 = 1.5$ μC = 1.5 and $q_2 = 2.5$ μC = 2.5) which are 2cm apart.

Solution 2: Force Between Two Charges

Given:

- $q_1 = 1.5\ \mu C = 1.5 \times 10^{-6}$ C
- $q_2 = 2.5\ \mu C = 2.5 \times 10^{-6}$ C
- r = 2 cm = 0.02 m
- $k = 8.99 \times 10^9\ N{\cdot}m^2/C^2$ (Coulomb's constant)

Using Coulomb's Law: $F = k \times (q_1\, q_2)/r^2$

$F = (8.99 \times 10^9) \times (1.5 \times 10^{-6} \times 2.5 \times 10^{-6})/ (0.02)^2$

$F = (8.99 \times 10^9) \times (3.75 \times 10^{-12})/ (4 \times 10^{-4})$

$F = (8.99 \times 10^9) \times (9.375 \times 10^{-9})$

$F = 84.28$ N

3. Point charge q_1 = 5 μC, is placed at the origin of the Cartesian coordinate system. Another point charge q_2 = 6 μC is placed at (0,6) cm and q_3 = 10 μC is placed at (0, -4) cm. Find the net force on q_1

Solution 3: Net Force on a Charge in a System

Given:

- $q_1 = 5\ \mu C = 5 \times 10^{-6}$ C at (0,0)
- $q_2 = 6\ \mu C = 6 \times 10^{-6}$ C at (0,6) cm = (0,0.06) m
- $q_3 = 10\ \mu C = 10 \times 10^{-6}$ C at (0,-4) cm = (0,-0.04) m

First, I'll calculate the force between q_1 and q_2:

$F_{12} = k \times (q_1 q_2)/r_{12}^2$

$F_{12} = (8.99 \times 10^9) \times (5 \times 10^{-6} \times 6 \times 10^{-6})/(0.06)^2$

$F_{12} = (8.99 \times 10^9) \times (30 \times 10^{-12})/(36 \times 10^{-4})$

$F_{12} = (8.99 \times 10^9) \times (8.333 \times 10^{-9})$ $F_{12} = 74.92$ N

Since q_2 is at (0,6) cm and q_1 is at the origin, the force on q_1 points along the positive y-axis (repulsive force as both charges are positive).

Next, the force between q_1 and q_3:

$F_{13} = k \times (q_1\, q_3)/r_{13}^2$ $F_{13} = (8.99 \times 10^9) \times (5 \times 10^{-6} \times 10 \times 10^{-6})/(0.04)^2$

$F_{13} = (8.99 \times 10^9) \times (50 \times 10^{-12})/(16 \times 10^{-4})$

$F_{13} = (8.99 \times 10^9) \times (31.25 \times 10^{-9})$

$F_{13} = 280.94$ N

Since q_3 is at (0, -4) cm and q_1 is at the origin, the force on q_1 points along the positive y-axis (repulsive force as both charges are positive).

The net force is the vector sum of F_{12} and F_{13}:

$F_{net} = F_{12} + F_{13} = 74.92 \text{ N} + 280.94 \text{ N} = 355.86$ N

The net force on q_1 is 355.86 N in the positive y-direction.