PHYS 112: ICEs - Coulomb's Law I

Name:

1) Two small plastic spheres are given positive electrical charges. When they are 15.0 cm apart, the repulsive force between them has magnitude 0.220 N. Find the charge on each sphere if one sphere has four times the charge of the other.

\[ F = \frac{k q_1 q_2}{r^2} \Rightarrow q^2 = \frac{Fr^2}{4k} \Rightarrow q = \frac{1}{2} \sqrt{\frac{Fr^2}{k}} \]

So \( q = \frac{1}{2} (0.15 \text{ m}) \sqrt{\frac{0.220 \text{ N}}{8.99 \times 10^9 \text{ N m}^2/\text{C}^2}} = 3.71 \times 10^{-7} \text{ C} = 3.71 \text{ nC} \)

Sphere 1: \( q = 3.71 \text{ nC} \)
Sphere 2: \( 4q = 4(3.71 \text{ nC}) = 148.4 \text{ nC} \)

2) A positive point charge \( q = 6.00 \mu \text{C} \) is placed at the point \( x = +0.150 \text{ m}, y = 0 \), and an identical point charge is placed at \( x = -0.150 \text{ m}, y = 0 \). Find the total electric force that these charges make on a third identical point charge at \( x = 0, y = 0.200 \text{ m} \). Express this force in x- and y-components. (Hint: Draw a diagram!)

\[ r = \sqrt{x^2 + y^2} = \sqrt{(0.15 \text{ m})^2 + (0.12 \text{ m})^2} = 0.25 \text{ m} \]

\[ \vec{F}_{\text{tot,3}} = \vec{F}_{13} + \vec{F}_{23} = 2 \vec{F}_{13} \cos \theta \hat{j} \text{ due to symmetry} \]

\[ \vec{F}_{\text{tot,3}} = 2 \left( \frac{k q^2}{r^2} \right) \cos \theta \hat{j} = 2 \left( \frac{k q^2}{r^2} \right) \left( \frac{y}{r} \right) \hat{j} = \frac{2 k q^2 y \hat{j}}{r^3} \]

Numerically:

\[ \frac{\vec{F}_{\text{tot,3}}}{(0.25 \text{ m})^3} = 2 \left( 8.99 \times 10^9 \text{ N m}^2/\text{C}^2 \right) \left( 6 \times 10^{-12} \text{ C} \right)^2 (0.25 \text{ m}) \hat{j} = 8.29 \text{ N} \hat{j} \]

UST Physics, P. Ohmann