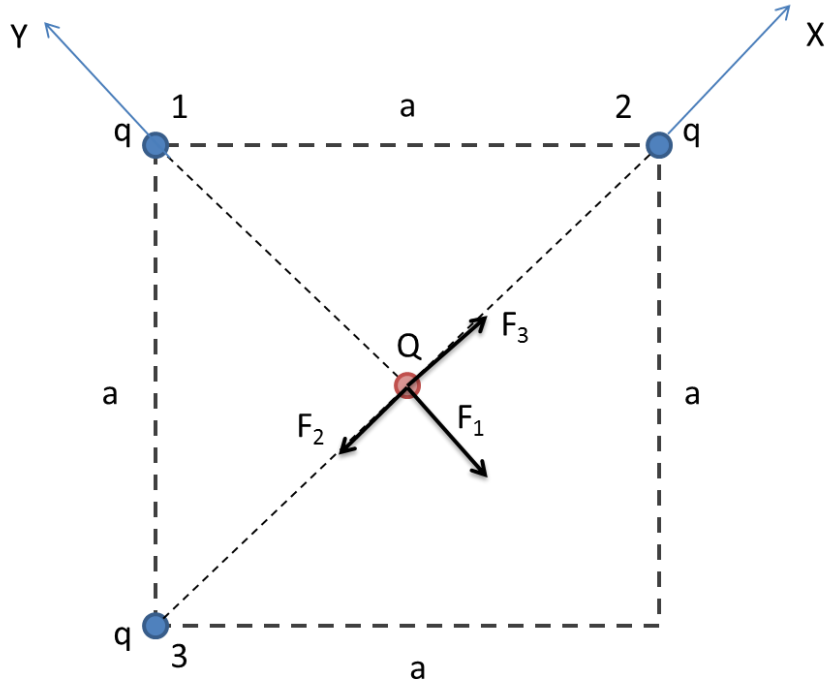
Answer on Question #48680, Physics, Electromagnetism

Point charges of 2x10^-9C are situated at each of the three corners of a square whose side is .20m. What would be the magnitude and direction of the resultant force on a point charge of -1x10^-9 if it were placed at the center of the square?

Solution.



Due to superposition principle the resultant force is the sum of three forces:

$$\overrightarrow{F_{res}} = \overrightarrow{F_1} + \overrightarrow{F_2} + \overrightarrow{F_3}$$

In projections on axes X and Y:

$$F_{res\,x} = F_{1\,x} + F_{2\,x} + F_{3\,x}$$

$$F_{res\,y} = F_{1\,y} + F_{2\,y} + F_{3\,y}$$

All three forces are equal by modulus due to symmetry:

$$F_1 = F_2 = F_3 = \frac{1}{4\pi\epsilon_0}\frac{qQ}{\left(\frac{a\sqrt{2}}{2}\right)^2} = \frac{1}{2\pi\epsilon_0}\frac{qQ}{a^2}$$

So:

$$F_{res\,x} = 0 - \frac{1}{2\pi\epsilon_0}\frac{qQ}{a^2} + \frac{1}{2\pi\epsilon_0}\frac{qQ}{a^2} = 0$$

$$F_{res\,y} = -\frac{1}{2\pi\epsilon_0}\frac{qQ}{a^2} + 0 + 0 = -\frac{1}{2\pi\epsilon_0}\frac{qQ}{a^2}$$

$$F_{res} = \sqrt{F_{res\,x}^2 + F_{res\,y}^2} = \frac{1}{2\pi\epsilon_0}\frac{qQ}{a^2}$$

Numerically:

$$F_{res} = \frac{1}{2 \cdot 3.14 \cdot 8.85 \cdot 10^{-12}\frac{F}{m}}\frac{2 \cdot 10^{-9}\,C \cdot 1 \cdot 10^{-9}\,C}{(0.2\,m)^2} \approx 9 \cdot 10^{-7}N$$

Answer: $9 \cdot 10^{-7}N$

Direction – opposite to Y axis