Answer on Question #42622-Physics-Electromagnetism

A charge of -3.88C is fixed at the center of a compass. Two additional charges are fixed on the circle of the compass (radius = 0.146 m). The charges on the circle are -5.03C at the position due north and +5.37C at the position due east. What is (a) the magnitude and (b) direction of the net electrostatic force acting on the charge at the center? Specify the direction as an angle relative to due east.

Solution

The formula for force between charged particles is

$$F = \frac{kq_1q_2}{r^2}.$$

The charges are given as -3.88 C, -5.03C and 5.37 C - these are really large charges, problems usually give charges in the order of μC or nC, so the force is going to be really large.

The charge from due north is negative, and so it the charge in the middle. Therefore the force will be repulsive and push directly south (We can eliminate the negatives since they are used to find the direction)

$$F_1 = \frac{(9 \cdot 10^9)(3.88)(5.03)}{(0.146)^2} = 8.24 \cdot 10^{12}\ N\ South.$$

From the other charge, since one is negative and the other is positive, the force will pull to the east

$$F_2 = \frac{(9 \cdot 10^9)(3.88)(5.37)}{(0.146)^2} = 8.80 \cdot 10^{12}\ N\ East.$$

Net force is found by the Pythagorean theorem

$$F = \sqrt{(8.24 \cdot 10^{12})^2 + (8.80 \cdot 10^{12})^2} = 1.20 \cdot 10^{13}\ N.$$

The direction is found by

$$\tan\theta = \frac{8.24 \cdot 10^{12}}{8.80 \cdot 10^{12}} \rightarrow \theta = 43.1° \text{ South of East.}$$

Again, this is quite large. If the charges are really supposed to be in μC or nC but just entered into the problem incorrectly, the procedure is valid, just off by several orders of magnitude. Just plug in the right values for the charge to get the answer you need. If the charges are really in Coulombs, then the answer is as expected.

Answer: (a) $\mathbf{1.20 \cdot 10^{13}}\ N$; (b) $\mathbf{43.1°}$ South of East.