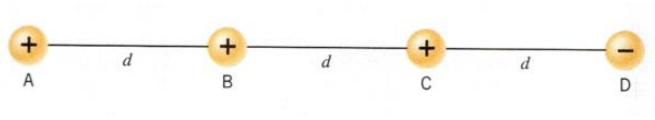
Answer on Question #42357-Physics-Electromagnetism

Four point charges have equal magnitudes. Three are positive, and one is negative, as the drawing shows. They are fixed in place on the same straight line, and adjacent charges are equally separated by a distance d. Consider the net electrostatic force acting on each charge. Calculate the ratio of the largest to the smallest net force.

Solution



The net electrostatic force acting on charge A

$$F_A = \frac{kq^2}{d^2} + \frac{kq^2}{(2d)^2} - \frac{kq^2}{(3d)^2} = \frac{kq^2}{d^2}\left(1 + \frac{1}{4} - \frac{1}{9}\right) = \frac{41}{36}\frac{kq^2}{d^2}.$$

The net electrostatic force acting on charge B

$$F_B = \frac{kq^2}{d^2} + \frac{kq^2}{(2d)^2} - \frac{kq^2}{d^2} = \frac{1}{4}\frac{kq^2}{d^2}.$$

The net electrostatic force acting on charge C

$$F_C = \frac{kq^2}{d^2} + \frac{kq^2}{(2d)^2} + \frac{kq^2}{d^2} = \frac{kq^2}{d^2}\left(1 + \frac{1}{4} + 1\right) = \frac{9}{4}\frac{kq^2}{d^2}.$$

The net electrostatic force acting on charge D

$$F_D = \frac{kq^2}{d^2} + \frac{kq^2}{(2d)^2} + \frac{kq^2}{(3d)^2} = \frac{kq^2}{d^2}\left(1 + \frac{1}{4} + \frac{1}{9}\right) = \frac{49}{36}\frac{kq^2}{d^2}.$$

The ratio of the largest to the smallest net force

$$\frac{F_C}{F_B} = \frac{\frac{9}{4}\frac{kq^2}{d^2}}{\frac{1}{4}\frac{kq^2}{d^2}} = 9.$$

Answer: 9.