Two charges $q_1$ and $q_2$ when combined give a total charge of 6 nC. When they are separated by 3 m, the force exerted by one charge on the other has the magnitude $8 \times 10^{-3}$ N. Find $q_1$ and $q_2$ if (a) both are positive so that they repel each other; (b) one is positive and the other negative so that they attract each other.

(a) \[ q_1 + q_2 = Q = 6 \times 10^{-6} \text{nC} \]

\[ k \frac{q_1 q_2}{r^2} = F = 8 \times 10^{-3} \text{N} \]

\[ r = 3 \text{m} \]

\[ q_1 q_2 = \frac{r^2 F}{k} = q_1 (Q - q_1) = q_1^2 - q_1 Q + \frac{r^2 F}{k} = 0 \]

\[ q_1^2 - 6 \times 10^{-6} q_1 + \frac{8 \times 10^{-3} \times 3 \times 10^{-3}}{8 \times 10^{-3}} = 0 \]

\[ q_1 = \frac{6 \times 10^{-6} \pm \sqrt{36 \times 10^{-12} - 8 \times 10^{-12}}}{2} = \frac{6 \times 10^{-6} + 2 \times 10^{-6}}{2} \]

\[ q_1 = 4 \mu \text{C}, \quad q_2 = 2 \mu \text{C} \]

(b) \[ q_1 - q_2 = Q, \quad -k \frac{q_1 q_2}{r^2} = F = \Rightarrow q_1 q_2 = \frac{k F}{r^2} = q_2 (Q + q_2) = q_2^2 + q_2 Q \]

\[ q_1 + q_2 + \frac{r^2 F}{k} = 0 \Rightarrow q_1^2 + 6 \times 10^{-6} q_2 - 8 \times 10^{-12} = 0 \]

\[ q_2 = \frac{-6 \times 10^{-6} \pm \sqrt{36 \times 10^{-12} + 8 \times 10^{-12}}}{2} = \frac{-6 \times 10^{-6} + \sqrt{8 \times 10^{-12}}}{2} \]

\[ q_2 \approx -7 \times 10^{-6} \mu \text{C} \]

$q_2$ around $0$ in calculation. Let:\[ q_1 = 4 \mu \text{C}, \quad q_2 = -7 \times 10^{-6} \mu \text{C} \]

\[ q_1 \text{ and } q_2 \text{ are solutions.} \]

$\Rightarrow$ neg. charge: \[ -(\sqrt{17} - 3) \mu \text{C} = -1.12 \mu \text{C} \]

pos. charge: \[ (3 + \sqrt{17}) \mu \text{C} = 7.12 \mu \text{C} \]