Coulomb's Law Practice

1) Two particles have charges equal to -35.0 μC and +50.0 C, and are separated by a distance of 30.0 mm. What is the magnitude of the force between the particles, and is the force attractive or repulsive?

2) Two objects are separated by a distance of 1.2 mm. The objects are initially neutral, and then each receive the same number of electrons, giving them the same charge. The force between the objects is now 24.0 pN. How many electrons did the two objects each receive?

3) Two particles have charges q_1 and q_2, and q_1 = 790 nC. The distance between the particles is 27 cm, and the attractive force between them is 0.2 N. What is q_2 (including sign)?

4) Two charges repel each other with a force of 5.00 N, and start to move apart. What will be the force between them after the distance between them is doubled?

Answers:

1) Two particles have charges equal to -35.0 μC and +50.0 C, and are separated by a distance of 30.0 mm. What is the magnitude of the force between the particles, and is the force attractive or repulsive?

$$F = \frac{k|q_1||q_2|}{r^2}$$

$$F = \frac{\left(8.99 \times 10^9 \text{ N} \cdot \frac{\text{m}^2}{\text{C}^2}\right)|-35.0 \times 10^{-6} C||50.0 \times 10^{-6} C|}{(30.0 \times 10^{-3} m)^2}$$

$$F = 17.5 \times 10^3 \ N$$

The force is 17.5 kN attractive.

2) Two objects are separated by a distance of 1.2 mm. The objects are initially neutral, and then each receives the same number of electrons, giving them the same charge. The force between the objects is now 24.0 pN. How many electrons did the two objects each receive?

Both objects have the same charge (both negative), and we need to find the charge in Coulomb's first. Let q represent the charge.

$$F = \frac{k|q_1||q_2|}{r^2}$$

$$F = \frac{k|\text{q}||\text{q}|}{r^2}$$

$$q^2 = \frac{Fr^2}{k}$$

$$q^2 = \frac{(24.0 \times 10^{-12} N)(1.2 \times 10^{-3} m)^2}{\left(8.99 \times 10^9 \text{ N} \cdot \frac{\text{m}^2}{\text{C}^2}\right)}$$

$$q^2 = 3.84427141 \times 10^{-27}$$

$$q = 6.2 \times 10^{-14} \ C$$

Now convert the Coulombs to electrons using 1 e = -1.6022×10^{-19} C

$$6.2 \times 10^{-14} \ C \times \frac{1 \ e}{1.6022 \times 10^{-19} \text{ C}} = 3.875 \times 10^5 \ e$$

So the number of electrons is 3.875×10^5.

3) Two particles have charges q_1 and q_2, and q_1 = 790 nC. The distance between the particles is 27 cm, and the attractive force between them is 0.2 N. What is q_2 (including sign)?

$$F = \frac{k|q_1||q_2|}{r^2}$$

$$|q_2| = \frac{Fr^2}{k|q_1|}$$

$$q_2 = \frac{(0.2\ N)(0.27\ m)^2}{\left(8.99 \times 10^9\ \mathrm{N} \cdot \frac{\mathrm{m}^2}{\mathrm{C}^2}\right)|790\ C|}$$

$$q_2 = 1.8 \times 10^{-4}\mathrm{C}$$

The force is attractive, so q_2 must be negative. Therefore, $q_1 = -1.8 \times 10^{-4}\mathrm{C}$

4) Two charges repel each other with a force of 5.00 N, and start to move apart. What will be the force between them after the distance between them is doubled?

Force varies inversely with the square of the distance between the charges. Therefore, if the distance is multiplied by two, the force will be divided by 4 (i.e. 2^2).

Therefore, the new force will be 5.00/4 = 1.25 N