

PQ 3 Electrostatics

Questions and Answers

Q1

A negative charge of -2.0×10^{-4} C and a positive charge of 8.0×10^{-4} C are separated by 0.30 m. What is the force between the two charges?

$$F = \frac{Kq_Aq_B}{d_{AB}^2} = \frac{(9.0 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2)(2.0 \times 10^{-4} \text{ C})(8.0 \times 10^{-4} \text{ C})}{(0.30 \text{ m})^2}$$
$$= 1.6 \times 10^4 \text{ N}$$

Q2

A negative charge of -6.0×10^{-6} C exerts an attractive force of 65 N on a second charge that is 0.050 m away. What is the magnitude of the second charge?

$$F = \frac{Kq_A q_B}{d_{AB}^2}$$

$$q_B = \frac{F d_{AB}^2}{K q_A} = \frac{(65 \text{ N})(0.050 \text{ m})^2}{(9.0 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2)(6.0 \times 10^{-6} \text{ C})}$$
$$= 3.0 \times 10^{-6} \text{ C}$$

Q3

Lightning A strong lightning bolt transfers about 25 C to Earth. How many electrons are transferred?

$$(-25 \text{ C}) \left(\frac{1 \text{ electron}}{-1.60 \times 10^{-19} \text{ C}} \right) = 1.6 \times 10^{20} \text{ electrons}$$

Q4

A positive and a negative charge, each of magnitude 2.5×10^{-5} C, are separated by a distance of 15 cm. Find the force on each of the particles.

$$\begin{aligned} F &= \frac{Kq_Aq_B}{d^2} = \frac{(9.0 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2)(2.5 \times 10^{-5} \text{ C})(2.5 \times 10^{-5} \text{ C})}{(1.5 \times 10^{-1} \text{ m})^2} \\ &= 2.5 \times 10^2 \text{ N, toward the other charge} \end{aligned}$$

Q5

A force of 2.4×10^2 N exists between a positive charge of 8.0×10^{-5} C and a positive charge of 3.0×10^{-5} C. What distance separates the charges?

$$F = \frac{Kq_Aq_B}{d^2}$$

$$d = \sqrt{\frac{Kq_Aq_B}{F}} = \sqrt{\frac{(9.0 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2)(8.0 \times 10^{-5} \text{ C})(3.0 \times 10^{-5} \text{ C})}{2.4 \times 10^2 \text{ N}}}$$
$$= 0.30 \text{ m}$$

Q6

Two identical positive charges exert a repulsive force of 6.4×10^{-9} N when separated by a distance of 3.8×10^{-10} m. Calculate the charge of each.

$$F = \frac{Kq_Aq_B}{d^2} = \frac{Kq^2}{d^2}$$
$$q = \sqrt{\frac{Fd^2}{K}} = \sqrt{\frac{(6.4 \times 10^{-9} \text{ N})(3.8 \times 10^{-10} \text{ m})^2}{9.0 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2}} = 3.2 \times 10^{-19} \text{ C}$$

Q7

A small sphere of charge $2.4 \mu\text{C}$ experiences a force of 0.36 N when a second sphere of unknown charge is placed 5.5 cm from it. What is the charge of the second sphere?

$$F = K \frac{q_A q_B}{d^2}$$

$$q_B = \frac{F d^2}{K q_A} = \frac{(0.36 \text{ N})(5.5 \times 10^{-2} \text{ m})^2}{(9.0 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2)(2.4 \times 10^{-6} \text{ C})} = 5.0 \times 10^{-8} \text{ C}$$

Q8

The force between a proton and an electron is 3.5×10^{-10} N. What is the distance between these two particles?

$$F = K \frac{q_A q_B}{d^2}$$

$$d = \sqrt{K \frac{q_A q_B}{F^2}}$$

$$= \sqrt{(9.0 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2) \frac{(1.60 \times 10^{-19} \text{ C})(1.6 \times 10^{-19} \text{ C})}{3.5 \times 10^{-10} \text{ N}}} = 8.1 \times 10^{-10} \text{ m}$$

Q9

- Positive test charge of $5.0 \times 10^{-6} \text{ C}$ is in a field that exerts a force of $2.0 \times 10^{-4} \text{ N}$ on it. What is the magnitude of the electric field at the location of the test charge?

$$E = \frac{F}{q} = \frac{2.0 \times 10^{-4} \text{ N}}{5.0 \times 10^{-6} \text{ C}} = 4.0 \times 10^1 \text{ N/C}$$

Q10

- A negative charge of $2.0 \times 10^{-8} \text{ C}$ experiences a force of 0.060 N to the right in an electric field. What are the field's magnitude and direction at that location?

$$E = \frac{F}{q} = \frac{0.060 \text{ N}}{2.0 \times 10^{-8} \text{ C}} = 3.0 \times 10^6 \text{ N/C}$$

directed to the left