Narayan Gurukul Academy

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CBSE · Physics · Class 12 **Chapter 1 · Electric Charges and Fields**

Section A · Mixed Numericals

1. Two small identical conducting spheres P and Q carry charges $-10\ \mu\text{C}$ and $+20\ \mu\text{C}$ respectively and are placed 2 m apart in air. (a) Find the force between them. (b) The spheres are brought into contact and then separated to the same distance. Find the new force and state whether it is attractive or repulsive.

2. Two α-particles, each of charge $+3.2 \times 10^{-19}$ C, are separated by 3.2×10^{-15} m. Calculate the electric force between them.

3. Charges $4q$ and q are separated by a distance d. A third charge is placed on the line joining them. Locate its position where the net force on it becomes zero.

4. Three identical charges $+q$ are placed at the three vertices of an equilateral triangle of side a. Find the net electrostatic force on any one charge.

5. A ring of radius R carries a total charge Q uniformly distributed on it. (a) Derive an expression for the field at a point on its axis at distance x from the centre. (b) At what value of x is the field maximum? (c) Obtain the maximum field in terms of Q, R and ε_0.

6. A solid non-conducting sphere of radius 10 cm carries a uniform charge of 2×10^{-7} C distributed throughout its volume. Find the electric field at $r = 5$ cm and at $r = 20$ cm.

7. A point charge of $1.2\ \mu\text{C}$ is placed at the centre of a cube. Find the electric flux through one face of the cube.

8. A non-uniform electric field $\mathbf{E} = 3.0x\,\hat{i} + 4.0\,\hat{j}$ N/C (with x in metres) pierces the faces of a cube whose faces are at $x = 1$ m and $x = 3$ m, each of area $4\ \text{m}^2$. Find the flux through the right face, the left face and the top face, and hence the net charge enclosed by the cube.

9. A small sphere of mass 0.3 g and charge 2×10^{-8} C is suspended in a uniform horizontal electric field of $3 \times 10^{4}\ \text{N/C}$. Find the angle the string makes with the vertical.

Section B · Derivations and Conceptual

10. An electron of charge e and mass m enters symmetrically with velocity v_0 into a uniform electric field E between two parallel plates of length l. Derive an expression for the angle of deviation of the electron.

11. Two point charges $+16\ \mu\text{C}$ and $+9\ \mu\text{C}$ are placed 10 cm apart in air. Locate the point on the line joining them where the net electric field is zero.

12. Distinguish between the fields of an infinite non-conducting sheet and an infinite conducting sheet. Explain the discontinuity of the electric field across a charged surface.

13. Using Gauss's law, derive the electric field at a distance r from an infinitely long straight wire of uniform linear charge density λ.

14. With the help of sketches, describe how the magnitude of the electric field varies with r for (a) a solid non-conducting sphere of charge and (b) a uniformly charged thin spherical shell.

15. Two identical small balls, each of mass m and charge q, are suspended from a common point by insulating strings of length l. Prove that at equilibrium the angle θ with the vertical satisfies $\tan\theta = \dfrac{q^2}{16\pi\varepsilon_0\, m\, g\, l^2 \sin^2\theta}$.

Answer Key — Assignment 2

1. (a) $0.45\ \text{N}$ attractive. (b) $+5\ \mu\text{C}$ on each; $0.056\ \text{N}$ repulsive

2. $90\ \text{N}$, repulsive

3. At distance $d/3$ from the charge q

4. $\sqrt{3}\,k\,q^2/a^2$ directed away from the centre

5. (b) $x = R/\sqrt{2}$ (c) $E_{max} = Q/(6\sqrt{3}\,\pi\varepsilon_0 R^2)$

6. $9 \times 10^4\ \text{N/C}$ at 5 cm; $4.5 \times 10^4\ \text{N/C}$ at 20 cm

7. $Q/6\varepsilon_0 \approx 2.26 \times 10^4\ \text{N}\,m^2/C$

8. Right $36\ \text{N}\,m^2/C$, left -12, top $+16$; net $40\ \text{N}\,m^2/C$, $q_{enc} \approx 3.5 \times 10^{-10}\ \text{C}$

9. $\theta \approx 11.5^\circ$

11. At $40/7 \approx 5.7$ cm from the $16\ \mu\text{C}$ charge