Class 12 Physics - Electrostatics

JEE track | Short Notes + 5 CBSE-based questions + 5 JEE Main PYQ-based questions with solutions

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Format: Quick revision + solved practice	Chapter scope: Class 12 Physics

1. Quick Short Notes

- Coulomb's law: $F = \frac{1}{4\pi\epsilon_0} \cdot \frac{q_1 q_2}{r^2}$. Force acts along the line joining the charges.
- Electric field due to a point charge: $E = kq / r^2$. Direction is radially outward for +q and inward for -q.
- Electric potential due to a point charge: $V = kq / r$. Potential is a scalar quantity.
- For a dipole, dipole moment $p = q \times (2a)$, directed from -q to +q. Torque in field: $\tau = pE \sin(\theta)$.
- Potential energy of a dipole in uniform field: $U = -pE \cos(\theta)$.
- Gauss's law: total electric flux through a closed surface = $q_{enclosed} / \epsilon_0$.
- Parallel plate capacitor: $C = \epsilon A/d$. If dielectric constant is K, new capacitance becomes KC.
- Capacitors in series: $1/C_{eq} = \sum(1/C_i)$. Capacitors in parallel: $C_{eq} = \sum(C_i)$.
- Energy stored in a capacitor: $U = (1/2)CV^2 = Q^2/(2C) = (1/2)QV$.
- Board tip: always show sign, direction, and SI unit clearly in electrostatics numericals.

2. CBSE-based Board Practice

Q1. Define electric dipole moment. State its SI unit.

Solution: Electric dipole moment is the product of magnitude of one charge and separation vector from -q to +q. $p = q \times 2a$. SI unit: coulomb-metre (C m).

Q2. Find the electric field at a point 0.30 m away from a point charge of 2 microC in vacuum.

Solution: $E = kq/r^2 = (9 \times 10^9 \times 2 \times 10^{-6})/(0.30)^2 = 2.0 \times 10^5$ N/C.

Q3. A 4 microF and a 6 microF capacitor are connected in series across a 12 V battery. Find equivalent capacitance, charge on each capacitor and potential across each capacitor.

Solution: $C_{eq} = (4 \times 6)/(4 + 6) = 2.4$ microF. $Q = C_{eq} V = 2.4 \times 12 = 28.8$ microC. $V_1 = Q/C_1 = 28.8/4 = 7.2$ V. $V_2 = Q/C_2 = 28.8/6 = 4.8$ V.

Q4. State Gauss's law. Using it, write the expression for electric field outside a charged spherical shell of total charge Q.

Solution: Gauss's law: $\int(E \cdot dA)$ over a closed surface = $q_{enclosed}/\epsilon_0$. For a spherical shell, field outside behaves like a point charge at the centre: $E = \frac{1}{4\pi\epsilon_0} \times Q/r^2$.

Q5. A dipole of moment 3 x 10^-8 C m is kept in a uniform electric field of 2 x 10^4 N/C at 30 degrees. Find the torque acting on it.

3. JEE Main PYQ-based Practice

Q1. Three capacitors 2 microF, 3 microF and 6 microF are connected in series across 12 V. Find the equivalent capacitance and charge in the combination.

Solution: 1/Ceq = 1/2 + 1/3 + 1/6 = 1. So Ceq = 1 microF. Charge Q = Ceq V = 1 x 12 = 12 microC.

Q2. What is the work done in bringing a charge of 2 microC from infinity to a point at potential 30 V?

Solution: W = qV = 2 x 10^-6 x 30 = 60 x 10^-6 J = 60 microJ.

Q3. Find the electric flux through a closed surface enclosing a charge of 5 nC.

Solution: Phi = q/epsilon0 = 5 x 10^-9 / 8.854 x 10^-12 approx 5.65 x 10^2 N m^2/C.

Q4. Two point charges +2 microC and -2 microC are placed 20 cm apart. What is the electric potential at the midpoint?

Solution: Potential is scalar: V = kq/r + k(-q)/r = 0. So the net potential at the midpoint is zero.

Q5. An isolated charged capacitor is completely filled with a dielectric of constant K = 4. What happens to its stored energy?

Solution: For an isolated capacitor, charge remains constant. Energy U = Q^2/(2C). Since capacitance becomes 4C, energy becomes U/4.

Practice tip: First revise the short notes, then attempt CBSE board questions in written format, and finally solve the exam-specific section in timed mode.