Electric Charges and Fields

Class 12 Physics · 24 NEET MCQs with answers & explanations

Electric Charges and Fields covers Coulomb's law, electric field, electric flux, Gauss's law and electric dipoles. NEET tests Coulomb's law numericals, electric field due to various charge distributions, Gauss's law application and dipole field/torque — both conceptual and numerical questions.

Key Electrostatics Concepts

Concept	Key Formula
Coulomb's law	$F = kq_1q_2/r^2$; $k = 9 \times 10^9$ N m² C⁻²
Electric field	$E = F/q_0 = kQ/r^2$; direction: away from +, towards −
Gauss's law	$\oint E \cdot dA = q_{enc}/\varepsilon_0$; useful for symmetric charge distributions
Dipole moment	$p = qd$; torque $\tau = p \times E = pE \sin\theta$
Field on axis of dipole	$E = 2kp/r^3$ (far field); on equatorial: $E = kp/r^3$
Electric flux	$\Phi = E \cdot A = EA\cos\theta$; total flux through closed surface = q/ε_0

Questions

Q1. A charge +Q is placed at the centre of a spherical Gaussian surface. If the radius of the sphere is doubled, the total electric flux through the surface becomes:

(A) Double
(B) Half
(C) Unchanged
(D) One-fourth

Q2. The SI unit of electric flux is:

(A) N/C
(B) N·m/C
(C) N·m²/C
(D) C/m²

Q3. Coulomb's law is applicable when the interacting charges are:

(A) Point charges at rest in vacuum or air
(B) Large conducting spheres only
(C) Moving charges with relativistic speed
(D) Current-carrying conductors

Q4. Gauss's law states that the total electric flux through any closed surface is equal to:

(A) Enclosed charge multiplied by ε_0
(B) Enclosed charge divided by ε_0
(C) Total charge inside and outside divided by ε_0
(D) Net charge outside the surface divided by ε_0

Q5. The SI unit of electric field intensity is:

(A) C/N
(B) N/C (equivalent to V/m)
(C) N·m/C
(D) C/V

Q6. A dipole of moment 4×10^{-8} C·m is placed perpendicular to a uniform electric field of 5×10^{5} N/C. The torque acting on the dipole is:

(A) 1×10^{-2} N·m
(B) 5×10^{-3} N·m
(C) 2×10^{-2} N·m
(D) Zero

Q7. Three charges +2 μC, +3 μC and −5 μC are placed at vertices of an equilateral triangle. The net force on +2 μC is obtained by:

(A) Adding only the magnitudes of the two forces on it
(B) Vector addition of the force due to +3 μC and the force due to −5 μC on +2 μC
(C) Multiplying the individual force magnitudes
(D) Taking the average of the two force magnitudes

Q8. The electric field due to an infinite plane sheet having uniform surface charge density σ is:

(A) $\sigma/(2\varepsilon_0)$
(B) σ/ε_0
(C) $\sigma/(4\varepsilon_0)$
(D) $\sigma/(2\pi\varepsilon_0)$

Q9. Consider the following statements about an electric dipole: I. The net charge of a dipole is always zero. II. The dipole moment is a scalar quantity. III. Dipole moment depends on both charge magnitude and separation. IV. A single isolated charge can act as a dipole. How many of the above statements are CORRECT?

(A) Only I
(B) Only I and III
(C) Only II and IV
(D) All four

Q10. An infinitely long straight wire has uniform linear charge density λ. The electric field at a perpendicular distance r from the wire is:

(A) $\lambda/(4\pi\varepsilon_0 r)$
(B) $\lambda/(2\pi\varepsilon_0 r)$
(C) $\lambda/(\pi\varepsilon_0 r)$
(D) $\lambda/(2\varepsilon_0 r)$

Q11. Which of the following is NOT a fundamental property of electric charge?

(A) Conservation
(B) Quantisation
(C) Additivity
(D) Polarisation

Q12. Which of the following is the correct SI unit of electric charge?

(A) Farad
(B) Coulomb
(C) Ampere
(D) Volt

Q13. A solid conducting sphere carries charge +Q. The electric field inside the conductor in electrostatic equilibrium is:

(A) Maximum at the centre
(B) Zero everywhere inside
(C) Increases linearly with distance from the centre
(D) Constant but non-zero

Q14. The number of electric field lines drawn from a charge is proportional to:

(A) The magnitude of the charge
(B) The square of the charge
(C) The sign of the charge only
(D) The distance from the charge

Q15. A body possesses a net charge of $+4.8 \times 10^{-19}$ C. The minimum number of electrons removed from the body is:

(A) 2
(B) 1
(C) 3
(D) 4

Q16. Which of the following best describes charge conservation in an isolated system?

(A) The net charge of an isolated system always remains constant
(B) Total charge increases during charging by friction
(C) Charge can be destroyed if temperature is high enough
(D) Charge conservation applies only to conductors

Q17. Which of the following statements about electric charge is INCORRECT?

(A) Charge is additive in nature
(B) Charge is quantised
(C) Charge is conserved
(D) A charged body contains only the excess charge type and no charge of the opposite sign

Q18. A current of 2 A flows through a conductor for 5 s. The total charge passing through any cross-section is:

(A) 5 C
(B) 2.5 C
(C) 20 C
(D) 10 C

Q19. In charging by induction, which of the following is the CORRECT sequence to give a metal sphere a positive charge using a negatively charged rod?

(A) Bring rod near → touch rod to sphere → remove rod
(B) Bring rod near → earth the sphere → remove earthing → remove rod
(C) Bring rod near → remove rod → earth the sphere
(D) Touch rod to sphere → earth the sphere → remove rod

Q20. Which of the following correctly represents the quantisation of electric charge at the NCERT level?

(A) q = ne, where n is a non-zero integer and e = 1.6×10^{-19} C
(B) q = n/e, where n is any real number
(C) q = ne, where n = 0 is included and represents neutral bodies
(D) q = e/n, where n is a positive integer

Q21. A glass rod rubbed with silk becomes positively charged because:

(A) It gains protons from silk
(B) It gains electrons from silk
(C) It loses electrons to silk
(D) Positive charges move from silk to glass

Q22. Which of the following quantities remains unchanged during charging by friction?

(A) Number of electrons in each body
(B) Total charge of the system
(C) Charge on each body
(D) Electrostatic potential of each body

Q23. Two small identical metal bodies carry charges of +3e and −5e. They are brought into contact and then separated. The charge on each body after separation is:

(A) −e
(B) +3e and −5e
(C) +e and −e
(D) −2e and −2e

Q24. A neutral metal sphere is given a positive charge by induction (earthing removed first, then rod removed). Which statement correctly describes the final charge on the sphere?

(A) The sphere remains neutral
(B) The sphere becomes negatively charged
(C) The sphere becomes positively charged
(D) The sphere loses all its electrons

Answer key

1-C	**2-C**	**3-A**	**4-B**	**5-B**	**6-C**	**7-B**	**8-A**
9-B	**10-B**	**11-D**	**12-B**	**13-B**	**14-A**	**15-C**	**16-A**
17-D	**18-D**	**19-B**	**20-A**	**21-C**	**22-B**	**23-A**	**24-C**

Answers with explanations

Q1 — Answer: (C) Unchanged
Gauss's law: flux = q_enclosed/ε_0, depends only on enclosed charge, not on size or shape of surface. Doubling radius does not change enclosed charge. Option A is wrong — radius change has no effect on flux.

Q2 — Answer: (C) N·m²/C
$\Phi = E \cdot A$ gives units (N/C)(m^2) = N·m^2/C. Option A is unit of E alone; Option B misses one power of metre; Option D is surface charge density.

Q3 — Answer: (A) Point charges at rest in vacuum or air
Coulomb's law is valid for stationary point charges. Moving charges require full electromagnetic treatment; current conductors involve drift velocity, not static charges.

Q4 — Answer: (B) Enclosed charge divided by ε_0
Gauss's law: net electric flux = Q_enc/ε_0. Only charges enclosed by the surface contribute; external charges produce zero net flux. Option C is the named trap: student incorrectly includes all charges regardless of position.

Q5 — Answer: (B) N/C (equivalent to V/m)
Electric field E = F/q gives units of N/C, equivalently written as V/m. Option A (C/N) inverts the ratio; options C and D are dimensionally incorrect combinations.

Q6 — Answer: (C) 2×10^{-2} N·m
$\tau = pE\sin\theta$. At $\theta=90°$, $\sin\theta=1$: $\tau = 4\times10^{-8}\times5\times10^{5} = 2\times10^{-2}$ N·m. Option D (zero) is the stable-equilibrium trap — applies only at $\theta=0°$, not $\theta=90°$.

Q7 — Answer: (B) Vector addition of the force due to +3 μC and the force due to −5 μC on +2 μC
Superposition principle: each force is calculated independently via Coulomb's law, then added vectorially. Magnitude-only addition (Option A) ignores direction and gives wrong results for non-collinear forces.

Q8 — Answer: (A) $\sigma/(2\varepsilon_0)$
A pillbox Gaussian surface of area A straddles the sheet. Flux exits both flat faces: $2EA = \sigma A/\varepsilon_0$, giving $E = \sigma/(2\varepsilon_0)$. Option B is the conducting-sheet result — the most dangerous distractor at this level.

Q9 — Answer: (B) Only I and III
Net charge is zero (I true). Dipole moment p = qd is a vector, not scalar (II false). p depends on q and d (III true). A single charge has no separation, so cannot form a dipole (IV false). Only I and III are correct.

Q10 — Answer: (B) $\lambda/(2\pi\varepsilon_0 r)$
A cylindrical Gaussian surface of radius r and length L gives enclosed charge λL. Flux passes only through curved surface: $E(2\pi rL) = \lambda L/\varepsilon_0$, so $E = \lambda/(2\pi\varepsilon_0 r)$. Option A is the point-charge formula with r, a common substitution error.

Q11 — Answer: (D) Polarisation
NCERT lists exactly three fundamental properties of charge: conservation, quantisation, and additivity. Polarisation is charge redistribution under an external field — a consequence of these properties, not a property itself.

Q12 — Answer: (B) Coulomb
Charge is measured in coulomb (C); 1 C is charge transported by 1 A in 1 s. Farad is unit of capacitance, Ampere of current, Volt of potential difference.

Q13 — Answer: (B) Zero everywhere inside
In electrostatic equilibrium, excess charge resides on the outer surface; the interior has no net charge, so E = 0 everywhere inside by Gauss's law. Options A, C, D all incorrectly assign a non-zero interior field.

Q14 — Answer: (A) The magnitude of the charge
The number of field lines is proportional to the magnitude of charge. A charge 2q has twice the field lines of charge q. Sign determines direction, not count.

Q15 — Answer: (C) 3
Positive charge indicates electron removal. $n = q/e = (4.8\times10^{-19})/(1.6\times10^{-19}) = 3$. Option A (n=2) gives only 3.2×10^{-19} C, which does not match. Quantisation: q = ne.

Q16 — Answer: (A) The net charge of an isolated system always remains constant
The Law of Conservation of Charge: total charge of an isolated system is constant. Charges are only transferred, never created or destroyed. This applies to all materials, not conductors alone.

Q17 — Answer: (D) A charged body contains only the excess charge type and no charge of the opposite sign
A charged body has excess or deficiency of electrons but still contains both protons and electrons. Net charge is non-zero, but both charge types coexist. Options A, B, C are all fundamental NCERT properties of charge.

Q18 — Answer: (D) 10 C
Q = It = 2 × 5 = 10 C. A common error is dividing: Q = I/t = 0.4 C (Option A trap). Current is charge per unit time, so charge = current × time.

Q19 — Answer: (B) Bring rod near → earth the sphere → remove earthing → remove rod
The rod repels electrons in the sphere to earth. Removing earthing first traps the electron deficiency. Removing the rod last leaves the sphere positive. Option A (conduction) gives negative charge. Option C earths after rod removal — no redistribution occurs.

Q20 — Answer: (A) q = ne, where n is a non-zero integer and e = 1.6 × 10^{-19} C
Charge quantisation: q = ne, n is any integer (positive, negative; n = 0 means neutral, not a "charged" body). Option C is a subtle trap — n = 0 is mathematically valid but the formula applies to charged bodies per NCERT context. Option B and D are dimensionally or conceptually wrong.

Q21 — Answer: (C) It loses electrons to silk
Rubbing transfers electrons from the glass rod to silk. Protons are tightly bound inside atomic nuclei and cannot be transferred. The glass rod, having lost electrons, acquires net positive charge.

Q22 — Answer: (B) Total charge of the system
During friction, individual bodies become oppositely charged, but total charge of the isolated system is conserved. A common error is selecting "charge on each body" — each body's charge changes sign and magnitude; only the total is constant.

Q23 — Answer: (A) −e
Total charge = +3e + (−5e) = −2e. Distributed equally between identical bodies: each gets −e. Option D (−2e each) is a common trap — students forget to divide by 2. Illustrates additivity and conservation.

Q24 — Answer: (C) The sphere becomes positively charged
Induction with a negative rod pushes electrons to earth. Removing earthing first traps the electron deficiency. Removing the rod leaves the sphere with net positive charge. Option B (negative) is the error when students assume sphere takes sign of the rod.

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