

CUET · PHYSICS · CLASS XII · CODE 322

Electric Charges and Fields

CUET unit: Electrostatics → Electric Charges and Fields

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 **Snapshot**

- Foundational chapter of Class XII electrostatics: introduces electric charge as a scalar additive conserved quantised quantity, Coulomb's law, and the field concept that underlies the entire Unit-I of CUET Physics.
- Establishes the inverse-square Coulomb force law in vector form and uses superposition to build up fields of point charges, dipoles and continuous distributions.
- Defines electric flux and states Gauss's law ($\Phi = q_{\text{enc}} / \epsilon_0$), then applies it to derive fields of a long line charge ($\lambda / (2\pi \epsilon_0 r)$), an infinite sheet ($\sigma / (2\epsilon_0)$) and a thin spherical shell.
- CUET typically tests this chapter through one-step numerical plug-ins (force, dipole moment, torque, flux), conceptual statements about properties of charge / field lines, and Gauss's-law applications with symmetric distributions.

 **Detailed Notes****2.1 Core concepts**

Electrostatics is the branch of physics that studies forces, fields and potentials arising from charges at rest. Almost every electrical phenomenon we encounter — a comb attracting bits of paper after running through dry hair, the spark when removing a sweater on a winter day, lightning during a thunderstorm — is electrostatic in origin (NCERT §1.1, p. 1–2). Two thousand years ago Greek philosophers noticed that amber rubbed with silk attracted small objects; the modern word "electricity" comes from **elektron**, the Greek for amber. The systematic study began with William Gilbert in 1600 and culminated in the precision experiments of Charles-Augustin de Coulomb in 1785.

Experiment shows that there are **two kinds of electric charge** — positive and negative (NCERT §1.2, p. 2–3). Conventionally, the charge developed on a glass rod rubbed with silk is positive, and that on a plastic rod rubbed with cat's fur is negative. **Like charges repel** (positive repels positive, negative repels negative) and **unlike charges attract** (positive attracts negative). The two kinds neutralise one another when combined in equal amounts, leaving a body electrically neutral overall — which is what most macroscopic matter is, because every proton's positive charge is balanced by an electron's negative charge.

Materials are broadly classified by how easily charge moves through them (NCERT §1.3, p. 3–4). **Conductors** (most metals, the human body, the Earth) allow charge to move freely; touching a charged body to a conductor disperses the charge throughout it.

Insulators (glass, plastic, nylon, wood) do not allow charge to move easily; a charge deposited on one part of an insulator stays there. **Semiconductors** (silicon, germanium) have intermediate behaviour and are the basis of all modern electronics.

Three basic properties of electric charge (NCERT § 1.4, p. 4–6). First, **additivity**: charges add algebraically like real numbers, with their signs included; if a body has charges $+q_1$, $+q_2$, $-q_3$, the net charge is $q_1 + q_2 - q_3$. Second, **conservation**: the total charge of an **isolated** system is constant in time. Charge cannot be created or destroyed, only transferred between bodies; even nuclear reactions and particle decays conserve total charge. Third, **quantisation**: electric charge always appears as integral multiples of the elementary charge $e = 1.602192 \times 10^{-19}$ C. Robert Millikan demonstrated this beautifully in his 1909–1912 oil-drop experiment by measuring the charge on isolated oil droplets and finding all values to be small integer multiples of e . At macroscopic scales the quantum is so small that charge appears continuous, but at the level of single electrons and ions it is sharply discrete.

Coulomb's law (NCERT § 1.5, p. 6–9). Two point charges q_1 and q_2 separated by distance r in vacuum exert on each other a force of magnitude

$$F = k q_1 q_2 / r^2 = (1/4\pi \epsilon_0)(q_1 q_2 / r^2) \quad (\text{NCERT Eq. 1.1, p. 6}),$$

where $k = 1/(4\pi \epsilon_0) \approx 9 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$ and $\epsilon_0 = 8.854 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$ is the permittivity of free space. The force is along the line joining the two charges, repulsive if $q_1 q_2 > 0$ and attractive if $q_1 q_2 < 0$. In full vector form,

$$F_{21} = (1/4\pi \epsilon_0)(q_1 q_2 / r_{21}^2) \hat{r}_{21} \quad (\text{NCERT Eq. 1.3, p. 9}),$$

where \hat{r}_{21} is the unit vector from charge 1 to charge 2. Coulomb's law manifestly obeys Newton's third law: $F_{12} = -F_{21}$. It is valid down to subatomic distances ($\sim 10^{-10}$ m), where it underlies the structure of atoms and molecules.

The **superposition principle (NCERT § 1.6, p. 11–12)** says that the force on a given charge due to a collection of other charges is the vector sum of the pairwise Coulomb forces, **unaffected** by the presence of the other charges. The deep simplicity of electrostatics is that two ingredients — Coulomb's law and superposition — suffice to predict every other result in the subject.

Electric field (NCERT § 1.7, p. 14). Rather than thinking about forces between pairs of charges, it is often easier to think of each source charge as setting up a **field** in the space around it, and then asking what force this field exerts on any test charge placed at a given point. The electric field E at a point is defined as the force per unit positive test charge in the limit that the test charge goes to zero:

$$\mathbf{E}(\mathbf{r}) = \lim_{q \rightarrow 0} \mathbf{F}/q.$$

For a point charge Q the field at distance r is



$\mathbf{E} = (1/4\pi\epsilon_0)(Q/r^2) \hat{r}$ (NCERT Eq. 1.6, p. 14),

directed radially outward for +Q and radially inward for –Q. SI unit of E is $\mathbf{N C}^{-1}$ (equivalently V m^{-1}). For a system of charges, the total field at a point is the vector sum of the fields produced by each charge separately (NCERT §1.7.1, Eq. 1.10, p. 15).

Electric field lines (NCERT § 1.8, p. 19–21). Field lines are a pictorial device introduced by Michael Faraday. They have four important properties: (i) the tangent to a field line at any point gives the direction of E; (ii) the density of lines through unit area perpendicular to them is proportional to |E|; (iii) lines start on positive charges and end on negative charges, or extend to infinity; and (iv) **lines never cross**, because E must have a unique direction at every point. Electrostatic field lines do not form closed loops — that property is reserved for magnetic field lines.

Electric flux (NCERT § 1.9, p. 21–23). For a small area element ΔS (treated as a vector along the outward normal), the electric flux of E through it is

$$\Delta\Phi = \mathbf{E} \cdot \Delta\mathbf{S} = E \Delta S \cos \theta.$$

For a finite surface S, $\Phi = \int_S \mathbf{E} \cdot d\mathbf{S}$. Unit: $\text{N C}^{-1} \text{m}^2$ (or V m). Geometrically, flux measures the number of field lines piercing the surface, with directionality.

Electric dipole (NCERT § 1.10, p. 23–25). A pair of equal and opposite charges +q and –q separated by 2a is an **electric dipole**. The dipole moment

$\mathbf{p} = q \times 2\mathbf{a}$, directed from –q to +q (NCERT Eq. 1.19, p. 24), unit C m.

The field of a short dipole ($r \gg a$) falls off as $1/r^3$, much faster than a point charge's $1/r^2$. On the **axial** line at distance r from the centre, $E = 2p/(4\pi\epsilon_0 r^3)$ along \hat{p} . On the **equatorial** plane, $E = -p/(4\pi\epsilon_0 r^3)$, anti-parallel to \hat{p} . The axial field is exactly **twice** the equatorial field in magnitude.

Dipole in a uniform external field (NCERT § 1.11, p. 27). A dipole feels equal and opposite forces from a uniform E, so the net force is zero. But the two forces form a couple producing a torque

$$\boldsymbol{\tau} = \mathbf{p} \times \mathbf{E}, \text{ magnitude } pE \sin \theta,$$

which tries to align p with E. The torque vanishes when p is parallel (or anti-parallel) to E.

Continuous charge distributions (NCERT § 1.12, p. 28). Real charges occupy macroscopic regions, so we work with charge **densities**: linear ($\lambda = \Delta Q/\Delta l$, C m^{-1}) along thin wires; surface ($\sigma = \Delta Q/\Delta S$, C m^{-2}) on thin sheets and conductors' surfaces; and volume ($\rho = \Delta Q/\Delta V$, C m^{-3}) inside extended bodies. The field of a continuous distribution is found by integrating the contributions of infinitesimal charge elements, with superposition replacing the discrete sum by an integral.

Gauss's law (NCERT § 1.13, p. 29–31). The net electric flux through any closed surface (a **Gaussian surface**) equals the net enclosed charge divided by ϵ_0 :

§ $\mathbf{E} \cdot d\mathbf{S} = q_{\text{enc}} / \epsilon_0$ (NCERT Eq. 1.31, p. 30).

This is one of Maxwell's four equations and a direct consequence of the inverse-square Coulomb law plus superposition. Two crucial features: the flux depends **only on the enclosed charge**, not on its location inside the surface or on the shape of the surface; and the \mathbf{E} on the left-hand side is due to **all** charges (inside and outside), although the contribution of outside charges to the net flux is exactly zero. When a charge configuration has enough symmetry (spherical, cylindrical or planar), Gauss's law lets us compute \mathbf{E} with almost no integration.

Three classic applications (NCERT § 1.14, p. 33–36).

- 1. Infinite straight line charge of linear density λ .** Use a coaxial cylindrical Gaussian surface of radius r and length l . By symmetry \mathbf{E} is radial; only the curved side contributes flux: $E \times 2\pi rl = \lambda l / \epsilon_0 \Rightarrow \mathbf{E} = \lambda / (2\pi \epsilon_0 r)$ (NCERT Eq. 1.32, p. 34).
- 2. Infinite plane sheet of surface density σ .** Use a pillbox Gaussian surface straddling the sheet, with end caps of area A on either side. Both end caps contribute flux EA in the same outward sense: $2EA = \sigma A / \epsilon_0 \Rightarrow \mathbf{E} = \sigma / (2\epsilon_0)$, independent of distance from the sheet (NCERT Eq. 1.33, p. 34).
- 3. Uniformly charged thin spherical shell of total charge q .** Concentric Gaussian sphere of radius r . For $r \geq R$ (outside the shell) the entire charge is enclosed: $\mathbf{E} = q / (4\pi \epsilon_0 r^2)$ — the shell behaves as if all its charge were at the centre. For $r < R$ (inside) the Gaussian sphere encloses no charge: $\mathbf{E} = \mathbf{0}$ (NCERT Eqs. 1.34–1.35, p. 35–36).

These three results are the staple of CUET problems and should be at the fingertips.

2.2 Definitions to memorise

Term	Definition	Page
Electric charge	Scalar property of matter responsible for electrical phenomena; exists in two kinds, positive and negative	2
Conductors	Materials that allow charge to flow freely (most metals, the human body, the Earth)	3
Insulators	Materials that resist the flow of charge (glass, plastic, nylon, wood)	3
Additivity	Charges add algebraically with signs	4
Conservation of charge	Total charge of an isolated system is constant in time	5
Quantisation of charge	q on any body equals $n e$ where n is an integer and $e = 1.6 \times 10^{-19} \text{ C}$	5
Elementary charge (e)	$1.602192 \times 10^{-19} \text{ C}$ — the smallest free charge	6
Coulomb's law	$F = (1/4\pi \epsilon_0)(q_1 q_2 / r^2)$ along the line joining two point charges	6–8

Term	Definition	Page
Permittivity of free space (ϵ_0)	$8.854 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$; $k = 1/(4\pi \epsilon_0) \approx 9 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$	8
Superposition principle	Force on a charge due to several charges is the vector sum of forces due to each charge taken one at a time	11
Electric field E	Force per unit positive test charge: $E = \lim(q \rightarrow 0) F/q$; unit N C^{-1}	14
Field line	Imaginary curve whose tangent gives the direction of E and density gives its magnitude	19
Electric flux (Φ)	$\Phi = E \cdot \Delta S = E \Delta S \cos \theta$; unit $\text{N C}^{-1} \text{ m}^2$	22
Electric dipole	Pair of equal and opposite charges $+q$ and $-q$ separated by $2a$	23
Dipole moment (p)	$p = q \times 2a$, directed from $-q$ to $+q$; unit C m	24
Axial line of dipole	Line passing through both charges (along p)	24
Equatorial line of dipole	Perpendicular bisector of the dipole	24
Torque on dipole	$\tau = p \times E$; magnitude $pE \sin \theta$	27
Linear charge density (λ)	$\Delta Q/\Delta l$, unit C m^{-1}	28
Surface charge density (σ)	$\Delta Q/\Delta S$, unit C m^{-2}	28
Volume charge density (ρ)	$\Delta Q/\Delta V$, unit C m^{-3}	28
Gaussian surface	Imaginary closed surface used to apply Gauss's law	30
Gauss's law	Net electric flux through any closed surface = $q_{\text{enc}} / \epsilon_0$	30
Spherical symmetry	Symmetry exploited for shells and point charges	35

2.3 Diagrams / processes to remember

- **Fig. 1.1 (p. 2)** — like-charges repel / unlike-charges attract between glass-silk and plastic-fur rods.
- **Fig. 1.2 (p. 4)** — gold-leaf electroscope to detect charge; the divergence of the leaves measures the amount of charge.
- **Fig. 1.3 (p. 8)** — geometry and direction of vector Coulomb force showing $F_{12} = -F_{21}$ (Newton's third law).
- **Fig. 1.5 (p. 11)** — system of three / many charges showing superposition of pairwise forces.
- **Fig. 1.12 and 1.13 (p. 19–20)** — radial field lines of a point charge; the line density falls as $1/r^2$ because the area through which lines pass grows as r^2 .

- **Fig. 1.14 (p. 21)** — field-line patterns for single +q, single -q, two equal positive charges, and a dipole (+q, -q).
- **Fig. 1.17 (p. 24)** — geometry for the dipole field at an axial point and at an equatorial point.
- **Fig. 1.19 (p. 27)** — dipole in a uniform external field: equal opposite forces produce a torque $\tau = p \times E$.
- **Fig. 1.22 (p. 29)** — sphere of radius r around a point charge q used to derive Gauss's law $\Phi = q/\epsilon_0$.
- **Fig. 1.26 (p. 33)** — cylindrical Gaussian surface for an infinite line charge: only the curved side contributes ($E \times 2\pi r l = \lambda l/\epsilon_0$).
- **Fig. 1.27 (p. 34)** — pillbox Gaussian surface for an infinite plane sheet: $2EA = \sigma A/\epsilon_0$.
- **Fig. 1.28 (p. 35)** — concentric spherical Gaussian surfaces for a charged thin shell: field outside is $q/(4\pi\epsilon_0 r^2)$, zero inside.

2.4 Common confusions / NTA trap points

- Confusing the Coulomb constant $k = 1/(4\pi\epsilon_0) \approx 9 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$ with ϵ_0 itself ($8.854 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$); NTA loves to put both numerical values among the options.
- For the infinite plane sheet the field is $\sigma/(2\epsilon_0)$ and is **independent of distance**; students often write σ/ϵ_0 (which is the field outside a conductor's surface) and expect a 1/r-type fall-off.
- The field of a uniformly charged thin shell is **zero strictly inside** ($r < R$) but **$q/(4\pi\epsilon_0 r^2)$** outside ($r \geq R$); a typical distractor treats the field as $q/(4\pi\epsilon_0 R^2)$ at every interior point.
- Dipole field falls as **$1/r^3$** (not $1/r^2$), and the axial field is exactly **twice** the equatorial field in magnitude and opposite in direction.
- In Gauss's law, q on the right side is **only the enclosed charge**, but E on the left is due to **all charges** (inside and outside the surface).
- The torque $\tau = p \times E$ has magnitude **$pE \sin \theta$** ; the net **force** on a dipole in a **uniform** field is zero — students often mark a non-zero net force.
- Two equal point charges of opposite sign at the same distance produce field-vectors that **add** at the midpoint (not cancel), giving twice each single-charge contribution.
- Charge quantisation does not mean charges can be any integer multiple of **some** unit — they must be integer multiples of the elementary charge e specifically.
- A test charge q used to **define** E must be taken in the limit $q \rightarrow 0$, otherwise it disturbs the source distribution it is measuring.
- Field lines start on +q, end on -q, never cross, and never form closed loops in electrostatics.

- For an infinite line charge, E falls off as $1/r$ (not $1/r^2$ as for a point charge).
- Don't confuse the term "uniformly charged" (constant σ or ρ) with "uniform field" (constant E).

2.5 Key formulas table

Symbol	Formula	Meaning	NCERT page
Coulomb's law	$F = (1/4\pi\epsilon_0)(q_1q_2/r^2)$	Force between point charges	6, Eq. 1.1
k	$1/(4\pi\epsilon_0) \approx 9 \times 10^9 \text{ N m}^2/\text{C}^2$	Coulomb constant	8
ϵ_0	$8.854 \times 10^{-12} \text{ C}^2/(\text{N m}^2)$	Vacuum permittivity	8
Quantisation	$q = ne$	n integer, $e = 1.6 \times 10^{-19} \text{ C}$	5
Superposition (force)	$F = \sum F_i$ (vector)	Net force from many charges	11
E (point)	$E = (1/4\pi\epsilon_0)(Q/r^2)$	Field of a point charge	14, Eq. 1.6
E (system)	$E = (1/4\pi\epsilon_0) \sum q_i \hat{r}_{iP} / r_{iP}^2$	Field of n charges	15, Eq. 1.10
Dipole moment	$p = q \times 2a$	From $-q$ to $+q$	24, Eq. 1.19
Axial field	$E = 2p/(4\pi\epsilon_0 r^3)$	Short dipole on axis	25
Equatorial field	$E = -p/(4\pi\epsilon_0 r^3)$	Short dipole, equatorial plane	25
Torque	$\tau = p \times E$	On dipole in uniform E	27, Eq. 1.22
Flux	$\Phi = \int E \cdot dS$	Surface integral of field	22
λ, σ, ρ	linear, surface, volume densities	Charge per unit length/area/volume	28
Gauss's law	$\oint E \cdot dS = q_{enc}/\epsilon_0$	Total flux equals enclosed charge	30, Eq. 1.31
E (line)	$E = \lambda/(2\pi\epsilon_0 r)$	Infinite line charge	34, Eq. 1.32
E (sheet)	$E = \sigma/(2\epsilon_0)$	Infinite plane sheet	35, Eq. 1.33
E (shell, outside)	$E = q/(4\pi\epsilon_0 r^2)$	$r \geq R$	35, Eq. 1.34
E (shell, inside)	$E = 0$	$r < R$	36, Eq. 1.35
E (conductor surface)	$E = \sigma/\epsilon_0 \hat{n}$	Just outside a conductor	(later, §2.9)
Force on charge	$F = qE$	In an external field	14
Vector Coulomb	$F_{21} = k q_1q_2 \hat{r}_{21}/r_{21}^2$	Vector form	9, Eq. 1.3

Practice MCQs

PYQ Alignment

This chapter is one of the two highest-yield topics in CUET Physics — roughly 10–12 MCQs across CUET 2023–2025 papers combined, with strong over-representation of (i) plug-in numerical questions on Coulomb's law, dipole moment and torque, and (ii) Gauss's-law applications (flux through a closed surface, fields of long wires/sheets/shells). Conceptual statement-based MCQs on properties of charge, properties of electric field lines and the $\sigma/(2\epsilon_0)$ vs σ/ϵ_0 trap also appear regularly.

CUET 2025 — Actual PYQs from this chapter

Q.1 (CUET 2025) If the protons and electrons are the only basic charges in the universe, all observable charges must be integral multiples of e . If an object contains x electrons and y protons, the net charge on the object will be:

- A) $(x - y)e$ B) $(x + y)e$ C) $(y - x)e$ D) $(y + x)e$ **Tests:** Net charge on an object — quantisation, $(y - x)e$ **Answer:** Not in extracted key

Q.5 (CUET 2025) If the net flux through a cube is $1.05 \text{ N m}^2 \text{ C}^{-1}$, what will be the total charge inside the cube? (Given: $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$)

- A) $9.29 \times 10^{-11} \text{ C}$ B) $9.27 \times 10^{-10} \text{ C}$ C) $9.22 \times 10^{-6} \text{ C}$ D) $9.29 \times 10^{-12} \text{ C}$ **Tests:** Gauss's law — total charge inside from net flux **Answer:** Not in extracted key

Q.8 (CUET 2025) Two point charges placed at distance d exert force F . If one charge is doubled, to keep force same, separation should become:

- A) $2d$ B) $d/2$ C) $\sqrt{2}d$ D) $d/\sqrt{2}$ **Tests:** Coulomb's law — doubling one charge, scaling distance **Answer:** Not in extracted key

CUET 2024 — Actual PYQs from this chapter

Q.1 (CUET 2024) Two charged particles placed at distance d exert force F . If each charge is doubled, to keep the force unchanged the distance should be:

- A) $4d$ B) $2d$ C) d D) $d/2$ **Tests:** Coulomb's law — force vs charge and distance **Answer:** Not in extracted key

Q.3 (CUET 2024) Two large parallel plates have surface charge densities $+\sigma$ and $-\sigma$. A charge q is placed at points P_1, P_2, P_3 . The forces F_1, F_2, F_3 respectively are:

- A) $F_1=0, F_2=0, F_3=0$ B) $F_1=0, F_2 \neq 0, F_3=0$ C) $F_1 \neq 0, F_2 \neq 0, F_3 \neq 0$ D) $F_1=0, F_2=0, F_3 \neq 0$ **Tests:** Force on a charge between two oppositely charged parallel sheets **Answer:** Not in extracted key

Q.4 (CUET 2024) Two metallic spheres of radii R_1 and R_2 touch and are separated. Final charge ratio Q_1/Q_2 is:

- A) R_2/R_1 B) $< R_2/R_1$ C) $> R_2/R_1$ D) R_1/R_2 Tests: Charge sharing between conducting spheres — final charge ratio Answer: Not in extracted key

Q.33 (CUET 2024) Transfer of integral number of _____ is evidence of quantization of electric charge.

- A) photons B) nuclei C) electrons D) neutrons Tests: Quantization of charge — integral multiples of electronic charge Answer: Not in extracted key

Q.35 (CUET 2024) A copper ball (density 8 g/cc, diameter 1 cm) is immersed in oil (density 0.8 g/cc). If electric field 600 N/C upward keeps it suspended, charge on the ball is:

- A) 2×10^{-6} C B) 2×10^{-5} C C) 1×10^{-5} C D) 1×10^{-6} C Tests: Millikan-style charged drop in oil with apparent weight balanced by qE Answer: Not in extracted key

CUET 2023 — Actual PYQs from this chapter

Q.1 (CUET 2023) Choose the correct statements. A. The total charge in an isolated system remains constant. B. When charge is transferred to a conductor, it stays at the same place without getting distributed over the entire surface. C. One coulomb of negative charge is equal to the charge of 6.25×10^{18} electrons. D. Electric field is a scalar field. E. Potential difference between two dipole moments exists irrespective of external electric field. Options:

- A) B, C, D and E only B) A, D and E only C) B and D only D) A, C and E only Tests: Charge quantization, conservation, conductor charge distribution Answer: Not in extracted key

Q.2 (CUET 2023) Choose the correct statements about Gauss's law. 1. Gauss law is true for any open surface. 2. Gauss law includes the charges enclosed by the surface for evaluation of electric flux through the surface. 3. Gauss law can be used to calculate magnetic field due to steady current. 4. Gauss law is not based on the inverse square dependence on distance contained in Coulomb's law. Options:

- A) 1 B) 2 C) 3 D) 4 Tests: Gauss's law — closed surface, enclosed charge, electric flux Answer: Not in extracted key

Q.3 (CUET 2023) If three charged particles are in equilibrium, then:

- A) All charged particles have equal charge. B) All the charged particles have the same sign and the distances between consecutive charged particles are same. C) All the charged particles have some sign. D) All the charged particles cannot have the same sign. Tests: Equilibrium of system of point charges Answer: Not in extracted key

Q.5 (CUET 2023) The electric field intensity due to an infinite thin plane sheet of surface charge density σ is:

- A) $\sigma \epsilon_0$ B) $\frac{\sigma}{2\epsilon_0}$ C) $-\sigma \epsilon_0$ D) $-\frac{2\sigma}{\epsilon_0}$ Tests: Electric field due to infinite plane sheet of charge Answer: Not in extracted key

$\{\varepsilon_0\} - \varepsilon_0 2\sigma$ Tests: Electric field of an infinite plane sheet of charge

Answer: Not in extracted key

