Electric Charges and Fields — CBSE Class 12 Physics Chapter Test

FREE CHAPTER TEST · CLASS XII · PHYSICS (042) · PATTERN OF THE CBSE SAMPLE QUESTION PAPER 2026-27

TIME ALLOWED	MAXIMUM MARKS	QUESTIONS	NAME / ROLL NO.
1½ hours	37	17 (A 8 · B 3 · C 3 · D 1 · E 2)	

GENERAL INSTRUCTIONS

Read the following instructions very carefully and strictly follow them:

1. This question paper contains 17 questions. All questions are compulsory.
2. This question paper is divided into five sections: A, B, C, D and E.
3. Section A (Q1–8) contains 6 multiple choice questions and 2 assertion-reason based questions of 1 mark each.
4. Section B (Q9–11) contains short answer questions of 2 marks each.
5. Section C (Q12–14) contains short answer questions of 3 marks each.
6. Section D (Q15) contains case study based questions of 4 marks each, with four sub-parts of 1 mark.
7. Section E (Q16–17) contains long answer questions of 5 marks each.
8. There is no overall choice. However, an internal choice has been provided in 1 question in Section B, 1 question in Section C, 2 questions in Section E. Attempt only one of the alternatives in such questions.
9. Use of calculators is not allowed. You may use: $k = 1/4\pi\varepsilon_0 = 9 \times 10^9$ N m² C⁻², $\varepsilon_0 = 8.854 \times 10^{-12}$ C² N⁻¹ m⁻², $e = 1.6 \times 10^{-19}$ C, $m_e = 9.1 \times 10^{-31}$ kg.
10. This chapter test follows the section structure, question types and marks per question of the CBSE Class XII Physics (042) Sample Question Paper 2026-27, at about half the length of the 70-mark board paper: 37 marks in 1½ hours.
11. The answer key and the marking scheme are at the end of this booklet. Attempt the paper in 1½ hours before you look at them.

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Chapter: Electric Charges and Fields · **Topics:** Electric charge, quantisation and conservation · Coulomb's law and superposition · Electric field and field lines · Electric dipole and torque · Electric flux and Gauss's law · Applications of Gauss's law

SECTION A

This section comprises 8 questions of 1 mark each: 6 multiple choice questions (MCQs) and 2 assertion-reason based questions.

1. Two identical small conducting spheres carry charges +8 μC and −2 μC and attract each other with a force F when kept a certain distance apart. They are made to touch each other and are then put back at the same distance. The magnitude of the new force is 1

(A) $\frac{9}{16}$ F (B) $\frac{3}{4}$ F

(C) $\frac{16}{9}$ F (D) $\frac{1}{4}$ F

2. How many electrons must be added to a neutral body to give it a charge of −3.2 μC? 1

(A) 5×10^{12} (B) 2×10^{12}

(C) 2×10^{13} (D) 5×10^{13}

3. Which of the following statements about electrostatic field lines is **not** correct? 1

(A) Two field lines never cross each other.

(B) They start from positive charges and end on negative charges.

(C) They form closed loops.

(D) The tangent to a field line at a point gives the direction of the field there.

4. An electric dipole of dipole moment 3×10^{-9} C m is placed at 30° to a uniform electric field of 4×10^{4} N C^{-1}. The torque on the dipole is 1

(A) 1.2×10^{-4} N m (B) 6×10^{-5} N m

(C) 1.04×10^{-4} N m (D) 3×10^{-5} N m

5. A closed surface encloses the charges +q, −q and +2q. A charge +5q lies outside the surface. The net electric flux through the surface is 1

(A) $\frac{q}{\varepsilon_0}$ (B) $\frac{7q}{\varepsilon_0}$

(C) zero (D) $\frac{2q}{\varepsilon_0}$

6. The magnitude of the electric field at a distance r from a very large (infinite) plane sheet of uniform surface charge density varies as 1

(A) r^{-2} (B) r^{-1}

(C) r^{0} (D) r^{1}

7. **Assertion (A) :** The electric field inside a charged hollow conducting sphere is zero. 1
Reason (R) : The whole charge resides on the outer surface of the conductor, so a Gaussian surface drawn inside it encloses no charge.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

8. **Assertion (A) :** A plastic comb rubbed with dry hair attracts small pieces of paper. 1
Reason (R) : The pieces of paper carry a net charge opposite to that of the comb.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

SECTION B

This section comprises 3 short answer questions of 2 marks each.

9. A point charge +2 μC is placed at the origin and a point charge −8 μC at x = 30 cm on the x-axis. Find the point on the x-axis where the net electric field is zero. 2

10. (a) Define electric dipole moment. Write its SI unit and its direction. 2

OR

(b) State Gauss's law in electrostatics. A point charge q is placed at the centre of a cube. Using Gauss's law, find the electric flux through one face of the cube.

11. An electron, initially at rest, is accelerated by a uniform electric field of 3.0×10^{4} N C^{-1}. Find (i) its acceleration and (ii) the time it takes to travel 2.0 cm. ($e = 1.6 \times 10^{-19}$ C, $m_e = 9.1 \times 10^{-31}$ kg; ignore gravity.) 2

SECTION C

This section comprises 3 short answer questions of 3 marks each.

12. Derive an expression for the electric field at a point on the axial line of an electric dipole of charges ±q separated by 2a, at a distance r from its centre. Show that for $r \gg a$ it reduces to $E = \frac{1}{4\pi\varepsilon_0}\,\frac{2p}{r^3}$. 3

13. (a) Three point charges, each of +1 μC, are placed at the corners of an equilateral triangle of side 10 cm. Find the magnitude and direction of the net force on any one of them. 3

OR

(b) Using Gauss's law, obtain the expression for the electric field due to an infinitely long straight wire of uniform linear charge density λ at a distance r from it. Find the field at 10 cm from such a wire with $\lambda = 2 \times 10^{-8}$ C m^{-1}.

14. A thin spherical shell of radius 10 cm carries a charge of 4 nC spread uniformly over it. Find (i) the electric field at 5 cm from its centre, (ii) the electric field at 20 cm from its centre and (iii) its surface charge density. 3

SECTION D

This section comprises 1 case study based question of 4 marks, with four sub-parts of 1 mark each.

15. A water molecule behaves as a permanent electric dipole: its dipole moment is about 6.2×10^{-30} C m, directed from the oxygen atom towards the middle of the two hydrogen atoms. In a microwave oven, the electric field of the waves keeps reversing, and the torque on the molecules makes them rotate back and forth; the energy given to the molecules heats the food. Consider a single water molecule in a uniform electric field of 1.0×10^{6} N C^{-1}.

(I) The net force on the molecule in the uniform field is
(A) zero (B) pE (C) 2pE (D) pE sin θ [1]

(II) The molecule is in stable equilibrium when the angle between its dipole moment and the field is
(A) 0° (B) 45° (C) 90° (D) 180° [1]

(III) The maximum torque on the molecule is
(A) 3.1×10^{-24} N m (B) 6.2×10^{-24} N m (C) 1.24×10^{-23} N m (D) 6.2×10^{-36} N m [1]

(IV) The work needed to turn the molecule from its stable equilibrium position through 180° is
(A) 3.1×10^{-24} J (B) 6.2×10^{-24} J (C) 1.24×10^{-23} J (D) zero [1]

SECTION E

This section comprises 2 long answer questions of 5 marks each.

16. (a) (i) Using Gauss's law, derive an expression for the electric field due to a very large (infinite) plane sheet of uniform surface charge density σ. 5
(ii) Two large, thin parallel plates carry uniform surface charge densities +σ and −σ. Find the electric field (I) between the plates and (II) outside the plates. Find the field between them for $\sigma = 8.854 \times 10^{-9}$ C m^{-2}.

OR

(b) (i) Derive an expression for the electric field at a point on the equatorial line of an electric dipole, at a distance r from its centre. Write its form for $r \gg a$.
(ii) Charges of +5 μC and −5 μC are placed 4.0 mm apart. Find the electric field at a point 20 cm from the centre of this dipole on its equatorial line.

17. (a) (i) State Coulomb's law. Write it in vector form for the force on charge q_2 due to q_1. 5

(ii) Four point charges +3 μC, −4 μC, +3 μC and −4 μC are placed, in this order, at the corners of a square of side 20 cm. Find the net force on a charge of +2 μC placed at the centre of the square. Justify.

(iii) Two point charges +q and +4q are kept a distance d apart. Where, and what charge, must a third charge Q be placed so that all three are in equilibrium?

OR

(b) (i) Define electric flux. Write its SI unit.

(ii) A uniform electric field $\mathbf{E} = 2 \times 10^3\,\hat{\imath}$ N C^{-1} exists in a region. Find the flux of this field through a square of side 20 cm whose plane is (I) parallel to the y-z plane, (II) such that its normal makes an angle of 60° with the x-axis.

(iii) A point charge of 3.0 μC is at the centre of a cubical Gaussian surface of edge 12 cm. Find the net electric flux through the surface and through each face.

END OF THE QUESTION PAPER

ANSWER KEY — SECTION A

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
(A)	(C)	(C)	(B)	(D)	(C)	(A)	(C)

MARKING SCHEME AND WORKED SOLUTIONS

Marks for each step are shown in brackets, as in the CBSE marking scheme. Any correct alternative method earns full marks.

Q1. Answer (A). Before: $F \propto |8 \times (-2)| = 16$. On touching, the total charge 6 μC is shared equally: 3 μC each, so $F' \propto 3 \times 3 = 9$ (now repulsive). $F' = (9/16)\ F$.

Q2. Answer (C). $q = ne$, so $n = 3.2 \times 10^{-6}/1.6 \times 10^{-19} = 2 \times 10^{13}$.

Q3. Answer (C). Electrostatic field lines begin on positive charges and end on negative charges (or at infinity), so they cannot form closed loops; the field is conservative.

Q4. Answer (B). $\tau = pE \sin\theta = 3 \times 10^{-9} \times 4 \times 10^{4} \times \sin 30° = 6 \times 10^{-5}$ N m.

Q5. Answer (D). By Gauss's law $\Phi = q_{enclosed}/\varepsilon_0 = (q - q + 2q)/\varepsilon_0 = 2q/\varepsilon_0$. The charge outside contributes no net flux.

Q6. Answer (C). Gauss's law gives $E = \sigma/2\varepsilon_0$ for an infinite sheet: the field does not depend on the distance, i.e. it varies as r^{0}.

Q7. Answer (A). A is true. In electrostatics the charge on a conductor lies on its outer surface; a Gaussian sphere inside encloses no charge, and by symmetry E is the same at every point of it, so E = 0. R explains A. Answer (A).

Q8. Answer (C). A is true. The paper pieces are neutral: the charged comb polarises them, and the nearer, opposite induced charge is attracted more than the farther one is repelled. R is false. Answer (C).

Q9. (2 marks) Answer: x = −30 cm (30 cm to the left of the +2 μC charge).
Between the charges both fields point the same way (towards −8 μC), so E cannot be zero there; beyond −8 μC the larger charge is nearer. The zero lies to the left of +2 μC, at x = −d. [½]
$k(2)/d^2 = k(8)/(d + 0.30)^2$, so $(d + 0.30)/d = 2$ [1], giving d = 0.30 m: the point x = −30 cm. [½]

Q10. (2 marks) Answer: (a) $p = q \times 2a$, C m, from −q to +q; (b) $q/6\varepsilon_0$.
(a) For two equal and opposite charges ±q a distance 2a apart, the dipole moment is $p = q \times 2a$. [1]
SI unit: coulomb metre (C m) [½]; direction: from the negative charge to the positive charge, along the dipole axis. [½]
OR (b) The net electric flux through any closed surface is $1/\varepsilon_0$ times the net charge enclosed: $\oint E \cdot dA = q_{enc}/\varepsilon_0$. [1]
The cube is a closed surface enclosing q, so the total flux is q/ε_0; by symmetry the six faces share it equally: $q/6\varepsilon_0$ through each face. [1]

Q11. (2 marks) Answer: (i) $\approx 5.3 \times 10^{15}$ m s^{-2}; (ii) $\approx 2.8 \times 10^{-9}$ s.
(i) $a = eE/m = (1.6 \times 10^{-19} \times 3.0 \times 10^{4})/(9.1 \times 10^{-31}) \approx 5.3 \times 10^{15}$ m s^{-2}, opposite to the field. [1]
(ii) $s = \tfrac{1}{2}at^2$, so $t = \sqrt{(2s/a)} = \sqrt{(2 \times 0.020/5.27 \times 10^{15})} \approx 2.8 \times 10^{-9}$ s. [1]

Q12. (3 marks) Answer: $E = 2kpr/(r^2 - a^2)^2 \rightarrow 2kp/r^3$ for $r \gg a$, along p.
Take P on the axis, at distance r from the centre, on the side of +q. Field of +q (distance r − a): $E_+ = kq/(r - a)^2$, away from +q; field of −q (distance r + a): $E_- = kq/(r + a)^2$, towards −q, i.e. opposite. [1]
$E = kq[1/(r - a)^2 - 1/(r + a)^2] = kq \times 4ar/(r^2 - a^2)^2 = 2kpr/(r^2 - a^2)^2$ with $p = 2qa$, directed along p. [1½]
For $r \gg a$, $(r^2 - a^2)^2 \approx r^4$, so $E = 2kp/r^3 = (1/4\pi\varepsilon_0)(2p/r^3)$. [½]

Q13. (3 marks) Answer: (a) ≈ 1.56 N along the angle bisector, outward; (b) $E = \lambda/2\pi\varepsilon_0 r$, 3.6×10^3 N C⁻¹.
(a) Each of the other two charges repels it with $F = kq^2/a^2 = 9 \times 10^9 \times (10^{-6})^2/(0.10)^2 = 0.9$ N. [1]
The two forces are 60° apart, so the resultant is $2F \cos 30° = \sqrt{3}\, F$ [1] ≈ 1.56 N, along the bisector of the angle at that corner, pointing away from the triangle. [1]
OR (b) Gaussian surface: a coaxial cylinder of radius r and length l. By symmetry E is radial; there is no flux through the flat ends and E is the same over the curved surface: $E \times 2\pi rl = \lambda l/\varepsilon_0$. [1½]
$E = \lambda/(2\pi\varepsilon_0 r) = 2k\lambda/r$. [½] With $\lambda = 2 \times 10^{-8}$ C m⁻¹, r = 0.10 m: $E = 2 \times 9 \times 10^9 \times 2 \times 10^{-8}/0.10 = 3.6 \times 10^3$ N C⁻¹, directed radially outward. [1]

Q14. (3 marks) Answer: (i) 0; (ii) 900 N C⁻¹; (iii) ≈ 3.2×10^{-8} C m⁻².
(i) Inside the shell a Gaussian sphere encloses no charge, so E = 0. [1]
(ii) Outside, the shell acts as a point charge at its centre: $E = kQ/r^2 = 9 \times 10^9 \times 4 \times 10^{-9}/(0.20)^2 = 900$ N C⁻¹, radially outward. [1]
(iii) $\sigma = Q/4\pi R^2 = 4 \times 10^{-9}/(4\pi \times 0.01) \approx 3.2 \times 10^{-8}$ C m⁻². [1]

Q15. (4 marks) Answer: (I) A; (II) A; (III) B; (IV) C.
(I) (A) The forces qE and −qE on the two ends are equal and opposite: the net force is zero (only a torque acts). [1]
(II) (A) $U = -pE\cos\theta$ is least at θ = 0°: p along E. [1]
(III) (B) $\tau_{max} = pE = 6.2 \times 10^{-30} \times 1.0 \times 10^6 = 6.2 \times 10^{-24}$ N m (at θ = 90°). [1]
(IV) (C) $W = U(180°) - U(0°) = pE - (-pE) = 2pE = 1.24 \times 10^{-23}$ J. [1]

Q16. (5 marks) Answer: (a) $\sigma/2\varepsilon_0$; σ/ε_0 between, 0 outside; 1.0×10^3 N C⁻¹; (b) $kp/(r^2 + a^2)^{\wedge}(3/2) \rightarrow kp/r^3$; 2.25×10^4 N C⁻¹.
(a) (i) Gaussian surface: a cylinder of cross-section A through the sheet, with its flat faces parallel to the sheet. E is normal to the sheet and has the same magnitude on both faces; no flux passes through the curved surface. [1]
Flux = EA + EA = 2EA; charge enclosed = σA. Gauss: $2EA = \sigma A/\varepsilon_0$, so $E = \sigma/2\varepsilon_0$, directed away from a positive sheet and independent of distance. [2]
(ii) (I) Between the plates the two fields $\sigma/2\varepsilon_0$ are in the same direction: $E = \sigma/\varepsilon_0$, from the + plate to the − plate. (II) Outside they are opposite: E = 0. [1]
$E = 8.854 \times 10^{-9}/8.854 \times 10^{-12} = 1.0 \times 10^3$ N C⁻¹. [1]
OR (b) (i) At P on the perpendicular bisector, each charge is at $\sqrt{(r^2 + a^2)}$ and each field has magnitude $kq/(r^2 + a^2)$. [1]
Their components along the bisector cancel; those parallel to the axis add, both pointing from +q to −q: $E = 2 \times kq/(r^2 + a^2) \times a/\sqrt{(r^2 + a^2)} = kp/(r^2 + a^2)^{3/2}$, opposite to p. [1½]
For $r \gg a$: $E = kp/r^3 = p/(4\pi\varepsilon_0 r^3)$. [½]
(ii) $p = 5 \times 10^{-6} \times 4.0 \times 10^{-3} = 2.0 \times 10^{-8}$ C m; r = 0.20 m ≫ a. [1]
$E = kp/r^3 = 9 \times 10^9 \times 2.0 \times 10^{-8}/(0.20)^3 = 2.25 \times 10^4$ N C⁻¹, opposite to p. [1]

Q17. (5 marks) Answer: (a) zero; x = d/3 from +q, Q = −4q/9; (b) 80 and 40 N m² C⁻¹; 3.39×10^5 and 5.65×10^4 N m² C⁻¹.
(a) (i) The force between two point charges is proportional to the product of the charges and inversely proportional to the square of the distance between them, along the line joining them. [½] $\mathbf{F}_{21} = (1/4\pi\varepsilon_0)(q_1 q_2/r^2)\, \hat{\mathbf{r}}_{12}$, where $\hat{\mathbf{r}}_{12}$ is the unit vector from q_1 to q_2. [½]
(ii) The +3 μC charges are at opposite corners, equidistant from the centre, so their forces on +2 μC are equal and opposite; the same holds for the two −4 μC charges. [1½] Net force = 0. [½]
(iii) Q must lie between them, at distance x from +q: $kqQ/x^2 = k(4q)Q/(d - x)^2$, so $d - x = 2x$, $x = d/3$. [1]
For +q to be in equilibrium: $kQq/(d/3)^2 = k(4q)q/d^2$, so Q = −4q/9 (negative). [1]
OR (b) (i) Electric flux through a surface is the number of field lines crossing it: $\Phi = \int \mathbf{E} \cdot d\mathbf{A}$ (= EA cos θ for a uniform field and a plane area). SI unit N m² C⁻¹ (or V m). [1]
(ii) $A = (0.20)^2 = 0.04$ m². (I) Normal along x: $\Phi = EA = 2 \times 10^3 \times 0.04 = 80$ N m² C⁻¹. [1] (II) $\Phi = EA\cos 60° = 40$ N m² C⁻¹. [1]
(iii) $\Phi = q/\varepsilon_0 = 3.0 \times 10^{-6}/8.854 \times 10^{-12} \approx 3.39 \times 10^5$ N m² C⁻¹ (the size of the cube does not matter). [1]
Through each face: Φ/6 ≈ 5.65×10^4 N m² C⁻¹. [1]

All questions are original and © Master Testing Agency. Free to download and use for personal practice; not for resale. Every answer in this paper was checked independently by computer: forces and fields added as vectors from Coulomb's law, the zero-field point found by scanning the axis, the dipole formulas compared with the exact field.