Chapter- 01

ELECTRIC CHARGES AND FIELD

Electric Charges; Conservation of charge

Very Short Answer Type Questions (1 Mark)

01. If 10^9 electrons move out of a body to another body every second, how much time is required to get a total charge of 1 C on the other body? (NCERT)

02. A polythene piece rubbed with wool is found to have a negative charge of $3\times10^{-7}C$. (a) Estimate the number of electrons transferred (from which to which?) (b) Is there a transfer of mass from wool to polythene? (NCERT)

Assertion and reason

DIRECTION: In the following questions a statement of assertion is followed by a corresponding statement of reason. Of the following statements, choose the correct one.

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(d)Assertion is incorrect but Reason is correct.

03. **Assertion:** Charge is quantized because only integral number of electrons can be transferred

Reason: There is no possibility of transfer of some fraction of electron.

Short questions (2 Marks)

04. How much positive and negative charge is there in a cup (250 g) of water? (NCERT)

05. (a) Explain the meaning of the statement 'electric charge of a body is quantized'.
(b) Why can one ignore quantization of electric charge when dealing with macroscopic i.e., large scale charges? (NCERT)

06. When a glass rod is rubbed with a silk cloth, charges appear on both. A similar phenomenon is observed with many other pairs of bodies. Explain how this observation is consistent with the law of conservation of charge. (NCERT)

Coulomb's law-force between two point charges

Very Short Answer Type Questions (1 Mark)

07. What is the relative permittivity of the vacuum?

Assertion and reason

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08. **Assertion:**Charge is quantized because only integral number of electrons can be transferred
Reason: There is no possibility of transfer of some fraction of electron.

Short questions (2 Marks)

09. What is the force between two small charged spheres having charges of $2\times10^{-7}C$ and $3\times10^{-7}C$ placed 30 cm apart in air?(NCERT)
(b) What is the force on the second sphere due to the first?(NCERT)

10. Check that the ratio $\frac{ke^2}{Gm_em_p}$ is dimensionless. Determine the value of this ratio. What does the ratio signify?(NCERT)

Short questions (3 Marks)

11. (a) Two insulated charged copper spheres A and B have their centres separated by a distance of 50 cm. What is the mutual force of electrostatic repulsion if the charge on each is $6.5\times10^{-7}C$? The radii of A and B are negligible compared to the distance of separation.
(b) What is the force of repulsion if each sphere is charged double the above amount, and the distance between them is halved?(NCERT)

Five Marks questions.

12. State Coulomb's law. Write the law in vector form. Show that Coulomb's law obeys Newton's third law of motion?

Forces between multiple charges; superposition principle and continuous charge distribution.

Short questions (2 Marks)

13. Two charges *q* and –3*q* are placed fixed on *x*-axis separated by distance '*d*'. Where should a third charge 2*q* be placed such that it will not experience any force?(Exemplar)

Short questions (3 Marks)

14. Consider three charges q_1, q_2, q_3 each equal to *q* at the vertices of an equilateral triangle of side *l*. What is the force on a charge *Q* (with the same sign as *q*) placed at the centroid of the triangle, as shown in Fig. 1.9?(NCERT)

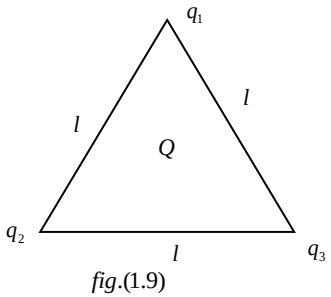


fig.(1.9)

15. Four point charges $q_A = 2\mu C$, $q_B = -5\mu C$, $q_C = 2\mu C$, and $q_D = -5\mu C$ are located at the corners of a square ABCD of side 10 cm. What is the force on a charge of $1\mu C$ placed at the centre of the square?(NCERT)

16. Consider the charges *q*, *q*, and –*q* placed at the vertices of an equilateral triangle, as shown in Fig. 1.10. What is the force on

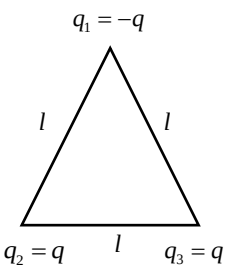


fig.(1.10)

each charge?(NCERT)

17. Two-point charges +Q and +4Q are separated by a distance of 6m. Find the point of the line joining the two charges where the electric field is zero?

Five Marks questions.

18. Total charge –Q is uniformly spread along length of a ring of radius *R*. A small test charge *+q* of mass *m* is kept at the centre of the ring and is given a gentle push along the axis of the ring. (a) Show that the particle executes a simple harmonic oscillation. (b) Obtain its time period.(Exemplar)

Electric field, electric field due to a point charge, electric field lines

MCQ

19. A point positive charge is brought near an isolated conducting sphere (Fig. 1.2). The electric field is best given by

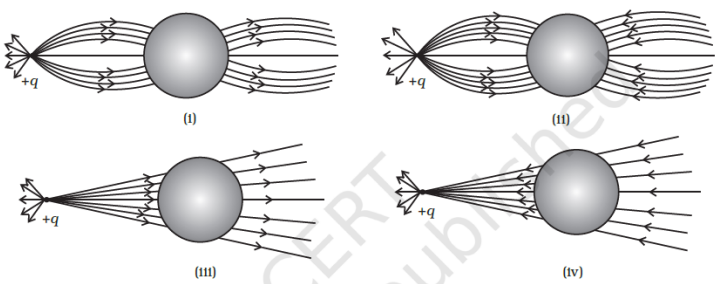


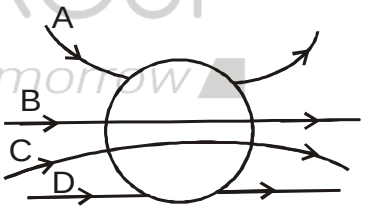
Fig. 1.2

(a) Fig (i) (b) Fig (iii)
(c)Fig (ii)
(d)Fig (iv)(Exemplar)

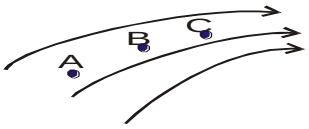
20. The Electric field at a point is
(a) always continuous.
(b) continuous if there is no charge at that point.
(c) discontinuous only if there is a negative charge at that point.
(d) discontinuous if there is a charge at that point.(Exemplar)

Very Short Answer Type Questions (1 Mark)

21. A metallic sphere is placed in an external uniform electric field, which lines of force are correct?



22. An electric field is represented as shown in the figure. Arrange the electric field in decreasing order.



Assertion and reason

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23. **Assertion:**Electrostatic field lines start at positive charges and end at negative charges. **Reason:**Field lines are continuous curves without breaks and they form closed loop.
24. **Assertion:**If a proton and an electron are placed in a same uniform electric field, they experience different acceleration.
Reason: Electric force on a test charge is independent of its mass.

Short questions (2 Marks)

25. Sketch the Electric field lines due to point charges. (i) q < 0 (ii) q >0
26. (a) An electrostatic field line is a continuous curve. That is, a field line cannot have sudden breaks. Why not?(b) Explain why two field lines never cross each other at any point?(NCERT)

Short questions (3 Marks)

27. An oil drop of 12 excess electrons is held stationary under a constant electric field of $2.55\times10^{4}\,N/C$ (Millikan's oil drop experiment). The density of the oil is $1.26g/cm^{3}$. Estimate the radius of the drop. (NCERT)

Electric dipole, electric field due to a dipole

Very Short Answer Type Questions (1 Mark)

28. A system has two charges $q_A = 2.5\times10^{-7}C$ and $q_B = -2.5\times10^{-7}C$ located at points A: (0, 0, –15 cm) and B: (0,0, +15 cm), respectively. What are the total charge and electric dipole moment of the system?(NCERT)

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Short questions (2 Marks)

29. Graphically represent the variation of electric field for isolated charge and electric dipole.

30. An electric dipole is formed by $+5\mu C$. and -5 μc charge at 4 mm distance, calculate the dipole moment, and give its direction.

Short questions (3 Marks)

31. Two point charges q_1 and q_2, of magnitude $+10^{-8}C$ and $-10^{-8}C$, respectively, are placed 0.1 m apart. Calculate the electric fields at points A, B and C shown in Fig.

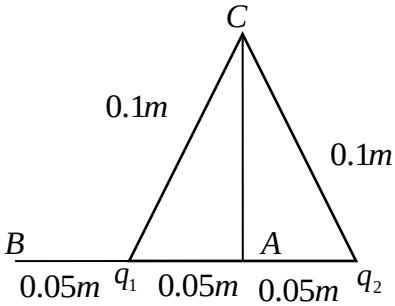


fig.(1.14)

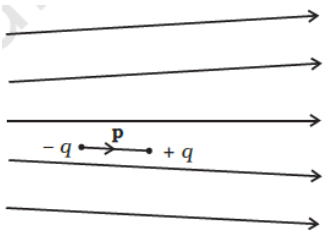
1.14.(NCERT)

Five Marks questions.

32. Find out the electric field intensity due to an electric dipole at any point on (i) Axial line and (ii) Equatorial line.

Torque on a dipole in uniform electric fleld

MCQ



33. Figure 1.5 shows electric field lines in which an electric dipole p is placed as shown. Which of the following statements is correct?

(a) The dipole will not experience any force.

(b) The dipole will experience a force towards right.

(c) The dipole will experience a force towards left.

(d) The dipole will experience a force upwards.(Exemplar)

Very Short Answer Type Questions (1 Mark)

34. An electric dipole with dipole moment $4\times10^{-9}C\cdot m$ is aligned at 30 deg with the direction of a uniform electric field of magnitude $5\times10^{4}N/C$. Calculate the magnitude of the torque acting on the dipole. (NCERT)

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Short questions (2 Marks)

35. An electric dipole when placed at 30 deg with respect to uniform field $10^{4}N/C$ experience a torque of $9\times10^{-26}N\cdot m$. Calculate the dipole moment of the dipole.

36. An electric dipole is placed at an angle of 60 deg with an electric field of $10^{5}N/C$. It experiences a torque on $8\sqrt{3}$ Nm. Calculate the charge on dipole if the dipole length is 2 cm.

Short questions (3 Marks)

37. An electric dipole of dipole moment $\vec{p}$ is placed in a uniform electric field $\vec{E}$. Derive an expression for the torque experienced by the dipole. Show diagrammatically the orientation of the dipole in the field for which the torque is : (i) maximum value and (ii) zero.

Electric flux, statement of Gauss's theorem

MCQ

38. If $\oint_S \vec{E}\cdot d\vec{S}=0$ over a surface, then (a) the electric field inside the surface and on it is zero.

(b) the electric field inside the surface is necessarily uniform.

(c) the number of flux lines entering the surface must be equal to the number of flux lines leaving it.

(d) all charges must necessarily be outside the surface.(Exemplar)

Very Short Answer Type Questions (1 Mark)

39. An arbitrary surface encloses a dipole. What is the electric flux through this surface?(Exemplar)

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40. **Assertion:**The charge given to a metallic sphere does not depend on whether it is hollow or solid.

Reason:Since the charge reside only on the surface of the conductor.

41. **Assertion:**If Gaussian surface does not enclose any charge, then electric field at any point on the Gaussian surface must be zero

Reason: No net charge is enclosed by Gaussian surface, so net flux passing through the surface is zero.

42. **Assertion:**Electric field outside vicinity of a conductor depends only on the local charge density σ and it is independent of the charges present anywhere on the conductor.

Reason: Electric field outside vicinity of a conductor is given by $\frac{\sigma}{\varepsilon_0}$.

Short questions (2 Marks)

43. Consider a uniform electric field $\vec{E} = 3\times10^3 \hat{i}N/C$. (a) What is the flux of this field through a square of 10 cm on a side whose plane is parallel to the *yz* plane? (b) What is the flux through the same square if the normal to its plane makes a 60deg angle with the *x*-axis?(NCERT)

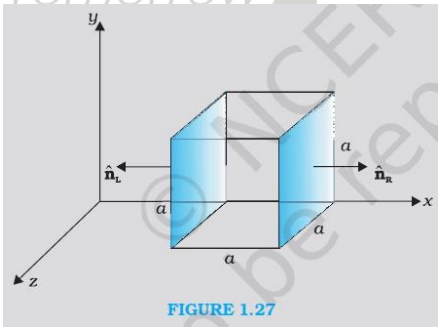


FIGURE 1.27

44. What is the net flux of the uniform electric field $\vec{E} = 3\times10^3 \hat{i}N/C$ through a cube of side 20 cm oriented so that its faces are parallel to the coordinate planes? (NCERT)

45. A point charge of $2\mu C$ is at the centre of a cubic Gaussian surface 9.0 cm on edge. What is the net electric flux through the surface?(NCERT)

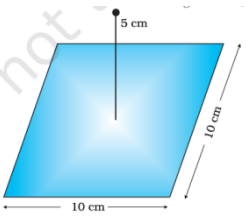


FIGURE 1.34

46. A point charge $+10\mu C$ is a distance 5 cm directly above the centre of a square of side 10 cm, as shown in Fig. 1.34. What is the magnitude of the electric flux through the square? (*Hint:* Think of the square as one face of a cube with edge 10 cm.)(NCERT)

Five Marks questions.

47. An electric field is uniform, and in the positive *x* direction for positive *x*, and uniform with the same magnitude but in the negative *x* direction for negative *x*. It is given that $\vec{E} = 200\hat{i}N/C$ for *x* > 0 and $\vec{E} = -200\hat{i}N/C$ for *x* < 0. A right circular cylinder of length 20 cm and radius 5 cm has its centre at the origin and its axis along the *x*-axis so that one face is at *x* = +10 cm and the other is at *x* = –10 cm. (a) What is the net outward flux through each flat face? (b) What is the flux through the side of the cylinder? (c) What is the net outward flux through the cylinder? (d) What is the net charge inside the cylinder?(NCERT)

Field due to infinitely long straight wire, uniformly charged infinite plane sheet

MCQ

48. A point charge +*q*, is placed at a distance *d* from an isolated conducting plane. The field at a point P on the other side of the plane is

(a) directed perpendicular to the plane and away from the plane.

(b) directed perpendicular to the plane but towards the plane.

(c) directed radially away from the point charge.

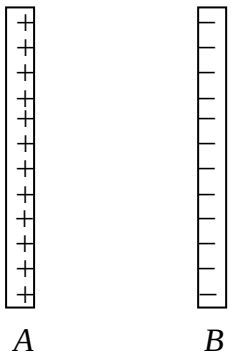
(d) directed radially towards the point charge.(Exemplar)

Short questions (2 Marks)

49. An infinite line charge produces a field of $9\times10^4 N/C$ at a distance of 2 cm. Calculate the linear charge density.(NCERT)

Case study based questions.

50. Surface charge density is defined as the charge per unit surface area of surface charge distribution.i.e., $\sigma = \frac{q}{A}$. Two large thin metal plates are parallel and close to each other. On their inner faces, the plates have surface charge densities of opposite signs having magnitude of $17.0\times10^{-22} C/m^2$ as shown in the figure. The intensity of electric field at a point is $E = \frac{\sigma}{\varepsilon_0}$ where ε_0 is the permittivity of free space



(i) E in the outer region of the first plate is (a) $17.0\times10^{-22} N/C$ (b) $1.5\times10^{-15} N/C$ (c) $1.9\times10^{-10} N/C$ (d)zero

(ii) E in the outer region of the second plate is a) $17.0\times10^{-22} N/C$ (b) $1.5\times10^{-15} N/C$ (c) $1.9\times10^{-10} N/C$ (d)zero

(iii)E between the plates is a) $17.0\times10^{-22}N/C$ (b) $1.5\times10^{-15}N/C$ (c) $1.9\times10^{-10}N/C$ (d)zero

(iv) The ratio of E at a point from right side of B at distance 2cm and 4 cm, respectively is (a)1:2 (b)2:1 (c)1:1 (d) $1:\sqrt{2}$

(v) In order to estimate the electric field due to a thin finite plane metal plate,the Gaussian surface considered is (a)spherical (b)cylindrical (c)straight line (d)None of these

Uniformly charged thin spherical shell (field inside and outside).

MCQ

51. A hemisphere is uniformly charged positively. The electric field at a point on a diameter away from the centre is directed

(a) perpendicular to the diameter

(b) parallel to the diameter

(c) at an angle tilted towards the diameter

(d) at an angle tilted away from the diameter.(Exemplar)

Very Short Answer Type Questions (1 Mark)

52. Calculate the surface charge density of a spherical cell of radius 'R' having a total uniform charge Q.

Short questions (2 Marks)

53. A uniformly charged conducting sphere of 2.4 m diameter has a surface charge density of $80\mu C/m^2$. (a) Find the charge on the sphere. (b) What is the total electric flux leaving the surface of the sphere?

Five Marks questions.

54. State Gauss's theorem in electrostatics and express it mathematically. Using it, derive an expression for electric field due to a uniformly charged thin spherical shell (i) Outside the shell (ii) Inside the shell.