PHYSICS

1 Electric Charges and Fields

Multiple Choice Questions (MCQs)

DIRECTIONS : *This section contains multiple choice questions. Each question has four choices (a), (b), (c) and (d) out of which only one is correct.*

1. Two small spheres each having the charge $+Q$ are suspended by insulating threads of length L from a hook. This arrangement is taken in space where there is no gravitational effect, then the angle ______ between the two suspensions and the tension is _______ in each thread.

(a) $180°, \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{(2L)^2}$ (b) $90°, \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{L^2}$

(c) $180°, \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{2L^2}$ (d) $180°, \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{L^2}$

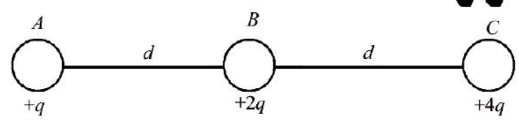
2. Two equal point charges each of $3\mu C$ are separated by a certain distance in metres. If they are located at $(\hat{i}+\hat{j}+\hat{k})$ and $(2\hat{i}+3\hat{j}+\hat{k})$, then the electrostatic force between them is

(a) 9×10^3 N (b) 16×10^{-3} N
(c) 10^{-3} N (d) 9×10^{-2} N

3. A body is positively charged, it implies that
(a) there is only positive charge in the body
(b) there is positive as well as negative charge in the body but the positive charge is more than negative charge
(c) there is equal positive and negative charge in the body but the positive charge lies in the outer regions
(d) negative charge is displaced from its position

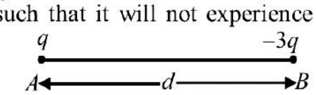
4. On rubbing, when one body gets positively charged and other negatively charged, the electrons transferred from positively charged body to negatively charged body are
(a) valence electrons only
(b) electrons of inner shells
(c) both valence electrons and electrons of inner shell
(d) yet to be established

5. Three charges $+q$, $+2q$ and $+4q$ are connected by strings as shown in the figure. What is ratio of tensions in the strings AB and BC ?



(a) 1 : 2 (b) 1 : 3 (c) 2 : 1 (d) 3 : 1

6. Two charge q and $-3q$ are placed fixed on x–axis separated by distance d. Where should a third charge $2q$ be placed such that it will not experience any force?



(a) $\frac{d-\sqrt{3}d}{2}$ (b) $\frac{d+\sqrt{3}d}{2}$

(c) $\frac{d+3d}{2}$ (d) $\frac{d-3d}{2}$

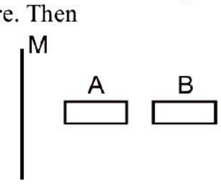
7. Two positive ions, each carrying a charge q, are separated by a distance d. If F is the force of repulsion between the ions, the number of electrons missing from each ion will be (e being the charge of an electron)

(a) $\frac{4\pi\varepsilon_0 Fd^2}{e^2}$ (b) $\sqrt{\frac{4\pi\varepsilon_0 Fe^2}{d^2}}$

(c) $\sqrt{\frac{4\pi\varepsilon_0 Fd^2}{e^2}}$ (d) $\frac{4\pi\varepsilon_0 Fd^2}{q^2}$

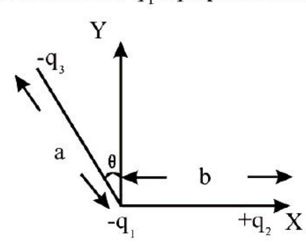
8. A large nonconducting sheet M is given a uniform charge density. Two uncharged small metal rods A and B are placed near the sheet as shown in figure. Then

(a) M attracts A
(b) M attracts B
(c) A attracts B
(d) All of these



9. Three charges $-q_1$, $+q_2$ and $-q_3$ are place as shown in the figure. The x - component of the force on $-q_1$ is proportional to

(a) $\frac{q_2}{b^2}-\frac{q_3}{a^2}\cos\theta$
(b) $\frac{q_2}{b^2}+\frac{q_3}{a^2}\sin\theta$
(c) $\frac{q_2}{b^2}+\frac{q_3}{a^2}\cos\theta$
(d) $\frac{q_2}{b^2}-\frac{q_3}{a^2}\sin\theta$



10. A total charge Q is broken in two parts Q_1 and Q_2 and they are placed at a distance R from each other. The maximum force of repulsion between them will occur. when

(a) $Q_2 = \frac{Q}{R}, Q_1 = Q - \frac{Q}{R}$ (b) $Q_2 = \frac{Q}{4}, Q_1 = Q - \frac{2Q}{3}$

(c) $Q_2 = \frac{Q}{4}, Q_1 = \frac{3Q}{4}$ (d) $Q_1 = \frac{Q}{2}, Q_2 = \frac{Q}{2}$

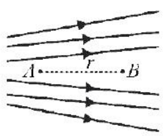
11. Figure shows the electric lines of force emerging from a charged body. If the electric field at A and B are E_A and E_B respectively and if the displacement between A and B is r then

(a) $E_A > E_B$

(b) $E_A < E_B$

(c) $E_A = \frac{E_B}{r}$

(d) $E_A = \frac{E_B}{r^2}$



12. An electric dipole with dipole moment 4×10^{-9} cm is aligned at 30° with the direction of a uniform electric field of magnitude 5×10^4 NC^{-1}. The torque acting on the dipole is

(a) 1×10^{-4} Nm (b) 5×10^{-8} Nm

(c) 11×10^{-12} Nm (d) 25×10^{-19} Nm

13. The electric field at a point on equatorial line of a dipole _________ to direction of the dipole moment.

(a) will be parallel

(b) will be in opposite direction

(c) will be perpendicular

(d) are not related

14. The electric field intensity just sufficient to balance the earth's gravitational attraction on an electron will be: (given mass and charge of an electron respectively are 9.1×10^{-31} kg and 1.6×10^{-19} C.)

(a) -5.6×10^{-11} N/C (b) -4.8×10^{-15} N/C

(c) -1.6×10^{-19} N/C (d) -3.2×10^{-19} N/C

15. Which one of the following is not a property of field lines

(a) Field lines are continuous curves without any breaks.

(b) Two field lines cannot cross each other.

(c) Field lines start at positive charge and end at negative charge

(d) They form closed loop

16. If a dipole of dipole moment $\vec{p}$ is placed in a uniform electric field $\vec{E}$, then torque acting on it is given by

(a) $\vec{\tau} = \vec{p}.\vec{E}$ (b) $\vec{\tau} = \vec{p} \times \vec{E}$

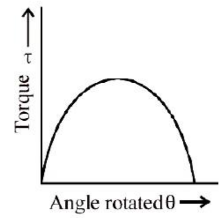
(c) $\vec{\tau} = \vec{p} + \vec{E}$ (d) $\vec{\tau} = \vec{p} - \vec{E}$

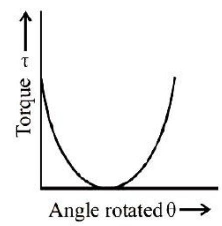
17. If E_a be the electric field strength of a short dipole at a point on its axial line and E_e that on the equatorial line at the same distance, then

(a) $E_e = 2E_a$ (b) $E_a = 2E_e$

(c) $E_a = E_e$ (d) None of these

18. Which of the following graphs shows the correct variation in magnitude of torque on an electric dipole rotated in a uniform electric field from stable equillibrium to unstable equillibrium?

(a)


(b)


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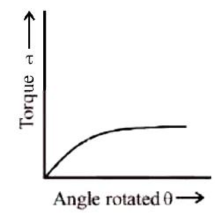
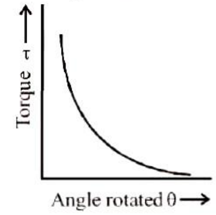


(d)


19. The electric intensity due to a dipole of length 10 cm and having a charge of 500 μC, at a point on the axis at a distance 20 cm from one of the charges in air, is

(a) 6.25×10^7 N/C (b) 9.28×10^7 N/C

(c) 13.1×10^{11} N/C (d) 20.5×10^7 N/C

20. A rod of length 2.4 m and radius 4.6 mm carries a negative charge of 4.2×10^{-7} C spread uniformly over it surface. The electric field near the mid–point of the rod, at a point on its surface is

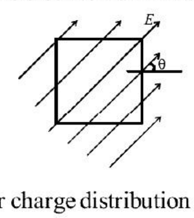
(a) -8.6×10^5 N C^{-1} (b) 8.6×10^4 N C^{-1}

(c) -6.7×10^5 N C^{-1} (d) 6.7×10^4 N C^{-1}

21. The total electric flux emanating from a closed surface enclosing an α-particle is (e-electronic charge)

(a) $\frac{2e}{\varepsilon_0}$ (b) $\frac{e}{\varepsilon_0}$ (c) $e\varepsilon_0$ (d) $\frac{\varepsilon_0 e}{4}$

22. A square surface of side L meter in the plane of the paper is placed in a uniform electric field E (volt/m) acting along the same plane at an angle θ with the horizontal side of the square as shown in Figure. The electric flux linked to the surface, in units of volt. m, is



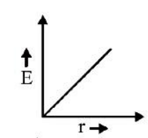
(a) EL^2

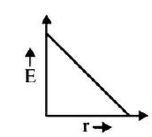
(b) $EL^2 \cos\theta$

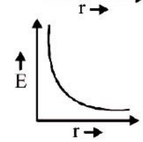
(c) $EL^2 \sin\theta$

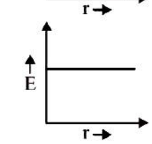
(d) zero

23. The E-r curve for an infinite linear charge distribution will be

(a)


(b)


(c)


(d)


24. At the centre of a cubical box + Q charge is placed. The value of total flux that is coming out a wall is

(a) Q/ε_0 (b) $Q/3\varepsilon_0$ (c) $Q/4\varepsilon_0$ (d) $Q/6\varepsilon_0$

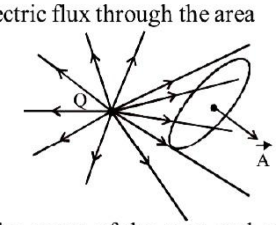
25. The Gaussian surface

(a) can pass through a continuous charge distribution.
(b) cannot pass through a continuous charge distribution.
(c) can pass through any system of discrete charges.
(d) can pass through a continuous charge distribution as well as any system of discrete charges.

26. In a region, the intensity of an electric field is given by $\vec{E} = 2\hat{i} + 3\hat{j} + \hat{k}$ in NC^{-1}. The electric flux through a surface $\vec{S} = 10\hat{i}\ m^2$ in the region is

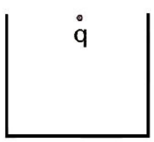
(a) $5\ Nm^2C^{-1}$ (b) $10\ Nm^2C^{-1}$
(c) $15\ Nm^2C^{-1}$ (d) $20\ Nm^2C^{-1}$

27. In the figure the net electric flux through the area A is $\phi = \vec{E} \cdot \vec{A}$ when the system is in air. On immersing the system in water the net electric flux through the area



(a) becomes zero
(b) remains same
(c) increases
(d) decreases

28. A charge q is placed at the centre of the open end of a cylindrical vessel. The flux of the electric field through the surface of the vessel is



(a) zero
(b) q/ε_0
(c) $q/2\varepsilon_0$
(d) $2q/\varepsilon_0$

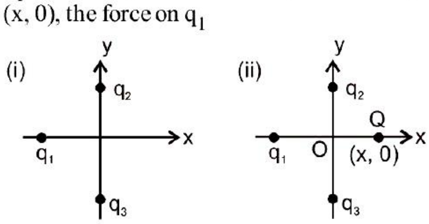
29. If the electric flux entering and leaving an enclosed surface respectively is ϕ_1 and ϕ_2, the electric charge inside the surface will be

(a) $(\phi_2 + \phi_2) \times \varepsilon_0$ (b) $(\phi_2 - \phi_2) \times \varepsilon_0$
(c) $(\phi_1 + \phi_2) \times \varepsilon_0$ (d) $(\phi_2 - \phi_1) \times \varepsilon_0$

30. If the net electric flux through a closed surface is zero, then we can infer **[CBSE 2020]**

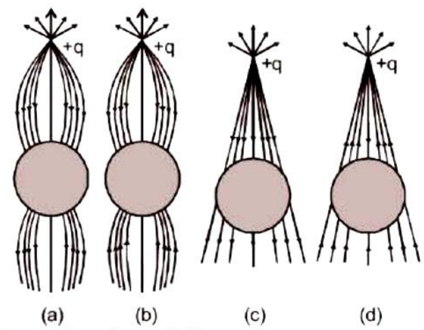
(a) no net charge is enclosed by the surface.
(b) uniform electric field exists within the surface.
(c) electric potential varies from point to point inside the surface.
(d) charge is present inside the surface.

31. In figure two positive charges q_2 and q_3 fixed along the y-axis, exert a net electric force in the + x-direction on a charge q_1 fixed along the x-axis. If a positive charge Q is added at (x, 0), the force on q_1

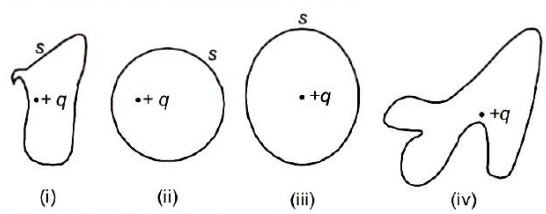


(a) shall increase along the positive x-axis
(b) shall decrease along the positive x-axis
(c) shall point along the negative x-axis
(d) shall increase but the direction changes because of the intersection of Q with q_2 and q_3

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

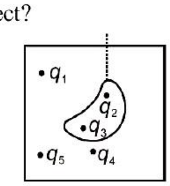


33. The electric flux through the surface



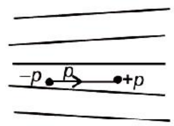
(a) in Fig. (iv) is the largest
(b) in Fig. (iii) is the least
(c) in Fig. (ii) is same as Fig. (iii) but is smaller than Fig. (iv)
(d) is the same for all the figures

34. Five charges q_1, q_2, q_3, q_4, and q_5 are fixed at their positions as shown in Figure, S is a Gaussian surface. The Gauss' law is given by $\int_s E.dS = \frac{q}{\varepsilon_0}$. Which of the following statements is correct?



(a) E on the LHS of the above equation will have a contribution from q_1, q_5 and q_1, q_5 and q_3 while q on the RHS will have a contribution from q_2 and q_4 only
(b) E on the LHS of the above equation will have a contribution from all charges while q on the RHS will have a contribution from q_2 and q_4 only
(c) E on the LHS of the above equation will have a contribution from all charges while q on the RHS will have a contribution from q_1, q_3 and q_5.
(d) Both E on the LHS and q on the RHS will have contributions from q_2 and q_4 only

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



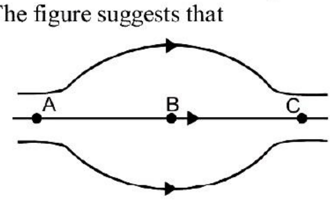
(a) The dipole will not experience any force
(b) The dipole will experience a force towards right
(c) The dipole will experience a force towards left
(d) The dipole will experience a force upwards

36. 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.

37. A hemisphere is uniformely 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

38. Among two discs A and B, first have radius 10 cm and charge 10^{-6} μC and second have radius 30 cm and charge 10^{-5}C. When they are touched, charge on both q_A and q_B respectively will, be
(a) $q_A = 2.75\mu C$, $q_B = 3.15\mu C$
(b) $q_A = 1.09\mu C$, $q_B = 1.53\mu C$
(c) $q_A = q_B = 5.5\mu C$
(d) None of these

39. Figure shows some of the electric field lines corresponding to an electric field. The figure suggests that



(a) $E_A > E_B > E_C$
(b) $E_A = E_B = E_C$
(c) $E_A = E_C > E_B$
(d) $E_A = E_C < E_B$

40. The surface density on the copper sphere is σ. The electric field strength on the surface of the sphere is
(a) σ (b) σ/2 (c) $\sigma / 2\varepsilon_0$ (d) Q / ε_0

41. When a body is charged by induction, then the body
(a) becomes neutral
(b) does not lose any charge
(c) loses whole of the charge on it
(d) loses part of the charge on it

42. Quantisation of charge implies
(a) charge cannot be destroyed
(b) charge exists on particles
(c) there is a minimum permissible charge on a particle
(d) charge, which is a fraction of a coulomb is not possible.

43. For an isolated system, it is possible to create or destroy charged particle, but it is not possible to create or destroy.
(a) net charge of the system
(b) charge on each particle
(c) charge distribution of system
(d) None of these

44. When some charge is transferred to ...*A*... it readily gets distributed over the entire surface of ... *A*... If some charge is put on ... *B*..., it stays at the same place. Here, A and B refer to
(a) insulator, conductor (b) conductor, insulator
(c) insulator, insulator (d) conductor, conductor

45. A positively charged rod is brought near an uncharged conductor. If the rod is then suddenly withdrawn, the charge left on the conductor will be
(a) positive (b) negative
(c) zero (d) cannot say

46. Two spheres A and B of exactly same mass are given equal positive and negative charges respectively. Their masses after charging
(a) remains unaffected (b) mass of A > mass of B
(c) mass of A < mass of B (d) Nothing can be said

47. Coulomb's law is true for
(a) atomic distances (= 10^{-11} m)
(b) nuclear distances (= 10^{-15} m)
(c) charged as well as uncharged particles
(d) all the distances

48. In annihilation process, in which an electron and a positron transform into two gamma rays, which property of electric charge is displayed?
(a) Additivity of charge
(b) Quantisation of charge
(c) Conservation of charge
(d) Attraction and repulsion

49. Which of the following statements is incorrect?
(a) The charge q on a body is always given by q = ne, where n is any integer, positive or negative.
(b) By convention, the charge on an electron is taken to be negative.
(c) The fact that electric charge is always an integral multiple of e is termed as quantisation of charge.
(d) The quatisation of charge was experimentally demonstrated by Newton in 1912.

50. Which of the following statements is incorrect? Study of charges, by scientists, concludes that
(a) there are two kinds of electric charges.
(b) bodies like plastic, fur acquire elecrtic charge on rubbing.
(c) like charges attract, unlike charges repel each other.
(d) the property which differentiates two kinds of charges is called the polarity of the charge.

51. What happens when some charge is placed on a soap bubble?
(a) Its radius decreases (b) Its radius increases
(c) The bubble collapses (d) None of these

52. Consider a neutral conducting sphere. A positive point charge is placed outside the sphere. The net charge on the sphere is then
(a) negative and distributed uniformly over the surface of the sphere
(b) negative and appears only at the point on the sphere closest to the point charge
(c) negative and distributed non-uniformly over the entire surface of the sphere
(d) zero

53. A charged particle is free to move in an electric field. It will travel
(a) always along a line of force
(b) along a line of force, if its initial velocity is zero
(c) along a line of force, if it has some initial velocity in the direction of an acute angle with the line of force
(d) none of the above

54. If one penetrates a uniformly charged spherical cloud, electric field strength
(a) decreases directly as the distance from the centre
(b) increases directly as the distance from the centre
(c) remains constant
(d) None of these

55. Electric lines of force about a negative point charge are
(a) circular anticlockwise (b) circular clockwise
(c) radial, inwards (d) radial, outwards

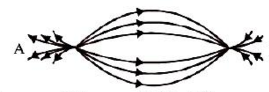
56. Electric lines of force
(a) exist everywhere
(b) exist only in the immediate vicinity of electric charges
(c) exist only when both positive and negative charges are near one another
(d) are imaginary

57. A region surrounding a stationary electric dipoles has
(a) magnetic field only
(b) electric field only
(c) both electric and magnetic fields
(d) no electric and magnetic fields

58. The electric field at a point on equatorial line of a dipole and direction of the dipole moment
(a) will be parallel
(b) will be in opposite direction
(c) will be perpendicular
(d) are not related

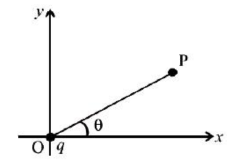
59. An electric dipole is placed at an angle of 30° to a non-uniform electric field. The dipole will experience
(a) a translational force only in the direction of the field
(b) a translational force only in the direction normal to the direction of the field
(c) a torque as well as a translational force
(d) a torque only

60. The spatial distribution of electric field due to charges (A, B) is shown in figure. Which one of the following statements is correct ?



(a) A is +ve and B –ve, |A| > |B|
(b) A is –ve and B +ve, |A| = |B|
(c) Both are +ve but A > B
(d) Both are –ve but A > B

61. In the figure, charge q is placed at origin O. When the charge q is displaced from its position the electric field at point P changes



(a) at the same time when q is displaced.
(b) at a time after $\frac{OP}{c}$ where c is the speed of light.
(c) at a time after $\frac{OP\cos\theta}{c}$.
(d) at a time after $\frac{OP\sin\theta}{c}$

62. An electric dipole is placed in a uniform electric field. The dipole will experience
(a) a force that will displace it in the direction of the field
(b) a force that will displace it in a direction opposite to the field.
(c) a torque which will rotate it without displacement
(d) a torque which will rotate it and a force that will displace it

63. On decreasing the distance between the two charges of a dipole which is perpendicular to electric field and decreasing the angle between the dipole and electric field, the torque on the dipole
(a) increases (b) decreases
(c) remains same (d) cannot be predicted.

64. A sphere of radius R has uniform distribution of electric charge in its volume. At a distance x from its centre for x <R, the electric field is directly proportional to
(a) $1/x^2$ (b) $1/x$ (c) x (d) x^2

65. In a medium of dielectric constant K, the electric field is $\vec{E}$. If ϵ_0 is permittivity of the free space, the electric displacement vector is
(a) $\frac{K\vec{E}}{\epsilon_0}$ (b) $\frac{\vec{E}}{K\epsilon_0}$ (c) $\frac{\epsilon_0\vec{E}}{K}$ (d) $K\epsilon_0\vec{E}$

66. Positive electric flux indicates that electric lines of force are directed
(a) outwards (b) inwards
(c) either (a) or (b) (d) None of these

67. If the flux of the electric field through a closed surface is zero, then
(a) the electric field must be zero everywhere on the surface
(b) the electric field may not be zero everywhere on the surface
(c) the charge inside the surface must be zero
(d) the charge in the vicinity of the surface must be zero

68. If the electric flux entering and leaving an enclosed surface respectively is ϕ_1 and ϕ_2, the electric charge inside the surface will be

(a) $(\phi_2 + \phi_2) \times \varepsilon_o$ (b) $(\phi_2 - \phi_2) \times \varepsilon_o$
(c) $(\phi_1 + \phi_2) \times \varepsilon_o$ (d) $(\phi_2 - \phi_1) \times \varepsilon_o$

69. The Gaussian surface

(a) can pass through a continuous charge distribution.
(b) cannot pass through a continuous charge distribution.
(c) can pass through any system of discrete charges.
(d) can pass through a continuous charge distribution as well as any system of discrete charges.

70. Gauss's law is true only if force due to a charge varies as

(a) r^{-1} (b) r^{-2} (c) r^{-3} (d) r^{-4}

71. For a given surface the Gauss's law is stated as $\oint \vec{E} . d\vec{A} = 0$. From this we can conclude that

(a) E is necessarily zero on the surface
(b) E is perpendicular to the surface at every point
(c) the total flux through the surface is zero
(d) the flux is only going out of the surface

72. Total electric flux coming out of a unit positive charge put in air is

(a) ε_0 (b) ε_0^{-1} (c) $[4\pi\varepsilon_0]^{-1}$ (d) $4\pi\varepsilon_0$

73. A hollow sphere of charge does not produce an electric field at any

(a) interior point (b) outer point.
(c) beyond 2 m (d) beyond 10 m

74. A point charge +q is placed at mid point of a cube of side 'L'. The electric flux emerging from the cube is

(a) $\frac{q}{\varepsilon_0}$ (b) $\frac{6qL^2}{\varepsilon_0}$ (c) $\frac{q}{6L^2\varepsilon_0}$ (d) zero

75. It is not convenient to use a spherical Gaussian surface to find the electric field due to an electric dipole using Gauss's theorem because

(a) Gauss's law fails in this case
(b) This problem does not have spherical symmetry
(c) Coulomb's law is more fundamental than Gauss's law
(d) Spherical Gaussian surface will alter the dipole moment

76. An electric dipole is put in north-south direction in a sphere filled with water. Which statement is correct?

(a) Electric flux is coming towards sphere
(b) Electric flux is coming out of sphere
(c) Electric flux entering into sphere and leaving the sphere are same
(d) Water does not permit electric flux to enter into sphere

77. The electric field near a conducting surface having a uniform surface charge density is given by

(a) $\frac{\sigma}{\varepsilon_0}$ and is parallel to the surface
(b) $\frac{2\sigma}{\varepsilon_0}$ and is parallel to the surface
(c) $\frac{\sigma}{\varepsilon_0}$ and is normal to the surface
(d) $\frac{2\sigma}{\varepsilon_0}$ and is normal to the surface

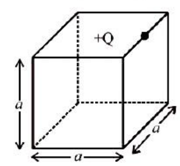
78. Select the correct statements from the following.

(a) The electric field due to a charge outside the Gaussian surface contributes zero net flux through the surface.
(b) The electgric flux of the electric field $\oint \vec{E} \cdot d\vec{A}$ is zero. The electric field is zero everywhere on the surface.
(c) Total flux linked with a closed body, not enclosing any charge will be zero.
(d) Total electric flux, if a dipole is enclosed by a surface is zero.

79. The number of electric lines of force that radiate outwards from one coulomb of charge in vacuum is

(a) 1.13×10^{11} (b) 1.13×10^{10}
(c) 0.61×10^{11} (d) 0.61×10^{9}

80. In figure + Q charge is located at one of the edge of the cube, then electric flux through cube due to + Q charge is



(a) $\frac{+Q}{\epsilon_0}$ (b) $\frac{+Q}{2\epsilon_0}$
(c) $\frac{+Q}{4\epsilon_0}$ (d) $\frac{+Q}{8\epsilon_0}$

81. A square frame of edge l cm is placed with its positive normal making an angle of 60° with a uniform electric field E. The flux of the electric field through the surface bounded by the frame is

(a) $El^2/2$ (b) $El^2/\sqrt{3}$ (c) $El^2/3$ (d) $2El^2$

Case/Passage Based Questions

DIRECTIONS : *Study the given Case/Passage and answer the following questions.*

Case/Passage-I

A body can be charged by following methods.

(a) **By friction :** By rubbing two bodies together, both positive and negative charges in equal amounts appear simultaneously due to transfer of electrons from one body to the other.

(b) **By electrostatic induction :** If a charged body is brought near a neutral body, the charged body will attract opposite charge and repel similar charge present in the neutral body. As a result of this one side of neutral body becomes (+ ve) while the other (–ve). This process is called "electrostatic induction".

(c) **By conduction :** Take two conductors, one charged and other uncharged. Bring the conductors in contact with each other. The charge (whether – ve or + ve) under its own repulsion will spread over both the conductors. Thus the conductors will be charged with the same sign.

82. When a body is charged by induction, then the body
(a) becomes neutral
(b) does not lose any charge
(c) loses whole of the charge on it
(d) loses part of the charge on it

83. On charging by conduction, mass of a body may
(a) increase (b) decreases
(c) increase or decrease (d) None of these

84. If a body is positively charged, then it has
(a) excess of electrons (b) excess of protons
(c) deficiency of electrons (d) deficiency of neutrons

85. A clyindrical conductor is placed near another positively charged conductor. The net charge acquired by the cylindrical conductor will be
(a) positive only (b) negative only
(c) zero (d) either positive or negative

86. A positive point charge Q is brought near an isolated metal cube then
(a) the cube becomes negatively charged.
(b) the cube becomes positively charged.
(c) the interior becomes positively charged and the surface becomes negatively charged.
(d) the interior remains charge free and the surface gets nonuniform charge distribution.

Case/Passage-II

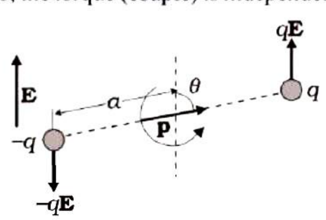
Electric dipole is a pair of equal and opposite point charges separated by a small distance.

Dipole moment is the product of the magnitude of either charge and the distance between them,

Dipole moment $= |\vec{p}| = q \times 2a$

It is directed from negative to positive charge.

Dipole in a uniform external field : There is a force q**E** on q and a force –q**E** on –q. The net force on the dipole is zero, since **E** is uniform. However, the charges are separated, so the forces act at different points, resulting in a torque on the dipole. When the net force is zero, the torque (couple) is independent of the origin.



87. An electric dipole has a pair of equal and opposite point charges q and $-q$ separated by a distance $2x$. The axis of the dipole is
(a) from positive charge to negative charge
(b) from negative charge to positive charge
(c) perpendicular to the line joining the two charges drawn at the centre and pointing upward direction
(d) perpendicular to the line joining the two charges drawn at the centre and pointing downward direction

88. The electric field at a point on equatorial line of a dipole and direction of the dipole moment
(a) will be parallel
(b) will be in opposite direction
(c) will be perpendicular
(d) are not related

89. An electric dipole is placed at an angle of 30° to a non-uniform electric field. The dipole will experience
(a) a translational force only in the direction of the field
(b) a translational force only in the direction normal to the direction of the field
(c) a torque as well as a translational force
(d) a torque only

90. Intensity of an electric field (E) depends on distance r, due to a dipole, is related as
(a) $E \propto \frac{1}{r}$ (b) $E \propto \frac{1}{r^2}$ (c) $E \propto \frac{1}{r^3}$ (d) $E \propto \frac{1}{r^4}$

91. On decreasing the distance between the two charges of a dipole which is perpendicular to electric field and decreasing the angle between the dipole and electric field, the torque on the dipole
(a) increases (b) decreases
(c) remains same (d) cannot be predicted

Case/Passage-III

Electric flux over an area in an electric field is the total number of electric lines of force crossing this area.

It is measured by the product of surface area and the corresponding component of electric field normal to the area.

$$\phi = \oint \vec{E}.d\vec{s}$$

It is a scalar quantity. Its SI unit is volt metre (Vm) or Nm^2/C. Dimensions : $[ML^3T^{-3}A^{-1}]$

92. For a given surface the Gauss's law is stated as $\oint \vec{E}.d\vec{A} = 0$. From this we can conclude that
(a) E is necessarily zero on the surface
(b) E is perpendicular to the surface at every point
(c) the total flux through the surface is zero
(d) the flux is only going out of the surface

93. In a region of space having a uniform electric field E, a hemispherical bowl of radius r is placed. The electric flux ϕ through the bowl is
(a) $2\pi RE$ (b) $4\pi R^2E$ (c) $2\pi R^2E$ (d) πR^2E

94. A cylinder of radius R and length ℓ is placed in a uniform electric field E parallel to the axis of the cylinder. The total flux over the curved surface of the cylinder is
(a) zero (b) πR^2E (c) $2\pi R^2E$ (d) $E/\pi R^2$

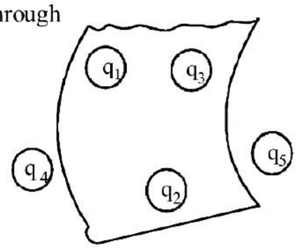
95. Electric flux over a surface in an electric field may be
(a) positive (b) negative
(c) zero (d) All of these

96. Electric charges are distributed in a small volume. The flux of the electric field through a spherical surface of radius 1 m surrounding the total charge is 100 V-m. The flux over the concentric sphere of radius 2 m will be
(a) 25V-m (b) 50V-m (c) 100V-m (d) 200V-m

Case/Passage-IV

Figure shows five charged lumps of plastic. The cross-section of Gaussian surface S is indicated. Assuming $q_1 = q_4 = 3.1$ nC, $q_2 = q_5 = -5.9$ nC, and $q_3 = -3.1$ nC.

97. Find the net electric flux through the surface is



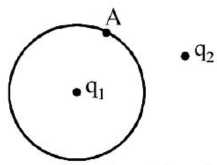
(a) $-670\ Nm^2/C$

(b) $+670\ Nm^2/C$

(c) $-360\ Nm^2/C$

(d) $+360\ Nm^2/C$

98. Electric field at point A depends on __________ charge.



(a) q_1

(b) q_2

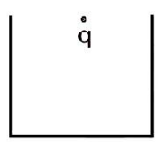
(c) both q_1 and q_2

(d) None of these

99. The surface density on the copper sphere is σ. The electric field strength on the surface of the sphere is

(a) σ (b) $\sigma/2$ (c) $\sigma / 2\varepsilon_o$ (d) σ / ε_o

100. A charge q is placed at the centre of the open end of a cylindrical vessel. The flux of the electric field through the surface of the vessel is



(a) zero

(b) q/ε_o

(c) $q/2\varepsilon_o$

(d) $2q/\varepsilon_o$

101. At the centre of a cubical box + Q charge is placed. The value of total flux that is coming out a wall is

(a) Q / ε_o (b) $Q / 3\varepsilon_o$ (c) $Q / 4\varepsilon_o$ (d) $Q / 6\varepsilon_o$

Assertion & Reason

DIRECTIONS : *Each of these questions contains an assertion followed by reason. Read them carefully and answer the question on the basis of following options. You have to select the one that best describes the two statements.*

(a) If both **Assertion** and **Reason** are **correct** and the Reason is the **correct explanation** of the Assertion.

(b) If both **Assertion** and **Reason** are correct but Reason is **not the correct explanation** of the Assertion.

(c) If the **Assertion** is **correct** but **Reason** is **incorrect**.

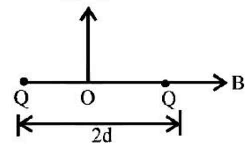
(d) If the **Assertion** is **incorrect** but the **Reason** is **correct**.

102. Assertion : When bodies are charged through friction, there is a transfer of electric charge from one body to another, but no creation or destruction of charge.
Reason : This follows from conservation of electric charges.

103. Assertion : Coulomb force and gravitational force follow the same inverse-square law.
Reason : Both laws are same in all aspects.

104. Assertion : The property that the force with which two charges attract or repel each other are not affected by the presence of a third charge.
Reason : Force on any charge due to a number of other charge is the vector sum of all the forces on that charge due to other charges, taken one at a time.

105. Assertion : Consider two identical charges placed distance 2d apart, along x-axis.
The equilibrium of a positive test charge placed at the point O midway between them is stable for displacements along the x-axis.



Reason: Force on test charge is zero.

106. Assertion : If a proton and an electron are placed in the same uniform electric field. They experience different acceleration.
Reason : Electric force on a test charge is dependent of its mass.

107. Assertion : A metallic shield in form of a hollow shell may be built to block an electric field.
Reason : In a hollow spherical shield, the electric field inside it is zero at every point.

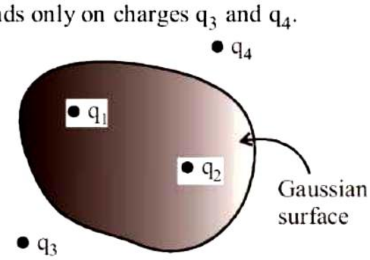
108. Assertion : A point charge is brought in an electric field, the field at a nearby point will increase or decrease, depending on the nature of charge.
Reason : The electric field is independent of the nature of charge.

109. Assertion : Electric field is always normal to equipotential surfaces and along the direction of decreasing order of potential.
Reason : Negative gradient of electric potential is electric field. **[CBSE Sample 2021]**

110. Assertion : On disturbing an electric dipole in stable equillibrium in an electric field, it returns back to its stable equillibrium orientation.
Reason : A restoring torque acts on the dipole on being disturbed from its stable equillibrium.

111. Assertion : On going away from a point charge or a small electric dipole, electric field decreases at the same rate in both the cases.
Reason : Electric field is inversely proportional to square of distance from the charge or an electric dipole.

112. Assertion : Four point charges q_1, q_2, q_3 and q_4 are as shown in figure. The flux over the shown Gaussian surface depends only on charges q_3 and q_4.



Reason : Electric field at all points on Gaussian surface depends only on charges q_1 and q_2.

113. **Assertion :** The surface charge densities of two spherical conductor of different radii are equal. Then electric field intensity near their surfaces are also equal.
Reason : Surface charge density is equal to charge per unit area.

114. **Assertion :** A uniformly charged disc has a pin hole at its centre. The electric field at the centre of the disc is zero.
Reason : Disc can be supposed to be made up of many rings. Also electric field at the centre of uniformly charged ring is zero.

115. **Assertion :** On bringing a positively charged rod near the uncharged conductor, the conductor gets attracted towards the rod.
Reason : The electric field lines of the charged rod are perpendicular to the surface of conductor.

Match the Following

DIRECTIONS : *Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in column-I have to be matched with statements (1, 2, 3, 4) in column-II.*

116.

Column I	Column II
(A) Linear charge density	(1) $\frac{\text{Charge}}{\text{Volume}}$
(B) Surface charge density	(2) $\frac{\text{Charge}}{\text{Length}}$
(C) Volume charge density	(3) $\frac{\text{Charge}}{\text{Area}}$
(D) Discrete charge distribution	(4) System consisting of ultimate individual charges

(a) A → (2), B → (3), C → (1), D → (4)
(b) A → (1), B → (3), C → (1), D → (4)
(c) A → (3), B → (1), C → (2), D → (4)
(d) A → (3), B → (2), C → (1), D → (4)

117. Match the entries of column I with that of Column II.

Column I	Column II
(A) Coulomb's law	(1) Total electric flux through a closed surface.
(B) Gauss's law	(2) Vector sum of forces.
(C) Principle of superposition	(3) Force is inversely proportional to square of distance
(D) Quantisation of charge	(4) Discrete nature of charge

(a) (A) → (2), (B) → (3), (C) → (1), (D) → (4)
(b) (A) → (3), (B) → (1), (C) → (2), (D) → (4)
(c) (A) → (1), (B) → (4), (C) → (3), (D) → (2)
(d) (A) → (1), (B) → (2), (C) → (3), (D) → (4)

Fill in the Blanks

DIRECTIONS : *Complete the following statements with an appropriate word / term to be filled in the blank space(s).*

118. 1μC charge contains n units of basic charge e, where n is _______.

119. When an electric dipole $\vec{P}$ is placed in a uniform electric field $\vec{E}$ then angle between $\vec{P}$ and $\vec{E}$ the value of torque will be maximum is _______.

120. If the electric flux entering and leaving a closed surface are 6×10^6 and 9×10^6 S.I. units respectively, then the charge inside the surface of permittivity of free space ε_0 is _______.

121. The magnitude of the average electric field normally present in the atmosphere just above the surface of the Earth is about 150 N/C, directed inward towards the center of the Earth. This gives the total net surface charge carried by the Earth to be _______.
[Given $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$, $R_E = 6.37 \times 10^6$ m]

122. If the electric field is given by $(5\hat{i} + 4\hat{j} + 9\hat{k})$. The electric flux through a surface of area 20 units lying in the Y-Z plane will be _______.

True / False

DIRECTIONS : *Read the following statements and write your answer as true or false.*

123. The positive charge particle is placed in front of a spherical uncharged conductor. The number of lines of forces terminating on the sphere will be more than those emerging from it.

124. The surface charge density at a point on the sphere nearest to the point charge will be negative and maximum in magnitude compared to other points on the sphere.

125. The property that the force with which two charges attract or repel each other are not affected by the presence of a third charge.

126. Force on any charge due to a number of other charge is the vector sum of all the forces on that charge due to other charges, taken one at a time.

ANSWER KEY & SOLUTIONS

1. **(a)** In the absence of gravitational force, the only force acts on the spheres is electrostatic repulsion and so the angle between two suspension becomes 180°. So force between the sphere

$$F=\frac{1}{4\pi\in_0}\frac{Q^2}{(2L)^2}$$

2. **(b)** Here, $r_1=\hat{i}+\hat{j}+\hat{k}\Rightarrow r_2=2\hat{i}+3\hat{j}+\hat{k}$

$\therefore\quad \vec{r}=\vec{r}_2-\vec{r}_1=(2\hat{i}+3\hat{j}+\hat{k})-(\hat{i}+\hat{j}+\hat{k})=\hat{i}+2\hat{j}$

$|\vec{r}|=\sqrt{(1)^2+(2)^2}=\sqrt{5}$

By Coulomb's law,

$$F=\frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}=\frac{9\times10^9\times3\times10^{-6}\times3\times10^{-6}}{(\sqrt{5})^2}$$

$=\frac{81}{5}\times10^{-3}$ N, Nearest answer is 16×10^{-3} N.

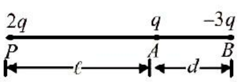
3. **(b)** When we say that a body is charged, we always mean that the body is having excess of electrons (negatively charged) or is of deficient of electrons (positively charged).

4. **(a)** Valence electrons are outermost electrons these can get transferred on rubbing.

5. **(b)** $T_{AB}=\frac{kq\cdot2q}{d^2}+\frac{kq\cdot4q}{(2d)^2}=\frac{3kq^2}{d}$

$T_{BC}=\frac{k\cdot4q\cdot2q}{d^2}+\frac{kq\cdot4q}{(2d)^2}=\frac{9kq^2}{d^2}$

6. **(b)**



Let a charge $2q$ be placed at P, at a distance I from A where charge q is placed, as shown in figure.

The charge $2q$ will not experience any force, when force, when force of repulsion on it due to q is balanced by force of attraction on it due to $-3q$ at B where AB = d

or $\quad\frac{(2q)(q)}{4\pi\varepsilon_0\ell^2}=\frac{(2q)(-3q)}{4\pi\varepsilon_0(\ell+d)^2}$

$(\ell+d)^2=3\ell^2$ or $2\ell^2-2\ell d-d^2=0$

$\therefore\quad \ell=\frac{2d\pm\sqrt{4d^2+2d^2}}{4}=\frac{d}{2}\pm\frac{\sqrt{3}d}{2}$

$\ell=\frac{d+\sqrt{3}d}{2}$

7. **(c)** Let n be the number of electrons missing.

$$F=\frac{1}{4\pi\varepsilon_0}\cdot\frac{q^2}{d^2}\Rightarrow q=\sqrt{4\pi\varepsilon_0d^2F}=ne$$

$$\therefore\quad n=\sqrt{\frac{4\pi\varepsilon_0Fd^2}{e^2}}$$

8. **(d)**

9. **(b)** Force on charge q_1 due to q_2 is

$F_{12}=k\frac{q_1q_2}{b^2}$

Force on charge q_1 due to q_3 is

$F_{13}=k\frac{q_1q_3}{a^2}$

The X - component of the force (F_x) on q_1 *is* $F_{12}+F_{13}\sin\theta$

$\therefore\quad F_x=k\frac{q_1q_2}{b^2}+k\frac{q_1q_2}{a^2}\sin\theta$

$\therefore\quad F_x\propto\frac{q_2}{b^2}+\frac{q_3}{a^2}\sin\theta$

10. **(d)** $Q_1+Q_2=Q\quad\ldots$(i) and $F=k\frac{Q_1Q_2}{r^2}\quad\ldots$(ii)

From (i) and (ii) $F=\frac{kQ_1(Q-Q_1)}{r^2}$

For F to be maximum $\frac{dF}{dQ_1}=0\Rightarrow Q_1=Q_2=\frac{Q}{2}$

11. **(a)** Figure indicates the presence of some positive charge to the left of A.

$\therefore\quad E_A>E_B\ (\because r_A<r_B)$

12. **(a)** Given,

Dipole moment, p = 4×10^{-9} Cm

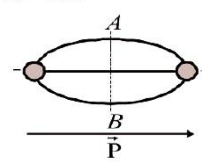
Electric field, E = 5×10^4 NC^{-1}

Torque is given by

τ = p.E sin θ

$=4\times10^{-9}\times5\times10^4\times\sin30°=1\times10^{-4}$ Nm

13. **(b)** The direction of electric field at equatorial point A or B will be in opposite direction, as that of direction of dipole moment.



14. **(a)** $-eE=mg$

$$\vec{E}=-\frac{9.1\times10^{-31}\times10}{1.6\times10^{-19}}=-5.6\times10^{-11}\text{ N/C}$$

15. **(d)** Electric field lines do not form closed loop. This follows from the conservative nature of electric field.

16. **(b)** **Given :** Dipole moment of the dipole = $\vec{p}$ and uniform electric field = $\vec{E}$. We know that dipole moment (p) = q.a (where q is the charge and a is dipole length). And when a dipole of dipole moment $\dot{p}$ is placed in uniform electric field $\vec{E}$, then Torque (τ) = Either force × perpendicular distance between the two forces = qa E sin θ or $\tau=pE\sin\theta$ or $\vec{\tau}=\vec{p}\times\vec{E}$ (vector form)

17. **(b)** We have $E_a = \frac{2kp}{r^3}$ and $E_e = \frac{kp}{r^3}$; $\therefore E_a = 2E_e$

18. **(a)**

19. **(a)** **Given :** Length of the dipole $(2l) = 10\text{cm} = 0.1\text{m}$ or $l = 0.05\text{m}$

Charge on the dipole (q) = 500 μC = 500 × 10^{-6} C and distance of the point on the axis from the mid-point of the dipole (r) = 20 + 5 = 25 cm = 0.25 m.

We know that the electric field intensity due to dipole on the given point (E)

$$= \frac{1}{4\pi\varepsilon_0} \times \frac{2(q.2l)r}{(r^2 - l^2)^2}$$

$$= 9 \times 10^9 \times \frac{2(500 \times 10^{-6} \times 0.1) \times 0.25}{[(0.25)^2 - (0.05)^2]^2}$$

$$= 6.25 \times 10^7 \; N/C \text{ (k = 1 for air)}$$

20. **(c)** Here, $\ell = 2.4\ m$, $r = 4.6\ mm = 4.6 \times 10^{-3}\ m$
$q = -4.2 \times 10^{-7}$ C

Linear charge density, $\lambda = \frac{q}{\ell}$

$$= \frac{-4.2 \times 10^{\;7}}{2.4} = -1.75 \times 10^{-7} \text{ C m}^{-1}$$

Electric field, $E = \frac{\lambda}{2\pi\varepsilon_0 r}$

$$= \frac{-1.75 \times 10^{-7}}{2 \times 3.14 \times 8.854 \times 10^{-12} \times 4.6 \times 10^{-3}}$$

$= -6.7 \times 10^5$ N C^{-1}

21. **(a)** According to Gauss's law total electric flux through a closed surface is $\frac{1}{\varepsilon_0}$ times the total charge inside that surface.

Electric flux, $\phi_E = \frac{q}{\varepsilon_0}$

Charge on α-particle = 2e $\quad \therefore \phi_E = \frac{2e}{\varepsilon_0}$

22. **(d)** Electric flux, $\phi = EA\cos\theta$, where θ = angle between E and normal to the surface.

Here $\theta = \frac{\pi}{2} \Rightarrow \phi = 0$

23. **(c)** The field due to infinite linear charge distribution

$$E = \frac{1}{4\pi\varepsilon_0}\int\frac{dq}{r} \Rightarrow E \propto \frac{1}{r}$$

So curve is hyperbolic.

24. **(d)** According to Gauss' Law

$$\oint E.ds = \frac{Q_{\text{enclosed by closed surface}}}{\varepsilon_o} = \text{flux}$$

so total flux = Q/ε_o

Since cube has six face, so flux coming out through one wall or one face is $Q/6\varepsilon_o$.

25. **(a)** Gaussian surface cannot pass through any discrete charge because electric field due to a system of discrete charges is not well defined at the location of the charges. But the Gaussian surface can pass through a continuous charge distribution.

26. **(d)** Here, $\vec{E} = 2\hat{i} + 3\hat{j} + \hat{k}\ NC^{-1}$, $\vec{S} = 10\hat{i}\ m^2$

Electric flux, $\phi = \vec{E}.\vec{S}$

$$= (2\hat{i} + 3\hat{j} + \hat{k}\,NC^{-1}).(10\hat{i}\ m^2)$$
$$= 20\ Nm^2C^{-1}$$

27. **(d)** Since electric field $\vec{E}$ decreases inside water, therefore flux $\phi = \vec{E}\cdot\vec{A}$ also decreases.

28. **(a)** The flux is zero according to Gauss' Law because it is a open surface which enclosed a charge q.

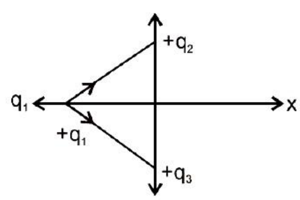
29. **(d)**

30. **(a)** According to Gauss's theorem

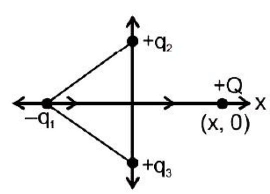
$$\phi = \frac{\Sigma q_{en}}{\varepsilon_0}$$

So, net charge enclosed by the surface is zero if the net electric flux through a closed surface is zero.

31. **(a)** The force on q_1 depend on the force acting between q_1 and q_2 and q_1 and q_3 so that the net force acting on q_1 by q_2 and q_1 by q_3 is along the + x-direction, so the force acting between q_1, q_2 and q_1, q_3 is attractive force as shown in figure :



The attractive force between these charges states that q_1 is a negative charge (since, q_2 and q_3 are positive). Then the force acting between q_1 and charge Q (positive) is also know as attractive force and then the net force on q_1 by q_2, q_3 and Q are along the same direction as shown in the figure.

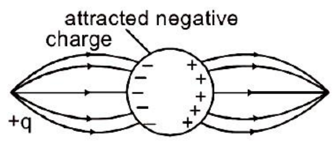


The figure shows that the force on q_1 shall increase along the positive x-axis due to the positive charge Q.

32. **(a)** If a positive point charge is brought near an isolated conducting sphere without touching the sphere, then the free electrons in the sphere are attracted towards the positive Charge and electric field passes through a charged body. This leaves an excess of positive charge on the (right) surface of sphere due to the induction process.

Both type of charges are bound in the (isolated conducting) sphere and cannot escape. They, therefore, reside on the surface.

Thus, the left surface of sphere has an excess of negative charge and the right surface of sphere has an excess of positive charge as shown in figure.



An electric field lines start from positive charge and ends at negative charge.

Also, electric field line emerges from a positive charge, in case of single charge and ends at infinity shown in figure (a).

33. **(d)** **By Gauss's law :** The total of the electric flux out of a closed surface is equal to the charge enclosed devided by the permittivity i.e., $\phi = \frac{Q}{\varepsilon_0}$.

Thus, electric flux through a surface doesn't depend on the shape, size or area of a surface but it depends on the number of charges enclosed by the surface. So all the given figures have same electric flux as all of them also has same single positive charge.

34. **(b)** Gauss's law states that total electric flux of an enclosed surface is given by, $\oint_s E.dS = \frac{q}{\varepsilon_0}$, includes the sum of all charges enclosed by the surface.

The charges may be located anywhere inside the surface, and out side the surface. Then, the electric field on the left side of equation is due to all the charges, both inside and outside S.

So, E on LHS of the above equation will have a contribution from all charges while q on the RHS will have a contribution from q_2 and q_4 only.

35. **(c)** The electric field lines, are directed away from positively charged source and directed toward negatively charged source. In electric field force are directly proportional to the electric field strength hence, higher the electric field strength greater the force and vice-versa. The space between the electric field lines is increasing, from left to right so strength of electric field decreases with the increase in the space between electric field lines. Then the force on charges also decreases from left to right. Thus, the force on charge $-q$ is greater than force on charge $+q$ in turn dipole will experience a force towards left.

36. **(a)** When a positive point charge +q is placed near an isolated conducting plane, some negative charge developes on the surface of the plane towards the charge and an equal positive charge developes on opposite side of the plane. This is called induction process and the electric field on a isolated conducting plane at point is directly projected in a plane perpendicular to the field and away from the plane.

37. **(a)** Consider a point on diameter away from the centre of hemisphere uniformly positively charged, then the electric field is perpendicular to the diameter and the component of electric intensity parallel to the diameter cancel out.

38. **(c)** The charge on disc A is 10^{-6} μC. The charge on disc B is 10×10^{-6} μC. The total charge on both = 11 μC. When touched, this charge will be distributed equally *i.e.*, 5.5 μC on each disc.

39. **(c)**

40. **(d)** According to Gauss's theorem,

$$E\oint ds = \frac{q}{\epsilon_0}\left[\text{Here} \oint ds = 4\pi R^2\right]$$

$$\therefore E = \frac{q/4\pi R^2}{\epsilon_0} \quad [\because q/4\pi R^2 = \sigma]$$

or $E = \sigma/\varepsilon_0$

41. **(b)** **42.** **(d)**

43. **(a)** The charge of an isolated system is conserved.

44. **(b)** When some charge is given to conductor it spreads on its surface. When some charge is given to insulator, it remains there, it do not spread, Free charges in conductor interact with added charge, so added charge spreads on surface to be in equilibrium.

45. **(c)** **46.** **(c)** **47.** **(d)**

48. **(c)** Electron having a charge of -1.6×10^{-19}C undergoes annihilation with it's antiparticle positron having a charge of $+1.6 \times 10^{-19}$C as $e^- + e^+ \to \gamma + \gamma$

Net charge before annihilation

$= -1.6 \times 10^{-19} C + 1.6 \times 10^{-19} C = 0$

Net charge after annihilation $= 0 + 0 = 0$

i.e., net charge remains same.

49. **(d)** Milikan demonstrated the quantisation of charge experimentally. Charge on electron = – e = -1.6×100^{-19}C. Addition of charge can occur in integral multiples of *e*.

50. **(c)** Like charges repel ⟵ ⊕ ⊕ ⟶

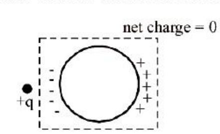
Unlike charges attract ⊕ ⟶ ⟵ ⊖

To specify particular charge on body, term used is polarity.

On rubbing, plastic rod acquires negative charge, cat's fur acquires positive charge. There are only two kinds of charges: +, –.

51. **(b)**

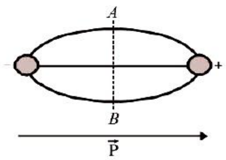
52. **(d)** When a positive point charge is placed outside a conducting sphere, a rearrangement of charge takes place on the surface. But the total charge on the sphere is zero as no charge has left or entered the sphere.



53. **(b)** If charge particle is put at rest in electric field, then it will move along line of force.

54. **(a)** **55. (c)** **56. (d)** **57. (b)**

58. **(b)** The direction of electric field at equatorial point A or B will be in opposite direction, as that of direction of dipole moment.



59. **(c)** The electric field will be different at the location of force on the two charges. Therefore the two charges will be unequal. This will result in a force as well as torque.

60. **(a)** Since lines of force starts from A and ends at B, so A is +ve and B is –ve. Lines of forces are more crowded near A, so A > B.

61. **(b)** The electric field around a charge propagates with the speed of light away from the charge. Therefore the

required time $= \dfrac{\text{distance}}{\text{speed}} = \dfrac{OP}{c}$.

62. **(c)** When a dipole is placed in a uniform electric field, two equal and opposite forces act on it. Therefore, a torque acts which rotates the dipole.

63. **(b)** Since $\tau = pE \sin\theta$ on decreasing the distance between the two charges, and on decreasing angle θ between the dipole and electric field, $\sin\theta$ decreases therefore torque decreases.

64. **(c)** Since $x < R$, that is the point is inside the sphere

electric field $E \propto x$. as $E = \dfrac{kq}{R^3}x$

65. **(d)** Electric displacement vector, $\vec{D} = \varepsilon \vec{E}$

As, $\varepsilon = \varepsilon_0 K$ $\quad \therefore\ \vec{D} = \varepsilon_0 K \vec{E}$

66. **(a)** **67. (c)** **68. (d)**

69. **(a)** Gaussian surface cannot pass through any discrete charge because electric field due to a system of discrete charges is not well defined at the location of the charges. But the Gaussian surface can pass through a continuous charge distribution.

70. **(b)**

71. **(c)** $\oint \vec{E}.d\vec{A} = 0$, represents charge inside close surface is zero. Electric field as any point on the surface may be zero.

72. **(b)** Total flux coming out from unit charge

$\phi = \vec{E}.\vec{ds} = \dfrac{1}{\varepsilon_0} \times 1 = \varepsilon_0^{-1}$

73. **(a)** At the interior point of a hollow sphere, the electric field is zero.

74. **(a)** By Gauss theorem

Total electric flux $= \dfrac{\text{Total charge inside cube}}{\varepsilon_0} = \dfrac{q}{\varepsilon_0}$

75. **(b)**

76. **(c)** If electric dipole, the flux coming out from positive charge is equal to the flux coming in at negative charge *i.e.* total charge on sphere = 0. From Gauss law, total flux passing through the sphere = 0.

77. **(c)** Electric field near the conductor surface is given by

$\dfrac{\sigma}{\varepsilon_0}$ and it is perpendicular to surface.

78. **(d)**

79. **(a)** Here, $q = 1$ C, $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2N^{-1}m^{-2}$

Number of lines of force = Electric force

$= \dfrac{q}{\varepsilon_0} = \dfrac{1}{8.85 \times 10^{-12}} = 1.13 \times 10^{11}$

80. **(c)**

81. **(a)** Flux $(\phi) = \vec{E} \cdot \Delta\vec{A} = E\Delta A \cos 60° = El^2/2$

82. **(b)** Charging by induction involves transfer of charges from one part to the other of the body. No loss of charge is involved.

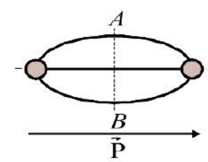
83. **(c)** On charging by conduction, body may gain mass, if it acquires negative charge. It may lose mass, if it acquires positive charge.

84. **(c)** Positive charge is due to deficiency of electrons.

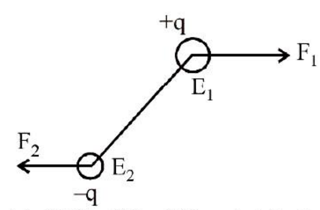
85. **(c)** Net charge acquired by induction is zero, as there is only transfer of electrons from one part of body to the other.

86. **(a)** **87. (b)**

88. **(b)** The direction of electric field at equatorial point A or B will be in opposite direction, as that of direction of dipole moment.



89. **(c)**



The electric field will be different at the location of force on the two charges. Therefore the two charges will be unequal. This will result in a force as well as torque.

90. **(c)** Intensity of electric field due to a Dipole

$E = \dfrac{p}{4\pi\varepsilon_0 r^3}\sqrt{3\cos^2\theta + 1} \Rightarrow E \propto \dfrac{1}{r^3}$

91. **(b)** Since $\tau = pE\sin\theta$ on decreasing the distance between the two charges, and on decreasing angle θ between the dipole and electric field, $\sin\theta$ decreases therefore torque decreases.

92. **(c)** $\oint \vec{E} \cdot d\vec{A} = 0$, represents charge inside close surface is zero. Electric field as any point on the surface may be zero.

93. **(c)** $\phi = E(ds)\cos\theta = E(2\pi r^2)\cos 0° = 2\pi r^2 E$.

94. **(a)** For the curved surface, $\theta = 90°$

$\therefore\ \phi = E\ ds \cos 90° = 0$.

95. **(d)**

96. **(c)** Flux does not depend on the size and shape of the close surface, and so, it remains same.

97. **(a)** $\phi = \frac{\Sigma q}{\epsilon_0} = \frac{-5.9 \times 10^{-9}}{8.85 \times 10^{-12}} = -670\ Nm^2/C$

98. **(c)** Electric field at any point depends on all the charges.

99. **(d)** According to Gauss's theorem,

$$E\oint ds = \frac{q}{\epsilon_0}\left[\text{Here} \oint ds = 4\pi R^2\right]$$

$$\therefore E = \frac{q/4\pi R^2}{\epsilon_0} \quad [\because q/4\pi R^2 = \sigma]$$

or $E = \sigma/\varepsilon_o$

100. **(a)** The flux is zero according to Gauss' Law because it is a open surface which enclosed a charge q.

101. **(d)** According to Gauss' Law

$$\oint E.ds = \frac{Q_{\text{enclosed by closed surface}}}{\varepsilon_o} = \text{flux}$$

so total flux = Q/ε_o

Since cube has six face, so flux coming out through one wall or one face is $Q/6\varepsilon_o$.

102. **(a)** Conservation of electric charge states that the total charge of an isolated system remains unchanged with time.

103. **(c)** Coulomb force and gravitational force follow the same inverse-square law. But gravitational force is always attractive force, while coulomb force can be of both force attractive and repulsive.

104. **(b)** The individual force are unaffected due to presence of other charges. This is the principal of superposition of charges. Force on any charge due to a number of other charges is the vector sum of all the forces on that charge due to the other charges, taken one at a time.

105. **(b)** If +ve charge is displaced along x-axis, then net force will always act in a direction opposite to that of displacement and the test charge will always come back to its original position.

106. **(c)** Electron and proton have same amount of charge so they have same coulomb force. They have different acceleration because they have different masses.

107. **(a)** The electrostatic shielding is possible by metallic conductor.

108. **(c)** The electric field will increase if positive charge is brought in an electric field.

109. **(b)** $E = -\frac{dv}{dx}$

110. **(a)** The restoring torque brings it back to its stable equillibrium.

111. **(d)** The rate of decrease of electric field is different in the two cases. In case of a point charge, it decreases as $1/r^2$ but in the case of electric dipole it decreases more rapidly, as $E \propto 1/r^3$.

112. **(d)** Electric field at any point depends on presence of all charges.

113. **(b)** $\frac{q_1}{q_2} = \frac{r_1^2}{r_2^2}$ [Let r_1 and r_2 be two different radii]

so, $\frac{E_1}{E_2} = \frac{q_1}{4\pi\varepsilon_0 r_1^2} \cdot \frac{4\pi\varepsilon_0 r_2^2}{q_2} \Rightarrow \frac{q_1}{q_2} \times \frac{r_2^2}{r_1^2} = 1$

so $E_1 = E_2$

114. **(a)** The electric field due to disc is superposition of electric field due to its constituent ring as given in Reason.

115. **(b)** Though the net charge on the conductor is still zero but due to induction negatively charged region is nearer to the rod as compared to the positively charged region. That is why the conductor gets attracted towards the rod.

116. **(a)** **117.** **(b)**

118. (6×10^{12}) $n = {}^{1\mu c}\!/_{1.6\times10^{-19}C} \approx 6 \times 10^{12}$

119. (90°)

120. $(3 \times 10^6 \times \varepsilon_0)$ By Gauss law, we know that

$\phi = \frac{q}{\varepsilon_0}$ Here, Net electric flux, $\phi = \phi_2 - \phi_1$

$= 9 \times 10^6 - 6 \times 10^6 = \frac{q}{\varepsilon_0} \Rightarrow q = 3 \times 10^6 \times \varepsilon_0$.

121. (–680) Given,

Electric field E = 150 N/C

Total surface charge carried by earth q = ?

According to Gauss's law.

$\phi = \frac{q}{\epsilon_0} = EA$ or, $q = \epsilon_0 E A = \epsilon_0 E \pi r^2$.

$= 8.85 \times 10^{-12} \times 150 \times (6.37 \times 10^6)^2 \simeq 680$ Kc

As electric field directed inward hence q = – 680 Kc

122. (100) Here, E must be perpendicular to Y-Z plane, i.e., area must be parallel to X-plane,

so $d\vec{s} = 20\hat{i}$ units

$\therefore$ electric flux = $\vec{E}.d\vec{s} = (5\hat{i} + 4\hat{j} + 9\hat{k}).(20\hat{i}) = 100$ units

123. (False) No. of lines entering the surface = No. of lines leaving the surface.

124. (True)

125. (True) The individual force are unaffected due to the presence of other charges.

126. (True) Force on any charge due to a number of other charges is the vector sum of all the forces on that charge due to the other charges, taken one at a time.