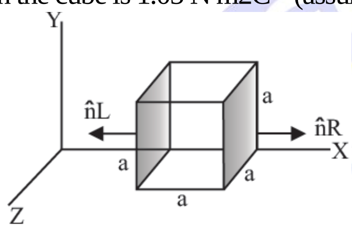
Chapter 01 Electrostatics

JEE-RANKER'S STUFF

SINGLE CORRECT QUESTION

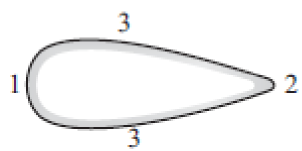
Q.1 The electric field components in the given figures are $E_x = ax^{1/2}$, $E_y = E_z = 0$ in which $\alpha = 800N\ C^{-1}\ m^{-1/2}$. The Charge within the cube is if net flux through the cube is 1.05 N m2C^{-1} (assume a = 0.1 m)



(1) 9.27×10^{12} C (2) 9.27×10^{-12} C
(3) 6.97×10^{-12} C (4) 6.97×10^{12} C

Q.2 In a regular polygon of n sides, each corner is at a distance r from the centre. Identical charges are placed at (n – 1) corners. At the centre, the intensity is E and the potential is V. The ratio V/E has magnitude
(1) r n (2) r(n – 1)/n
(3) (n – 1)/r (4) r (n – 1)

Q.3 Consider a non-spherical conductor shown in the figure which is given a certain amount of positive charge. The charge distributes itself on the surface such that the charge densities are σ_1, σ_2 and σ_3 at the region 1, 2 and 3 respectively. Then



(1) $\sigma_1 > \sigma_2 > \sigma_3$ (2) $\sigma_2 > \sigma_3 > \sigma_1$
(3) $\sigma_2 > \sigma_1 > \sigma_3$ (4) $\sigma_3 > \sigma_1 > \sigma_2$

Q.4 The electrostatic potential inside a charged spherical ball is given by $\phi = ar^2 + b$ where r is the distance from the centre; a,b are constants. Then the charge density inside the ball is :
(1) $-24\pi\ a\varepsilon_0 r$ (2) $-6\pi\ a\varepsilon_0 r$
(3) $-24\pi\ a\varepsilon_0$ (4) $-6\ a\varepsilon_0$

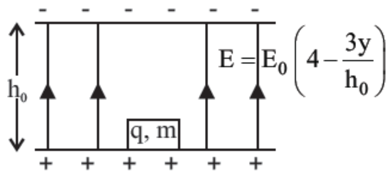
Q.5 A charge Q is placed at each of the opposite corners of a square. A charge q is placed at each of the other two corners. If the net electrical force on Q is zero, then Q/q equals:
(1) 1 (2) 2 (3) $-\sqrt{2}$ (4) $-2\sqrt{2}$

Q.6 The potential at a point x (measured in μm) due to some charges situated on the x-axis is given by $V(x) = 20/(x^2 - 4)$ volts. The electric field E at x = 4 μm is given by :
(1) 5/3 volt/μm and in the –ve x direction
(2) 5/3 volt/μm and in the +ve x direction
(3) 10/9 volt/μm and in the –ve x direction
(4) 10/9 volt/μm and in the +ve x direction

Q.7 Four charges equal to –Q each are placed at the four corners of a square and a charge q is at its centre. If the system is in equilibrium, the value of q is:
(1) $-\frac{Q}{4}(1+2\sqrt{2})$ (2) $\frac{Q}{4}(1+2\sqrt{2})$
(3) $-\frac{Q}{2}(1+2\sqrt{2})$ (4) $\frac{Q}{2}(1+2\sqrt{2})$

Q.8 A pendulum bob carriers a negative charge –q. A positive charge +q is held at the point of support. Then, the time period of the bob is
(1) Greater than $2\pi\sqrt{\frac{L}{g}}$
(2) Less than $2\pi\sqrt{\frac{L}{g}}$
(3) Equal to $2\pi\sqrt{\frac{L}{g}}$ (4) Equal to $2\pi\sqrt{\frac{2L}{g}}$

Q.9 A block of mass 'm' and charge 'q' is placed in electric field $E = E_0\left[4 - \frac{3y}{h_0}\right]$ where y is a vertical distance from the starting point (as figure). Then



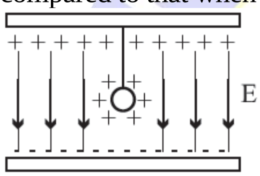
(1) If mass is released from rest then it will oscillates with time period $T = 2\pi\sqrt{\frac{mh_0}{3qE_0}}$

(2) With time period $T = 2\pi\left[\sqrt{\frac{mh_0}{3qE_0}} + \sqrt{\frac{m}{4qE_0}}\right]$

(3) With time period $T = 2\pi\left[\sqrt{\frac{mh_0}{3qE_0}} + \sqrt{\frac{m}{4qE_0} - g}\right]$

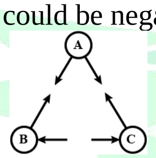
(4) None of these

Q.10 If a positively charged pendulum is oscillating in a uniform electric field as shown in diagram. Its frequency compared to that when it was uncharged



(1) Will not change
(2) Will decrease
(3) Will increase
(4) Will first increase and then decrease

Q.11 The diagram show the arrangement of there small uniform charged spheres A, B and C. The arrows indicate the direction of the electrostatic forces acting between the sphere (for example, the left arrow on sphere A indicates the electrostatic force on sphere A due to sphere B). At least two of the spheres are positively charged. Which sphere, if any, could be negatively charged?



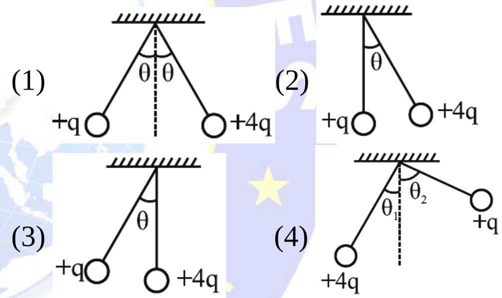
(1) Sphere C (2) Sphere B
(3) Sphere A (4) None of these

Q.12 An electric dipole is placed at an angle of 30°to a non – uniform electric field. The dipole will experience
(1) A translational force only in a direction perpendicular to the field
(2) A torque as well as a translational force
(3) A torque only
(4) A translational force only in the direction of the field

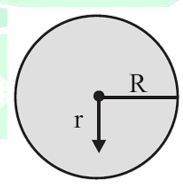
Q.13 Two point charges + 8q and –2q are located at x = 0 and *x* = L respectively. The location of a point on the *x* axis at which then electric field due to two point charges is zero is
(1) $\frac{L}{4}$ (2) 2L (3) 4L (4) 8L

Q.14 A nonconducting ring of radius R has uniformly distributed positive charge Q. A small part of the ring, of length d, is removed (d << R). The electric field at the centre of the ring will now be:
(1) Directed towards the gap, inversely proportional to R^3
(2) Directed towards the gap, inversely proportional to R^2
(3) Directed away from the gap, inversely proportional to R^3
(4) Directed away from the gap, inversely proportional to R^2

Q.15 Two metal spheres of same mass are suspended from a common point by a light insulating string. The length of each string is same. The sphere are given electric charges +q on one end and +4q on the other. Which of the following diagrams best shows the resulting positions of sphere?

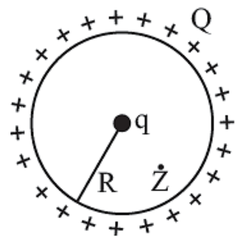


Q.16 If charges are distributed in the sphere, where charge density is $\rho = \rho_0\left(1 + \frac{r}{R}\right)$ where 'r' is the distance from the centre of the sphere then :



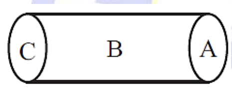
(1) Sphere is conducting
(2) Sphere is non-conducting
(3) Information is incomplete
(4) None of these

Q.17 A positive charge Q is uniformly distributed along a circular ring of radius R. A small test charge q is placed at the centre of the ring as shown in figure. Then



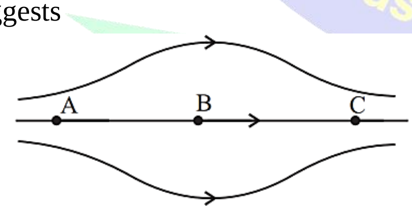
(1) If q > 0, and is displaced away from the centre in the plane of the ring, it will be pushed back towards the centre.
(2) If q < 0 and is displaced away from the centre in the plane of the ring, it will never return to the centre and will continue moving till it hits the ring.
(3) If q < 0 it will perform SHM for small displacement along the axis.
(4) All of the above

Q.18 A hollow cylinder has a charge q within it. If ϕ is the electric flux in unit of volt meter associated with the curved surface B, the flux linked with the plane surface A in unit of volt meter will be



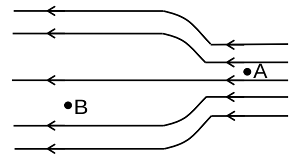
(1) $\frac{1}{2}\left(\frac{q}{\varepsilon_0}-\phi\right)$ (2) $\frac{q}{2\varepsilon_0}$
(3) $\frac{\phi}{3}$ (4) $\frac{q}{\varepsilon_0}-\phi$

Q.19 The figure shows some of the electric field lines corresponding to an electric field. The figure suggests



(1) $E_A > E_B > E_C$ (2) $E_A = E_B = E_C$
(3) $E_A = E_C > E_B$ (4) $E_A > E_C > E_B$

Q.20 In the electric field shown in figure, the electric field lines on the left have twice the separation as that between those on the right. If the magnitude of the field at point A is $40NC^{-1}$,find the magnitude to electric field at the point B.



(1) 15 NC^{-1} (2) 20 NC^{-1}
(3) 25 NC^{-1} (4) 30 NC^{-1}

Q.21 An electric dipole is kept on the axis of a uniform charged ring at large distance from the centre of the ring. The direction of the dipole moment is along the axis. The dipole moment is p, charge of the ring is Q & radius of the ring is R. The force on the dipole is

(1) $\frac{pQ}{3\pi\varepsilon_0\sqrt{3}R^2}$ (2) $\frac{4pQ}{3\pi\varepsilon_0\sqrt{3}R^2}$
(3) $\frac{pQ}{3\pi\varepsilon_0 R^2}$ (4) Zero

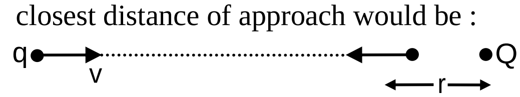
Q.22 Two identical conducting spheres having unequal positive charges q_1 and q_2 separated by distance r, If they are made to touch each other and then separated again to the same distance, the electrostatic force between the spheres in the case will be (neglect induction of charges)

(1) More than before (2) Same as before
(3) Less than before (4) Zero

Q.23 Two thin wire rings, each having a radius R are placed at a distance d apart with their axes coinciding. The charges on the two rings are +q and –q. The potential difference between the centers of the two rings is

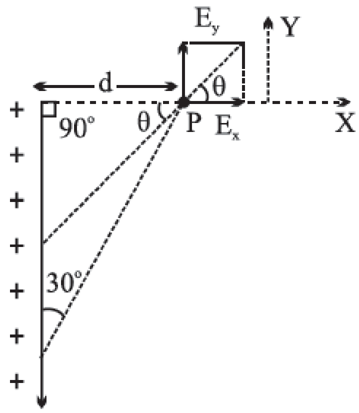
(1) zero (2) $\frac{q}{4\pi\varepsilon_0}\left[\frac{1}{R}-\frac{1}{\sqrt{R^2+d^2}}\right]$
(3) $\frac{qR}{4\pi\varepsilon_0 d^2}$ (4) $\frac{q}{2\pi\varepsilon_0}\left[\frac{1}{R}-\frac{1}{\sqrt{R^2+d^2}}\right]$

Q.24 A charged particle 'q' is shot towards another charged particle 'Q', which is fixed, with a speed 'v'. It approaches 'Q' upto a closest distance r and then returns. If q were given a speed of '2v', the closest distance of approach would be :



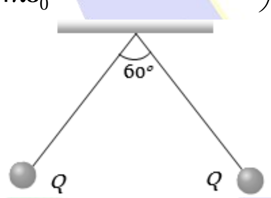
(1) r (2) 2r (3) r/2 (4) r/4

Q.25 The direction (θ) of $\vec{E}$ at point P due to uniformly charged finite rod will be



(1) At angle 45° from X-axis
(2) At angle 30° from X-axis
(3) At angle 60° from X-axis
(4) None of these

Q.26 Two small spherical balls each carrying a charge Q = 10 μC are suspended by two insulting threads of equal length 1 m each, from a point fixed in the ceiling. It is found that in equilibrium threads are separated by and 60° between them, as shown in the figure. What is the tension in the threads? $\left(\text{Given}: \frac{1}{4\pi\varepsilon_0} = 9\times10^9\,\text{Nm}/\text{C}^2\right)$



(1) 1.8 N (2) 18 N
(3) 0.18 N (4) None of these

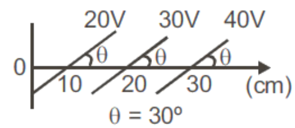
Q.27 A square of side 'a' is lying in xy plane such that two of its sides are lying on the axis. If an electric field $\vec{E} = E_0 x\hat{k}$ is applied on the square. The flux passing through the square is 'a'.

(1) $E_0 a^3$ (2) $\frac{E_0 a^3}{3}$ (3) $\frac{E_0 a^3}{2}$ (4) $\frac{E_0 a^2}{2}$

Q.28 An electric dipole of moment $\vec{p}$ is placed at the origin along the x-axis. The angle made by electric field with x-axis at a point P, whose position vector mages an angle θ with x-axis is $\left(\text{Where } \tan\alpha = \frac{1}{2}\tan\theta\right)$

(1) α (2) $\theta + \alpha$ (3) θ (4) $\theta + 2\alpha$

Q.29 Some equipotential surfaces are shown in the figure. The magnitude and direction of the electric field is –

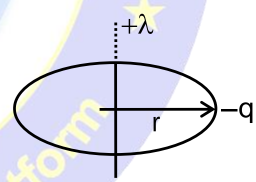


(1) 100 V/m making angle 1200 with the x-axis
(2) 100 V/m making angle 600 with the x-axis
(3) 200 V/m making angle 1200 with the x-axis
(4) None of the above

Q.30 Two spherical conductor A and B of radii 1 mm and 2 mm are separated by a distance of 5 cm and are uniformly charged. If the spheres are connected by a conducting wire then in equilibrium condition, the ratio of the magnitude of the electric fields at the surfaces of spheres A and B is

(1)1 : 2 (2) 2 : 1 (3) 1 : 4 (4) 4 : 1

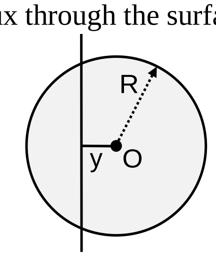
Q.31 A particle of charge –q & mass m moves in a circle of radius r around an infinitely long line charge of linear charge density +λ, Then time period will be. Where k = $\frac{1}{4\pi\varepsilon_0}$



(1) $T = 2\pi r\sqrt{\frac{m}{2k\lambda q}}$ (2) $T^2 = \frac{4\pi^2 m}{2k\lambda q}$

(3) $T = \frac{1}{2\pi r}\sqrt{\frac{2k\lambda q}{m}}$ (4) $T = \frac{1}{2\pi r}\sqrt{\frac{m}{2k\lambda q}}$

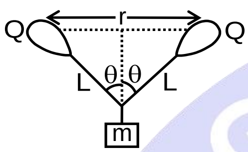
Q.32 A uniformly charged and infinitely long line having a linear charge density 'λ' is placed at a normal distance y from a point O. Consider a sphere of radius R with O as centre and R > y. Electric flux through the surface of the sphere is



(1) zero (2) $\frac{2\lambda R}{\varepsilon_0}$

(3) $\frac{2\lambda\sqrt{R^2-y^2}}{\varepsilon_0}$ (4) $\frac{\lambda\sqrt{R^2+y^2}}{\varepsilon_0}$

Q.33 Two similar balloons filled with helium gas are tied to L m long strings. A body of mass m is tied to another ends of the strings. The balloons float on air at distance r. If the amount of charge on the balloons is same then the magnitude of charge on each balloon will be



(1) $\left[\frac{mgr^2}{2k}\tan\theta\right]^{1/2}$ (2) $\left[\frac{2k}{mgr^2}\tan\theta\right]^{1/2}$

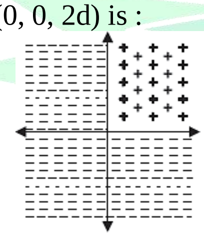
(3) $\left[\frac{mgr}{2k}\cot\theta\right]^{1/2}$ (4) $\left[\frac{2k}{mgr}\tan\theta\right]^{1/2}$

Q.34 A proton moves with a speed of u directly towards a free proton originally at rest. Find the distance of closest approach for the two protons.

(1) $\frac{e^2}{\pi\varepsilon_0 mu^2}$ (2) $\frac{e^2}{2\pi\varepsilon_0 mu^2}$

(3) $\frac{e^2}{\pi\varepsilon_0 u^2}$ (4) None of these

Q.35 If charge is distributed uniformly in xy plane with charge density $+\sigma$ in first quadrant and $-\sigma$ in remaining three quadrants, then work done by electric field in moving a point charge q from (0, 0, d) to (0, 0, 2d) is :



(1) $\frac{\sigma q}{4\varepsilon_0}d$ (2) $\frac{-\sigma q}{4\varepsilon_0}d$

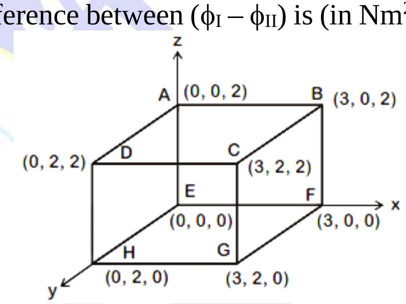
(3) $\frac{-\sigma q}{2\varepsilon_0}d$ (4) $\frac{\sigma q}{2\varepsilon_0}d$

NUMERICAL VALUE TYPE QUESTIONS

Q.36 A solid sphere of radius R has a charge Q distributed in its volume with a charge density $\rho = kr^a$, where k and a are constants and r is the distance from its centre. If the electric field at $r = \frac{R}{2}$ is $\frac{1}{8}$ times that at r = R, find the value of a.

Q.37 Three identical charge's each having a value 1.0×10^{-8} C, are placed at the corner of an equilateral triangle of side 20 cm. What is the force acting on unit positive charge at the centre.

Q.38 An electric field $\vec{E} = 4x\hat{i} - (y^2+1)\hat{j}$ N/C passes through the box shown in figure. The flux of the electric field through surfaces ABCD and BCGF are marked as ϕ_I and ϕ_{II} respectively. The difference between $(\phi_I - \phi_{II})$ is (in Nm^2/C) ______.



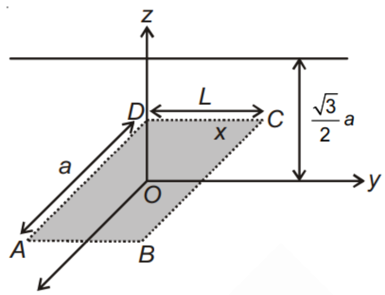
Q.39 Calculate the electric field intensity E which would be just sufficient to balance the weight of an electron. If this electric field is produced by a second electron located below the first one what would be the distance between them?
(Given: $e = 1.6 \times 10^{-19}$ C, $m = 9.1 \times 10^{-31}$ kg and $g = 9.8$ m/s^2)

Q.40 A particle, of mass 10^{-3} kg and charge 1.0 C, is initially at rest. At time t = 0, the particle comes under the influence of an electric field $\vec{E}(t) = E_0 \sin\omega t\,\hat{i}$, where $E_0 = 1.0$ NC^{-1} and $\omega = 10^3$ rad s^{-1}. Consider the effect of only the electrical force on the particle. Then the maximum speed, in ms^{-1}, attained by the particle at subsequent times is __________.

Q.41 A hollow metal sphere of radius 5 cm is charged such that the potential on its surface in 8 V. What will be the potential at the centre of sphere in volt?

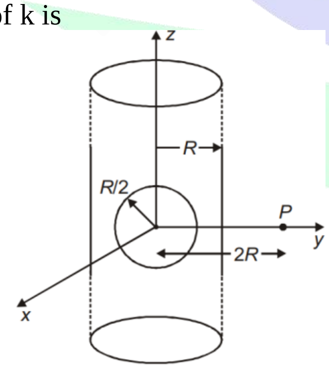
Q.42 An infinitely long uniform line charge distribution of charge per unit length λ lies parallel to the y-axis in the y-z plane at $z=\frac{\sqrt{3}}{2}a$ (see figure). If the magnitude of the flux of the electric field through the rectangular surface ABCD lying in the x-y plane with its centre at the origin is $\frac{\lambda L}{n\varepsilon_0}$

(ε_0 = permittivity of free space), then the value of n is



Q.43 An infinity number of charges each equal to $q=\frac{1}{6\times10^9}$ are placed along the x-axis at x = 1, x = 4, x = 4, x = 8….. and so on. Find the potential at the point x = 0 due to this set of charges.

Q.44 An infinitely long solid cylinder of radius R has a uniform volume charge density ρ. It has a spherical cavity of radius R/2 with its centre on the axis of the cylinder, as shown in the figure. The magnitude of the electric field at the point P, which is at a distance 2R from the axis of the cylinder, is given by the expression $\frac{23\rho R}{16k\varepsilon_0}$. The value of k is



STATEMENT TYPE QUESTIONS

Directions : Choose the correct option.

(A) If both Statement-I and Statement-II are true and the Statement-II is correct explanation of the Statement-I.

(B) If both Statement-I and Statement-II are true but Statement-II is not the correct explanation of Statement-II.

(C) If Statement-I is true, but the Statement-II is false.

(D) If Statement-I is false but the Statement-II is true.

Q.45 **Statement-I:** For a charged particle moving from point P to point Q, the net work done by an electrostatic field on the particle is independent of the path connecting point P to point Q.

Statement-II: The net work done by a conservative force on an object moving along a closed loop is zero.

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

Q.46 An insulating solid sphere of radius R has a uniformly positive charge density ρ. As a result of this uniform charge distribution there is a finite value of electric potential at the centre of the sphere, at the surface of the sphere and also at a point out side the sphere. The electric potential at infinity is zero.

Statement-I: When a charge 'q' is taken from the centre of the surface of the sphere, its potential energy changes by $\frac{q\rho}{3\varepsilon_0}$.

Statement-II: The electric field at a distance r(r < R) from the centre of the sphere is $\frac{\rho r}{3\varepsilon_0}$

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

Q.47 **Statements-I:** An electric dipole is placed at the centre of a hollow sphere. The flux of electric field through the sphere is zero but the electric field is not zero anywhere in the sphere.

Statement-II: If R is the radius of a solid metallic sphere and Q be the total charge on it. The electric field at any point on the spherical surface of radius r (< R) is zero but the electric flux passing through this closed spherical surface of radius r is not zero.

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

Q.48 **Statement-I:** A point charge is brought in an electric field. The value of electric field at a point near to the charge may increase, if the charge is positive.

Statement-II: An electric dipole is placed in an non-uniform electric field. The net electric force on the dipole will not be zero.

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

Q.49 **Statement-I:** A small metallic sphere is placed at the centre of a large charged spherical shell and two are the connected by a wire. The charge will not flow from outer sphere to inner sphere.

Statement-II: A charged conductor is placed inside the hollow conductor and two are connected by the wire. the whole charge will flow on the outer surface of the outer conductor.

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

MORE THAN ONE CORRECT TYPE QUESTIONS

Q.50 When two point charges q_A and q_B are placed at some separation on positive x-axis at points $(x_A,0)$ and $(x_B,0)$. Given that $|q_A|>|q_B|$ and $x_B > x_A$. If null point is the point where net electric field due to both the charges is zero, then

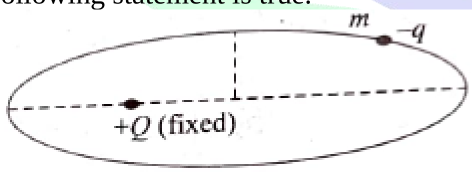
(1) If both q_A and q_B are positive, null point lies at some point $x_A < x < x_B$.

(2) If q_A is positive and q_B is negative, null point lies at some point $x < x_A$.

(3) If q_A is positive and q_B is negative, null point lies at some point $x > x_B$.

(4) If q_A is negative and q_B is positive, null point lies at some point $x > x_B$.

Q.51 A positive point charge +Q is fixed in space. A negative point charge -q of mass m revolves around fixed charge in elliptical orbit. The fixed charge +Q is at one focus of the ellipse. The only force acting on negative charge is the electrostatic force due to positive charge. Then which of the following statement is true.



(1) Linear momentum of negative point charge is conserved.

(2) Angular momentum of negative point charge about fixed positive charge is conserved.

(3) Total kinetic energy of negative point charge is conserved.

(4) The sum of electrostatic potential energy and kinetic energy of system of both point charges is conserved.

Q.52 A charged shell of radius R carries a total charge Q. Given Φ as the flux of electric field through a closed cylindrical surface of height h, radius r and with its centre same as that of the shell. Here, center of the cylinder is a point on the axis of the cylinder which is equidistant from its top and bottom surfaces. Which of the following option(s) is/are correct?

[ε_0 is the permittivity of free space]

(1) If $h > 2R$ and $r = 3R/5$ then $\Phi = Q/5\varepsilon_0$

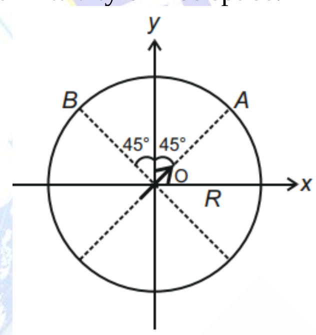
(2) If $h < 8R/5$ and $r = 3R/5$ then $\Phi = 0$

(3) If $h > 2R$ and $r > R$ then $\Phi = Q/\varepsilon_0$

(4) If $h > 2R$ and $r = 4R/5$ then $\Phi = Q/5\varepsilon_0$

Q.53 An electric dipole with dipole moment $\frac{p_0}{\sqrt{2}}(\hat{i}+\hat{j})$ is held fixed at the origin O in the presence of an uniform electric field of magnitude E_0. If the potential is constant on a circle of radius R centered at the origin as shown in figure, then the correct statement(s) is/are:

(ε_0 is permittivity of free space. R >> dipole size)



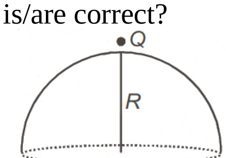
(1) Total electric field at point B is $\vec{E}_B = 0$.

(2) Total electric field at point A is $\vec{E}_A = \sqrt{2}E_0(\hat{i}+\hat{j})$.

(3) $R = \left(\frac{p_0}{4\pi\varepsilon_0 E_0}\right)^{\frac{1}{3}}$

(4) The magnitude of total electric field on any two points of the circle will be same.

Q.54 A point charge +Q is placed just outside an imaginary hemispherical surface of radius R as shown in the figure. Which of the following statements is/are correct?



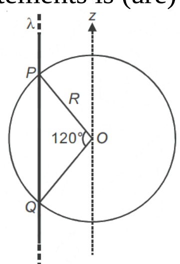
(1) The electric flux passing through the curved surface of the hemisphere is $-\frac{Q}{2\varepsilon_0}\left(1-\frac{1}{\sqrt{2}}\right)$

(2) The component of the electric field normal to the flat surface is constant over the surface.

(3) Total flux through the curved and the flat surface is $\frac{Q}{\varepsilon_0}$.

(4) The circumference of the flat surface is an equipotential.

Q.55 An infinitely long thin non-conducting wire is parallel to the z-axis and carries a uniform line charge density λ. It pierces a thin non-conducting spherical shell of radius R in such a way that the arc PQ subtends an angle 120° at the centre O of the spherical shell, as shown in the figure. The permittivity of free space is ε_0. Which of the following statements is (are) true?



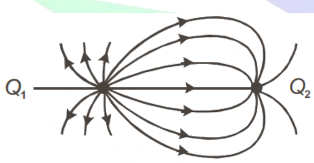
(1) The electric flux through the shell is $\frac{\sqrt{3}R\lambda}{\varepsilon_0}$.

(2) The z-component of the electric field is zero at all the points on the surface of the shell.

(3) The electric flux through the shell is $\frac{\sqrt{2}R\lambda}{\varepsilon_0}$.

(4) The electric field is normal to the surface of the shell at all points.

Q.56 A few electric field lines for a system of two charges Q_1 and Q_2 fixed at two different points on the x-axis are shown in the figure. These lines suggest that



(1) $|Q_1| > |Q_2|$

(2) $|Q_1| < |Q_2|$

(3) At a finite distance to the left of Q_1 the electric field is zero

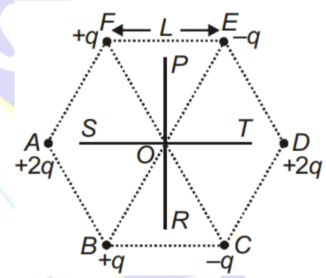
(4) At a finite distance to the right of Q_2 the electric field is zero

Q.57 A spherical metal shell A of radius R_A and a solid metal sphere B of radius $R_B(< R_A)$ are kept far apart and each is given charge '+Q'. Now they are connected by a thin metal wire. Then

(1) $E_A^{\text{inside}} = 0$ (2) $Q_A > Q_B$

(3) $\frac{\sigma_A}{\sigma_B} = \frac{R_B}{R_A}$ (4) $E_A^{\text{on surface}} < E_B^{\text{on surface}}$

Q.58 Six point charges are kept at the vertices of a regular hexagon of side L and centre O, as shown in the figure. Given that $K = \frac{1}{4\pi\varepsilon_0}\frac{q}{L^2}$, which of the following statement(s) is (are) correct?



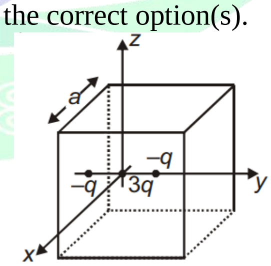
(1) The electric field at O is 6k along OD

(2) The potential at O is zero

(3) The potential at all points on the line PR is same

(4) The potential at all points on the line ST is same

Q.59 A cubical region of side a has its centre at the origin. It encloses three fixed point charges, –q at $\left(0, -\frac{a}{4}, 0\right)$, +3q at (0, 0, 0) and –q at $\left(0, +\frac{a}{4}, 0\right)$. Choose the correct option(s).



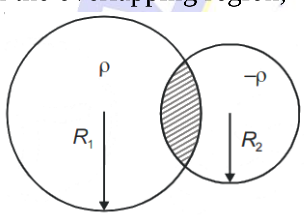
(1) The net electric flux crossing the plane $x = +\frac{a}{2}$ is equal to the net electric flux crossing the plane $x = -\frac{a}{2}$.

(2) The net electric flux crossing the plane $y = +\frac{a}{2}$ is more than the net electric flux crossing the plane $y = -\frac{a}{2}$.

(3) The net electric flux crossing the entire region is $\frac{q}{\varepsilon_0}$.

(4) The net electric flux crossing the plane $z = +\frac{a}{2}$ is equal to the net electric flux crossing the plane $x = +\frac{a}{2}$.

Q.60 Two non-conducting spheres of radii R_1 and R_2 and carrying uniform volume charge densities $+\rho$ and $-\rho$, respectively, are placed such that they partially overlap, as shown in the figure. At all points in the overlapping region,



(1) The electrostatic field is zero
(2) The electrostatic potential is constant
(3) The electrostatic field is constant in magnitude
(4) The electrostatic field has same direction

Q.61 Two non-conducting solid spheres of radii R and 2R, having uniform volume charge densities ρ_1 and ρ_2 respectively, touch each other. The net electric field at a distance 2R from the centre of the smaller sphere, along the line joining the centres of the spheres, is zero. The ratio $\frac{\rho_1}{\rho_2}$ can be-

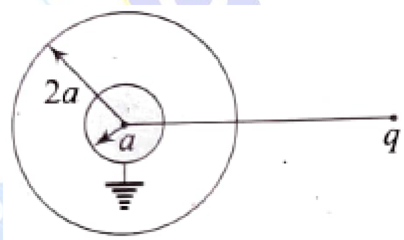
(1) – 4 (2) $-\frac{32}{25}$ (3) $\frac{32}{25}$ (4) 4

Q.62 A uniformly charged solid sphere of radius R has potential V_0 (measured with respect to ∞) on its surface. For this sphere the equipotential surfaces with potentials $\frac{3V_0}{2}, \frac{5V_0}{4}, \frac{3V_0}{4}$ and $\frac{V_0}{4}$ have radius R_1, R_2, R_3 and R_4 respectively. Then

(1) $R_1 = 0$ and $R_2 > (R_4 - R_3)$
(2) $R_1 \neq 0$ and $(R_2 - R_1) > (R_4 - R_3)$
(3) $R_1 = 0$ and $R_2 < (R_4 - R_3)$
(4) $2R < R_4$

COMPREHENSION TYPE QUESTIONS

Q.63 A solid conducting sphere of radius 'a' is surrounded by a thin uncharged concentric conducting shell of radius 2a. A point charge q is placed at a distance 4a from common centre of conducting sphere and shell. The inner sphere is then grounded.



(i) The charge on solid sphere is :

(1) $-\frac{q}{2}$ (2) $-\frac{q}{4}$

(3) $-\frac{q}{8}$ (4) $-\frac{q}{16}$

(ii) Pick up the correct statement :

(1) Charge on surface of inner sphere is non-uniformly distributed.
(2) Charge on inner surface of outer shell is non-uniformly distributed.
(3) Charge on outer surface of outer shell is non-uniformly distributed.
(4) All the above statements are false.

(iii) The potential of outer shell is

(1) $\frac{q}{32\pi\varepsilon_0 a}$ (2) $\frac{q}{16\pi\varepsilon_0 a}$

(3) $\frac{q}{8\pi\varepsilon_0 a}$ (4) $\frac{q}{4\pi\varepsilon_0 a}$

Q.64 A sphere of charge of radius R carries a positive charge whose volume charge density depends only on the distancer from the ball's centre as $\rho = \rho_0\left(1 - \frac{r}{R}\right)$, where ρ_0 is a constant. Assume ε as the permittivity of space.

(i) The magnitude of electric field as a function of the distance r inside the sphere is given by

(1) $E = \frac{\rho_0}{\varepsilon}\left[\frac{r}{3} - \frac{r^2}{4R}\right]$ (2) $E = \frac{\rho_0}{\varepsilon}\left[\frac{r}{4} - \frac{r^2}{3R}\right]$

(3) $E = \frac{\rho_0}{\varepsilon}\left[\frac{r}{3} + \frac{r^2}{4R}\right]$ (4) $E = \frac{\rho_0}{\varepsilon}\left[\frac{r}{4} + \frac{r^2}{3R}\right]$

(ii) The magnitude of the electric field as a function of the distance r outside the ball is given by

(1) $E = \frac{\rho_0 R^3}{8\varepsilon r^2}$ (2) $E = \frac{\rho_0 R^3}{12\varepsilon r^2}$

(3) $E = \frac{\rho_0 R^2}{8\varepsilon r^3}$ (4) $E = \frac{\rho_0 R^2}{12\varepsilon r^3}$

(iii) The value of distance r_m at which electric field intensity is maximum is given by

(1) $r_m = \frac{R}{3}$ (2) $r_m = \frac{3R}{2}$

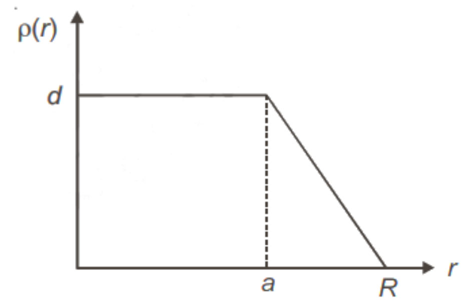
(3) $r_m = \frac{2R}{3}$ (4) $r_m = \frac{4R}{3}$

(iv) The maximum electric field intensity is

(1) $E_m = \frac{\rho_0 R}{9\varepsilon}$ (2) $E_m = \frac{\rho_0 \varepsilon}{9R}$

(3) $E_m = \frac{\rho_0 R}{3\varepsilon}$ (4) $E_m = \frac{\rho_0 R}{6\varepsilon}$

Q.65 The nuclear charge (Ze) is non-uniformly distributed within a nucleus of radius R. The charge density ρ(r) [charge per unit volume] is dependent only on the radial distance r from the centre of the nucleus as shown in figure. The electric field is only along the radial direction.



Choose the correct answer :

(i) The electric field at r = R is

(1) Independent of a

(2) Directly proportional to a

(3) Directly proportional to a^2

(4) Inversely proportional to a

(ii) For a = 0, the value of d (maximum value of ρ as shown in the figure) is

(1) $\frac{3Ze}{4\pi R^3}$ (2) $\frac{3Ze}{\pi R^3}$

(3) $\frac{4Ze}{3\pi R^3}$ (4) $\frac{Ze}{3\pi R^3}$

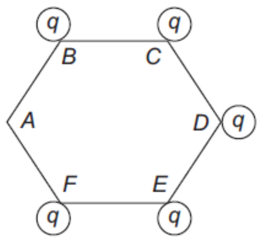
(iii) The electric field within the nucleus is generally observed to be linarly dependent on r. This implies

(1) a = 0 (2) $a = \frac{R}{2}$

(3) a = R (4) $a = \frac{2R}{3}$

MATCH THE COLUMN TYPE QUESTIONS

Q.66 Five identical charges are kept at five vertices of a regular hexagon. Match the following two columns at centre of the hexagon. If in the given situation electric field at centre is E. Then,



	Column I		Column II
(a)	If charge at B is removed, then electric field will become	(p)	2E
(b)	If charge at C is removed, then electric field will become	(q)	E
(c)	If charge at D is removed, then electric field will become	(r)	Zero
(d)	If charges at B and C both are removed, then electric field will become	(s)	$\sqrt{3}E$

(1) (a) → s, (b) → q, (c) → r, (d) → P

(2) (a) → s, (b) → q, (c) → s, (d) → P

(3) (a) → s, (b) → p, (c) → r, (d) → q

(4) (a) → s, (b) → r, (c) → q, (d) → P

Q.67 Electric potential on the surface of a solid sphere of charge is V . Radius of the sphere is 1m. Match the following two columns.

	Column I		Column II
(a)	Electric potential at $r = \frac{R}{2}$	(p)	$\frac{V}{4}$
(b)	Electric potential at r = 2R	(q)	$\frac{V}{2}$
(c)	Electric field at $r = \frac{R}{2}$	(r)	$\frac{3V}{4}$
(d)	Electric field at r = 2R	(s)	None of these

(1) (a) → p,s, (b) → p,r (c) → q, (d) → q,s

(2) (a) → q, (b) → q,r (c) → q, (d) → p,s

(3) (a) → q, (b) → p,r (c) → q, (d) → p,s

(4) (a) → q, (b) → q,r (c) → q, (d) → q,s

Q.68 The electric field E is measured at a point P(0, 0, d) generated due to various charge distributions and the dependence of E on d is found to be different for different charge distributions. List-I contains different relations between E and d. List-II describes different electric charge distributions, along with their locations. Match the functions in List-I with the related charge distributions in List-II.

	List I		List II
P	E is independent of d	1	A point charge Q at the origin
Q	$E \propto \frac{1}{d}$	2	A small dipole with point charges Q at (0, 0, l) and –Q at (0, 0, –l). Take 2l << d
R	$E \propto \frac{1}{d^2}$	3	An infinite line charge coincident with the x-axis, with uniform linear charge density λ.
S	$E \propto \frac{1}{d^3}$	4	Two infinite wires carrying uniform linear charge density parallel to the x-axis. The one along (y = 0, z = l) has a charge density +λ and the one along (y = 0, z = –l) has a charge density –λ. Take 2l << d

		5.	Infinite plane charge coincident with the xy-plane with uniform surface charge density

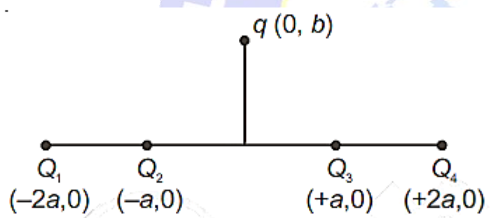
(1) P → 5; Q → 3, 4; R → 1; S → 2

(2) P → 5; Q → 3; R → 1, 4; S → 2

(3) P → 5; Q → 3; R → 1, 2; S → 4

(4) P → 4; Q → 2, 3; R → 1; S → 5

Q.69 Four charges Q_1, Q_2, Q_3 and Q_4 of same magnitude are fixed along the x axis at x =–2a, –a, +a and +2a, respectively. A positive charge q is placed on the positive y axis at a distance b > 0. Four options of the signs of these charges are given in List I. The direction of the forces on the charge q is given in List II. Match List I with List II and select the correct answer using the code given below the lists.



List I		List II	
P	Q_1, Q_2, Q_3, Q_4 all positive	1	+x
Q	Q_1, Q_2 positive; Q_3, Q_4 negative	2	–x
R	Q_1, Q_4 positive; Q_2, Q_3 negative	3	+y
S	Q_1, Q_3 positive; Q_2, Q_4 negative	4	-y

(1) P-3, Q-1, R-4, S-2

(2) P-4, Q-2, R-3, S-1

(3) P-3, Q-1, R-2, S-4

(4) P-3, Q-1, R-2, S-4

ANSWER KEY

JEE-RANKER'S STUFF

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans	2	4	3	4	4	4	2	3	1	3	3	2	2	1	1
Que.	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Ans	2	4	1	3	2	4	1	4	4	2	1	3	2	3	2
Que.	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**
Ans	1	3	1	1	2	a=2	F=0	–48	d=5	V=2	v=8V	n=6	V=3	k=6	1
Que.	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
Ans	4	3	2	2	1,3,4	2,4	1,2,3	1,3	1,4	1,2	1,4	1,2,3,4	1,2,3	1,3,4	3,4
Que.	**61**	**62**	**63(i)**	**63(ii)**	**63(iii)**	**64(i)**	**64(ii)**	**64(iii)**	**64(iv)**	**65(i)**	**65(ii)**	**65(iii)**	**66**	**67**	**68**
Ans	2,4	3,4	2	3	1	1	2	3	1	1	2	3	1	3	2
Que.	**69**														
Ans	1														