Chapter 01 Electrostatics

JEE-FLASHBACK

JEE MAINS QUESTION

Q.1 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 $\frac{Q}{q}$ equal. **[AIEEE-2009]**

(1) -1 (2) 1

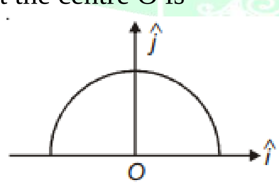
(3) $-\frac{1}{\sqrt{2}}$ (4) $-2\sqrt{2}$

Q.2 Let $\rho(r)=\frac{Q}{\pi R^4}r$ be the charge density distribution for a solid sphere of radius R and total charge Q. For a point 'p' inside the sphere at distance r_1 from the centre of the sphere, the magnitude of electric field is **[AIEEE-2009]**

(1) $\frac{Q}{4\pi\varepsilon_0 r_1^2}$ (2) $\frac{Qr_1^2}{4\pi\varepsilon_0 R^4}$

(3) $\frac{Qr_1^2}{3\pi\varepsilon_0 R^4}$ (4) 0

Q.3 A thin semi-circular ring of radius r has a positive charge q distributed uniformly over it. The net field $\vec{E}$ at the centre O is **[AIEEE-2009]**



(1) $\frac{q}{2\pi^2\varepsilon_0 r^2}\hat{j}$ (2) $\frac{q}{4\pi^2\varepsilon_0 r^2}\hat{j}$

(3) $-\frac{q}{4\pi^2\varepsilon_0 r^2}\hat{j}$ (4) $-\frac{q}{2\pi^2\varepsilon_0 r^2}\hat{j}$

Q.4 Two point P and Q are maintained at the potentials of 10 V and –4 V respectively. The work done in moving 100 electrons from P to Q is **[AIEEE-2009]**

(1) 9.60×10^{-17} J (2) -2.24×10^{-16} J

(3) 2.24×10^{-16} J (4) -9.60×10^{-17} J

Q.5 Let there be a spherically symmetric charge distribution with charge density varying as $\rho(r)=\rho_0\left(\frac{5}{5}-\frac{r}{R}\right)$ up to r=R, and $\rho(r)=0$ for r > R, where r is the distance from the origin. The electric field at a distance r(r < R) from the origin is given by **[AIEEE-2010]**

(1) $\frac{\rho_0 r}{3\varepsilon_0}\left(\frac{5}{4}-\frac{r}{R}\right)$ (2) $\frac{4\pi\rho_0 r}{3\varepsilon_0}\left(\frac{5}{4}-\frac{r}{R}\right)$

(3) $\frac{\rho_0 r}{4\varepsilon_0}\left(\frac{5}{4}-\frac{r}{R}\right)$ (4) $\frac{4\rho_0 r}{3\varepsilon_0}\left(\frac{5}{4}-\frac{r}{R}\right)$

Q.6 Two identical charged spheres are suspended by strings of equal lengths. The strings make an angle of 30° with each other. When suspended in a liquid of density 0.8 g cm^{-3}, the angle remains the same. If density of the material of the sphere is 1.6 g cm^{-3}, the dielectric constant of the liquid is **[AIEEE-2010]**

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

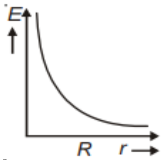
Q.7 Two positive charges of magnitude 'q' are placed at the ends of a side (side 1) of a square of side '2a'. Two negative charges of the same magnitude are kept at the other corners. Starting from rest, if a charge Q moves from the middle of side 1 to the centre of square, its kinetic energy at the centre of square is **[AIEEE-2011]**

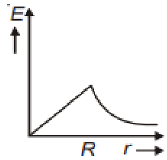
(1) $\frac{1}{4\pi\varepsilon_0}\frac{2qQ}{a}\left(1-\frac{2}{\sqrt{5}}\right)$ (2) $\frac{1}{4\pi\varepsilon_0}\frac{2qQ}{a}\left(1-\frac{1}{\sqrt{5}}\right)$

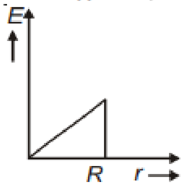
(3) Zero (4) $\frac{1}{4\pi\varepsilon_0}\frac{2qQ}{a}\left(1+\frac{1}{\sqrt{5}}\right)$

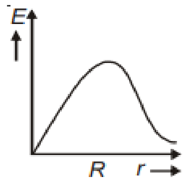
Q.8 In a uniformly charged sphere of total charge Q and radius R, the electric field E is plotted as a function of distance from the centre. The graph which would correspond to the above will be :

[AIEEE-2012]

(1) 

(2) 

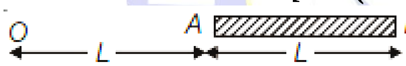
(3) 

(4) 

Q.9 Two charges, each equal to q, are kept at x = – a and x = a on the x-axis. A particle of mass m and charge $q_0 = \frac{q}{2}$ is placed at the origin. If charge q_0 is given a small displacement (y << a) along the y-axis, the net force acting on the particle is proportional to **[JEE(Mains)-2013]**

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

Q.10 A charge Q is uniformly distributed over a long rod AB of length L as shown in the figure. The electric potential at the point O lying at a distance L from the end A is **[JEE(Main)-2013]**



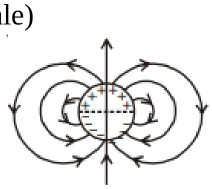
(1) $\frac{Q}{8\pi\varepsilon_0 L}$ (2) $\frac{3Q}{4\pi\varepsilon_0 L}$

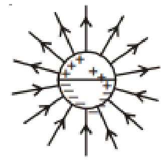
(3) $\frac{Q}{4\pi\varepsilon_0 L \ln 2}$ (4) $\frac{Q\ln 2}{4\pi\varepsilon_0 L}$

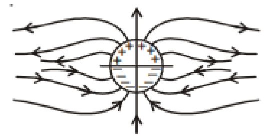
Q.11 Assume that an electric field $\vec{E} = 30x^2\hat{j}$ exists in space. Then the potential difference $V_A - V_O$, where V_0 is the potential at the origin and V_A the potential at x = 2 m is **[JEE(Main)-2014]**

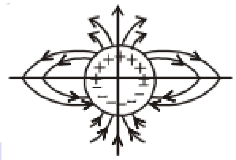
(1) 120 V (2) –120V (3) – 80V (4) 80 V

Q.12 A long cylindrical shell carries positive surface charge σ in the upper half and negative surface charge –σ in the lower half. The electric field lines around the cylinder will look like figure given in (figure are schematic and not drawn to scale) **[JEE(Mains)-2015]**

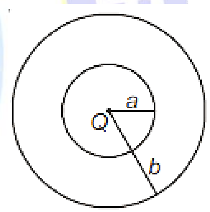
(1) 

(2) 

(3) 

(4) 

Q.13 The region between two concentric spheres of radii 'a' and 'b', respectively (see figure), has volume charge density $\rho = \frac{A}{r}$, where A is a constant and r is the distance from the centre. At the centre of the spheres is a point charge Q. The value of A such that the electric field in the region between the spheres will be constant, is : **[JEE(Mains)-2016]**



(1) $\frac{Q}{2\pi(b^2 - a^2)}$ (2) $\frac{2Q}{\pi(a^2 - b^2)}$

(3) $\frac{2Q}{\pi a^2}$ (4) $\frac{Q}{2\pi a^2}$

Q.14 An electric dipole has a fixed dipole moment $\vec{p}$, which makes angle θ with respect to x-axis. When subjected to an electric field $\vec{E}_1 = E\hat{i}$, it experiences a torque $\vec{T}_1 = \tau\hat{k}$. When subjected to another electric field $\vec{E}_2 = \sqrt{3}E_1\hat{j}$ it experiences a torque $T_2 = -T_1$ ________ . The angle θ is **[JEE(Mains)-2017]**

(1) 30° (2) 45° (3) 60° (4) 90°

Q.15 Three concentric metal shells A, B and C of respective radii a, b and c (a < b < c) have surface charge densities +σ, –σ and +σ respectively. The potential of shell B is **[JEE(Main)-2018]**

(1) $\frac{\sigma}{\varepsilon_0}\left[\frac{a^2-b^2}{a}+c\right]$ (2) $\frac{\sigma}{\varepsilon_0}\left[\frac{a^2-b^2}{b}+c\right]$

(3) $\frac{\sigma}{\varepsilon_0}\left[\frac{a^2-b^2}{b}+a\right]$ (4) $\frac{\sigma}{\varepsilon_0}\left[\frac{b^2-c^2}{c}+a\right]$

Q.16 Three charges +Q, q, +Q are placed respectively, at distance, 0, d/2 and d from the origin, on the x-axis. If the net force experienced by +Q, placed at x = 0, is zero then value of q is

[JEE(Mains)-2019]

(1) $\frac{+Q}{2}$ (2) $\frac{-Q}{2}$

(3) $\frac{-Q}{4}$ (4) $\frac{+Q}{4}$

Q.17 For a uniformly charged ring of radius R, the electric field on its axis has the largest magnitude at a distance h from its centre. Then value of h is

[JEE(Mains)-2019]

(1) $\frac{R}{\sqrt{2}}$ (2) $\frac{R}{\sqrt{5}}$ (3) R (4) $R\sqrt{2}$

Q.18 Two point charge $q_1\left(\sqrt{10}\mu C\right)$ and $q_2\left(-25\mu C\right)$ are placed on the x-axis at x = 1 m and x = 4 m respectively. The electric field (in V/m) at a point y = 3 m on y-axis is,

$\left[\text{Take}\,\frac{1}{4\pi\varepsilon_0}=9\times10^9\ Nm^2C^{-2}\right]$

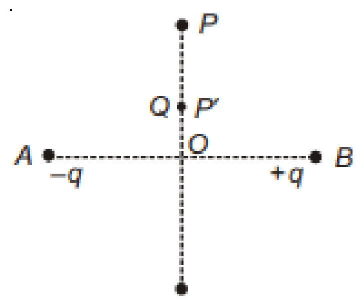
[JEE(Mains)-2019]

(1) $\left(63\hat{i}-27\hat{j}\right)\times10^2$ (2) $\left(81\hat{i}-81\hat{j}\right)\times10^2$

(3) $\left(-81\hat{i}+81\hat{j}\right)\times10^2$ (4) $\left(-63\hat{i}+27\hat{j}\right)\times10^2$

Q.19 Charges –q and +q located at A and B, respectively, constitute an electric dipole. Distance AB = 2a, O is the mid point of the dipole and OP is perpendicular to AB. A charge Q is placed at P where OP = y and y >> 2a. The charge Q experiences an electrostatic force F. If Q is now moved along the equatorial line to P′ such that $OP'=\left(\frac{y}{3}\right)$, the force on Q will be close to $\left(\frac{y}{3}>>2a\right)$

[JEE(Mains)-2019]



(1) $\frac{F}{3}$ (2) 9F

(3) 27 F (4) 3F

Q.20 An electric field of 1000 V/m is applied to an electric dipole at angle of 45°. The value of electric dipole moment is 10^{-29} Cm. What is the potential energy of the electric dipole?

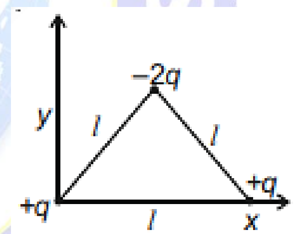
[JEE(Mains)-2019]

(1) -9×10^{-20} J (2) -10×10^{-29}

(3) -7×10^{-27} J (4) -20×10^{-18} J

Q.21 Determine the electric dipole moment of the system of three charges, placed on the vertices of an equilateral triangle, as shown in the figure

[JEE(Mains)-2019]



(1) $2ql\hat{j}$ (2) $\sqrt{3}ql\frac{\hat{j}-\hat{i}}{\sqrt{2}}$

(3) $-\sqrt{3}ql\hat{j}$ (4) $(ql)\frac{\hat{i}+\hat{j}}{\sqrt{2}}$

Q.22 An electric dipole is formed by two equal and opposite charges q with separation d. The charges have same mass m. It is kept in a uniform electric field E. If it is slightly rotated from its equilibrium orientation, then its angular frequency ω is:

[JEE(Mains)-2019]

(1) $\sqrt{\frac{2qE}{md}}$ (2) $2\sqrt{\frac{qE}{md}}$

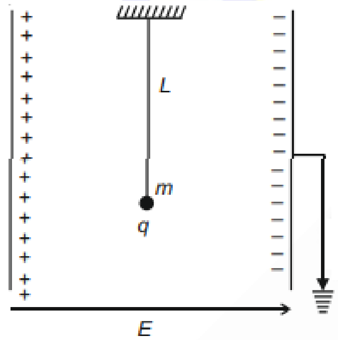
(3) $\sqrt{\frac{qE}{2md}}$ (4) $\sqrt{\frac{qE}{md}}$

Q.23 For point charges –q, +q, +q and –q are placed on y-axis at y = –2d, y = –d, y = +d and y = +2d, respectively. The magnitude of the electric field E at a point on the x-axis at x = D, with D >> d, will behave as **[JEE(Mains)-2019]**

(1) $E \propto \frac{1}{D^3}$ (2) $E \propto \frac{1}{D}$

(3) $E \propto \frac{1}{D^4}$ (4) $E \propto \frac{1}{D^2}$ c

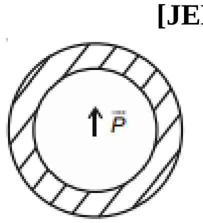
Q.24 A simple pendulum of length L is placed between the plates of a parallel plate capacitor having electric field E, as shown in figure. Its bob has mass m and charge q. The time period of the pendulum is given by **[JEE(Mains)-2019]**



(1) $2\pi\sqrt{\frac{L}{\left(g-\frac{qE}{m}\right)}}$ (2) $2\pi\sqrt{\frac{L}{\left(g+\frac{qE}{m}\right)}}$

(3) $2\pi\sqrt{\frac{L}{\sqrt{\left(g^2+\frac{qE}{m}\right)^2}}}$ (4) $2\pi\sqrt{\frac{L}{\sqrt{\left(g^2-\frac{q^2E^2}{m^2}\right)^2}}}$

Q.25 Shown in the figure is a shell made of a conductor. It has inner radius a and outer radius b, and carries charge Q. At its centre is a dipole $\vec{P}$ as shown. In this case: **[JEE(Mains)-2019]**



(1) Surface charge density on the outer surface depends on $|\vec{P}|$.

(2) Surface charge density on the inner surface is uniform and equal to $\frac{(Q/2)}{4\pi a^2}$.

(3) Electric field outside the shell is the same as that of point charge at the centre of the shell.

(4) Surface charge density on the inner surface of the shell is zero everywhere.

Q.26 Let a total charge 2 Q be distributed in a sphere of radius R, with the charge density given by ρ(r) = kr, where r is the distance from the centre. Two charges A and B, of –Q each, are placed on diametrically opposite points, at equal distance, a, from the centre. If A and B do not experience any force, then: **[JEE(Mains)-2019]**

(1) $a = \frac{3R}{2^{1/4}}$ (2) $a = R/\sqrt{3}$

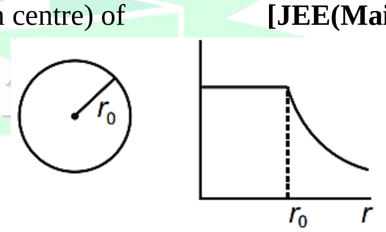
(3) $a = 2^{-1/4}$ R (4) $a = 8^{-1/4}$ R

Q.27 Four equal point charges Q each are placed in the xy plane at (0, 2), (4, 2), (4, –2) and (0, –2). The work required to put a fifth charge Q at the origin of the coordinate system will be **[JEE(Main)-2019]**

(1) $\frac{Q^2}{2\sqrt{2}\pi\varepsilon_0}$ (2) $\frac{Q^2}{4\pi\varepsilon_0}\left(1+\frac{1}{\sqrt{3}}\right)$

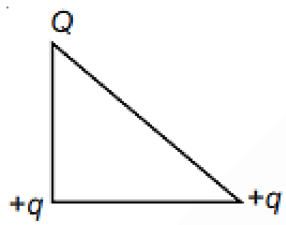
(3) $\frac{Q^2}{4\pi\varepsilon_0}$ (4) $\frac{Q^2}{4\pi\varepsilon_0}\left(1+\frac{1}{\sqrt{5}}\right)$

Q.28 The given graph shows variation (with distance r from centre) of **[JEE(Main)-2019]**



(1) Potential of a uniformly charged spherical shell.
(2) Electric field of a uniformly charged sphere.
(3) Electric field of uniformly charged spherical shell.
(4) Potential of uniformly charged sphere.

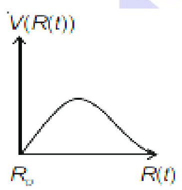
Q.29 Three charges Q, +q and +q are placed at the vertices of a right-angle isosceles triangles as shown below. The net electrostatic energy of the configuration is zero, if the value of Q is **[JEE(Main)-2019]**



(1) $\frac{-\sqrt{2}q}{\sqrt{2}+1}$ (2) + q

(3) – 2 q (4) $\frac{-q}{1+\sqrt{2}}$

Q.30 There is a uniform spherically symmetric surface charge density at a distance R_0 from the origin. The charge distribution is initially at rest and starts expanding because of mutual repulsion. The figure that represents best the speed V(R(t)) of the distribution as a function of its instantaneous radius R(t) is **[JEE(Main)-2019]**

(1)


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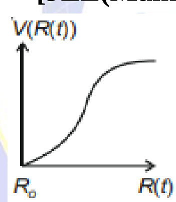

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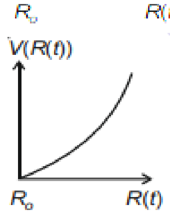

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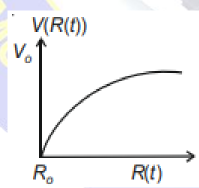


Q.31 A solid conducting sphere, having a charge Q, is surrounded by an uncharged conducting hollow spherical shell. Let the potential difference between the surface of the solid sphere and that of the outer surface of the hollow shell be V. If the shell is now given a charge of –4 Q, the new potential difference between the same two surfaces is **[JEE(Main)-2019]**

(1) –2 V (2) V

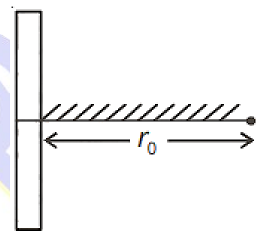
(3) 2 V (4) 4 V

Q.32 The electric field in a region is given by $\vec{E} = (Ax + B)\,\hat{i}$, where E is in NC^{-1} and x is in metres. The values of constants are A = 20 SI unit and B = 10 SI unit. If the potential at x = 1 is V_1 and that at x = – 5 is V_2, then $V_1 - V_2$ is : **[JEE(Main)-2019]**

(1) 180 V (2) –520 V

(3) 320 V (4) –48 V

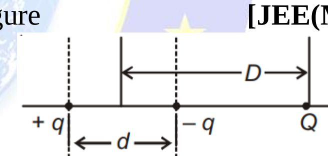
Q.33 A positive point charge is released from rest at a distance r_0 from a positive line charge with uniform density. The speed (v) of the point charge, as a function of instantaneous distance r from line charge, is proportional to : **[JEE(Main)-2019]**



(1) $V \propto \sqrt{\ln\left(\frac{r}{r_0}\right)}$ (2) $V \propto e^{+r/r_0}$

(3) $V \propto \ln\left(\frac{r}{r_0}\right)$ (4) $V \propto \left(\frac{r}{r_0}\right)$

Q.34 A system of three charges are placed as shown in the figure **[JEE(Main)-2019]**



If D >> d, the potential energy of the system is best given by

(1) $\frac{1}{4\pi\varepsilon_0}\left[-\frac{q^2}{d}-\frac{qQd}{D^2}\right]$

(2) $\frac{1}{4\pi\varepsilon_0}\left[+\frac{q^2}{d}+\frac{qQd}{D^2}\right]$

(3 $\frac{1}{4\pi\varepsilon_0}\left[-\frac{q^2}{d}+\frac{2qQd}{D^2}\right]$

(4) $\frac{1}{4\pi\varepsilon_0}\left[-\frac{q^2}{d}-\frac{qQd}{2D^2}\right]$

Q.35 A uniformly charged ring of radius 3a and total charge q is placed in xy-plane centred at origin. A point charge q is moving towards the ring along the z-axis and has speed v at z = 4a. The minimum value of v such that it crosses the origin is : **[JEE(Main)-2019]**

(1) $\sqrt{\frac{2}{m}}\left(\frac{1}{15}\frac{q^2}{4\pi\varepsilon_0 a}\right)^{\frac{1}{2}}$ (2) $\sqrt{\frac{2}{m}}\left(\frac{1}{5}\frac{q^2}{4\pi\varepsilon_0 a}\right)^{\frac{1}{2}}$

(3) $\sqrt{\frac{2}{m}}\left(\frac{4}{15}\frac{q^2}{4\pi\varepsilon_0 a}\right)^{\frac{1}{2}}$ (4) $\sqrt{\frac{2}{m}}\left(\frac{2}{15}\frac{q^2}{4\pi\varepsilon_0 a}\right)^{\frac{1}{2}}$

Q.36 In free space, a particle A of charge 1 μC is held fixed at a point P. Another particle B of the same charge and mass 4 μg is kept at a distance of 1 mm from P. If B is released, then its velocity at a distance of 9 mm from P is :**[JEE(Main)-2019]**

$\left[\text{Take}\ \frac{1}{4\pi\varepsilon_0} = 9\times10^9\ \text{Nm}^2\text{C}^{-2}\right]$

(1) 6.32×10^4 m/s (2) 2.0×10^3 m/s
(3) 1.5×10^2 m/s (4) 1.0 m/s

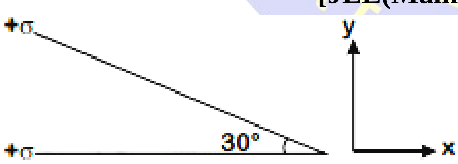
Q.37 A point dipole $\vec{p} = -p_0\hat{x}$ is kept at the origin. The potential and electric field due to this dipole on the y-axis at a distance d are, respectively : **[JEE(Main)-2019]**

(Take V = 0 at infinity)

(1) $\frac{|\vec{p}|}{4\pi\varepsilon_0 d^2}, \frac{\vec{p}}{4\pi\varepsilon_0 d^3}$ (2) $\frac{|\vec{p}|}{4\pi\varepsilon_0 d^2}, \frac{-\vec{p}}{4\pi\varepsilon_0 d^3}$

(3) $0, \frac{-\vec{p}}{4\pi\varepsilon_0 d^3}$ (4) $0, \frac{\vec{p}}{4\pi\varepsilon_0 d^3}$

Q.38 Two infinite planes each with uniform surface charge density $+\sigma$ are kept in such a way that the angle between them is 30°. The electric field in the region shown between them is given by **[JEE(Mains)-2020]**



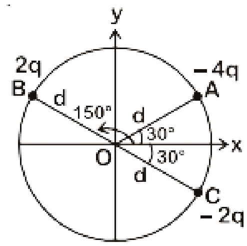
(1) $\frac{\sigma}{2\varepsilon_0}\left[\left(1+\sqrt{3}\right)\hat{y}+\frac{\hat{x}}{2}\right]$

(2) $\frac{\sigma}{2\varepsilon_0}\left[\left(1+\sqrt{3}\right)\hat{y}-\frac{\hat{x}}{2}\right]$

(3) $\frac{\sigma}{2\varepsilon_0}\left[\left(1-\sqrt{3}\right)\hat{y}-\frac{\hat{x}}{2}\right]$

(4) $\frac{\sigma}{\varepsilon_0}\left[\left(1+\sqrt{3}\right)\hat{y}+\frac{\hat{x}}{2}\right]$

Q.39 Three charged particles A, B and C with charges –4q, 2q and –2q are present on the circumference of a circle of radius d. The charged particles A, C and centre O of the circle formed an equilateral triangle as shown in figure. Electric field at O along x-direction is **[JEE(Mains)-2020]**



(1) $\frac{\sqrt{3}q}{\pi\varepsilon_0 d^2}$ (2) $\frac{3\sqrt{3}q}{4\pi\varepsilon_0 d^2}$

(3) $\frac{\sqrt{3}q}{4\pi\varepsilon_0 d^2}$ (4) $\frac{2\sqrt{3}q}{\pi\varepsilon_0 d^2}$

Q.40 In finding the electric field using Gauss law the formula $|\vec{E}| = \frac{q_{enc}}{\varepsilon_0 |A|}$ is applicable. In the formula ε_0 is permittivity of free space, A is the area of Gaussian surface and q_{enc} is charge enclosed by the Gaussian surface. This equation can be used in which of the following situation? **[JEE(Mains)-2020]**

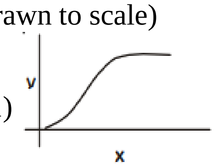
(1) Only when the Gaussian surface is an equipotential surface and $|\vec{E}|$ is constant on the surface.

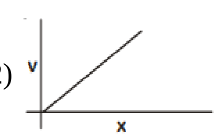
(2) Only when $|\vec{E}|$ = constant on the surface.

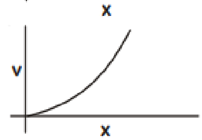
(3) Only when the Gaussian surface is an equipotential.

(4) For ay choice of Gaussian surface.

Q.41 A particle of mass m and charge q is released from rest in a uniform electric field. If there is no other force on the particle, the dependence of its speed v on the distance x travelled by it is correctly given by (graphs are schematic and not drawn to scale) **[JEE(Mains)-2020]**

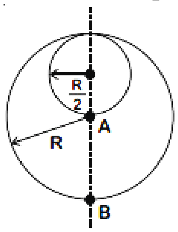
(1) 

(2) 

(3) 

(4) 

Q.42 Consider a sphere of radius R which carries a uniform charge density ρ. If a sphere of radius $\frac{R}{2}$ is carved out of it, as shown, the ratio $\frac{|\vec{E}_A|}{|\vec{E}_B|}$ of magnitude of electric field $\vec{E}_A$ and , $\vec{E}_B$ respectively, at points A and B due to the remaining portion is **[JEE(Mains)-2020]**



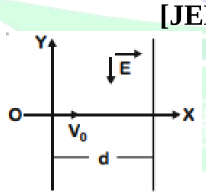
(1) $\frac{18}{34}$ (2) $\frac{18}{54}$ (3) $\frac{21}{34}$ (4) $\frac{17}{54}$

Q.43 An electric dipole of moment $\vec{p} - = \left(-\hat{i} - 3\hat{j} + 2\hat{k}\right) \times 10^{-29}$ C.m. is at the origin (0,0,0). The electric field due to this dipole at $\vec{r} = +\hat{i} + 3\hat{j} + 5\hat{k}$. (Note that $\vec{r}.\vec{p} = 0$)is parallel to **[JEE(Mains)-2020]**

(1) $\left(-\hat{i} - 3\hat{j} + 2\hat{k}\right)$ (2) $\left(+\hat{i} - 3\hat{j} - 2\hat{k}\right)$

(3) $\left(-\hat{i} + 3\hat{j} - 2\hat{k}\right)$ (4) $\left(+\hat{i} + 3\hat{j} - 2\hat{k}\right)$

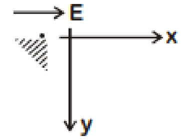
Q.44 A charged particle (mass m and charge q) moves along X-axis with velocity V_0. When it passes through the origin it enters a region having uniform electric field $\vec{E} = E\hat{j}$ which extends upto x = d. Equation of path of electron in the region x > d is **[JEE(Mains)-2020]**

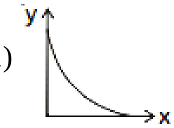
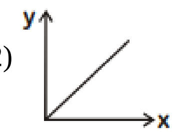


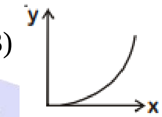
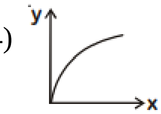
(1) $y = \frac{qEd}{mV_0^2}(x - d)$ (2) $y = \frac{qEd^2}{mV_0^2}x$

(3) $y = \frac{qEd}{mV_0^2}\left(\frac{d}{2} - x\right)$ (4) $y = \frac{qEd}{mV_0^2}x$

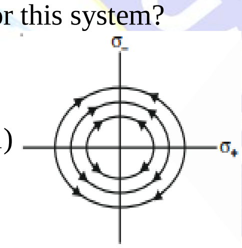
Q.45 A small point mass carrying some positive charge on it, is released from the edge of a table. There is a uniform electric field in this region in the horizontal direction. Which of the following options then correctly describe the trajectory of the mass? (Curves are drawn schematically and are not to scale). **[JEE(Mains)-2020]**

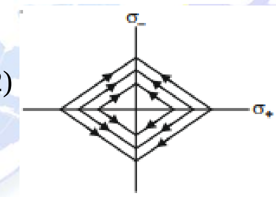


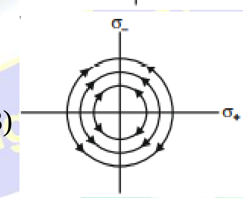
(1)  (2) 

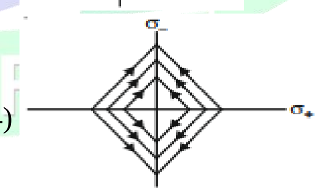
(3)  (4) 

Q.46 Two charged thin infinite plane sheets of uniform surface charge density σ+ and σ–, where |σ+| > |σ–|, intersect at right angle. Which of the following best represents the electric field lines for this system? **[JEE(Mains)-2020]**

(1) 

(2) 

(3) 

(4) 

Q.47 A particle of charge q and mass m is subjected to an electric field $E = E_0(1 - ax^2)$ in the x-direction, where a and E_0 are constants. Initially the particle was at rest at x = 0. Other than the initial position the kinetic energy of the particle becomes zero when the distance of the particle from the origin is **[JEE(Mains)-2020]**

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

Q.48 Ten charges are placed on the circumference of a circle of radius R with constant angular separation between successive charges. Alternate charges 1, 3, 5, 7, 9 have charge (+q) each, while 2, 4, 6, 8, 10 have charge (–q) each. The potential V and the electric field E at the centre of the circle are respectively
(Take V = 0 at infinity) **[JEE(Mains)-2020]**

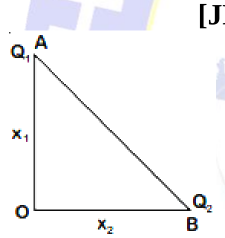
(1) V = 0; E = 0

(2) $V=\frac{10q}{4\pi\varepsilon_0 R};E=\frac{10q}{4\pi\varepsilon_0 R^2}$

(3) $V=\frac{10q}{4\pi\varepsilon_0 R};E=0$

(4) $V=0;E=\frac{10q}{4\pi\varepsilon_0 R^2}$

Q.49 Charges Q_1 and Q_2 are at points A and B of a right angle triangle OAB (see figure). The resultant electric field at point O is perpendicular to the hypotenuse, then Q_1/Q_2 is proportional to **[JEE(Mains)-2020]**



(1) $\frac{x_1^3}{x_2^3}$ (2) $\frac{x_2^2}{x_1^2}$ (3) $\frac{x_1}{x_2}$ (4) $\frac{x_2}{x_1}$

Q.50 Two identical electric point dipoles have dipole moments $\overline{p}_1=p\hat{i}$ and $\overline{p}_2=-p\hat{i}$ and are held on the x axis at distance 'a' from each other. When released, they move along the x-axis with the direction of their dipole moments remaining unchanged. If the mass of each dipole is 'm', their speed when they are infinitely far apart is **[JEE(Mains)-2020]**

(1) $\frac{p}{a}\sqrt{\frac{1}{2\pi\varepsilon_0 ma}}$ (2) $\frac{p}{a}\sqrt{\frac{2}{\pi\varepsilon_0 ma}}$

(3) $\frac{p}{a}\sqrt{\frac{1}{\pi\varepsilon_0 ma}}$ (4) $\frac{p}{a}\sqrt{\frac{3}{2\pi\varepsilon_0 ma}}$

Q.51 Consider the force F on a charge 'q' due to a uniformly charged spherical shell of radius R carrying charge Q distributed uniformly over it. Which one of the following statements is true for F, if 'q' is placed at distance r from the centre of the shell ? **[JEE(Mains)-2020]**

(1) $F=\frac{1}{4\pi\varepsilon_0}\frac{Qq}{r^2}$ for al r

(2) $\frac{1}{4\pi\varepsilon_0}\frac{Qq}{R^2}>F>0$ for r < R

(3) $F=\frac{1}{4\pi\varepsilon_0}\frac{Qq}{r^2}$ for r > R

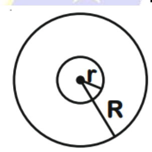
(4) $F=\frac{1}{4\pi\varepsilon_0}\frac{Qq}{R^2}$ for r < R

Q.52 Consider two charged metallic spheres S1 and S_2 of radii R_1 and R_2, respectively. The electric fields E_1 (on S_1) and E_2 (on S_2) on their surfaces are such that $E_1/E_2 = R_1/R_2$. Then the ratio V_1 (on S_1)/V_2(on S_2) of the electrostatic potentials on each sphere is **[JEE(Main)-2020]**

(1) $(R_1/R_2)^2$ (2) (R_2/R_1)

(3) $\left(\frac{R_1}{R_2}\right)^3$ (4) R_1/R_2

Q.53 A charge Q is distributed over two concentric conducting thin spherical shells radii r and R (R > r). If the surface charge densities on the two shells are equal, the electric potential at the common centre is **[JEE(Main)-2020]**



(1) $\frac{1}{4\pi\varepsilon_0}\frac{(R+r)}{R^2+r^2}Q$

(2) $\frac{1}{4\pi\varepsilon_0}\frac{(R+2r)Q}{2(R^2+r^2)}$

(3) $\frac{1}{4\pi\varepsilon_0}\frac{(R+r)}{2(R^2+r^2)}Q$

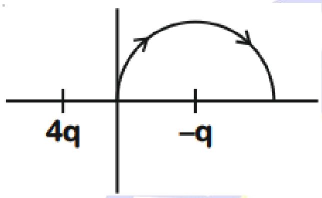
(4) $\frac{1}{4\pi\varepsilon_0}\frac{(2R+r)}{(R^2+r^2)}Q$

Q.54 Concentric metallic hollow spheres of radii R and 4R hold charges Q_1 and Q_2 respectively. Given that surface charge densities of the concentric spheres are equal, the potential difference V(R) – V(4R) is **[JEE(Main)-2020]**

(1) $\frac{3Q_2}{4\pi\varepsilon_0 R}$ (2) $\frac{3Q_1}{16\pi\varepsilon_0 R}$

(3) $\frac{Q_2}{4\pi\varepsilon_0 R}$ (4) $\frac{3Q_1}{4\pi\varepsilon_0 R}$

Q.55 A two point charges 4q and –q are fixed on the x-axis at $x = -\frac{d}{2}$ and , $x = \frac{d}{2}$ respectively. If a third point charge 'q' is taken from the origin to x = d along the semicircle as shown in the figure, the energy of the charge will **[JEE(Main)-2020]**



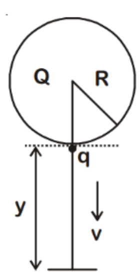
(1) Decrease by $\frac{q^2}{4\pi\varepsilon_0 d}$

(2) Decrease by $\frac{4q^2}{3\pi\varepsilon_0 d}$

(3) Increase by $\frac{2q^2}{3\pi\varepsilon_0 d}$

(4) Increase by $\frac{3q^2}{4\pi\varepsilon_0 d}$

Q.56 A solid sphere of radius R carries a charge Q + q distributed uniformly over its volume. A very small point like piece of it of mass m gets detached from the bottom of the sphere and falls down vertically under gravity. This piece carries charge q. If it acquires a speed v when it has fallen through a vertical height y (see figure), then (assume the remaining portion to be spherical). **[JEE(Main)-2020]**



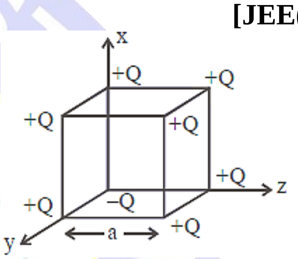
(1) $v^2 = y\left[\frac{qQ}{4\pi\varepsilon_0 R(R+y)} + g\right]b$

(2) $v^2 = 2y\left[\frac{qQR}{4\pi\varepsilon_0 (R+r)^3 m} + g\right]$

(3) $v^2 = y\left[\frac{qQ}{4\pi\varepsilon_0 R^2 ym} + g\right]$

(4) $v^2 = 2y\left[\frac{qQ}{4\pi\varepsilon_0 R(R+y)m} + g\right]$

Q.57 A cube of side a has point charges +Q located at each of its vertices except at the origin, where the charge is –Q. The electric field at the centre of cube is **[JEE(Main)-2021]**



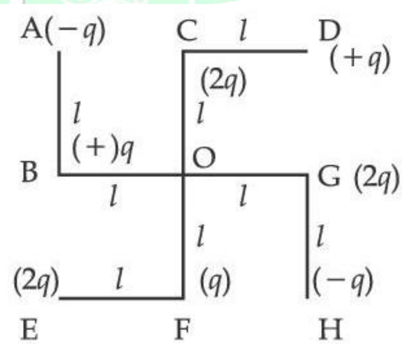
(1) $\frac{-Q}{3\sqrt{3}\pi\varepsilon_0 a^2}(\hat{x}+\hat{y}+\hat{z})$

(2) $\frac{Q}{3\sqrt{3}\pi\varepsilon_0 a^2}(\hat{x}+\hat{y}+\hat{z})$

(3) $\frac{-2Q}{3\sqrt{3}\pi\varepsilon_0 a^2}(\hat{x}+\hat{y}+\hat{z})$

(4) $\frac{2Q}{3\sqrt{3}\pi\varepsilon_0 a^2}(\hat{x}+\hat{y}+\hat{z})$

Q.58 What will be the magnitude of electric field at point O as shown in figure ? Each side of the figure is l and perpendicular to each other. **[JEE(Main)-2021]**



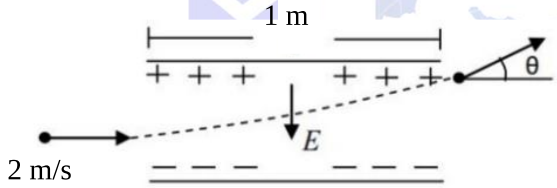
(1) $\frac{1}{4\pi\varepsilon_0}\frac{q}{l^2}$ (2) $\frac{1}{4\pi\varepsilon_0}\frac{q}{(2l^2)}(2\sqrt{2}-1)$

(3) $\frac{q}{4\pi\varepsilon_0(2l)^2}$ (4) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{2l^2}(\sqrt{2})$

Q.59 A positive charge particle of 100 mg is thrown in opposite direction to a uniform electric field of strength 1×10^5 NC^{-1}. If the charge on the particle is 40 μC and the initial velocity is 200 ms^{-1}, how much distance it will travel before coming to the rest momentarily **[JEE(Main)-2021]**

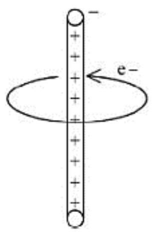
(1) 1 m (2) 5 m
(3) 10 m (4) 0.5 m

Q.60 A uniform electric field E = (8 m/e) V/m is created between two parallel plates of length 1 m as shown in figure, (where, m = mass of electron and e = charge of electron). An electron enters the field symmetrically between the plates with a speed of 2 m/s. The angle of the deviation q of the path of the electron as it comes out of the field will be . **[JEE(Main)-2022]**



(1) $\tan^{-1}(4)$ (2) $\tan^{-1}(2)$
(3) $\tan^{-1}(1/3)$ (4) $\tan^{-1}(3)$

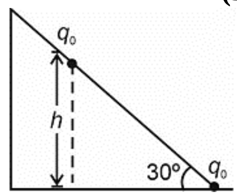
Q.61 An electron revolves around an infinite cylindrical wire having uniform linear charge density 2×10^{-8} C m^{-1} in circular path under the influence of attractive electrostatic field as shown in the figure. The velocity of electron with which it is revolving is ____ $\times 10^6$ m s^{-1}.
Given mass of electron = 9×10^{-31} kg
(JEE Mains-2023)



Q.62 As shown in the figure, a configuration of two equal point charges (q_0 = +2μ C) is placed on an inclined plane. Mass of each point charge is 20 g. Assume that there is no friction between charge and plane. For the system of two point charges to be in equilibrium (at rest) the height h = x × 10^{-3} m. The value of x is ________.

$$\left(\text{Take } \frac{1}{4\pi\varepsilon_0} = 9\times10^9 \text{ N m}^2\text{C}^{-2}, g = 10 \text{ ms}^{-2}\right)$$

(JEE Mains-2023)

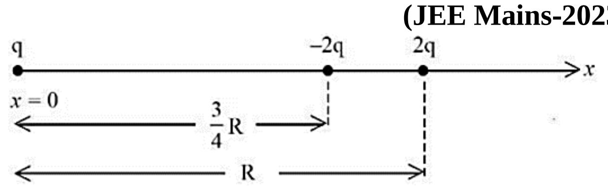


Q.63 Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R. **Assertion A :** If an electric dipole of dipole moment 30×10^{-5} Cm is enclosed by a closed surface, the net flux coming out of the surface will be zero.
Reason R : Electric dipole consists of two equal and opposite charges. In the light of above, statements, Choose the correct answer from the options given below. **(JEE Mains-2023)**
(1) Both A and R are true and R is the correct explanation of A
(2) A is false but R is true
(3) A is true but R is false
(4) Both A and R are true and R is NOT the correct explanation of A

Q.64 64 identical drops each charged upto potential of 10 mV are combined to form a bigger drop. The potential of the bigger drop will be _______ mV.
(JEE Mains-2023)

Q.65 A 10 μC charge is divided into two parts and placed at 1 cm distance so that the repulsive force between them is maximum. The charges of the two parts are: **(JEE Mains-2023)**
(1) 7 μC, 3 μC (2) 8 μC, 2 μC
(3) 5 μC, 5 μC (4) 9 μC, 1 μC

Q.66 Three point charges q, –2q and 2q are placed on x– axis at a distance x = 0, $x = \frac{3}{4}R$ and x = R respectively from origin as shown. If q = 2 × 10^{-6} C and R = 2 cm, the magnitude of net force experienced by the charge –2q is _______ N.
(JEE Mains-2023)



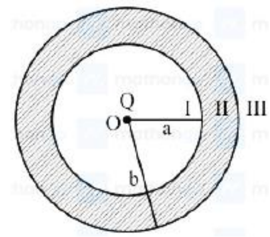
Q.67 Two charges of each magnitude 0.01 C and separated by a distance of 0.4 mm constitute an electric dipole. If the dipole is placed in an uniform electric field.
$\rightarrow$ E' of 10 dyne/C making 30° angle with
$\rightarrow$ E, the magnitude of torque acting on dipole is:
(JEE Mains-2023)
(1) 4.0×10^{-10} Nm (2) 1.0×10^{-8} Nm
(3) 1.5×10^{-9} Nm (4) 2.0×10^{-10} Nm

Q.68 The electric field due to a short electric dipole at a large distance (r) from center of dipole on the equatorial plane varies with distance as :
(JEE Mains-2023)
(1) r (2) $\frac{1}{r^2}$
(3) $\frac{1}{r^3}$ (4) $\frac{1}{r}$

Q.69 A thin infinite sheet charge and an infinite line charge of respective charge densities $+\sigma$ and $+\lambda$ are placed parallel at 5 m distance from each other. Points 'P' and 'Q' are at $\frac{3}{\pi}$ m and $\frac{4}{\pi}$ m perpendicular distances from line charge towards sheet charge, respectively. 'EP' and 'EQ' are the magnitudes of resultant electric field intensities at point 'P' and 'Q', respectively. If $\frac{E_P}{E_Q} = \frac{4}{a}$ for $2|\sigma| = |\lambda|$, then the value of a is ___
(JEE Mains-2023)

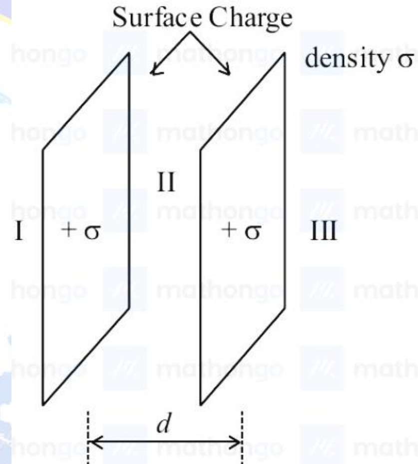
Q.70 For a charged spherical ball, electrostatic potential inside the ball varies with r as $V = 2ar^2 + b$.
Here, a and b are constant and r is the distance from the centre. The volume charge density inside the ball is $-\lambda a\varepsilon$. The value of λ is ___.
e = permittivity of medium.
[JEE Mains-2023(29 Jan. Shift-2)]

Q.71 As shown in the figure, a point charge Q is placed at the centre of conducting spherical shell of inner radius a and outer radius b. the electric field due to charge Q in three different region I, II and III is given by : (I : r < a, II : a < r < b, III : r > b)
[JEE Mains-2023(30 Jan. Shift-2)]



(1) $E_I = 0, E_{II} = 0, E_{III} \neq 0$
(2) $E_I \neq 0, E_{II} = 0, E_{III} \neq 0$
(3) $E_I \neq 0, E_{II} = 0, E_{III} = 0$
(4) $E_I = 0, E_{II} = 0, E_{III} = 0$

Q.72 Let σ be the uniform surface charge density of two infinite thin plane sheets shown in figure. Then the electric fields in three different region E_I, E_{II} and



E_{III} are: **[JEE Mains-2023(01 Feb. Shift-1)]**

(1) $\vec{E}_I = \frac{2\sigma}{\epsilon_0}\hat{n}, \vec{E}_{II} = 0, \vec{E}_{III} = \frac{2\sigma}{\epsilon_0}\hat{n}$

(2) $\vec{E}_I = 0, \vec{E}_{II} = \frac{2\sigma}{\epsilon_0}\hat{n}, \vec{E}_{III} = 0$

(3) $\vec{E}_I = \frac{2\sigma}{2\epsilon_0}\hat{n}, \vec{E}_{II} = 0, \vec{E}_{III} = \frac{2\sigma}{2\epsilon_0}\hat{n}$

(4) $\vec{E}_I = \frac{\sigma}{\epsilon_0}\hat{n}, \vec{E}_{II} = 0, \vec{E}_{III} = \frac{\sigma}{\epsilon_0}\hat{n}$

Q.73 Two equal positive point charges are separated by a distance 2a. The distance of a point from the centre of the line joining two charges on the equatorial line (perpendicular bisector) at which force experienced by a test charge q_0 becomes maximum is $\frac{a}{\sqrt{x}}$. The value of x is _____.
[JEE Mains-2023(01 Feb. Shift-1)]

JEE ADVANCED QUESTION

Q.1 A long, hollow conducting cylinder is kept coaxially inside another long, hollow conducting cylinder of larger radius. Both the cylinders are initially electrically neutral.

[IIT-JEE-2007 (Paper-1)]

(1) A potential difference appears between the two cylinders when a charge density is given to the inner cylinder
(2) A potential difference appears between the two cylinders when a charge density is given to the outer cylinder
(3) No potential difference appears between the two cylinders when a uniform line charge is kept along the axis of the cylinders
(4) No potential difference appears between the two cylinders when same charge density is given to both the cylinders

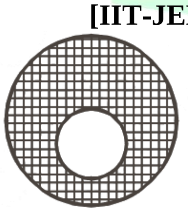
Q.2 Consider a neutral conducting sphere. A positive point charge is placed outside the sphere. The net charge on the sphere is then,

[IIT-JEE-2007 (Paper-1)]

(1) Negative and distributed uniformly over the surface of the sphere
(2) Negative and appears only at the point on the sphere closest to the point charge
(3) Negative and distributed non-uniformly over the entire surface of the sphere
(4) Zero

Q.3 A spherical portion has been removed from a solid sphere having a charge distributed uniformly in its volume as shown in figure. The electric field inside the emptied space is

[IIT-JEE-2007 (Paper-2)]



(1) Zero everywhere
(2) Non-zero and uniform
(3) Non-uniform
(4) Zero only at its centre

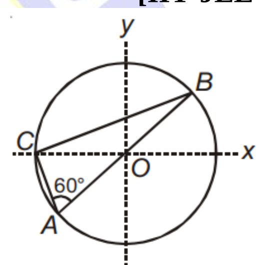
Q.4 Positive and negative point charges of equal magnitude are kept at $\left(0,0\frac{a}{2}\right)$ and $\left(0,0\frac{-a}{2}\right)$, respectively. The work done by the electric field when another positive point charge is moved from (– a, 0, 0) to (0, a, 0) is

[IIT-JEE-2007 (Paper-2)]

(1) Positive
(2) Negative
(3) Zero
(4) Depends on the path connecting the initial and final positions.

Q.5 Consider a system of three charges $\frac{q}{3},\frac{q}{3}$ and $-\frac{2q}{3}$ placed at points A, B and C, respectively, as shown in the figure. Take O to be the centre of the circle of radius R and angle CAB = 60°

[IIT-JEE-2008 (Paper-2)]



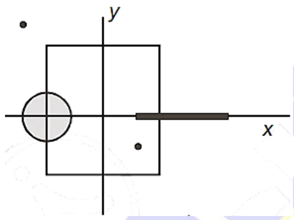
(1) The electric field at point O is $\frac{q}{8\pi\varepsilon_0 R^2}$ directed along the negative x-axis.
(2) The potential energy of the system is zero.
(3) The magnitude of the force between the charges at C and B is $\frac{q^2}{54\pi\varepsilon_0 R^2}$.
(4) The potential at point O is $\frac{q}{12\pi\varepsilon_0 R}$.

Q.6 Three concentric metallic spherical shells of radii R, 2R, 3R, are given charges Q_1,Q_2,Q_3, respectively.; It is found that the surface charge densities on the outer surfaces of the shells are equal. Then, the ratio of the charges given to the shells, Q_1,Q_2,Q_3,is **[IIT-JEE-2009 (Paper-1)]**

(1) 1 : 2 : 3 (2) 1 : 3 : 5
(3) 1 : 4 : 9 (4) 1 : 8 : 18

Q.7 A disk of radius a/4 having a uniformly distributed charge 6 C is placed in the x-y plane with its centre at (– a/2, 0, 0). A rod of length a carrying a uniformly distributed charge 8 C is placed on the x-axis from x = a/4 to x = 5a/4. Two point charges – 7 C and 3 C are placed at (a/4, – a/4, 0) and (– 3a/4 3a/4, 0), respectively. Consider a cubical surface formed by six surfaces x = ± a/2, y = ± a/2, z = ± a/2. The electric flux through this cubical surface is

[IIT-JEE-2009 (Paper-1)]



(1) $\frac{-2C}{\varepsilon_0}$ (2) $\frac{2C}{\varepsilon_0}$

(3) $\frac{10C}{\varepsilon_0}$ (4) $\frac{12C}{\varepsilon_0}$

Q.8 Under the influence of the Coulomb field of charge +Q, a charge –q is moving around it in an elliptical orbit. Find out the correct statement(s) **[IIT-JEE-2009 (Paper-2)]**

(1) The angular momentum of the charge –q is constant

(2) The linear momentum of the charge –q is constant

(3) The angular velocity of the charge –q is constant

(4) The linear speed of the charge –q is constant

Q.9 A tiny spherical oil drop carrying a net charge q is balanced in still air with a vertical uniform electric field of strength $\frac{84\pi}{7}\times10^5\ \text{Vm}^{-1}$. When the field is switched off, the drop is observed to fall with terminal velocity 2×10^{-3} ms^{-1}. Given g = 9.8 ms^{-2} , viscosity of the air = 1.8×10^{-5} Ns m^{-2} and the density of oil = 900 kg m^{-3}, the magnitude of q is **[IIT-JEE-2010 (Paper-2)]**

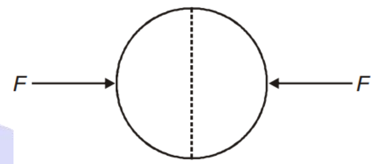
(1) 1.6×10^{-19} C

(2) 3.2×10^{-19} C

(3) 4.8×10^{-19} C

(4) 8.0×10^{-19} C

Q.10 A uniformly charged thin spherical shell of radius R carries uniform surface charge density of σ per unit area. It is made of two hemispherical shells, held together by pressing them with force F (see figure). F is proportional to **[IIT-JEE-2010 (Paper-2)]**



(1) $\frac{1}{\varepsilon_0}\sigma^2R^2$ (2) $\frac{1}{\varepsilon_0}\sigma^2R$

(3) $\frac{1}{\varepsilon_0}\frac{\sigma^2}{R}$ (4) $\frac{1}{\varepsilon_0}\frac{\sigma^2}{R^2}$

Q.11 Which of the following statement(s) is/are correct? **[IIT-JEE-2011 (Paper-2)]**

(1) If the electric field due to a point charge varies as $r^{-2.5}$ instead of r^{-2}, then the gauss's law will still be valid

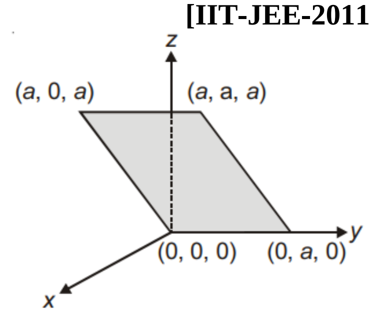
(2) The Gauss law can be used to calculate the field distribution around an electric dipole

(3) If he electric field between two point charges is zero somewhere, then the sign of the two charges is the same

(4) The work done by the external force in moving a unit positive charge from point A at potential VA to point B at potential V_B is (V_B – V_A)

Q.12 Consider an electric field $\vec{E} = E_0\hat{x}$, Where E_0 is a constant. The flux through the shaded area (as shown in the figure) due to this field is

[IIT-JEE-2011 (Paper-1)]



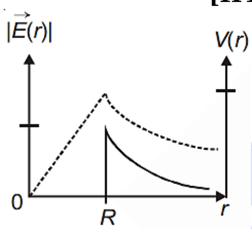
(1) $2E_0a^2$ (2) $\sqrt{2}\,E_0a^2$

(3) E_0a^2 (4) $\dfrac{E_0a^2}{\sqrt{2}}$

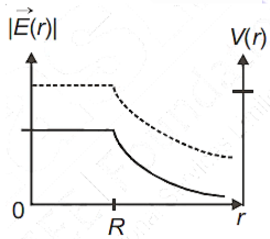
Q.13 Consider a thin spherical shell of radius R with its centre at the origin, carrying uniform positive surface charge density. The variation of the magnitude of the electric field $\left|\vec{E}(r)\right|$ and the electric potential V(r) with the distance r from the centre, is best represented by which graph?

[IIT-JEE-2012 (Paper-1)]

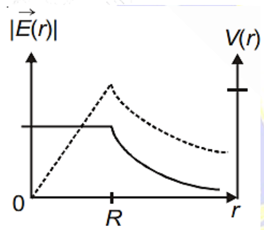
(1)



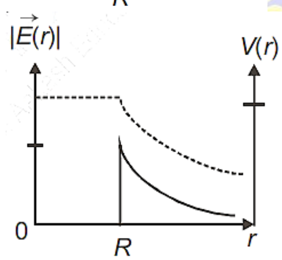
(2)



(3)



(4)



Q.14 Two large vertical and parallel metal plates having a separation of 1 cm are connected to a DC voltage source of potential difference X. A proton is released at rest midway between the two plates. It is found to move at 45° to the vertical JUST after release. Then X is nearly

[IIT-JEE-2012 (Paper-1)]

(1) 1×10^{-5} V (2) 1×10^{-7} V

(3) 1×10^{-9} V (4) 1×10^{-10} V

Q.15 A thin spherical insulating shell of radius R carries a uniformly distributed charge such that the potential at its surface is V_0. A hole with a small area $\alpha 4\pi R^2 (\alpha << 1)$ is made on the shell without affecting the rest of the shell. Which one of the following statements is correct?

[IIT-JEE-2012 (Paper-1)]

(1) The potential at the center of the shell is reduced by $2\alpha V_0$

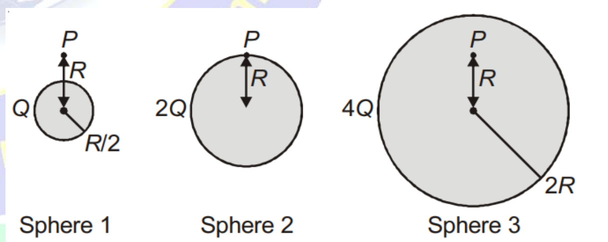
(2) The magnitude of electric field at the center of the shell is reduced by $\dfrac{\alpha V_0}{2R}$

(3) The magnitude of electric field at a point, located on a line passing through the hole and shell's center, on a distance 2R from the center of the spherical shell will be reduced by $\dfrac{\alpha V_0}{2R}$

(4) The ratio of the potential at the center of the shell to that of the point at $\dfrac{1}{2}$R from center towards the hole will be $\dfrac{1-\alpha}{1-2\alpha}$.

Q.16 Charges Q, 2Q and 4Q are uniformly distributed in three dielectric solid spheres 1, 2 and 3 of radii R/2, R and 2R respectively, as shown in figure. If magnitudes of the electric fields at point P at a distance R from the centre of sphere 1, 2 and 3 are E_1, E_2 and E_3 respectively, then

[JEE (Adv)-2014 (Paper-2)]

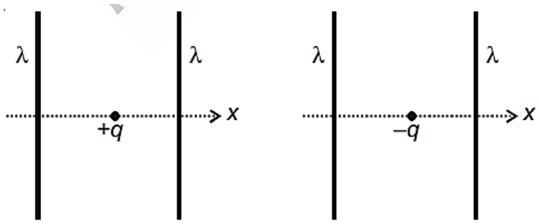


(1) $E_1 > E_2 > E_3$ (2) $E_3 > E_1 > E_2$

(3) $E_2 > E_1 > E_3$ (4) $E_3 > E_2 > E_1$

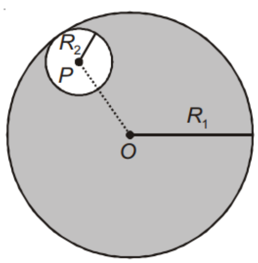
Q.17 The figures below depict two situations in which two infinitely long static line charges of constant positive line charge density λ are kept parallel to each other. In their resulting electric field, point charges q and –q are kept in equilibrium between them. The point charges are confined to move in the x direction only. If they are given a small displacement about their equilibrium positions, then the correct statement(s) is(are)

[JEE (Adv)-2015 (Paper-1)]



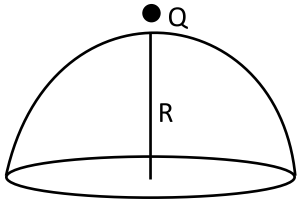
(1) Both charges execute simple harmonic motion.
(2) Both charges will continue moving in the direction of their displacement.
(3) Charge +q executes simple harmonic motion while charge –q continues moving in the direction of its displacement.
(4) Charge –q executes simple harmonic motion while charge +q continues moving in the direction of its displacement.

Q.18 Consider a uniform spherical charge distribution of radius R_1 centred at the origin O. In this distribution, a spherical cavity of radius R_2, centred at P with distance OP = a = $R_1 - R_2$ (see figure) is made. If the electric field inside the cavity at position $\vec{r}$ is $\vec{E}(\vec{r})$, then the correct statement(s) is(are)**[JEE (Adv)-2015 (Paper-2)]**



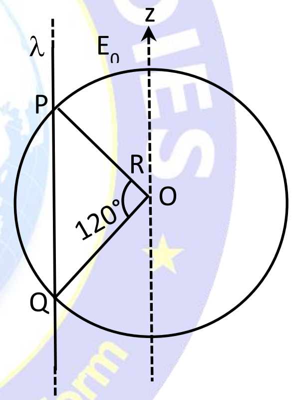
(1) $\vec{E}$ is uniform, its magnitude is independent of R_2 but its direction depends on $\vec{r}$.
(2) $\vec{E}$ is uniform, its magnitude depends on R2 and its direction depends on $\vec{r}$.
(3) $\vec{E}$ is uniform, its magnitude is independent of a but its direction depends on $\vec{a}$.
(4) $\vec{E}$ is uniform and both its magnitude and direction depend on $\vec{a}$.

Q.19 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? **[JEE Advance 2017]**



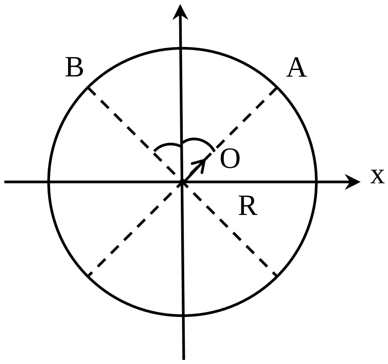
(1) The electric flux passing through the curved surface of the hemisphere is $-\dfrac{Q}{2\in_0}\left(1-\dfrac{1}{\sqrt{2}}\right)$
(2) Total flux through the curved and the flat surfaces is $\dfrac{Q}{\in_0}$
(3) The component of the electric field normal to the surface is constant over the surface
(4) The circumference of the flat surface is an equipotential

Q.20 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 center O of the spherical shell, as shown in the figure. The permittivity of free space is $\in_0$. Which of the following statement is (are) true?
[JEE Advance 2018]



(1) The electric flux through the shell is $\sqrt{3}R\lambda/\in_0$
(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 $\sqrt{2}R\lambda/\in_0$
(4) The electric field is normal to the surface of the shell at all points

Q.21 An electric dipole with dipole moment $\dfrac{p_0}{\sqrt{2}}\left(\hat{i}+\hat{j}\right)$ is held fixed at the origin O in the presence of a 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, ($\in_0$ is the permittivity of the free space, R ≫ dipole size).

[JEE Advance 2019]

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

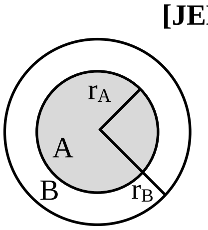
(2) Total electric field at point B is $\vec{E}_B = 0$.

(3) $R = \left(\dfrac{p_0}{4p \in_0 E_0}\right)^{1/3}$

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

Q.22 In the figure, the inner (shaded) region A represents a sphere of radius $r_A = 1$, within which of the electrostatic charge density varies with the radial distance r from the centre as $\rho_A = kr$, where k is positive. In the spherical shell B of outer radius r_B, the electrostatic charge density varies as $\rho_B = \dfrac{2k}{r}$. Assume that dimensions are taken care of. All physical quantities are in their SI units.

[JEE Advance 2022]



Which of the following statements(s) is(are) correct?

(1) If rB = $\sqrt{\dfrac{3}{2}}$, then the electric field is zero everywhere outside B.

(2) If $r_B = \dfrac{3}{2}$, then the electric potential just outside B is $\dfrac{k}{\varepsilon_0}$.

(3) If $r_B = 2$, then the total charge of the configuration is $15\pi k$.

(4) If $r_B = \dfrac{5}{2}$, then the magnitude of the electric field just outside B is $\dfrac{13\pi k}{\varepsilon_0}$.

Q.23 A disk of radius R with uniform positive charge density σ is placed on the xy plane with its center at the origin. The Coulomb potential along the z-axis is

$$v(z) = \frac{\sigma}{2\varepsilon_0}\left(\sqrt{R^2+z^2}-z\right).$$

A particle of positive charge q is placed initially at rest at a point on the z axis with $z = z_0$ and $z_0 > 0$. In addition to the Coulomb force, the particle experiences a vertical force $\vec{F} = -c\hat{k}$ with $c > 0$. Let $\beta = \dfrac{2c\varepsilon_0}{q\sigma}$.

Which of the following statement(s) is(are) correct? **[JEE Advance 2022]**

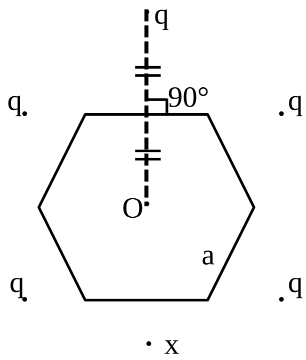
(1) For $\beta = \dfrac{1}{4}$ and $z_0 = \dfrac{25}{7}R$, the particles reaches the origin.

(2) For $\beta = \dfrac{1}{4}$ and $z_0 = \dfrac{3}{7}R$, the particle reaches the origin.

(3) For $\beta = \dfrac{1}{4}$ and $z_0 = \dfrac{R}{\sqrt{3}}$, the particles returns back to $z = z_0$.

(4) For $\beta > 1$ and $z_0 > 0$, the particle always reaches the origin.

Q.24 Six charges are placed around a regular hexagon of side length a as shown in the figure. Five of them have charge q, and the remaining one has charge x. The perpendicular from each charge to the nearest hexagon side passes through the center 0 of the hexagon and is bisected by the side. **[JEE Advance 2022]**



(1) When x = q, the magnitude of the electric field at 0 is zero.

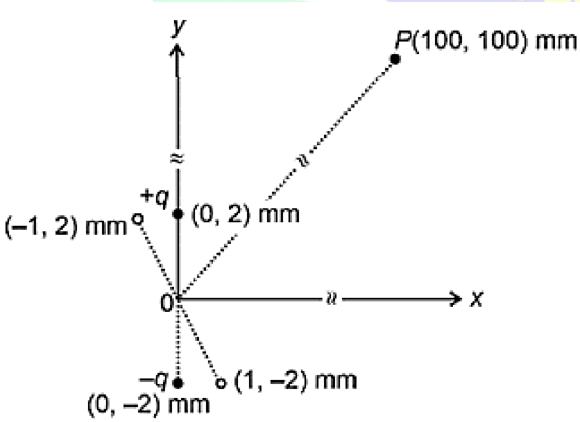
(2) When x = –q, the magnitude of the electric field at 0 is $\frac{q}{6\pi\varepsilon_0 a^2}$.

(3) when x = 2q, the potential at 0 is $\frac{7q}{4\sqrt{3}\pi\varepsilon_0 a}$.

(4) When x = –3q, the potential at 0 is $-\frac{3q}{4\sqrt{3}\pi\varepsilon_0 a}$.

Q.25 An electric dipole is formed by two charges +q and -q located in xy-plane at (0, 2) mm and (0, -2) mm, respectively, as shown in the figure. The electric potential at point P(100, 100) mm due to the dipole is Vo. The charges +q and -q are then moved to the points (-1, 2) mm and (1,-2) mm, respectively. What is the value of electric potential at P due to the new dipole?

[JEE (Adv)-2023 (Paper-2)]



(1) $\frac{V_0}{4}$ (2) $\frac{V_0}{2}$

(3) $\frac{V_0}{\sqrt{2}}$ (4) $\frac{3V_0}{4}$

ANSWER KEY

JEE-FLASHBACK

JEE MAINS QUESTIONS

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans	4	2	4	3	3	4	2	2	1	4	3	1	4	3	2
Que.	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Ans	3	1	1	3	3	3	1	3	3	3	4	4	1	1	4
Que.	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**
Ans	2	1	1	1	4	2	3	3	1	1	4	1	4	3	2
Que.	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
Ans	4	1	1	3	1	3	1	1	2	2	4	3	4	4	2
Que.	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**		
Ans	8	300	1	160	3	5440	4	3	6	12	2	4	2		

JEE ADVANCE QUESTIONS

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans	1	4	2	3	3	2	1	1	4	1	3	3	4	3	4
Que.	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**					
Ans	3	3	4	1,4	1,2	2,3	1,2	1,3,4	1,2,3	2					