# Exercise-3

**✍ Marked Questions can be used as Revision Questions.**

## PART - I : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

**1.** On moving a charge of 20 coulombs by 2 cm, 2 J of work is done, then the potential difference between the points is : **[AIEEE-2002, 4/300]**

(1) 0.1 V (2) 8 V (3) 2 V (4) 0.5 V

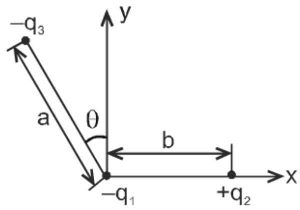
**2.** If a charge q is placed at the centre of the line joining two equal charges Q each such that the system is in equilibrium, then the value of q is : **[AIEEE-2002, 4/300]**

(1) Q / 2 (2) –Q/2 (3) Q / 4 (4) –Q/4

**3.** A thin spherical conducting shell of radius R has a charge q. Another charge Q is placed at the centre of the shell. The electrostatic potential at a point P at a distance R/2 from the centre of the shell is : **[AIEEE-2003, 4/300]**

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

**4.** Three charges $-q_1$, $+q_2$ and $-q_3$ are placed as shown in the figure. The x-component of the force on $-q_1$ is proportional to : **[AIEEE-2003, 4/300]**




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

(3) $\frac{q_2}{b^2} + \frac{q_3}{a^2}\cos\theta$ (4) $\frac{q_2}{b^2} - \frac{q_3}{a^2}\sin\theta$

**5.** If the electric flux entering and leaving an enclosed surface respectively is $\varphi_1$ and $\varphi_2$, the electric charge inside the surface will be : **[AIEEE-2003, 4/300]**

(1) $(\varphi_2 - \varphi_1)\varepsilon_0$ (2) $(\varphi_1 + \varphi_2)/\varepsilon_0$ (3) $(\varphi_2 - \varphi_1)/\varepsilon_0$ (4) $(\varphi_1 + \varphi_2)\varepsilon_0$

**6.** Two spherical conductors B and C having equal radii and carrying equal charges repel each other with a force F when kept apart at some distance. A third spherical conductor having same radius as that of B but uncharged is brought in contact with B, then brought in contact with C and finally removed away from both. The new force of repulsion between B and C is : **[AIEEE-2004, 4/300]**

(1) $\frac{F}{4}$ (2) $\frac{3F}{4}$ (3) $\frac{F}{8}$ (4) $\frac{3F}{8}$

**7.** 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 : **[AIEEE-2004, 4/300]**


(1) r (2) 2r (3) $\frac{r}{2}$ (4) $\frac{r}{4}$

**8.** 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: **[AIEEE-2004, 4/300]**

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

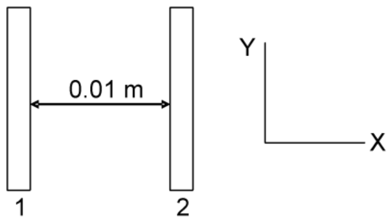
**9.** A charged oil drop is suspended in uniform field of $3 \times 10^4$ V/m so that it neither falls nor rises. The charge on the drop will be :
(take the mass of the charge = $9.9 \times 10^{-15}$ kg, g = 10m/s$^2$) **[AIEEE-2004, 4/300]**

(1) $3.3 \times 10^{-18}$ C (2) $3.2 \times 10^{-18}$ C (3) $1.6 \times 10^{-18}$ C (4) $4.8 \times 10^{-18}$ C

**10.** An electric dipole is placed at an angle of 30º to a non-uniform electric field. The dipole will experience **[AIEEE-2006, 4/220]**

(1) A torque as well as a translational force.
(2) A torque only.
(3) A translational force only in the direction of the field.
(4) A translational force only in a direction normal to the direction of the field.

**11.** Two insulating plates are both uniformly charged in such a way that the potential difference between them is $V_2 - V_1 = 20$ V. (i.e. plate 2 is at a higher potential). The plates are separated by d = 0.01 m and can be treated as infinitely large. An electron is released from rest on the inner surface of plate 1. What is its speed when it hits plate 2?




($e = 1.6 \times 10^{-19}$ C, $m_e = 9.11 \times 10^{-31}$ kg) **[AIEEE-2006, 4/220]**

(1) $1.87 \times 10^6$ m/s
(2) $32 \times 10^{-19}$ m/s
(3) $2.65 \times 10^6$ m/s
(4) $7.02 \times 10^{12}$ m/s

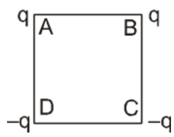
**12.** Two spherical conductors A and B of radii 1 mm and 2mm are separated by a distance of 5 cm and are uniformly charged. If the spheres are connected by a conducting wire then in equilibrium condition, the ratio of the magnitude of the electric fields at the surfaces of sphere A and B is : **[AIEEE-2006, 4/220]**

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

**13.** An electric charge $10^{-3}\mu$C is placed at the origin (0,0) of X–Y co-ordinate system. Two points A and B are situated at $(\sqrt{2},\sqrt{2})$ and (2,0) respectively. The potential difference between the points A and B will be **[AIEEE-2007, 3/120]**

(1) 9 volt (2) zero (3) 2 volt (4) 4.5 volt

**14.** Charges are placed on the vertices of a square as shown. Let $\vec{E}$ be the electric field and V the potential at the centre. If the charges on A and B are interchanged with those on D and C respectively, then **[AIEEE-2007, 3/120]**

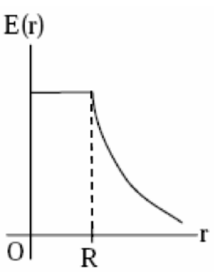


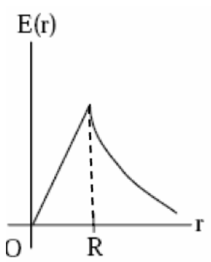

(1) $\vec{E}$ remains unchanged, V changes
(2) Both $\vec{E}$ and V change
(3) $\vec{E}$ and V remain unchanged
(4) $\vec{E}$ changes, V remains unchanged

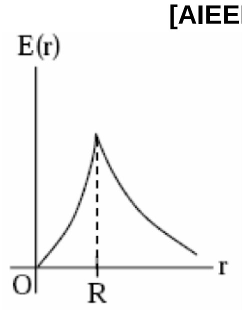
**15.** The potential at a point x (measured in μm) due to some charges situated on the x-axis is given by $V(x) = 20/(x^2 - 4)$ volts. The electric field E at x = 4 μm is given by : **[AIEEE-2007, 3/120]**

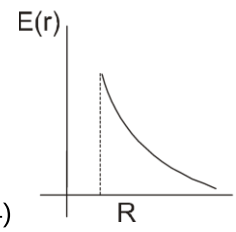
(1) 5/3 volt/μm and in the –ve x direction
(2) 5/3 volt/μm and in the +ve x direction
(3) 10/9 volt/μm and in the –ve x direction
(4) 10/9 volt/μm and in the +ve x direction

**16.** A thin spherical shell of radius R has charge Q spread uniformly over its surface. Which of the following graphs most closely represents the electric field E (r) produced by the shell in the range $0 \le r < \infty$, where r is the distance from the centre of the shell? **[AIEEE-2008, 3/105]**

(1) 


(2) 


(3) 


(4) 


**17.** Two points 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, 4/144]**

(1) $9.60 \times 10^{-17}$ J (2) $-2.24 \times 10^{-16}$ J (3) $2.24 \times 10^{-16}$ J (4) $-9.60 \times 10^{-17}$ J

**18.** 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 : **[AIEEE-2009, 4/144]**

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

**19.** Statement 1 : 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.

**[AIEEE-2009, 6/144]**

Statement 2 : The net work done by a conservative force on an object moving along a closed loop is zero.

(1) Statement-1 is true, Statement-2 is true; Statement-2 is the correct explanation of Statement-1.

(2) Statement-1 is true, Statement-2 is true; Statement-2 is not the correct explanation of Statement-1.

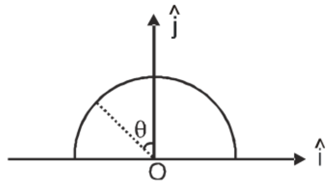
(3) Statement-1 is false, Statement-2 is true.

(4) Statement-1 is true, Statement-2 is false.

**20.** 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 sphere, the magnitude of electric field is: **[AIEEE-2009, 4/144]**

(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

**21.** 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-2010, 4/144]**




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

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

**22.** Let there be a spherically symmetric charge distribution with charge density varying as $\rho(r) = \rho_0\left(\frac{5}{4} - \frac{r}{R}\right)$ upto 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, 4/144]**

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

**23.** Two identical charged spheres are suspended by strings of equal lengths. The strings make an angle of 30º 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, 8/144]**

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

**24.** The electrostatic potential inside a charged spherical ball is given by $\varphi = ar^2 + b$ where r is the distance from the centre; a,b are constants. Then the charge density inside the ball is **[AIEEE - 2011, 4/120, –1]**

(1) $-24\pi a\varepsilon_0 r$ (2) $-6\pi a\varepsilon_0 r$ (3) $-24\pi a\varepsilon_0$ (4) $-6 a\varepsilon_0$

**25.** Two identical charged spheres suspended from a common point by two massless strings of length $\ell$ are initially a distance d(d < < $\ell$) apart becuase of their mutual repulsion. The charge begins to leak from both the spheres at a constant rate. As a result the charges approach each other with a velocity $\upsilon$. Then as a function of distance x between them : **[AIEEE - 2011, 4/120, –1]**

(1) $\upsilon \propto x^{-1/2}$ (2) $\upsilon \propto x^{-1}$ (3) $\upsilon \propto x^{1/2}$ (4) $\upsilon \propto x$

**26.** 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, 11 May; 4/120, –1]**

(1) zero

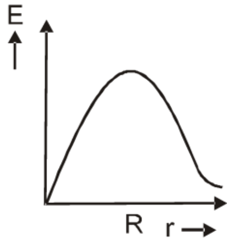
(2) $\frac{1}{4\pi\varepsilon_0}\frac{2qQ}{a}\left(1+\frac{1}{\sqrt{5}}\right)$

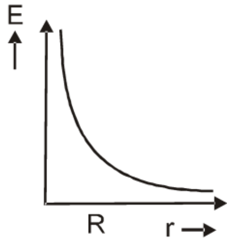
(3) $\frac{1}{4\pi\varepsilon_0}\frac{2qQ}{a}\left(1-\frac{2}{\sqrt{5}}\right)$

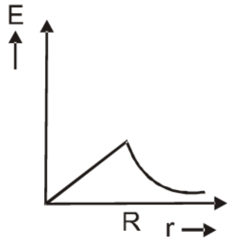
(4) $\frac{1}{4\pi\varepsilon_0}\frac{2qQ}{a}\left(1-\frac{1}{\sqrt{5}}\right)$

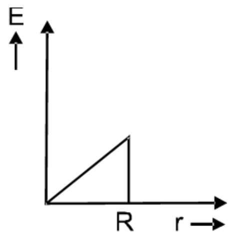
**27.** In a uniformly charged sphere of total charge Q and radius R, the electric field E is plotted as function of distance from the centre. The graph which would correspond to the above will be :

**[AIEEE 2012, ; 4/120, –1]**

(1) 


(2) 


(3) 


(4) 


**28.** This questions has statement-1 and statement-2. Of the four choices given after the statements, choose the one that best describe the two statements.
An insulating solid sphere of radius R has a unioformly positive charge density $\rho$. 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 infinite is zero.
**Statement-1 :** When a charge 'q' is take from the centre to the surface of the sphere its potential energy changes by $\frac{q\rho}{3\varepsilon_0}$.

**[AIEEE 2012, ; 4/120, –1]**

**Statement-2 :** The electric field at a distance r (r < R) from the centre of the sphere is $\frac{\rho r}{3\varepsilon_0}$.

(1) Statement-1 is true, Statement-2 is true; Statement-2 is not the correct explanation of statement-1.
(2) Statement 1 is true Statement 2 is false.
(3) Statement 1 is false Statement 2 is true.
(4) Statement 1 is true, Statement 2 is true, Statement 2 is the correct explanation of Statement 1.

**29.** 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(Main)-2013; 4/120, –1]**

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

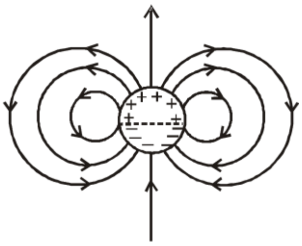
**30.** A charge Q is uniformly distributed over a long rod AB of length L as shown in the figure. The electric potential at the point O lying at distance L from the end A is : **[JEE(Main)-2013; 4/120, –1]**


(1) $\frac{Q}{8\pi\epsilon_0 L}$
(2) $\frac{3Q}{4\pi\epsilon_0 L}$
(3) $\frac{Q}{4\pi\epsilon_0 L\ln 2}$
(4) $\frac{Q\ln 2}{4\pi\epsilon_0 L}$

**31.** Assume that an electric field $\vec{E} = 30x^2\hat{i}$ exists in space. Then the potential difference $V_A - V_O$, where $V_O$ is the potential at the origin and $V_A$ the potential at x = 2 m is : **[JEE(Main)-2014 ; 4/120. –1]**

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

**32.** A long cylindrical shell carries positive surface charge $\sigma$ in the upper half and negative surface charge $-\sigma$ in the lower half. The electric field lines around the cylinder will look like figure given in :
(figures are schematic and not drawn to scale) **[JEE(Main)-2015; 4/120, –1]**

(1)


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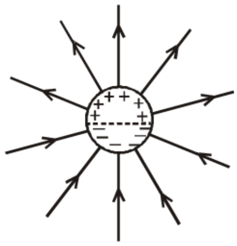

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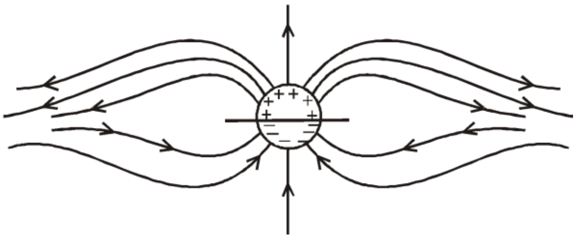
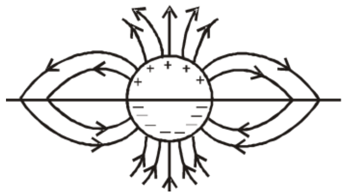


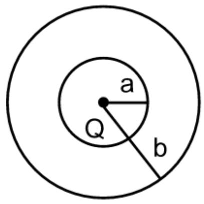
(4)


**33.*** A uniformly charged solid sphere of radius R has potential $V_0$ (measured with respect to $\infty$) 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 **[JEE(Main)-2015; 4/120, –1]**

(1) $R_1 = 0$ and $R_2 > (R_4 - R_3)$ (2) $R_1$ 0 and $(R_2 - R_1) > (R_4 - R_3)$

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

**34.** 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(Main) 2016; 4/120, –1]**




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

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

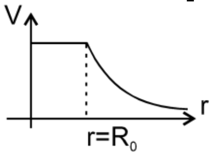
**35.** An electric dipole has a fixed dipole moment $\vec{p}$, which makes angle $\theta$ with respect to x-axis. When subjected to an electric field $\vec{E_1} = E\hat{i}$, it experiences a torque $\vec{T_1} = \tau\hat{k}$. When subjected to another electric field $\vec{E_2} = \sqrt{3}E_1\hat{j}$ it experiences a torque $\vec{T_2} = -\vec{T_1}$. The angle $\theta$ is : **[JEE(Main)-2017; 4/120, –1]**

(1) 90° (2) 30° (3) 45° (4) 60°

## PART - II : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

*** Marked Questions may have more than one correct option.**

**1.✍*** For spherical symmetrical charge distribution, variation of electric potential with distance from centre is given in diagram. Given that : **[JEE 2006, 5/184]**




V = $\frac{q}{4\pi\varepsilon_0 R_0}$ for r $R_0$ and V = $\frac{q}{4\pi\varepsilon_0 r}$ for $r \geq R_0$.

Then which option(s) are correct :

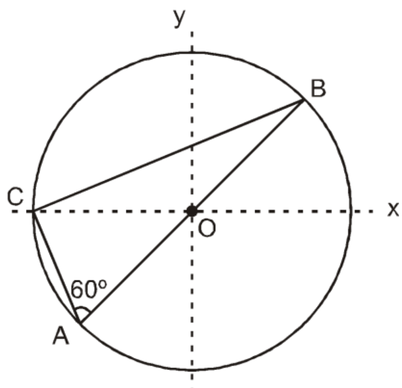
(A) Total charge within $2R_0$ is q.
(B) Total electrostatic energy for $r \leq R_0$ is zero.
(C) At $r = R_0$ electric field is dicontinuous.
(D) There will be no charge anywhere except at $r = R_0$

**2.✍** A long hollow conducting cylinder is kept coaxially inside another long, hollow conducting cylinder of larger radius. Both the cylinders are initially electrically neutral. **[JEE 2007, 3/184]**
(A) A potential difference appears between the two cylinders when a charge density is given to the inner cylinder.
(B) A potential difference appears between the two cylinders when a charge density is given to the outer cylinder.
(C) No potential difference appears between the two cylinders when a uniform line charge is kept along the axis of the cylinders.
(D) No potential difference appears between the two cylinders when same charge density is given to both the cylinders.

**3.** Consider a neutral conducting sphere. A positive point charge is placed outside the sphere. The net charge on the sphere is then, **[JEE 2007, 3/184]**
(A) negative and distributed uniformly over the surface of the sphere
(B) negative and appears only at the point on the sphere closest to the point charge
(C) negative and distributed non-uniformly over the entire surface of the sphere
(D) zero

**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 **[JEE 2007, 3/184]**
(A) positive (B) negative (C) zero
(D) depends on the path connecting the initial and final positions.

**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 = 60º **[JEE 2008, 3/163]**



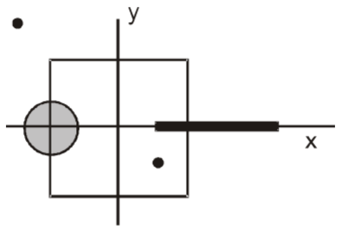

(A) The electric field at point O is $\frac{q}{8\pi\varepsilon_0 R^2}$ directed along the negative x-axis
(B) The potential energy of the system is zero
(C) The magnitude of the force between the charges at C and B is $\frac{q^2}{54\pi\varepsilon_0 R^2}$
(D) The potential at point O is $\frac{q}{12\pi\varepsilon_0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

**6.** **STATEMENT -1**

For practical purposes, the earth is used as a reference at zero potential in electrical circuits.
and
**STATEMENT -2**
The electrical potential of a sphere of radius R with charge Q uniformly distributed on the surface is given by $\frac{Q}{4\pi\varepsilon_0 R}$. **[JEE -2008, 3 –1/163]**

(A) STATEMENT -1 is True, STATEMENT -2 is True; STATEMENT -2 is a correct explanation for STATEMENT -1
(B) STATEMENT -1 is True, STATEMENT -2 is True; STATEMENT -2 is NOT a correct explanation for STATEMENT -1
(C) STATEMENT -1 is True, STATEMENT -2 is False
(D) STATEMENT -1 is False, STATEMENT -2 is True.

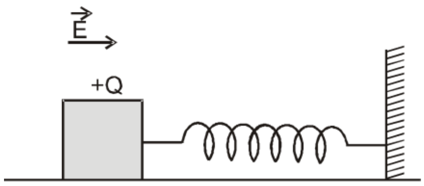
**7.** A disk of radius a/4 having a uniformly distributed charge 6C is placed in the x-y plane with its centre at (–a/2, 0, 0). A rod of length a carrying a uniformly distributed charge 8C is placed on the x-axis from x = a/4 to x = 5a/4. Two point charges –7C and 3C are placed at (a/4, –a/4, 0) and (–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 **[JEE -2009, 3/160, –1]**




(A) $\frac{-2C}{\varepsilon_0}$ (B) $\frac{2C}{\varepsilon_0}$ (C) $\frac{10C}{\varepsilon_0}$ (D) $\frac{12C}{\varepsilon_0}$

**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). [Electrostatics] **[JEE -2009, 4/160, –1]**
(A) The angular momentum of the charge –q is constant
(B) The linear momentum of the charge –q is constant
(C) The angular velocity of the charge – q is constant
(D) The linear speed of the charge –q is constant

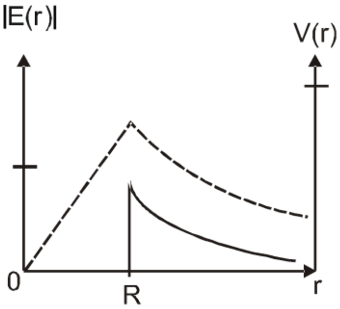
**9.** A wooden block performs SHM on a frictionless surface with frequency, $\nu_0$. The block carries a charge +Q on its surface. If now a uniform electric field $\vec{E}$ is switched-on as shown, then the SHM of the block will be **[JEE-2011, 3/160, –1]**

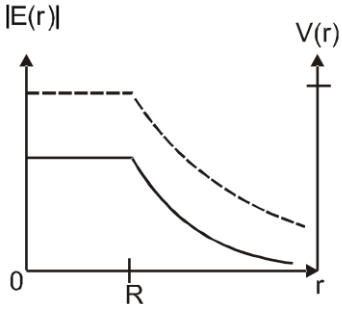


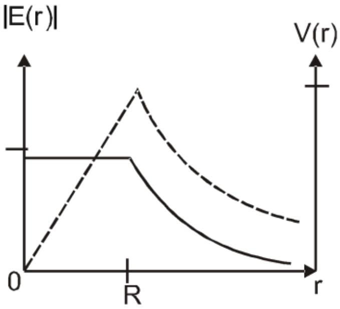

(A) of the same frequency and with shifted mean position.
(B) of the same frequency and with the same mean position.
(C) of changed frequency and with shifted mean position.
(D) of changed frequency and with the same mean position.

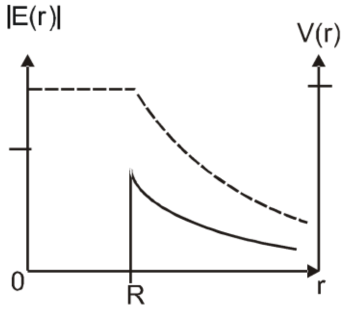
**10.** Which of the following statement(s) is/are correct? **[JEE-2011, 4/160 ]**
(A) If the electric field due to a point charge varies as $r^{-2.5}$ instead of $r^{-2}$, then the Gauss law will still be valid.
(B) The Gauss law can be used to calculate the field distribution around an electric dipole.
(C) If the electric field between two point charges is zero somewhere, then the sign of the two charges is the same.
(D) The work done by the external force in moving a unit positive charge from point A at potential $V_A$ to point B at potential $V_B$ is ($V_B$ — $V_A$).

**11.** 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 $|\vec{E}(r)|$ and the electric potential V(r) with the distance r from the centre, is best represented by which graph?**[JEE-2012, Paper-1 : 3/70, –1]**

(A) 

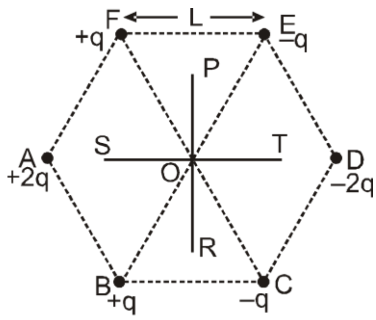

(B) 


(C) 


(D) 


**12.✍*** 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?

**[JEE-2012, Paper-1 : 4/66]**




(A) The elecric field at O is 6K along OD

(B) The potential at O is zero

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

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

**13.✍*** Two non-conducting solid spheres of radii R and 2R, having uniform volume charge densities $\rho_1$ and $\rho_2$ 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

**[JEE(Advanced)-2013, P-1 : 4/60, –1]**

(A) –4 (B) $-\frac{32}{25}$ (C) $\frac{32}{25}$ (D) 4

**14.*✍** 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 :

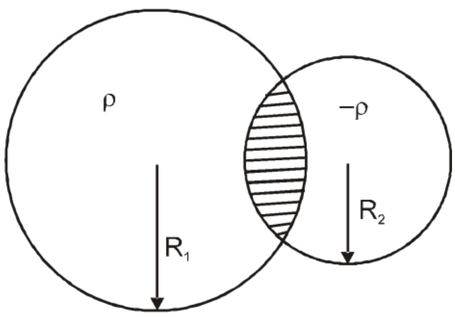
**[JEE(Advanced)-2013, P-2: 3/60,–1]**

(A) the electrostatic field is zero

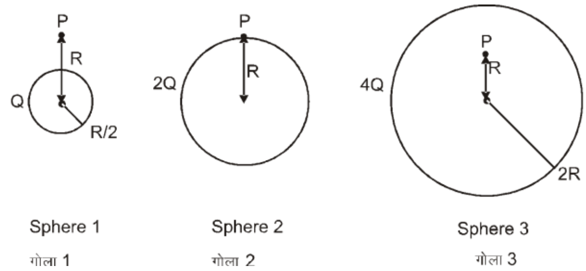
(B) the electrostatic potential is constant

(C) the electrostatic field is constant in magnitude

(D) the electrostatic field has same direction




**15.✍** 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 spheres 1, 2 and 3 are $E_1$ $E_2$ and $E_3$ respectively, then **[JEE(Advanced)-2014, 3/60, –1]**



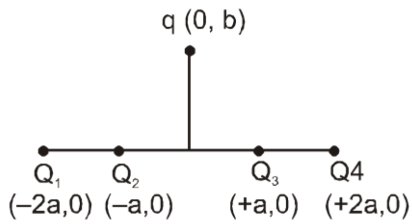

(A) $E_1 > E_2 > E_3$ (B) $E_3 > E_1 > E_2$ (C) $E_2 > E_1 > E_3$ (D) $E_3 > E_2 > E_1$

**16.** Let $E_1(r)$, $E_2(r)$ and $E_3(r)$ be the respective electric fields at a distance r from a point charge Q, an infinitely long wire with constant linear charge density $\lambda$, and an infinite plane with uniform surface charge density $\sigma$. if $E_1(r_0) = E_2(r_0) = E_3(r_0)$ at a given distance $r_0$, then **[JEE (Advanced)-2014,P-1, 3/60]**

(A) $Q = 4\sigma\pi r_0^2$ (B) $r_0 = \frac{\lambda}{2\pi\sigma}$

(C) $E_1(r_0/2) = 2E_2(r_0/2)$ (D) $E_2(r_0/2) = 4E_3(r_0/2)$

**17.** Four charge $Q_1, Q_2, Q_3$, 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-1 with List-II and select the correct answer using the code given below the lists. **[JEE (Advanced)-2014, 3/60, –1]**




| | **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 |

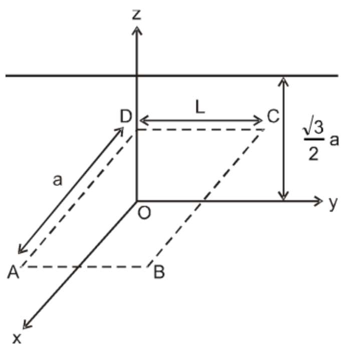
**Code :**

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

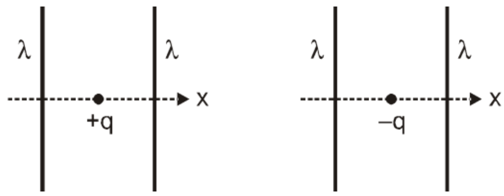
(C) P-3, Q-1, R-2,S-4 (D) P-4, Q-2, R-1, S-3

**18.** An infinitely long uniform line charge distribution of charge per unit length $\lambda$ 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 $\frac{\lambda L}{n\varepsilon_0}$ ($\varepsilon_0$ = permittivity of free space), then the value of n is :

**[JEE(Advanced) 2015 ; P-1, 4/88]**




**19.** The figures below depict two situations in which two infinitely long static line charges of constant positive line charge density $\lambda$ 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 dispacement about their equilibrium positions, then the



correct ststement(s) is (are) :

**[JEE(Advanced) 2015 ; 4/88, –2]**

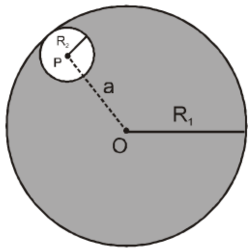
(A) Both charges execute simple harmonic motion.

(B) Both charges will continue moving in the direction of their displacement.

(C) Charge +q executes simple haramonic motion while charge –q continues moving in the direction of its displacement.

(D) Charge –q executes simple haramonic motion while charge +q continues moving in the direction of its displacement.

**20.** Consider a uniform speherical 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(Advanced) 2015 ; P-2, 4/88, –2]**

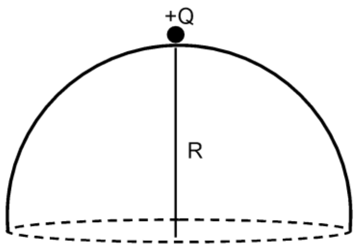
(A) $\vec{E}$ is uniform, its magnitude is independent of $R_2$ but its direction depends on $\vec{r}$

(B) $\vec{E}$ is uniform, its magnitude independs of $R_2$ and its direction depends on $\vec{r}$

(C) $\vec{E}$ is uniform, its magnitude is independent of a but its direction depends on $\vec{a}$

(D) $\vec{E}$ is uniform, and both its magnitude and direction depends on $\vec{a}$

**21.** 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(Advanced)-2017 ; 4/61, –2]**




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

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

(C) The circumference of the flat surface is an equipotential

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

## Answers

### EXERCISE # 1

**Section (A) :**

**A-1.** (2) **A-2.** (1) **A-3.** (1)

**A-4.** (1) **A-5.** (1) **A-6.** (3)

**A-7.** (2) **A-8.** (3) **A-9.** (4)

**A-10.** (1) **A-11.** (3)

**Section (B) :**

| | | | | | |
|---|---|---|---|---|---|
| **B-1.** | (4) | **B-2.** | (2) | **B-3.** | (3) |
| **B-4.** | (3) | **B-5.** | (3) | **B-6.** | (2) |
| **B-7.** | (3) | **B-8.** | (3) | **B-9.** | (1) |
| **B-10.** | (4) | **B-11.** | (4) | **B-12.** | (4) |
| **B-13.** | (2) | **B-14.** | (3) | **B-15.** | (2) |

**Section (C) :**

| | | | | | |
|---|---|---|---|---|---|
| **C-1.** | (1) | **C-2.** | (2) | **C-3.** | (2) |
| **C-4.** | (1) | **C-5.** | (3) | **C-6.** | (2) |
| **C-7.** | (1) | **C-8.** | (4) | **C-9.** | (1) |
| **C-10.** | (2) | **C-11.** | (3) | **C-12.** | (3) |
| **C-13.** | (3) | **C-14.** | (2) | **C-15.** | (1) |
| **C-16.** | (2) | **C-17.** | (3) | **C-18.** | (1) |
| **C-19.** | (2) | **C-20.** | (4) | **C-21.** | (1) |
| **C-22.** | (1) | **C-23.** | (2) | **C-24.** | (3) |
| **C-25.** | (4) | **C-26.** | (3) | **C-27.** | (2) |

**Section (D) :**

| | | | | | |
|---|---|---|---|---|---|
| **D-1.** | (2) | **D-2.** | (3) | **D-3.** | (2) |
| **D-4.** | (4) | **D-5.** | (2) | **D-6.** | (4) |

**Section (E) :**

| | | | | | |
|---|---|---|---|---|---|
| **E-1.** | (4) | **E-2.** | (4) | **E-3.** | (1) |

**Section (F) :**

| | | | |
|---|---|---|---|
| **F-1.** | (4) | **F-2.** | (4) |

**Section (G) :**

| | | | | | |
|---|---|---|---|---|---|
| **G-1.** | (4) | **G-2.** | (3) | **G-3.** | (1) |
| **G-4.** | (4) | **G-5.** | (3) | | |

**Section (H) :**

| | | | | | |
|---|---|---|---|---|---|
| **H-1.** | (4) | **H-2.** | (2) | **H-3.** | (1) |
| **H-4.** | (3) | **H-5.** | (2) | **H-6.** | (1) |
| **H-7.** | (2) | **H-8.** | (2) | **H-9.** | (3) |

**Section (I) :**

| | | | | | |
|---|---|---|---|---|---|
| **I-1.** | (1) | **I-2.** | (2) | **I-3.** | (3) |
| **I-4.** | (4) | | | | |

**Section (J) :**

| | | | | | |
|---|---|---|---|---|---|
| **J-1.** | (2) | **J-2.** | (3) | **J-3.** | (2) |
| **J-4.** | (4) | **J-5.** | (1) | **J-6.** | (3) |
| **J-7.** | (3) | **J-8.** | (2) | **J-9.** | (3) |
| **J-10.** | (4) | **J-11.** | (1) | **J-12.** | (3) |
| **J-13.** | (3) | **J-14.** | (1) | **J-15.** | (1) |
| **J-16.** | (2) | **J-17.** | (1) | | |

## EXERCISE # 2

### PART - I

| | | | | | |
|---|---|---|---|---|---|
| **1.** | (4) | **2.** | (1) | **3.** | (1) |
| **4.** | (2) | **5.** | (3) | **6.** | (4) |
| **7.** | (1) | **8.** | (1) | **9.** | (2) |
| **10.** | (1) | **11.** | (2) | **12.** | (3) |
| **13.** | (2) | **14.** | (3) | **15.** | (4) |
| **16.** | (1) | **17.** | (3) | **18.** | (1) |
| **19.** | (3) | **20.** | (1) | **21.** | (1) |
| **22.** | (2) | **23.** | (2) | **24.** | (3) |
| **25.** | (1) | **26.** | (3) | **27.** | (2) |
| **28.** | (1) | **29.** | (2) | **30.** | (4) |
| **31.** | (3) | **32.** | (3) | **33.** | (4) |
| **34.** | (1) | **35.** | (4) | **36.** | (1) |
| **37.** | (2) | **38.** | (3) | **39.** | (2) |
| **40.** | (4) | **41.** | (1) | **42.** | (2) |
| **43.** | (2) | | | | |

### PART - II

**Section (A) :**

| | | | | | |
|---|---|---|---|---|---|
| **A-1.** | (1) | **A-2.** | (1) | **A-3.** | (1) |
| **A-4.** | (2) | | | | |

**Section (B) :**

**B-1.** (1) → (R), (2) → (S), (3) → (Q), (4) → (P)

**B-2.** (1) → S; (2) → R; (3) → Q; (4) → P

**Section (C) :**

| | | | | | |
|---|---|---|---|---|---|
| **C-1.** | (1,3,4) | **C-2.** | (1,3) | **C-3.** | (2,3) |
| **C-4.** | (1,4) | **C-5.** | (1,2,3,4) | | |

## EXERCISE # 3

### PART- I

| | | | | | |
|---|---|---|---|---|---|
| **1.** | (1) | **2.** | (4) | **3.** | (3) |
| **4.** | (2) | **5.** | (1) | **6.** | (4) |
| **7.** | (4) | **8.** | (2) | **9.** | (1) |
| **10.** | (1) | **11.** | (3) | **12.** | (1) |
| **13.** | (2) | **14.** | (4) | **15.** | (4) |
| **16.** | (4) | **17.** | (3) | **18.** | (4) |
| **19.** | (1) | **20.** | (2) | **21.** | (3) |
| **22.** | (2) | **23.** | (3) | **24.** | (4) |
| **25.** | (1) | **26.** | (4) | **27.** | (3) |
| **28.** | (3) | **29.** | (1) | **30.** | (4) |
| **31.** | (3) | **32.** | (1) | **33.** | (3,4) |
| **34.** | (4) | **35.** | (4) | | |

### PART- II

| | | | | | |
|---|---|---|---|---|---|
| **1.** | (CD) | **2.** | (A) | **3.** | (D) |
| **4.** | (C) | **5.** | (C) | **6.** | (B) |
| **7.** | (A) | **8.** | (A) | **9.** | (A) |
| **10.** | (C) | **11.** | (D) | **12.** | (ABC) |
| **13.** | (BD) | **14.** | (CD) | **15.** | (C) |
| **16.** | (C) | **17.** | (A) | **18.** | 6 |
| **19.** | (C) | **20.** | (D) | **21.** | (CD) |