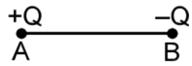
# Exercise-2

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

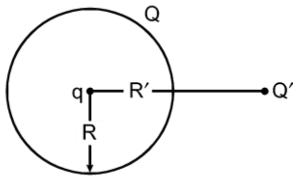
## PART - I : OBJECTIVE QUESTIONS

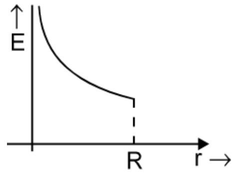
**1.** Two point charges of the same magnitude and opposite sign are fixed at points A and B. A third small point charge is to be balanced at point P by the electrostatic force due to these two charges. The point P :

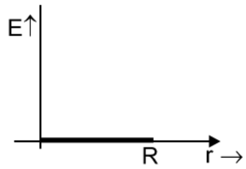


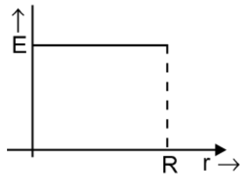

(1) lies on the perpendicular bisector of line AB (2) is at the mid point of line AB
(3) lies to the left of A (4) none of these.

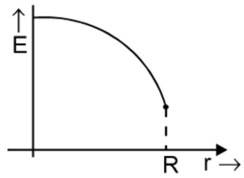
**2.✍** A charge ' q ' is placed at the centre of a conducting spherical shell of radius R, which is given a charge Q. An external charge Q′ is also present at distance R′ (R′ > R) from ' q '. Then the resultant field will be best represented for region r < R by :
[where r is the distance of the point from q]



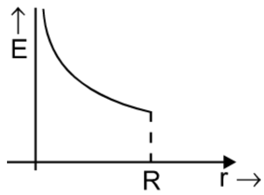

(1) 

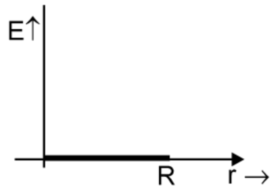

(2) 

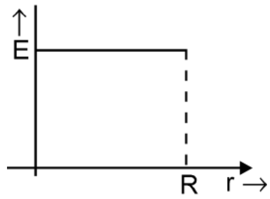

(3) 

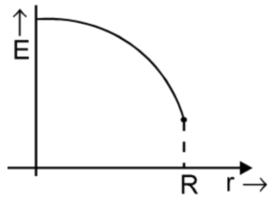

(4) 


**3.** In the above question if Q' is removed then which option is correct :

(1) 


(2) 

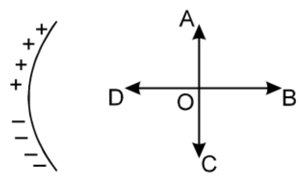

(3) 


(4) 


**4.✍** The electric field near the centre of a uniformly charged nonconducting disc is E. If the nonconducting disc is now replaced by a conducting disc, with the charge same as before, the new electric field at the same point is

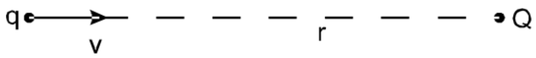
(1) 2E (2) E (3) E/2 (4) None of these

**5.** The linear charge density on upper half of a segment of ring is  and at lower half it is . The direction of electric field at centre O of ring is :



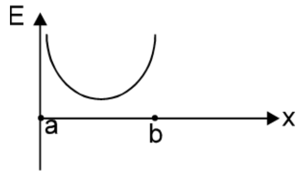

(1) along OA (2) along OB
(3) along OC (4) along OD

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




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

**7.** Two point charges a & b whose magnitudes are same are positioned at a certain distance from each other, a is at origin. Graph is drawn between electric field strength  at points between a & b and distance x from a. E is taken positive if it is along the line joining from a to b. From the graph it can be decided that

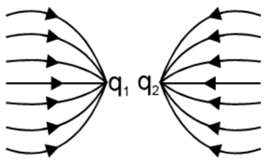



(1) a is positive, b is negative  (2) a and b both are positive
(3) a and b both are negative  (4) a is negative, b is positive

**8.** The net charge given to an isolated conducting solid sphere:
(1) must be distributed uniformly on the surface
(2) may be distributed uniformly on the surface
(3) must be distributed uniformly in the volume
(4) may be distributed uniformly in the volume.

**9.** The net charge given to a solid insulating sphere :
(1) must be distributed uniformly in its volume
(2) may be distributed uniformly in its volume
(3) must be distributed uniformly on its surface
(4) the distribution will depend upon whether other charges are present or not.

**10.** The given figure gives electric lines of force due to two charges $q_1$ and $q_2$. What are the signs of the two charges?




(1) Both are negative  (2) Both are positive
(3) $q_1$ is positive but $q_2$ is negative  (4) $q_1$ is negative but $q_2$ is positive

**11.** In an electron gun, electrons are accelerated through a potential difference of V volt. Taking electronic charge and mass to be respectively e and m, the maximum velocity attained by them is :

(1) $\frac{2eV}{m}$  (2) $\sqrt{\frac{2eV}{m}}$  (3) 2 m/eV  (4) $(V^2/2em)$

**12.** In a cathode ray tube if V is the potential difference between the cathode and anode, the speed of the electrons, when they reach the anode is proportional to (Assume initial velocity = 0) :

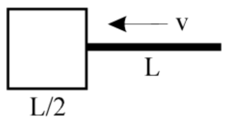
(1) V  (2) 1/V  (3) $\sqrt{V}$  (4) $(v^2/2em)$

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

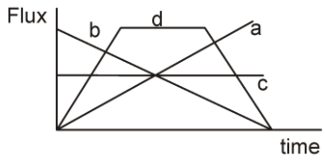
(1) $E_0a^3$  (2) $\frac{E_0a^3}{2}$  (3) $\frac{E_0a^3}{3}$  (4) $\frac{E_0a^2}{2}$

**14.** Select the correct statement :
(1) The electric lines of force are always closed curves
(2) Electric line of force is parallel to equipotential surface
(3) Electric line of force is perpendicular to equipotential surface
(4) Electric line of force is always the path of a positively charged particle.

**15.** Figure (a) shows an imaginary cube of edge L/2. A unifromly charged rod of length L moves towards left at a small but constant speed v. At t = 0, the left end just touches the centre of the face of the cube opposite it. Which of the graphs shown in fig.(b) represents the flux of the electric filed through the cube as the rod goes through it ?




(a)



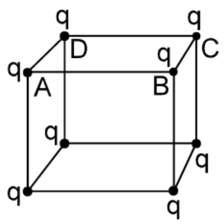

(b)

(1) a (2) b (3) c (4) d

**16.** Electric charges are distributed in a small volume. The flux of the electric field through a spherical surface of radius 10cm surrounding the total charge is 25 V-m. The flux over a concentric sphere of radius 20cm will be

(1) 25 V-m (2) 50 V-m (3) 100 V-m (4) 200 V-m

**17.** Eight point charges (can be assumed as small spheres uniformly charged and their centres at the corner of the cube) having values q each are fixed at vertices of a cube. The electric flux through square surface ABCD of the cube is




(1) $\frac{q}{24\epsilon_0}$ (2) $\frac{q}{12\epsilon_0}$

(3) $\frac{q}{6\epsilon_0}$ (4) $\frac{q}{8\epsilon_0}$

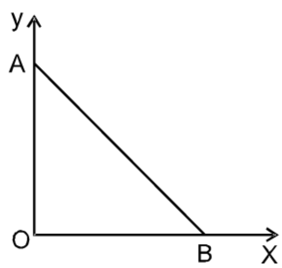
**18.** An electric dipole of moment $\vec{p}$ is placed at the origin along the x-axis. The angle made by electric field with x-axis at a point P, whose position vector makes an angle θ with x-axis, is (where $\tan\alpha = \frac{1}{2}\tan\theta$)

(1) α (2) θ (3) θ + α (4) θ + 2α

**19.** A Charged wire is bent in the from of a semi-circular arc of radius a. If charge per unit length is λ coulomb/metre, the electric field at the centre O is :

(1) $\frac{\lambda}{2\pi a^2\varepsilon_0}$ (2) $\frac{\lambda}{4\pi^2\varepsilon_0 a}$ (3) $\frac{\lambda}{2\pi\varepsilon_0 a}$ (4) zero

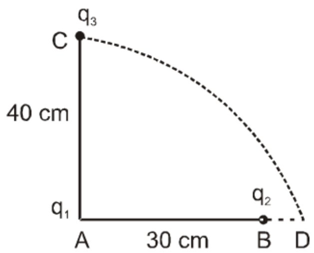
**20.** As per this diagram a point charge +q is placed at the origin O. Work done in taking another point charge –Q from the point A [co-ordiantes (o,a)] to another point B [co-ordinates(a,o)] along the straigth path AB is :




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

(3) $\left(\frac{qQ}{4\pi\varepsilon_0}\frac{1}{a^2}\right).\frac{a}{\sqrt{2}}$ (4) $\left(\frac{qQ}{4\pi\varepsilon_0}\frac{1}{a^2}\right)\sqrt{2}\,a$

**21.** Two charges $q_1$ and $q_2$ are placed 30 cm apart, as shown in the figue. A third charge $q_3$ is moved along the arc of a circle of radius 40 cm from C to D. The change in the potential energy of the system is $\frac{q_3}{4\pi\varepsilon_0}$ k, where k is :



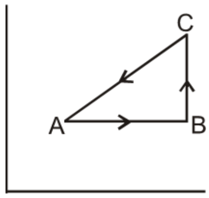

(1) $8q_2$ (2) $8q_1$

(3) $6q_2$ (4) $6q_1$

**22.** In order to balance the weight of an electron in an electric field E the magnitude and the direction of the electric field will be ($g = 10\ m/s^2$)

(1) $5.68 \times 10^{-11}$ N/C vertically upwards (2) $5.68 \times 10^{-11}$ N/C vertically downwards
(3) $5.68 \times 10^{-10}$ N/C vertically upwards (4) $5.68 \times 10^{-10}$ N/C vertically downwards

**23.** As shown in the figure, on bringing a charge Q from point A to B and from B to C, the work done are 2 joules and –3 joules respectively. The work done in bringing the charge from C to A will then be




(1) –1 J (2) 1 J
(3) 2 J (4) 5 J

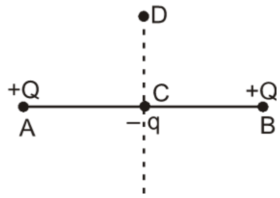
**24.** A conducting sphere of radius 'R' in vaccum carries a charge 'q'. There is a imaginary concentric spherical surface of radius $R_0$ (> R). If half the energy stored in the surrounding space lies from conducting surface to imginary surface, then radius $R_0$ of this spherical surface is :

(1) 4R (2) 9R (3) 2R (4) R

**25.** Two identical pith-balls of mass m and having charge q are suspended from a point by weightless strings of length '$l$'. If both the strings make an angle of $\theta$ with the vertical, then the distance between the balls will be. (taking $\theta$ to be small)

(1) $(q^2l/2\pi\epsilon_0 mg)^{1/3}$ (2) $(q^2l/4\pi\epsilon_0 mg)^{1/3}$ (3) $(ql^2/4\pi\epsilon_0 mg)^{1/3}$ (4) $(ql^2/2\pi\epsilon_0 mg)^{1/3}$

**26.** Two similar charge of +Q, as shown in figure are placed at A and B. –q charge is placed at point C midway between A and B, –q charge will oscillate if.




(1) it is moved towards A
(2) it is moved towards B
(3) it is moved upwards AB
(4) distance between A and B is reduced

**27.** A uniform electric field having a magnitude $E_0$ and direction along the positive X-axis exists. If the potential V is zero at x = 0, then its value at X = + x will be

(1) $V_{(x)} = + xE_0$ (2) $V_{(x)} = - xE_0$ (3) $V_{(x)} = + x^2E_0$ (4) $V_{(x)} = - x^2E_0$

**28.** Two point charge +3μC and +8μC repel each other with a force of 40 N. If a charge of –5μC is added to each of them, then the force between them will become

(1) –10 N (2) + 10 N (3) + 20 N (4) –20 N

**29.** Five point charges each of +q coulomb are placed on the five vertices of a regular hexagon of side L metre. The force acting on a point charge –q coulomb placed at the centre of the hexagon will be

(1) zero (2) $\frac{Kq^2}{L^2}$ netwon (3) $\frac{Kq}{L^2}$ netwon (4) $\frac{2Kq^2}{L^2}$ netwon

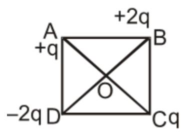
**30.** A charge q is placed at the centre of the line joining two equal charge Q to establish equilibrium. The system of three charges will be in equilibrium if q is equal to

(1) + Q/4 (2) +Q/2 (3) –Q/2 (4) –Q/4

**31.** Two point charges placed at a certain distance r in air exert a force F on each other. The distance r at which these charges will exert the same force in medium of dielectric constant k is given by

(1) r (2) r/k (3) $r/\sqrt{k}$ (4) None of these

**32.** Four charges are arranged at the corners of a square ABCD, as shown in the adjoining figure. The force on the charge kept at the centre O is




(1) zero (2) Along the diagonal AC
(3) Along the diagonal BD (4) Perpendicular to side AB

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

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

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

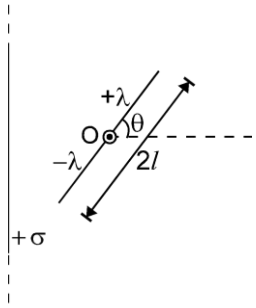
**34.** Two small spheres each having the charge +Q are suspended by insulating threads of length L from a hook. This arrangement is taken in space where there is no gravitational effect, then the angle between the two suspensions and the tension in each will be.

(1) 180º, $\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{(2L)^2}$ (2) 90º, $\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{L^2}$ (3) 180º, $\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{2L^2}$ (4) 180º, $\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{L^2}$

**35.** + 2 C and + 6 C two charges are repelling each other with a force of 12 N. If each charge is given – 2 C of charge, then the value of the force will be

(1) 4 N (attractive) (2) 4 N (repulsive) (3) 8 N (repulsive) (4) Zero

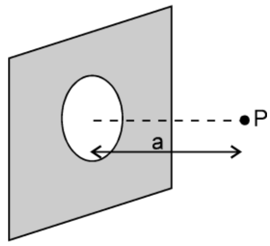
**36.** A large sheet carries uniform surface charge density $\sigma$. A rod of length $2\ell$ has a linear charge density $\lambda$ on one half and $-\lambda$ on the second half. The rod is hinged at mid-point O and makes angle $\theta$ with the normal to the sheet. The electric force experienced by the rod is




(1) 0 (2) $\frac{\sigma\lambda\ell^2}{2\epsilon_0}\sin\theta$

(3) $\frac{\sigma\lambda\ell^2}{\epsilon_0}\sin\theta$ (4) None of these

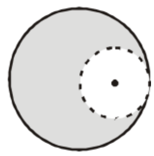
**37.** An infinitely large non- conducting plane of uniform surface charge density $\sigma$ has circular aperture of certain radius carved out from it. The electric field at a point which is at a distance 'a' from the centre of the aperture (perpendicular to the plane) is $\frac{\sigma}{2\sqrt{2}\,\epsilon_0}$. Find the radius of aperture :




(1) a $\sqrt{2}$ (2) a

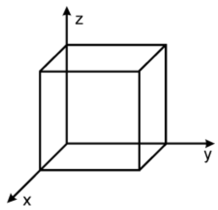
(3) 2a (4) 3a

**38.✍** A solid non-conducting sphere of Raidus R, having a spherical cavity of radius $\frac{R}{2}$ as shown, carries a uniformly distributed charge q. The electric field at the centre of the cavity is E. If there were no cavity and charge remains same (q), the field at the same point will be



(1) E (2) $\frac{3}{4}$ E (3) $\frac{7}{8}$ E (4) None of these

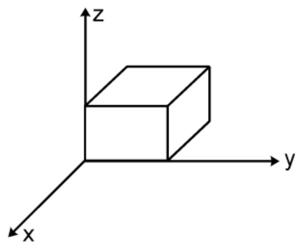
**39.✍** Electric field in a region is given by $\vec{E} = -4x\hat{i} + 6y\hat{j}$. Then find the charge enclosed in the cube of side 1m oriented as shown in the diagram.




(1) $\epsilon_0$ (2) $2\epsilon_0$

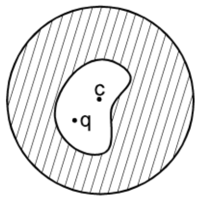
(3) $4\epsilon_0$ (4) $6\epsilon_0$

**40.** Figure above shows a closed Gaussian surface in the shape of a cube of edge length 3.0 m. There exists an electric field given by $\vec{E}$ = [(2.0x + 4.0)i + 8.0 j + 3.0 k] N/C, where x is in metres, in the region in which it lies. The net charge in coulombs enclosed by the cube is equal to



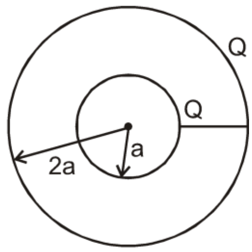

(1) – 54 $\in_0$ (2) 6 $\in_0$
(3) –6 $\in_0$ (4) 54 $\in_0$

**41.** The figure shows a charge q placed inside a cavity in an uncharged conductor. Now if an external electric field is switched on :



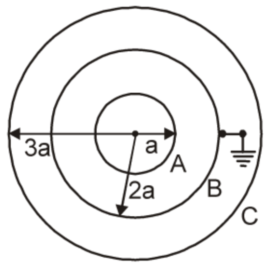

(1) only induced charge on outer surface will redistribute.
(2) only induced charge on inner surface will redistribute.
(3) both induced charge on outer and inner surface will redistribute.
(4) force on charge q placed inside the cavity will change.

**42.** Figure shows a solid metal sphere of radius a surrounded by a concentric thin metal shell of radius 2a. Initially both are having charges Q each. When the two are connected by a conducting wire as shown in the figure, then amount of heat produced in this process will be :




(1) $\frac{KQ^2}{2a}$ (2) $\frac{KQ^2}{4a}$
(3) $\frac{KQ^2}{6a}$ (4) $\frac{KQ^2}{8a}$

**43.** Figure shows a system of three concentric metal shells A, B and C with radii a, 2a and 3a respectively. Shell B is earthed and shell C is given a charge Q. Now if shell C is connected to shell A, then the final charge on the shell B, is equal to :

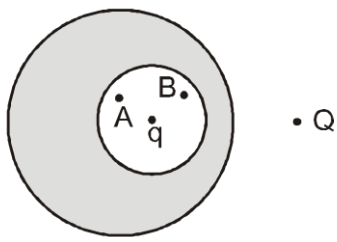



(1) – $\frac{4Q}{13}$ (2) – $\frac{8Q}{11}$
(3) – $\frac{5Q}{3}$ (4) – $\frac{3Q}{7}$

## PART - II : MISCELLANEOUS QUESTIONS

### Section (A) : Assertion/Reasoning

**A-1.** **STATEMENT-1 :** A point charge q is placed at centre of spherical cavity inside a spherical conductor as shown. Another point charge Q is placed outside the conductor as shown. Now as the point charge Q is pushed away from conductor, the potential difference ($V_A – V_B$) between two points A and B within the cavity of sphere remains constant.




**STATEMENT-2 :** The electric field due to charges on outer surface of conductor and outside the conductor is zero at all points inside the conductor.

(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True

**A-2.** **STATEMENT-1 :** A solid uncharged conducting cylinder moves with acceleration a (w.r.t ground). As a result of acceleration of cylinder, an electric field is produced within cylinder.


solid conducting cylinder

**STATEMENT-2 :** When a solid conductor moves with acceleration a, then from frame of conductor a pseudoforce (of magnitude ma; where m is mass of electron) will act on free electrons in the conductor. As a result some portion of the surface of conductor acquires negative charge and remaining portion of surface of conductor acquires positive charge.

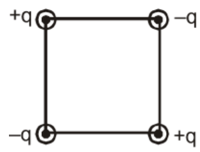
(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True

**A-3.** **STATEMENT-1 :** Two concentric conducting spherical shells are charged. The charge on the outer shell is varied keeping the charge on inner shell constant, as a result the electric potential difference between the two shells does not change.

**STATEMENT-2 :** If charge is changed on an thin conducting spherical shell, the potential at all points inside the shell changes by same amount.

(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True

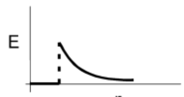
**A-4.** **STATEMENT-1 :** The electric potential and the electric field intensity at the centre of a square having four point charges at their vertices (as shown) are zero.



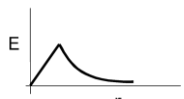

**STATEMENT-2 :** Electric field is negative derivative of the potential.

(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True.

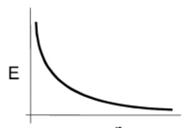
## Section (B) : Match The Column

**B-1.** (1) 


(P) infinitely large sheet

(2) 


(Q) line charge

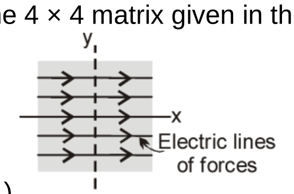
(3) 


(R) uniformly charged spherical shell

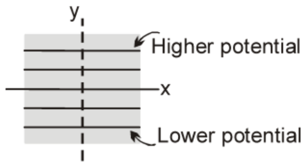
(4) 


(S) uniformly charged solid sphere

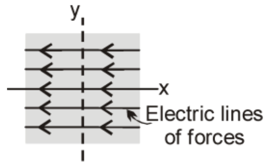
**B-2.** Column I gives certain situations in which electric field is represented by electric lines of forces in x-y plane. Column II gives corresponding representation of equipotential lines in x-y plane. Match the figures in Column I with the figures in Column II and indicate your answer by darkening appropriate bubbles in the 4 × 4 matrix given in the ORS.



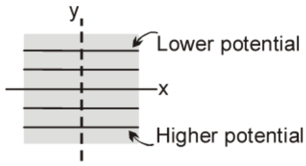
(1)



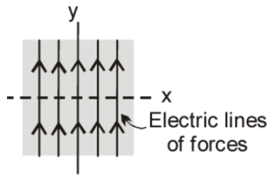
(P)



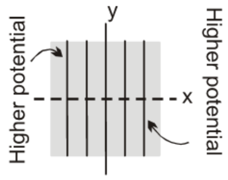
(2)



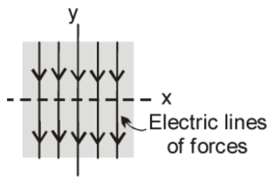
(Q)



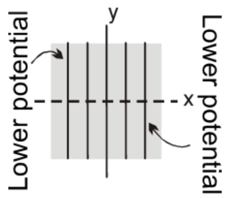
(3)



(R)



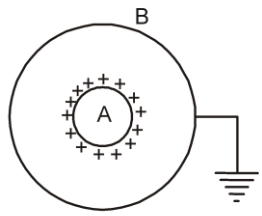
(4)



(S)

## Section (C) : One or More Than One Options Correct

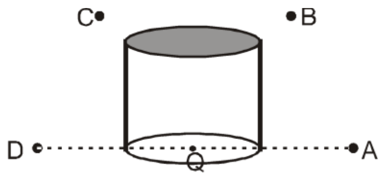
**C-1.** A and B are two conducting concentric spherical shells. A is given a charge Q while B is uncharged. If now B is earthed as shown in figure.Then:
(1) The charge appearing on inner surface of B is -Q
(2) The field inside and outside A is zero.
(3) The field between A and B is not zero.
(4) The charge appearing on outer surface of B is zero.




**C-2.** A non-conducting solid sphere of radius R is uniformly charged. The magnitude of the electric field due to the sphere at a distance r from its centre.
(1) increases as r increases, for r R
(2) decreases as r increases, for $0 < r < \infty$
(3) decreases as r increases, for $R < r < \infty$
(4) is discontinuous at r = R

**C-3.** An electric dipole is placed (not at infinity) in an electric field generated by a point charge.
(1) The net electric force on the dipole may be zero
(2) The net electric force on the dipole will not be zero
(3) The torque on the dipole due to the field may be zero
(4) The torque on the dipole due to the field must be zero

**C-4.** Figure shows a charge Q placed at the centre of open face of a cylinder as shown in figure. A second charge q is placed at one of the positions A, B, C and D, out of which positions A and D are lying on a straight line parallel to open face of cylinder. In which position(s) of this second charge, the flux of the electric field through the cylinder remains unchanged ?




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

**C-5.** At distance of 5cm and 10cm outwards from the surface of a uniformly charged solid sphere, the potentials are 100V and 75V respectively. Then :
(1) Potential at its surface is 150V.
(2) The charge on the sphere is (5/3) × $10^{-9}$C.
(3) The electric field on the surface is 1500 V/m.
(4) The electric potential at its centre is 225V.