Exercise - I (Objective Problems)

1. A point charge 50μC is located in the XY plane at the point of position vector $\vec{r}_0 = 2\hat{i} + 3\hat{j}$. What is the electric field at the point of position vector $\vec{r} = 8\hat{i} - 5\hat{j}$

(A) 1200 V/m (B) 0.04 V/m (C) 900 V/m (D) 4500 V/m

Sol.

2. A point charge q is placed at origin. Let $\vec{E}_A, \vec{E}_B$ and $\vec{E}_C$ be the electric field at three points A(1, 2, 3), B(1, 1, –1) and C(2, 2, 2) due to charge q. Then

[i] $\vec{E}_A \perp \vec{E}_B$ [ii] $|\vec{E}_B| = 4\,|\vec{E}_C|$

select the correct alternative

(A) only [i] is correct

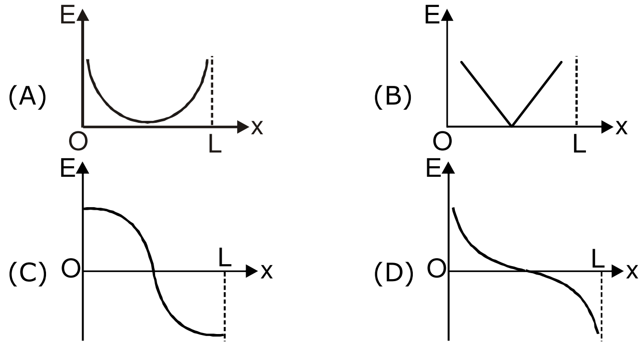
(B) only [ii] is correct

(C) both [i] and [ii] are correct

(D) both [i] and [ii] are wrong

Sol.

3. Two identical point charges are placed at a separation of l. P is a point on the line joining the charges, at a distance x from any one charge. The field at P is E. E is plotted against x for values of x from close to zero to slightly less than l. Which of the following best represents the resulting curve ?



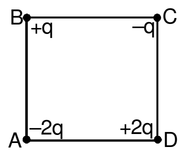
Sol.

4. A particle of mass m and charge Q is placed in an electric field E which varies with time t ass E = E_0 sinωt. It will undergo simple harmonic motion of amplitude

(A) $\dfrac{QE_0^2}{m\omega^2}$ (B) $\dfrac{QE_0}{m\omega^2}$ (C) $\sqrt{\dfrac{QE_0}{m\omega^2}}$ (D) $\dfrac{QE_0}{m\omega}$

Sol.

5. Four charges are arranged at the corners of a square ABCD, as shown. The force on +ve charge kept at the centre of the square is



(A) zero (B) along diagonal AC

(C) along diagonal BD (D) perpendicular to the side AB

Sol.

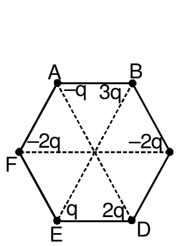
6. Two free positive charges 4q and q are a distance l apart. What charge Q is needed to achieve equilibrium for the entire system and where should it be placed form charge q ?

(A) $Q = \frac{4}{9}q$ (negative) at $\frac{l}{3}$ (B) $Q = \frac{4}{9}q$ (positive) at $\frac{l}{3}$

(C) Q = q (positive) at $\frac{l}{3}$ (D) Q = q (negative) at $\frac{l}{3}$

Sol.

7. Six charges are placed at the corner of a regular hexagon as shown. If an electron is placed at its centre O, force on it will be



(A) Zero (B) Along OF

(C) Along OC (D) None of these

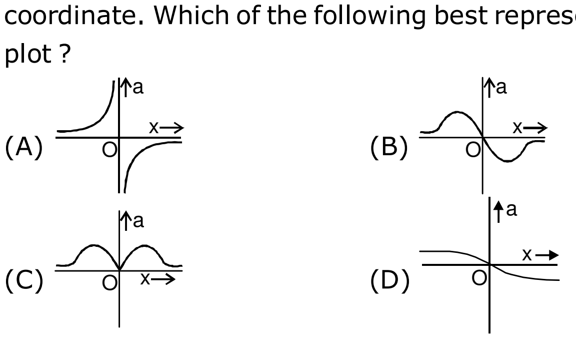
Sol.

8. A charged particle of charge q and mass m is released from rest in an uniform electric field E. Neglecting the effect of gravity, the kinetic energy of the charged particle after time 't' seconds is

(A) $\frac{Eqm}{t}$ (B) $\frac{E^2q^2t^2}{2m}$ (C) $\frac{2E^2t^2}{mq}$ (D) $\frac{Eq^2m}{2t^2}$

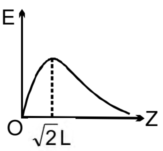
Sol.

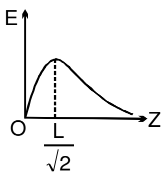
9. Two identical positive charges are fixed on the y-axis, at equal distances from the origin O. A particle with a negative charge starts on the x-axis at a large distance from O, moves along the +x-axis, passes through O and moves far away from O. Its acceleration a is taken as positive along its direction of motion. The particle's acceleration a is plotted against its x-coordinate. Which of the following best represents the plot ?

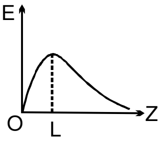


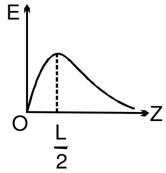
Sol.

10. Four equal positive charges are fixed at the vertices of a square of side L. Z-axis is perpendicular to the plane of the square. The point z = 0 is the point where the diagonals of the square intersect each other. The plot of electric field due to the four charges, as one moves on the z-axis.

(A) 

(B) 

(C) 

(D) 

Sol.

11. A nonconducting ring of radius R has uniformly distributed positive charge Q. A small part of the ring, of length d, is removed (d<<R). The electric field at the centre of the ring will now be -

(A) directed towards the gap, inversely proportional to R^3.

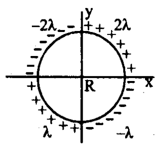
(B) directed towards the gap, inversely proportional to R^2.

(C) directed away from the gap, inversely proportional to R^3.

(D) directed away from the gap, inversely proportional to R^2.

Sol.

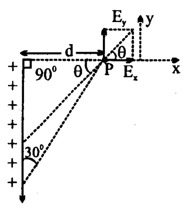
12. The charge per unit length of the four quadrant of the ring is 2λ, -2λ, λ and $-\lambda$ respectively. The electric field at the centre is -



(A) $-\dfrac{\lambda}{2\pi\varepsilon_0 R}\hat{i}$ (B) $\dfrac{\lambda}{2\pi\varepsilon_0 R}\hat{j}$ (C) $\dfrac{\sqrt{2}\lambda}{2\pi\varepsilon_0 R}\hat{i}$ (D) None

Sol.

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

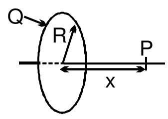


(A) at angle 30° from x-axis
(B) 45° from x-axis
(C) 60° from x-axis
(D) none of these

Sol.

14. Two equal negative charges are fixed at the points [0, a] and [0, –a] on the y-axis. A positive charge Q is released from rest at the points [2a, 0] on the x-axis. The charge Q will -
(A) execute simple harmonic motion about the origin
(B) move to the origin and remain at rest
(C) move to infinity
(D) execute oscillatory but not simple harmonic motion.

15. A small particle of mass m and charge –q is placed at point P on the axis of uniformly charged ring and released. If R >> x, the particle will undergo oscillations along the axis of symmetry with an angular frequency that is equal to -



(A) $\sqrt{\dfrac{qQ}{4\pi\varepsilon_0 mR^3}}$ (B) $\sqrt{\dfrac{qQx}{4\pi\varepsilon_0 mR^4}}$

(C) $\dfrac{qQ}{4\pi\varepsilon_0 mR^3}$ (D) $\dfrac{qQx}{4\pi\varepsilon_0 mR^4}$

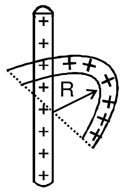
Sol.

16. A charged particle having some mass is resting in equilibrium at a height H above the centre of a uniformly charged non-conducting horizontal ring of radius R. The force of gravity acts downwards. The equilibrium of the particle will be stable -
(A) for all values of H (B) only if H > $R/\sqrt{2}$
(C) only if H < $R/\sqrt{2}$ (D) only if H = $R/\sqrt{2}$

Sol.

Sol.

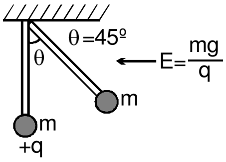
18. Find the force experienced by the semicircular rod charged with a charge q, placed as shown in figure. Radius of the wire is R and the infinitely long line of charge with linear density λ is passing through its centre and perpendicular to the plane of wire.



(A) $\frac{\lambda q}{2\pi^2\varepsilon_0 R}$ (B) $\frac{\lambda q}{\pi^2\varepsilon_0 R}$ (C) $\frac{\lambda q}{4\pi^2\varepsilon_0 R}$ (D) $\frac{\lambda q}{4\pi\varepsilon_0 R}$

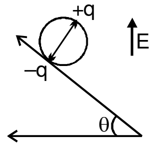
Sol.

17. In space of horizontal EF(E = (mg)/q) exist as shown in figure and a mass m attached at the end of a light rod. If mass m is released from the position shown in figure find the angular velocity of the rod when it passes through the bottom most position.



(A) $\sqrt{\frac{g}{l}}$ (B) $\sqrt{\frac{2g}{l}}$ (C) $\sqrt{\frac{3g}{l}}$ (D) $\sqrt{\frac{5g}{l}}$

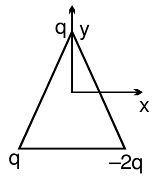
19. A wheel having mass m has charges +q and –q on diametrically opposite points. It remains in equilibrium on a rough inclined plane in the presence of uniform vertical electric field E =



(A) $\frac{mg}{q}$ (B) $\frac{mg}{2q}$ (C) $\frac{mg\tan\theta}{2q}$ (D) none

Sol.

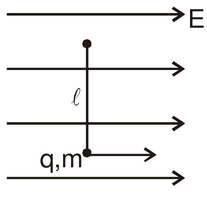
20. An equilateral triangle wire frame of side L having 3 point charges at its vertices is kept in x-y plane as shown. Component of electric field due to the configuration in z direction at (0, 0, L) is [origin is centroid of triangle]



(A) $\frac{9\sqrt{3}\,kq}{8L^2}$ (B) zero (C) $\frac{9\,kq}{8\,L^2}$ (D) None

Sol.

21. A simple pendulum has a length ℓ, mass of bob m. The bob is given a charge q coulomb. The pendulum is suspended in a uniform horizontal electric field of strength E as shown in figure, then calculate the time period of oscillation when the bob is slightly displace from its mean position is

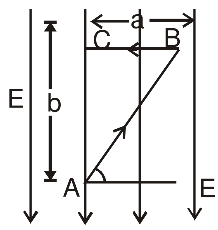


(A) $2\pi\sqrt{\frac{\ell}{g}}$ (B) $2\pi\sqrt{\left\{\frac{\ell}{g+\frac{qE}{m}}\right\}}$

(C) $2\pi\sqrt{\left\{\frac{\ell}{g-\frac{qE}{m}}\right\}}$ (D) $2\pi\sqrt{\frac{\ell}{\sqrt{g^2+\left(\frac{qE}{m}\right)^2}}}$

Sol.

22. The potential difference between points A and B in the given uniform electric field is :



(A) Ea (B) $E\sqrt{(a^2+b^2)}$ (C) Eb (D) $(Eb/\sqrt{2})$

Sol.

23. An equipotential surface and a line of force :

(A) never intersect each other (B) intersect at 45°

(C) intersect at 60° (D) intersect at 90°

Sol.

24. Which of the following is a volt -

(A) Erg per cm (B) Joule per coulomb

(C) Erg per ampere (D) Newton / (coulomb × m^2)

Sol.

25. An infinite nonconducting sheet of charge has a surface charge density of 10^{-7} C/m^2. The separation between two equipotential surfaces near the sheet whose potential differ by 5V is

(A) 0.88 cm (B) 0.88 mm (C) 0.88 m (D) 5×10^{-7} m

Sol.

26. In a uniform electric field, the potential is 10 V at the origin of coordinates, and 8V at each of the points (1, 0, 0), (0, 1, 0) and (0, 0, 1). The potential at the point (1, 1, 1) will be -

(A) 0 (B) 4 V (C) 8 V (D) 10 V

Sol.

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

(A) r n (B) r (n – 1) (C) (n–1)/r (D) r(n–1)/n

Sol.

28. In a certain region of space, the potential is given by : $V = k[2x^2 - y^2 + z^2]$. The electric field at the point (1,1,1) has magnitude =

(A) $k\sqrt{6}$ (B) $2k\sqrt{6}$ (C) $2k\sqrt{3}$ (D) $4k\sqrt{3}$

Sol.

29. When the seperation between two charges is increased, the electric potential energy of the charges

(A) increases (B) decresaes

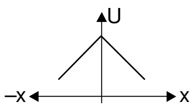
(C) remains the same

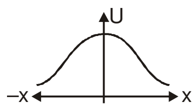
(D) may increase or decrease

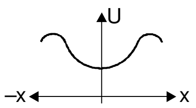
Sol.

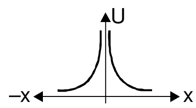
30. When a negative charge is released and moves in electric field, it moves toward a position of
(A) lower electric potential and lower potential energy
(B) lower electric potential and higher potential energy
(C) higher electric potential and lower potential energy
(D) higher electric potential and higher potential energy
Sol.

31. Four equal charges +q are placed at four corners of a square with its centre of origin and lying in yz plane. The electrostatic potential energy of a fifth charge +q varies or x-axis as

(A) 

(B) 

(C) 

(D) 

Sol.

32. Two identical thin rings, each of radius R meter are coaxially placed at distance R meter apart. If Q_1 and Q_2 coulomb are respectively the charges uniformly spread on the two rings, the work done in moving a charge q from the centre of one ring to that of the other is
(A) zero
(B) $q(Q_1 - Q_2)(\sqrt{2} - 1) / (\sqrt{2}.4\pi\varepsilon_0 R)$
(C) $q\sqrt{2}(Q_1 + Q_2) / 4\pi\varepsilon_0 R$
(D) $q(Q_1 - Q_2)(\sqrt{2} + 1) / (\sqrt{2}.4\pi\varepsilon_0 R)$
Sol.

33. Two positively charged particles X and Y are initially far away from each other and at rest. X begins to move towards Y with some initial velocity. The total momentum and energy of the system are p and E.
(A) If Y is fixed, both p and E are conserved
(B) If Y is fixed, E is conserved, but not p
(C) If both are free to move, p is conserved but not E
(D) If both are free, E is conserved, but not p
Sol.

34. Two particles X and Y, of equal mass and with unequal positive charges, are free to move and are initially far away from each other. With Y at rest, X begins to move towards it with initial velocity u. After a long time, finally.

(A) X will stop, Y will move with velocity u
(B) X and Y will both move with velocities u/2 each
(C) X will stop, Y will move with velocity < u
(D) both will move with velocities <u/2

Sol.

35. A circular ring of radius R with uniform positive charge density λ per unit length is located in the y-z plane with its centre at the origin O. A particle of mass m and positive charge q is projected from the point P($R\sqrt{3}$, O, O) on the positive x-axis directly towards O, with an initial kinetic energy $\frac{\lambda q}{4\varepsilon_0}$.

(A) The particle crosses O and goes to infinity
(B) The particle returns to P
(C) The particle will just reach O
(D) The particle crosses O and goes to $-R\sqrt{3}$.

Sol.

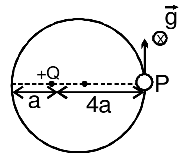
36. Two identical particles of mass m carry a charge Q each. Initially one is at rest on a smooth horizontal plane and the other is projected along the plane directly towards first particle from a large distance with speed v. The closed distance of approach be

(A) $\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{mv}$ (B) $\frac{1}{4\pi\varepsilon_0}\frac{4Q^2}{mv^2}$

(C) $\frac{1}{4\pi\varepsilon_0}\frac{2Q^2}{mv^2}$ (D) $\frac{1}{4\pi\varepsilon_0}\frac{3Q^2}{mv^2}$

Sol.

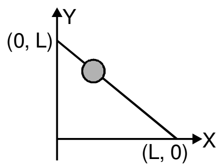
37. The diagram shows a small bead of mass m carrying charge q. The bead can freely move on the smooth fixed ring placed on a smooth horizontal plane. In the same plane a charge +Q has also been fixed as shown. The potential at the point P due to +Q is V. The velocity with which the bead should projected from the point P so that it can complete a circle should be greater than



(A) $\sqrt{\frac{6qV}{m}}$ (B) $\sqrt{\frac{qV}{m}}$ (C) $\sqrt{\frac{3qV}{m}}$ (D) none

Sol.

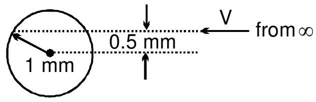
38. Electric field given by the vector $\vec{E} = x\hat{i} + y\hat{j}$ is present in the XY plane. A small ring carrying charge +Q, which can freely slide on a smooth non conducting rod, is projected along the rod from the point (0, L) such that it can reach the other end of the rod. What minimum velocity should be given to the ring ? (Assume zero gravity)



(A) $(QL^2/m)^{1/2}$ (B) $2(QL^2/m)^{1/2}$
(C) $4(QL^2/m)^{1/2}$ (D) $(QL^2/2m)^{1/.2}$

Sol.

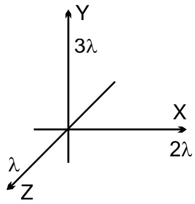
39. A particle of mass 1 kg & charge 1/3μC is projected towards a non conducting fixed spherical shell having the same charge uniformly distributed on its surface. Find the minimum initial velocity of projection required if the particle just grazes the shell.



(A) $\sqrt{\frac{2}{3}}m/s$ (B) $2\sqrt{\frac{2}{3}}m/s$ (C) $\frac{2}{3}m/s$ (D) none

Sol.

40. The diagram shows three infinitely long uniform line charges placed on the X, Y and Z axis. The work done in moving a unit positive charge from (1, 1, 1) to (0, 1, 1) is equal to -



(A) $(\lambda \ln 2) / 2\pi\varepsilon_0$ (B) $(\lambda \ln 2) / \pi\varepsilon_0$
(C) $(3\lambda \ln 2) / 2\pi\varepsilon_0$ (D) None

Sol.

41. A charged particle of charge Q is held fixed and another charged particle of mass m and charge q (of the same sign) is released from a distance r. The impulse of the force exerted by the external agent on the fixed charge by the time distance between Q and q becomes 2r is -

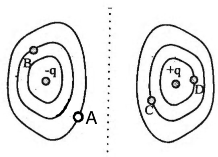
(A) $\sqrt{\dfrac{Qq}{4\pi\epsilon_0 mr}}$ (B) $\sqrt{\dfrac{Qqm}{4\pi\epsilon_0 r}}$ (C) $\sqrt{\dfrac{Qqm}{\pi\epsilon_0 r}}$ (D) $\sqrt{\dfrac{Qqm}{2\pi\epsilon_0 r}}$

Sol.

42. Two point charges of +Q each have been placed at the positions (–a/2, 0, 0) and (a/2, 0, 0). The locus of the points in YZ plane where –Q charge can be placed such the that total electrostatic potential energy of the system can become equal to zero, is represented by which of the following equations ?
(A) $Z^2 + (Y - a)^2 = 2a$ (B) $Z^2 + (Y - a)^2 = 27a^2/4$
(C) $Z^2 + Y^2 = 15a^2 / 4$ (D) None

Sol.

43. Figure shows equi-potential surfaces for a two charges system. At which of the labeled points point will an electron have the highest potential energy ?



(A) Point A (B) Point B (C) Point C (D) Point D

Sol.

44. The equation of an equipotential line in an electric field is y = 2x, then the electric field strength vector at (1, 2) may be

(A) $4\hat{i}+3\hat{j}$ (B) $4\hat{i}+8\hat{j}$ (C) $8\hat{i}+4\hat{j}$ (D) $-8\hat{i}+4\hat{j}$

Sol.

45. The electric field in region is given by : E = $(4axy\sqrt{z})\,\hat{i}$ + $(2ax^2\sqrt{z})\,\hat{j}$ + $(ax^2y/\sqrt{z})\,\hat{k}$, where a is a positive constant. The equation of an equipotential surface will be of the form -

(A) z = constant / $[x^3y^2]$ (B) z = constant / $[xy^2]$
(C) z = constant / $[x^4y^2]$ (D) None

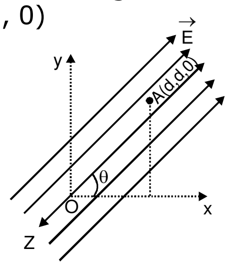
Sol.

46. A charge 3 coulomb experiences a force 3000 N when placed in a uniform electric field. The potential difference between two points separated by a distance of 1 cm along the field lines is

(A) 10 V (B) 90 V (C) 1000 V (D) 9000 V

Sol.

47. A uniform electric field having strength $\vec{E}$ is existing in x - y plane as shown in figure. Find the p.d. between origin O & A (d, d, 0)



(A) Ed(cosθ + sinθ) (B) –Ed (sinθ – cosθ)
(C) $\sqrt{2}$Ed (D) None of these

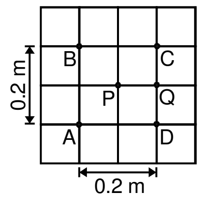
Sol.

48. Uniform electric field of magnitude 100 V/m in space is directed along the line y = 3 + x. Find the potential difference between point A(3, 1) & B(1, 3)

(A) 100 V (B) $200\sqrt{2}$ V (C) 200 V (D) 0

Sol.

49. A, B, C, D, P and Q are points in a uniform electric field. The potentials at these points are V(A) =2 volt. V(P) = V(B) = V(D) = 5 volt. V(C) = 8 volt. The electric field at P is



(A) 10 Vm^{-1} along PQ (B) $15\sqrt{2}$ Vm^{-1} along PA
(C) 5 Vm^{-1} along PC (D) 5 Vm^{-1} along PA

Sol.

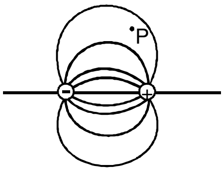
50. A and B are two points on the axis and the perpendicular bisector respectively of an electric dipole. A and B are far away from the dipole and at equal distance from it. The field at A and B are $\vec{E}_A$ and $\vec{E}_B$.

(A) $\vec{E}_A = \vec{E}_B$ (B) $\vec{E}_A = 2\vec{E}_B$ (C) $\vec{E}_A = -2\vec{E}_B$

(D) $|E_B| = \frac{1}{2}|E_A|$, and $\vec{E}_B$ is perpendicular to $\vec{E}_A$

Sol.

51. Figure shows the electric field lines around an electric dipole. Which of the arrows best represents the electric field at point P ?



(A) ↑ (B) ↖ (C) ↗ (D) ↙

Sol.

52. A dipole consists of two particles one with charge $+1\mu C$ and mass 1kg and the other with charge $-1\mu C$ and mass 2kg separated by a distance of 3m. For small oscillations about its equilibrium position, the angular frequency, when placed in a uniform electric field of 20kV/m is

(A) 0.1 rad/s (B) 1.1 rad/s (C) 10 rad/s (D) 2.5 rad/s

Sol.

53. The dipole moment of a system of charge +q distributed uniformly on an arc of radius R subtending an angle $\pi/2$ at its centre where another charge $-q$ is placed is.

(A) $\frac{2\sqrt{2}qR}{\pi}$ (B) $\frac{\sqrt{2}qR}{\pi}$ (C) $\frac{qR}{\pi}$ (D) $\frac{2qR}{\pi}$

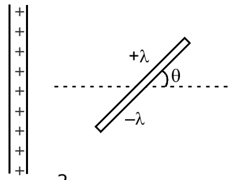
Sol.

54. An electric dipole is kept on the axis of a uniformly charged ring at distance $R/\sqrt{2}$ from the centre of the ring. The direction of the dipole moment is along the axis. The dipole moment is P, charge of the ring is Q and radius of the ring is R. The force on the dipole is nearly

(A) $\frac{4kPQ}{3\sqrt{3}R^2}$ (B) $\frac{4kPQ}{3\sqrt{3}R^3}$ (C) $\frac{2kPQ}{3\sqrt{3}R^3}$ (D) zero

Sol.

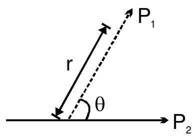
55. A large sheet carries uniform surface charge density σ. A rod of length $2l$ has a linear charge density λ on one half and $-\lambda$ on the second half. The rod is hinged at mid point O and makes an angle θ with the normal to the sheet. The torque experienced by the rod is



(A) 0 (B) $\frac{\sigma\lambda l^2}{2\varepsilon_0}\sin\theta$ (C) $\frac{\sigma\lambda l^2}{\varepsilon_0}\sin\theta$ (D) $\frac{\sigma\lambda l}{2\varepsilon_0}$

Sol.

56. Two short electric dipoles are placed as shown. The energy of electric interaction between these dipoles will be



(A) $\frac{2kP_1P_2\cos\theta}{r^3}$ (B) $\frac{-2kP_1P_2\cos\theta}{r^3}$

(C) $\frac{-2kP_1P_2\sin\theta}{r^3}$ (D) $\frac{-4kP_1P_2\cos\theta}{r^3}$

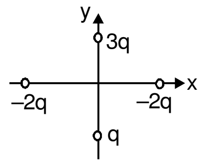
Sol.

57. Point P lies on the axis of a dipole. If the dipole is rotated by 90º anticlock wise, the electric field vector $\vec{E}$ at P will rotate by

(A) 90º clock wise (B) 180º clock wise
(C) 90º anti clock wise (D) none

Sol.

58. 4 charges are placed each at a distance 'a' from origin. The dipole moment of configuration is



(A) $2qa\hat{j}$ (B) $3qa\hat{j}$ (C) $2aq[\hat{i}+\hat{j}]$ (D) none

Sol.

REASONING TYPE

59. Statement - 1 : A positive point charge initially at rest in a uniform electric field starts moving along electric lines of forces. (Neglect all other forces except electric forces)

Statement - 2 : Electric lines of force represents path of charged particle which is released from rest in it.

(A) Statement - 1 is true, Statement - 2 is true and statement - 2 is correct explanation for statement - 1.
(B) Statement - 1 is true, Statement - 2 is true and statement - 2 is NOT correct explanation for statement - 1.
(C) Statement - 1 is true, statement - 2 is false.
(D) Statement - 1 is false, statement - 2 is true.

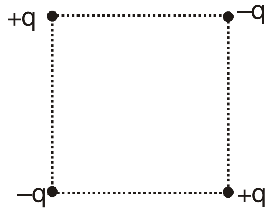
60. Statement - 1 : If electric potential while moving in a certain path is constant, then the electric field must be zero.

Statement - 2 : Component of electric field $E_r = -\frac{\partial V}{\partial r}$

(A) Statement - 1 is true, Statement - 2 is true and statement - 2 is correct explanation for statement - 1.
(B) Statement - 1 is true, Statement - 2 is true and statement - 2 is NOT correct explanation for statement - 1.
(C) Statement - 1 is true, statement - 2 is false.
(D) Statement - 1 is false, statement - 2 is true.
Sol.

61. Statement - 1 : For a non-uniformly charged thin circular ring with net charge zero, the electric potential at each point on axis of the ring is zero.
Statement - 2 : For a non-uniformly charged thin circular ring with net charge zero, the electric field at any point on axis of the ring is zero.
(A) Statement - 1 is true, Statement - 2 is true and statement - 2 is correct explanation for statement - 1.
(B) Statement - 1 is true, Statement - 2 is true and statement - 2 is NOT correct explanation for statement - 1.
(C) Statement - 1 is true, statement - 2 is false.
(D) Statement - 1 is false, statement - 2 is true.
Sol.

62. Statement - 1 : The electric potential and the electric field intensity at the centre of a square having four fixed point charges at their vertices as shown in figure are zero.



Statement - 2 : If electric potential at a point is zero then the magnitude of electric field at that point must be zero.
(A) Statement - 1 is true, Statement - 2 is true and statement - 2 is correct explanation for statement - 1.
(B) Statement - 1 is true, Statement - 2 is true and statement - 2 is NOT correct explanation for statement - 1.
(C) Statement - 1 is true, statement - 2 is false.
(D) Statement - 1 is false, statement - 2 is true.
Sol.

Exercise - II (One or more than one option is correct)

1. Select the correct alternative :

(A) The charge gained by the uncharged body from a charged body due to conduction is equal to half of the total charge initially present.

(B) The magnitude of charge increases with the increase in velocity of charge

(C) Charge can not exist without matter although matter can exist without charge

(D) Between two non-magnetic substances repulsion is the true test of electrification (electrification means body has net charge)

Sol.

2. Two equal negative charges –q are fixed at the point (0, a) and (0, –a) on the y-axis. A charge +Q is released from rest at the point (2a, 0) on the x-axis. The charge Q will :

(A) Execute simple harmonic motion about the origin.

(B) At origin velocity of particle is maximum

(C) Move to infinity

(D) Execute oscillatory but not simple harmonic motion.

Sol.

3. Mid way between the two equal and similar charges, we placed the third equal and similar charge. Which of the following statements is correct, concerned to the equilibrium along the line joining the charges ?

(A) The third charge experienced a net force inclined to the line joining the charges

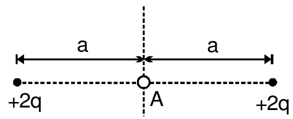
(B) The third charge is in stable equilibrium

(C) The third charge is in unstable equilibrium

(D) The third charge experiences a net force perpendicular to the line joining the charges

Sol.

4. A negative point charge placed at the point A is



(A) in stable equilibrium along x-axis

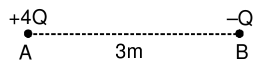
(B) in unstable equilibrium along y-axis

(C) in stable equilibrium along y-axis

(D) in unstable equilibrium along x-axis

Sol.

5. Two fixed charges 4Q (positive) and Q (negative) are located at A and B, the distance AB being 3 m.



(A) The point P where the resultant field due to both is zero is on AB outside AB.

(B) The point P where the resultant field due to both is zero is on AB inside AB.

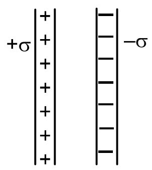
(C) If a positive charge is placed at P and displaced slightly along AB it will execute oscillations.

(D) If a negative charge is placed at P and displaced slightly along AB it will execute oscillation.

Sol.

6. Select the correct statement : (Only force on a particle is due to electric field)
(A) A charged particle always moves along the electric line of force.
(B) A charged particle may move along the line of force
(C) A charge particle never moves along the line of force
(D) A charged particle moves along the line of force only if released from rest.
Sol.

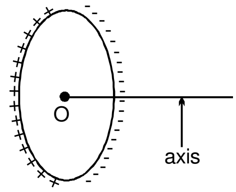
7. Two infinite sheets of uniform charge density $+\sigma$ and $-\sigma$ are parallele to each other as shown in the figure. Electric field at the



(A) points to the left or to the right of the sheets is zero
(B) midpoint between the sheets is zero
(C) midpoint of the sheets is σ/ε_0 and is directed towards right
(D) midpoint of the sheets is $2\sigma/\varepsilon_0$ and is directed towards right

Sol.

8. The figure shows a nonconducting ring which has positive and negative charge non uniformly distributed on it such that the total charge is zero. Which of the following statements is true ?



(A) The potential at all the points on the axis will be zero.
(B) The electric field at all the points on the axis will be zero.
(C) The direction of electric field at all points on the axis will be along the axis
(D) If the ring is placed inside a uniform external electric field then net torque and force acting on the ring would be zero.
Sol.

9. If we use permittivity ε, resistance R, gravitational constant G and voltage V as fundamental physical quantities, then -
(A) [angular displacement] = $\varepsilon^0R^0G^0V^0$
(B) [Velocity] = $\varepsilon^{-1}R^{-1}G^0V^0$
(C) [dipole moment] = $\varepsilon^1R^0G^0V^1$
(D) [force] = $\varepsilon^1R^0G^0V^2$
Sol.

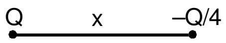
10. A particle of mass m and charge q is thrown in a region where uniform gravitational field and electric field are present. The path of particle

(A) may be a straight line (B) may be a circle

(C) may be a parabola (D) may be a hyperbola

Sol.

11. Two point charges Q and –Q/4 are separated by a distance x. Then



(A) potential is zero at a point on the axis which is x/3 on the right side of the charge –Q/4

(B) potential is zero at a point on the axis which is x/5 on the left side of the charge –Q/4

(C) electric field is zero at a point on the axis which is at a distance x on the right side of the charge –Q/4

(D) there exist two points on the axis where electric field is zero.

Sol.

12. An electric charge 10^{-8} C is placed at the point (4m, 7m, 2m). At the point (1m, 3m, 2m), the electric

(A) potential will be 18 V

(B) field has no Y-component

(C) field will be along Z-axis

(D) potential will be 1.8 V

Sol.

13. Four identical charges are placed at the points (1, 0, 0), (0, 1, 0), (–1, 0, 0) and (0, –1, 0).

(A) The potential at the origin is zero.

(B) The field at the origin is zero.

(C) The potential at all points on the z-axis, other than the origin, is zero.

(D) The field at all points on the z-axis, other than the origin acts along the z-axis.

Sol.

14. A proton and a deuteron are initially at rest and are accelerated through the same potential difference. Which of the following is false concerning the final properties of the two particles ?

(A) They have different speeds

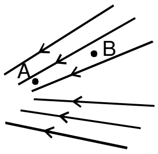
(B) They have same momentum

(C) They have same kinetic energy

(D) None of these

Sol.

15. Which of the following is true for the figure showing electric lines of force ? (E is electrical field, V is potential)



(A) $E_A > E_B$ (B) $E_B > E_A$ (C) $V_A > V_B$ (D) $V_B > V_A$

Sol.

16. Three point charges Q, 4Q and 16Q are placed on a straight line 9cm long. Charges are placed in such a way that the system has minimum potential energy. Then

(A) 4Q and 16Q must be at the ends and Q at a distance of 3 cm from the 16Q

(B) 4Q and 16Q must be at the ends and Q at a distance of 6 cm from the 16Q

(C) Electric field at the position of Q is zero

(D) Electric field at the position of Q is $\frac{Q}{4\pi\varepsilon_0}$

Sol.

17. Potential at a point A is 3 volt and at a point B is 7 volt, an electron is moving towards A from B.

(A) It must have some K.E. at B to reach A

(B) It need not have any K.E. at B to reach A

(C) to reach A it must have more than or equal to 4eV K.E. at B.

(D) when it will reach A, it will have K.E. more then or at least equal to 4eV if it was released from rest at B.

Sol.

18. A particle of charge 1μC & mass 1 gm moving with a velocity of 4m/s is subjected to a uniform electric field of magnitude 300 V/m for 10 sec. Then it's final speed cannot be :

(A) 0.5 m/s (B) 4 m/s (C) 3 m/s (D) 6 m/s

Sol.

19. Two particles of same mass and charge are thrown in the same direction along the horizontal with same velocity v from two different heights h_1 and h_2 ($h_1 < h_2$). Initially they were located on the same vertical line. Choose the correct alternative.

(A) Both the particles will lie on a vertical line until either of the ball hits the ground

(B) Acceleration of the centre of mass of two particles will be g downwards

(C) Horizontal displacement of the particle lying at h_1 is less and the particle lying at h_2 is more than the value, which would had been in the absence of charges on them.

(D) All of these

Sol.

20. Let V be electric potential and E the magnitude of the electric field. At a given position, which of the statement is true ?

(A) E is always zero where V is zero

(B) V is always zero where E is zero

(C) E can be zero where V is non zero

(D) E is always nonzero where V is nonzero

Sol.

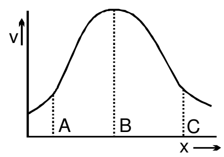
21. The electric potential decreases uniformly from V to –V along X-axis in a coordinate system as we moves from a point $(-x_0, 0)$ to $(x_0, 0)$, then the electric field at the origin.

(A) must be equal to V/x_0 (B) may be equal to V/x_0

(C) must be greater than V/x_0 (D) may be less than V/x_0

Sol.

22Variation of electrostatic potential along x-direction is shown in the graph. The correct statement about electric field is



(A) x component at point B is maximum

(B) x component at point A is towards positive x-axis

(C) x component at poin C is along negative x-axis

(D) x component at point C is along positive x-axis

Sol.

23An electric dipole moment $\vec{p} = (2.0\hat{i} + 3.0\hat{j})\,\mu C.m$ is placed in a uniform electric field $\vec{E} = (3.0\hat{i} + 2.0\hat{k}) \times 10^5 NC^{-1}$.

(A) The torque that $\vec{E}$ exerts on $\vec{p}$ is $(0.6\hat{i} - 0.4\hat{j} - 0.9\hat{k})Nm$

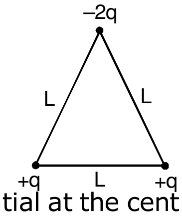
(B) The potential energy of the dipole is –0.6 J.

(C) The potential energy of the dipole is 0.6 J

(D) If the dipole is rotated in the electric field, the maximum potential energy of the dipole is 1.3 J.

Sol.

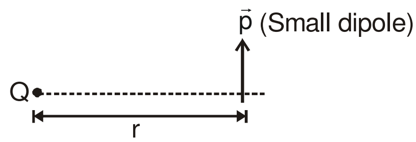
24. Three points charges are placed at the corners of an equilateral triangle of side L as shown in the figure.



(A) The potential at the centroid of the triangle is zero.
(B) The electric field at the centroid of the triangle is zero.
(C) The dipole moment of the system is $\sqrt{2}\,qL$
(D) The dipole moment of the system is $\sqrt{3}\,qL$
Sol.

25. Particle A having positive charge is moving directly head-on towards initially stationary positively charged particle B. At the instant when A and B are closest together.
(A) the momenta of A and B must be equal
(B) the velocities of A and B must be equal
(C) B would have gained less kinetic energy than A would have lost.
(D) B would have gained the same momentum as A would have lost.
Sol.

26. For the situation shown in the figure below (assume r >> lenth of dipole) mark out the correct statement(s).



(A) Force acting on the dipole is zero
(B) Force acting on the dipole is approximately $\frac{pQ}{4\pi\varepsilon_0 r^3}$ & is acting upward.
(C) Torque acting on the dipole is $\frac{pQ}{4\pi\varepsilon_0 r^2}$ in clockwise direction
(D) Torque acting on the dipole is $\frac{pQ}{4\pi\varepsilon_0 r^2}$ in anti-clockwise direction
Sol.

Exercise - III (SUBJECTIVE PROBLEMS)

1. The distance between two fixed positive charges 4e and e is ℓ. How should a third charge 'q' be arranged for it to be in equilibrium ? Under what condition will equilibrium of the charge 'q' be stable (for displacement on the line joining 4e and e) or will it be unstable ?

Sol.

2. Two particles A and B, each having a charge Q are placed a distance d apart. Where should a particle of charge q be placed on the perpendicular bisector of AB so that it experiences maximum force ? What is the magnitude of the maximum force ?

Sol.

3. A negative point charge 2q and a positive charge q are fixed at a distance l apart. Where should a positive test charge Q be placed on the line connecting the charge for it to be in equilibrium? What is the nature of the equilibrium with respect to longitudinal motions?

Sol.

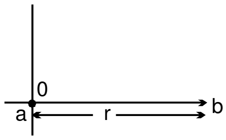
4. Two particles A and B each carrying a charge Q are held fixed with a separation d between then A particle C having mass m and charge q is kept at the midpoint of line AB. If it is displaced through a small distance x ($x<<d$) perpendicular to AB,

(a) then find the time period of the oscillations of C for $q < 0$.

(b) If in the above question C is displaced along AB, find the time period of the oscillations of C for $q < 0$.

Sol.

5. Draw E – r graph for 0 < r < b, if two point charges a & b are located r distance apart, when



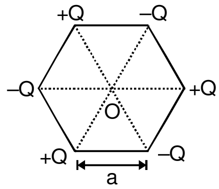
(i) both are +ve
(ii) both are –ve
(iii) a is +ve and b is –ve
(iv) a is –ve and b is +ve

Sol.

6. A charge + 10^{-9} C is located at the origin in free space & another charge Q at (2, 0, 0). If the X-component of the electric field at (3, 1, 1) is zero, calculate the value of Q. Is the Y-component zero at (3, 1, 1) ?

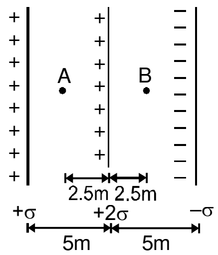
Sol.

7. Six charges are placed at the vertices of a regular hexagon as shown in the figure. Find the electric field on the line passing through O and perpendicular to plane of the figure as a function of distance x from point O.



Sol.

8. The figure shows three infinite non-conducting plates of charge perpendicular to the plane of the paper with charge per unit area +σ, +2σ and –σ. Find the ratio of the net electric field at that point A to that at point B.

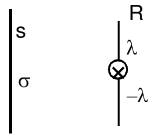


Sol.

9. A thin circular wire of radius r has a charge Q. If a point charge q is placed at the centre of the ring, then find the increase in tension in the wire.

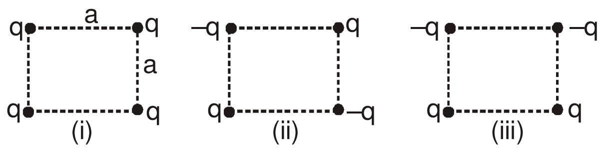
Sol.

10. In the figure shown S is a large nonconducting sheet of uniform charge density σ. A rod R of length l and mass 'm' is parallel to the sheet and hinged at its mid point. The linear charge densities on the upper and lower half of the rod are shown in the figure. Find the angular acceleration of the rod just after it is released.



Sol.

11. In the following figures find the magnitude of electric field at a point 'P' on the axis of the square. The distance of 'P' from the centre is 'x'.



Sol.

12. In the above question find electric field for two cases

(a) x = 0 (b) x > > a

Sol.

13. A charge of 8 mC is located at the origin. Calculate the work done by external agent in taking a small charge of -2×10^{-9} C from a point A (0, 0, 0.03 m) to a point B(0, 0.04m, 0) via a point C(0, 0.06m, 0.09m).

Sol.

14. A particle of mass m, charge q > 0 and initial kinetic energy K is projected from infinity toward a heavy nucleus of charge Q assumed to have a fixed position.

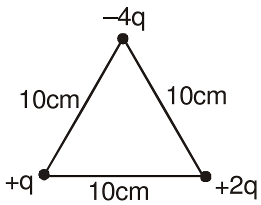
(a) If the aim is perfect, how close to the centre of the nucleus is the particle when it comes instantaneously to rest ?

Sol.

(b) With a particular imperfect aim the particle's closest approach to nucleus is twice the distance determined in (a) Determine speed of particle at the closest distance of approach.

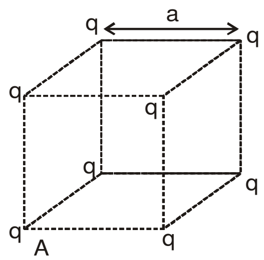
Sol.

15. Three point charges are arranged at the three vertices of a triangle as shown in figure. Given : q = 10^{-7}C. Calculate the electrostatic potential energy of the system.



Sol.

16. Eight equal point charges each of charge 'q' and mass 'm' are placed at eight corners of a cube of side 'a'.



(i) Find out potential energy of charge system

(ii) Find out work done by external agent against electrostatic forces and by electrostatic forces to increase all sides of cube from a to 2a

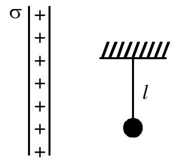
(iii) If all the charges are released at rest then find out their speed when they are at the corners of cube of side 2a.

(iv) If keeping all other charges fix, charge of corner 'A' is released then find out its speed when it is at infinite distance ?

(v) If all charges are released at rest then find out their speed when they are at a very large distance from each other.

Sol.

17. A simple pendulum of length l and bob mass m is hanging in front of a large nonconducting sheet having surface charge density σ. If suddenly a charge +q is given to the bob & it is released from the position shown in figure. Find the maximum angle through which the string is deflected from vertical.



Sol.

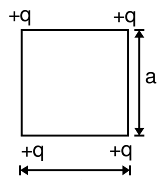
18. A charge +Q is uniformly distributed over a thin ring with radius R. A negative point charge –Q and mass m starts from rest at a point far away from the centre of the ring and moves towards the centre. Find the velocity of this particle at the moment it passes through the centre of the ring.

Sol.

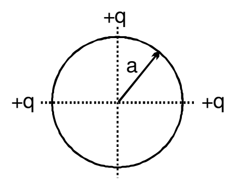
19. A point charge +q & mass 100 gm experiences a force of 100 N at a point a distance 20 cm from a long infinite uniformly charged wire. If it is released find its speed when it is at a distance 40 cm from wire

Sol.

20. Consider the configuration of a system of four charges each of value +q. Find the work done by external agent in changing the configuration of the system from figure (i) to fig (ii).



fig(i)



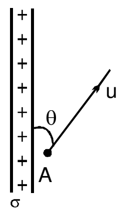
fig(ii)

Sol.

21. Two identical particles of mass m carry charge Q each. Initially one is at rest on a smooth horizontal plane and the other is projected along the plane directly towards the first from a large distance with an initial speed V. Find the closest distance of approach.

Sol.

22. A particle of mass m and negative charge q is thrown in a gravity free space with speed u from the point A on the large non conducting charged sheet with surface charge density σ, as shown in figure. Find the maximum distance from A on sheet where the particle can strike.



Sol.

23. Three charges 0.1 coulomb each are placed on the corners of an equilateral triangle of side 1 m. If the energy is supplied to this system at the rate of 1 kW, how much time would be required to move one of the charges onto the midpoint of the line joining the other two ?

Sol.

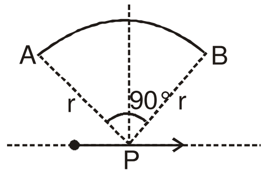
24. Two identical nonconducting spherical shells having equal charge Q are placed at a distance d apart. When they are released find out kinetic energy of each sphere when they are at a large distance.

Sol.

25. If $\vec{E} = 2x^2\hat{i} - 3y^2\hat{j}$ then find v(x, y, z)

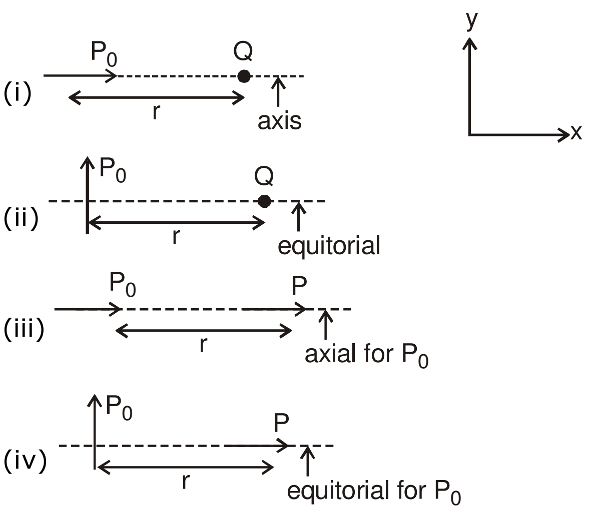
Sol.

26. A charge 'q' is carried from a point A (r, 135°) to point B(r, 45°) following a path which is a quadrant of circle of radius 'r'. If the dipole moment is $\vec{p}$. then find out the work done by external agent ?



Sol.

27. Find out force experienced by short dipole $\vec{P}_0$ is following different arrangements as shown in figures. [Assume point charge is Q, $\vec{P}_0 = q_0(2a)$ and $\vec{P} = q(2a)$]

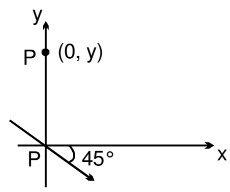


Sol.

28. Find out the magnitude of electric field intensity at point (2, 0, 0) due to a dipole of dipole moment, $\vec{P} = \hat{i} + \sqrt{3}\hat{j}$ kept at origin ? Also find out the potential at that point.

Sol.

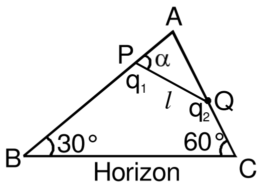
29. A dipole is placed at origin of coordinate system as shown in figure, find the electric field at point P(0, y).



Sol.

Exercise - IV (TOUGH SUBJECTIVE PROBLEMS)

Q.1 A rigid insulated wire frame in the form of a right angled triangle ABC, is set in a vertical plane as shown. Two bead of equal masses m each and carrying charges q_1 & q_2 are connected by a cord of length l & slide without friction on the wires. Considering the case when the beads are stationary, determine.



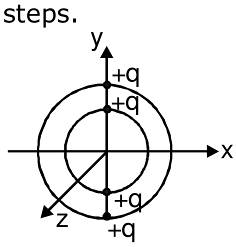
(a) The angle α.
(b) The tension in the cord &
(c) The normal reaction on the beads. If the cord is now cut, what are the values of the charges for which the beads continue to remain stationary.

Q.2 A clock face has negative charges –q, –2q, –3q, ..., –12q fixed at the position of the corresponding numerals on the dial. The clock hands do not disturb the net field due to point charges. At what time does the hour hand point in the same direction is electric field at the centre of the dial.

Q.3 A circular ring of radius R with uniform positive charge density λ per unit length is fixed in the Y-Z plane with its centre at the origin O. A particle of mass m and positive charge q is projected from the point P $\left(\sqrt{3}R, 0, 0\right)$ on the positive X-axis directly towards O, with initial velocity v. Find the smallest value of the speed v such that the particle does not return of P.

Q.4 2 small balls having the same mass & charge & located on the same vertical at heights h_1 & h_2 are thrown in the same direction along the horizontal at the same velocity v. The 1st ball touches the ground at a distance l from the initial vertical. At what height will the 2nd ball be at this instant? The air drag & the charges induced should be neglected.

Q.5 Two concentric rings of radii r and 2r are placed with centre at origin. Two charges +q each are fixed at the diametrically opposite points of the rings as shown in figure. Smaller ring is now rotated by an angle 90° about Z-axis then it is again rotated by 90° about Y-axis. Find the work done by electrostatic forces in each step. If finally larger ring is rotated by 90° about X-axis, find the total work required to perform all three steps.



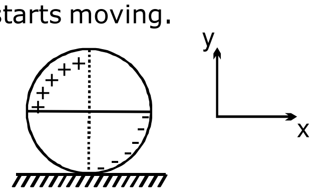
Q.6 Two identical balls of charges q_1 & q_2 initially have equal velocity of the same magnitude and direction. After a uniform electric field is applied for some time, the direction of the velocity of the first ball changes by 60° and the magnitude is reduced by half. The direction of the velocity of the second ball changes there by 90°. In what proportion will the velocity of the second ball changes ?

Q.7 Small identical balls with equal charges are fixed at vertices of regular 2004 - gon with side a. At a certain instant, one of the balls is released & a sufficiently long time interval later, the ball adjacent to the first released ball is freed. The kinetic energies of the released balls are found to differ by K at a sufficiently long distance from the polygon. Determine the charge q of each part.

Q.8 The electric field in a region is given by $\vec{E} = \frac{E_0 x}{l}\hat{i}$. Find the charge contained inside a cubical volume bounded by the surfaces x = 0, x = a, y = 0, y = a, z = 0 and z = a. Take $E_0 = 5 \times 10^3$ N/C, l = 2cm and a = 1 cm.

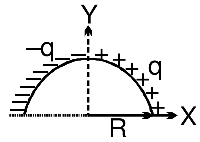
Q.9 2 small metallic balls of radii R_1 & R_2 are kept in vacuum at a large distance compared to the radii. Find the ratio between the charges on the 2 balls at which electrostatic energy of the system is minimum. What is the potential difference between the 2 balls ? Total charge of balls is constant.

Q.10 A nonconducting ring of mass m and radius R is charged as shown. The charged density i.e. charge per unit length is λ. It is then placed on a rough nonconducting horizontal surface plane. At time t = 0, a uniform electric field $\vec{E} = E_0 i$ is switched on and the ring start rolling without sliding. Determine the friction force (magnitude and direction) acting on the ring, when it starts moving.



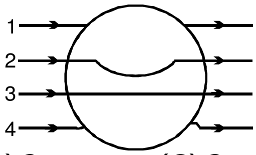
Q.11 Two spherical bobs of same mass & radius having equal charges are suspended from the same point by strings of same length. The bobs are immersed in a liquid of relative permittivity ε_r & density ρ_0. Find the density σ of the bob for which the angle of divergence of the strings to be the same in the air & in the liquid ?

Q.12 Find the electric field at centre of semicircular ring shown in figure.



Exercise - V (JEE-PROBLEMS)

1. A metallic solid sphere is placed in a uniform electric field. The lines of force follow the path (s) shown in figure as



(A) 1 (B) 2 (C) 3 (D)4
[IIT-96,2]

Sol.

2. A non-conducting ring of radius 0.5 m carries a total charge of 1.11×10^{-10} C distributed non-uniformly on its circumference producing an electric field E every where in space. The value of the line integral $\int_{\ell=\infty}^{\ell=0} -E.d\ell$ (l = 0 being centre of the ring) in volts is
[IIT-97,1]
(A) + 2 (B) – 1 (C) – 2 (D) zero

Sol.

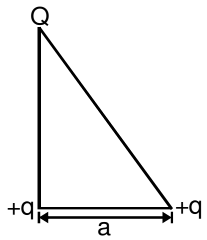
3. Select the correct alternative : **[IIT-98]**
(i) A + ly charged thin metal ring of radius R is fixed in the xy–plane with its centre at the origin O. A –ly charged particle P is released from rest at the point $(0, 0, z_0)$ where $z_0 > 0$. Then the motion of P is
(A) periodic, for all values of z_0 satisfying $0 < z_0 < \infty$
(B) simple harmonic, for all values of z_0 satisfying $0 < z_0 \le R$
(C) approximately simple harmonic, provided $z_0 << R$
(D) such that P crosses O & continues to move along the –ve z-axis towards $x = -\infty$
Sol.

(ii) A charge +q is fixed at each of the points $x = x_0$, $x = 3x_0$, $x = 5x_0$, ... ∞ on the x-axis & a charge –q is fixed at each of the points $x = 2x_0$, $x = 4x_0$, $x = 6x_0$, ... ∞. Here x_0 is a +ve constant. Take the electric potential at a point due to a charge Q at a distance r from it to be $\frac{Q}{4\pi \in_0 r}$. Then the potential at the origin due to the above system of charges is
(A) 0 (B) $\frac{q}{8\pi \in_0 x_0 \ell n2}$ (C) ∞ (D) $\frac{q \ell n2}{4\pi \in_0 x_0}$
Sol.

(iii) 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.
(A) increases as r increases, for r < R
(B) decreases as r increases, for 0 < r < ∞
(C) decreases as r increases, for R < r < ∞
(D) is discontinuous at r = R
Sol.

4. (a) The dimension of $\left(\frac{1}{2}\right) e_0 E^2$ (e_0 : permittivity of free space; E : electric field) is **[IIT-2000(Scr)]**
(A) MLT^{-1} (B) ML^2T^{-2} (C) MLT^{-2} (D) ML^2T^{-}
(E) $ML^{-1}T^{-2}$
Sol.

(b) Three charges Q, +q and +q are placed at the verticles of a right-angled isosceles triangle as shown. The net electrostatic energy of the configuration is zero if Q is equal to



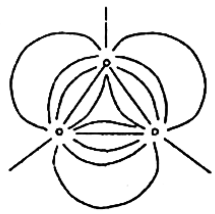
(A) $\frac{-q}{1+\sqrt{2}}$ (B) $\frac{-2q}{2+\sqrt{2}}$ (C) –2q (D) +q

Sol.

(c) Four point charges + 8μC, –1μC, –1μC and + 8μC, are fixed at the points, $-\sqrt{\frac{27}{2}}$ m, $-\sqrt{\frac{3}{2}}$ m, $+\sqrt{\frac{3}{2}}$ m and $+\sqrt{\frac{27}{2}}$ m respectively on the y-axis. A particle of mass 6×10^{-4} kg and of charge + 0.1μC moves along the –x direction. Its speed at x = + ∞ is v_0. Find the least value of v_0 for which the particle will cross the origin. Find also the kinetic energy of the particle at the origin. Assume that space is gratity free. (Given : $1/(4\pi\varepsilon_0) = 9 \times 10^9$ Nm^2/C^2) **[IIT-2000,10]**

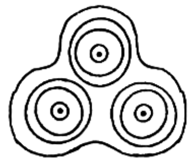
Sol.

5. Three positive charges of equal value q are placed at the vertices of an equilateral triangle. The resulting lines of force should be sketched as in **[IIT-2001(Scr)]**

(A)


(B)


(C)


(D)


Sol.

6. A small ball of mass 2×10^{-3} Kg having a charge of 1μC is suspended by a string length 0.8m. Another identical ball having the same charge is kept at the point of suspension. Determine the minimum horizontal velocity which should be imparted to the lower ball so that it can make complete revolution. **[IIT-2001]**

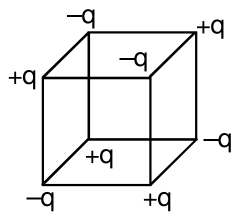
Sol.

7. Two equal point charges are fixed at x = –a and x = +a on the x-axis. Another point charge Q is placed at the origin. The change in the electrical potential energy of Q, when it is displaced by a small distance x along the x-axis, is approximately proportional to **[JEE 2002 (Scr).]**

(A) x (B) x^2 (C) x^3 (D) 1/x

Sol.

8. Charges +q and –q are located at the corners of a cube of side a as shown in the figure. Find the work done to separate the charges to infinite distance. **[JEE-2003]**



Sol.

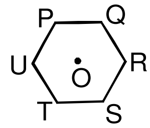
9. A charge +Q is fixed at the origin of the co-ordinate system while a small electric dipole of dipole-moment $\vec{p}$ pointing away from the charge along the x-axis is set free from a point far away from the origin.

(a) calculate the K.E. of the dipole when it reaches to a point (d, 0) **[JEE 2003]**

(b) calculate the force on the charge +Q at this moment.

Sol.

10. Six charges, three positive and three negative of equal magnitude are to be placed at the vertices of a regular hexagon such that the electric field at O is double the electric field when only one positive charge of same magnitude is placed at R. Which of the following arrangements of charges is possible for P, Q, R, S, T and U respectively ? **[JEE 2004 (SCR)]**



(A) +, –, +, –, –, + (B) +, –, +, –, +, –
(C) +, +, –, +, –, – (D) –, +, +, –, +, –

Sol.

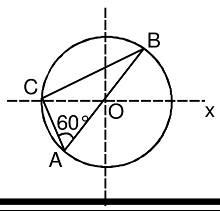
11. Two uniformly charged infinitely large planar sheet S_1 and S_2 are held in air parallel to each other with separation d between them. The sheets have charge distribution per unit area σ_1 and σ_2 (Cm^{-2}), respectively, with $\sigma_1 > \sigma_2$. Find the work done by the electric field on a point charge Q that moves from S_1 towards S_2 along a line of length a (a < d) making an angle $\pi/4$ with the normal to the sheets. Assume that the charge Q does not affect the charge distributions of the sheets. **[JEE 2004]**

Sol.

12. Which of the following groups do not have same dimensions -
(A) Young's modulus, pressure stress
(B) work, heat, energy
(C) electromotive force, potential difference, voltage
(D) electric dipole, electric flux, electric field
Sol.

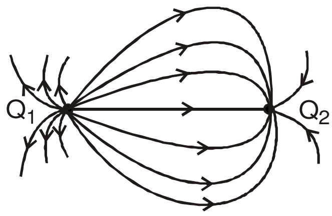
13. Positive and negative point charges of equal magnitude are kept at $\left(0,0,\frac{a}{2}\right)$ and $\left(0,0,-\frac{a}{2}\right)$, respectively. The work done by the electric field when another positive point charge is moved from (–a, 0, 0) to (0, a, 0) is -
(A) positive (B) negative (C) zero
(D) depends on the path connecting the initial and final positions **[JEE 2007]**
Sol.

14. 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° **[JEE 2008]**
Figure :



(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 $\frac{q}{12\pi\varepsilon_0 R}$
Sol.

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



(A) $|Q_1| > |Q_2|$ (B) $|Q_1| < |Q_2|$
(C) at a finite distance to the left of Q_1 the electric field is zero.
(D) at a finite distance to the right of Q_2 the electric field is zero. **[JEE 2010]**
Sol.

16. 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)

(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

[JEE 2010]

Sol.

17. A tiny spherical oil drop carrying a net charge q is balanced in still air with a vertical uniform electric field of strength $\frac{81\pi}{7} \times 10^5\ \text{Vm}^{-1}$. When the field is switched off, the drop is observed to fall with terminal velocity $2 \times 10^{-3}\ \text{ms}^{-1}$ Given $g = 9.8\ \text{ms}^{-2}$, viscosity of the air $= 1.8 \times 10^{-5}\ \text{Ns m}^{-2}$ and the density of oil $= 900\ \text{kg m}^{-5}$, the magnitude of q is :

(A) 1.6×10^{-19}C (B) 3.2×10^{-19}C

(C) 4.8×10^{-19}C (D) 8.0×10^{-19}C

[JEE 2010]

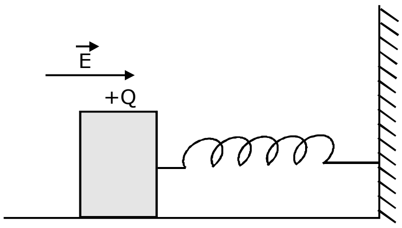
Sol.

18. Four point charges, each of +q are rigidly fixed at the four corners of a square planar soap film of side 'a'. The surface tension of the soap film is γ. the system of charges and planar film are in equilibrium, and $a = k\left[\frac{q^2}{\gamma}\right]^{1/N}$, where 'k' is a constant. Then N is

[JEE 2011]

Sol.

19. A wooden block performs SHM on a frictionless surface with frequency, v_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



(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 **[JEE 2011]**

Sol.