PHYSICS

BOOKS - CENGAGE PHYSICS (ENGLISH)

ELECTRIC POTENTIAL

Illustration

1. find the work done by an external agent in slowly shifting a charge $q = 1\mu C$ in the electric field $\overrightarrow{E} = 10^3 \hat{i} V m^{-1}$ from the point $P(1, 2) \text{to} Q(3, 4)$.

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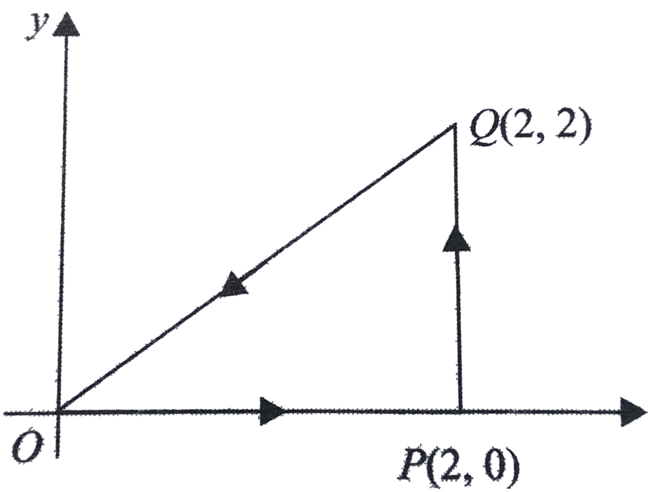
2. A charge particle $q = -10\mu C$ is carried along OP and PQ and then back to O along QO as shown in an electric field $\overrightarrow{E} = (x + 2y)\hat{i} + 2x\hat{j}$ Find the work done by an external agent in (i) each path and (ii) the round trip.



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3. The electric field in a region is given by $\vec{E} = \left(\frac{A}{x^3}\right)\vec{I}$. Write a suitable SI unit for A. Write an experssion for. the potential in the region assuming the potential at. infinity to be zero.

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4. Three charges $q_1 = 1\mu C, q_2 = -2\mu C$, and $q_3 = -1\mu C$ are placed at $A(0, 0, 0), B(-1, 2, 3,)$ and $C(2, -1, 1)$. Find the potential of the system of three charges at $P(1, -2, -1)$.

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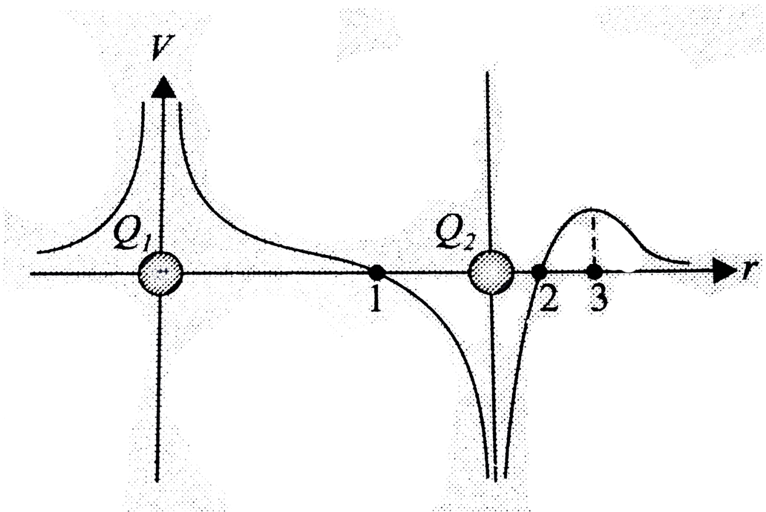
5. Two point charges Q_1 and Q_2 lie along a line at a distance from each other. Figure 3.7 shows the potential variation along the line of charges. At which of the points 1, 2, and 3 is the electric field zero ? What are the singns of the charges Q_1 and Q_2 and which of the two charges is greater in magnitude ?



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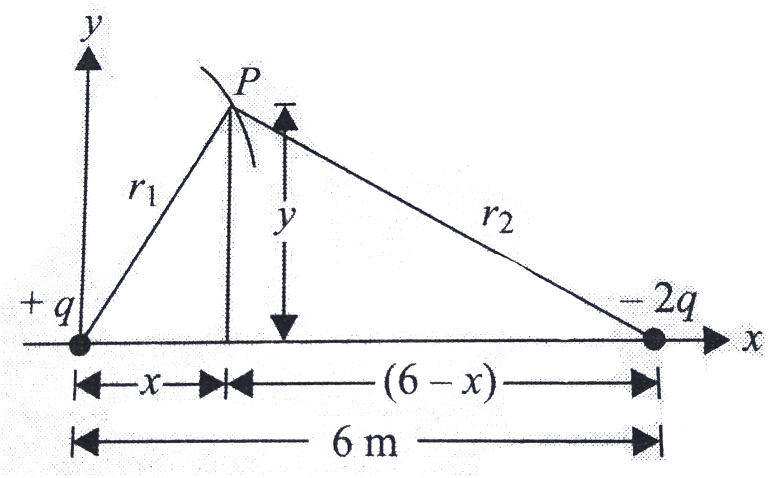
6. Two electric charges q and $-2q$ are placed at a distance 6 m apart on a horizontal plane. Find the locus of point on this plane where the potential has a value zero.



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7. $1\mu C$ charge is shifted from A to B, and it is found that work done by an external force is $40\mu J$. In doing so against electrostatic forces, find potential difference $V_A - V_B$.

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8. A uniform electric field is present in the positive x - direction. If the intensity of the field is $5NC^{-1}$ then find the potential difference $(V_B - V_A)$ between two points A (0 m, 2 m) and B (5 m, 3 m).

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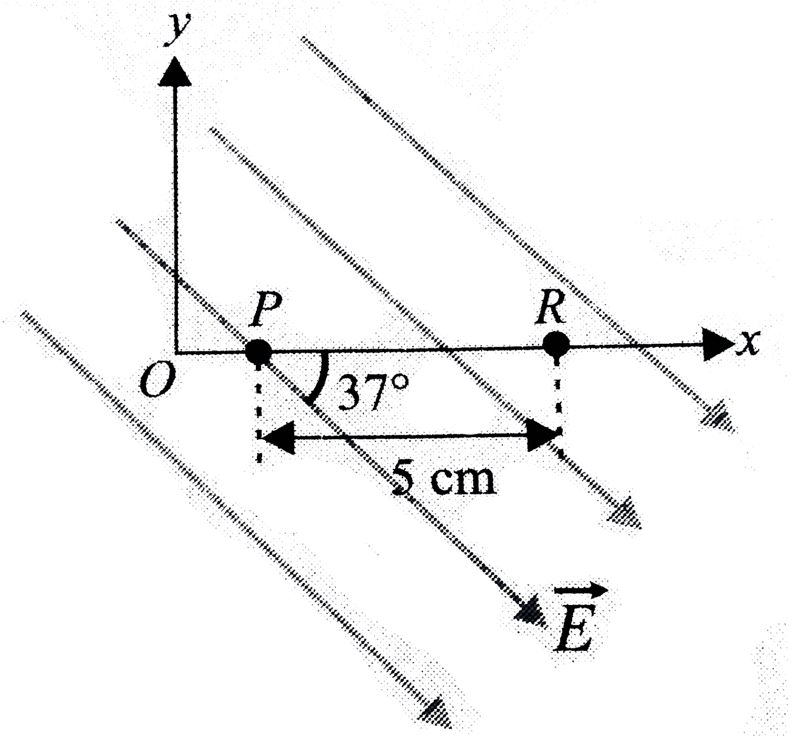
9. A uniform field of magnitude $\overrightarrow{E} = 2000NC^{-1}$ is directed $\theta = 37^\circ$ below the horizontal [fig. 3.11].



(i) Find the potential difference between P and R.

(ii) If we define the reference level of potential so that potential at R is $V_R = 500V$, what is the potential at P?

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10. Find the potential difference V_{AB} between $A(0, 0, 0)$ and $B(1m, 1m, 1m)$ in an electric field :

(i) $\vec{E} = \left(y\hat{i} + x\hat{j}\right)Vm^{-1}$

(ii) $\vec{E} = \left(3x^2y\hat{i} + x^3\hat{j}\right)Vm^{-1}$.

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11. Uniform electric field of magnitude $100Vm^{-1}$ in space is directed along the line $y = 3 + x$. Find the potential difference between points $A(3, 1)$ and $B(1, 3)$.

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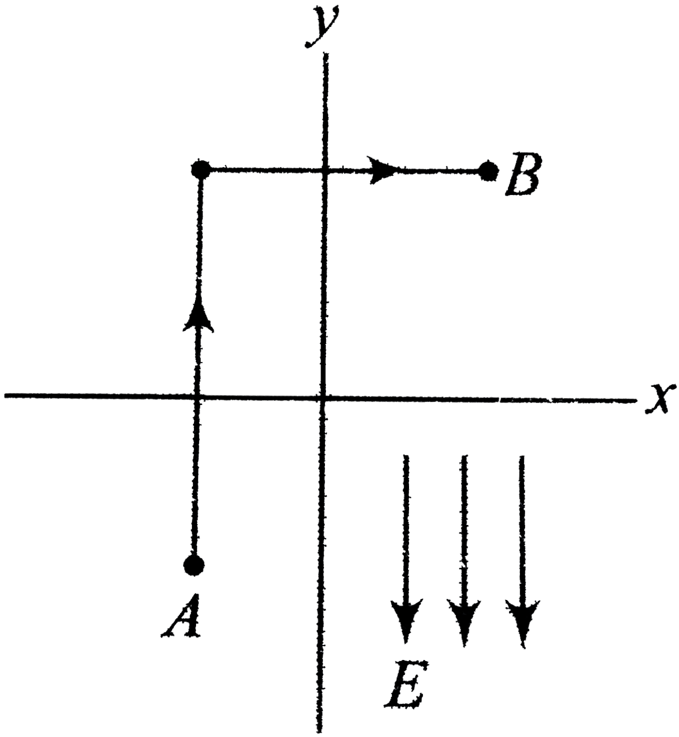
12. A uniform electric field of magnitude $325 V m^{-1}$ is directed in the negative y - direction in (fig. 3.12). Theb coordinates of point A are $(-0.2m, -0.3m)$ and those of point B are $(0.4m, 0.5m)$. Calculate the potential difference $V_B - V_A$ along the path shown in the figure.



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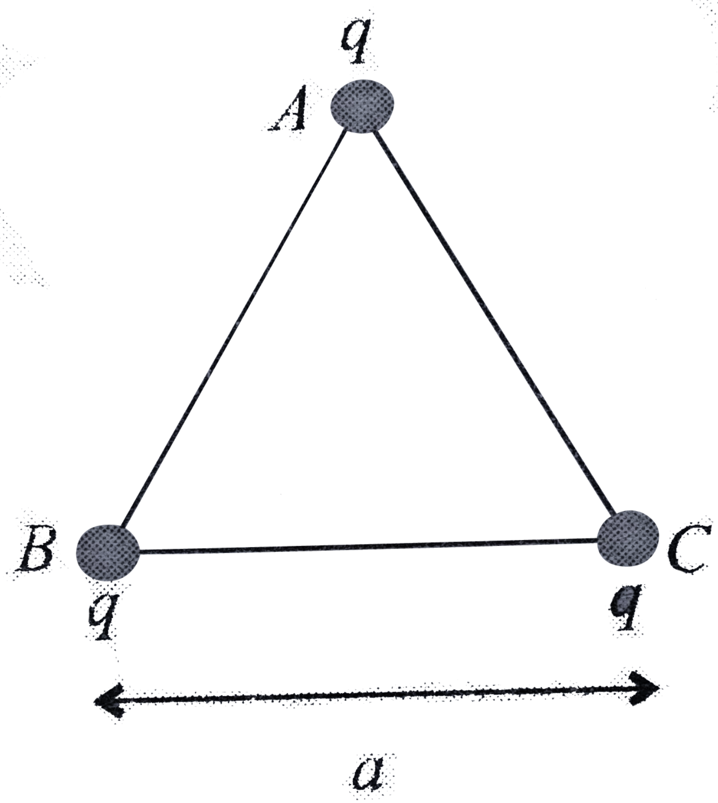
13. Three equal charges q are placed at the corners of an equilateral triangle of side A.

(i) Find out potential energy of charge system.

(ii) Calculate work required to decrease the side of triangle to $a/2$.

(iii) If the charges are released from the shown position and each of them has same mass m, then find the speed of each particle when they lie on triangle of side $2a$.



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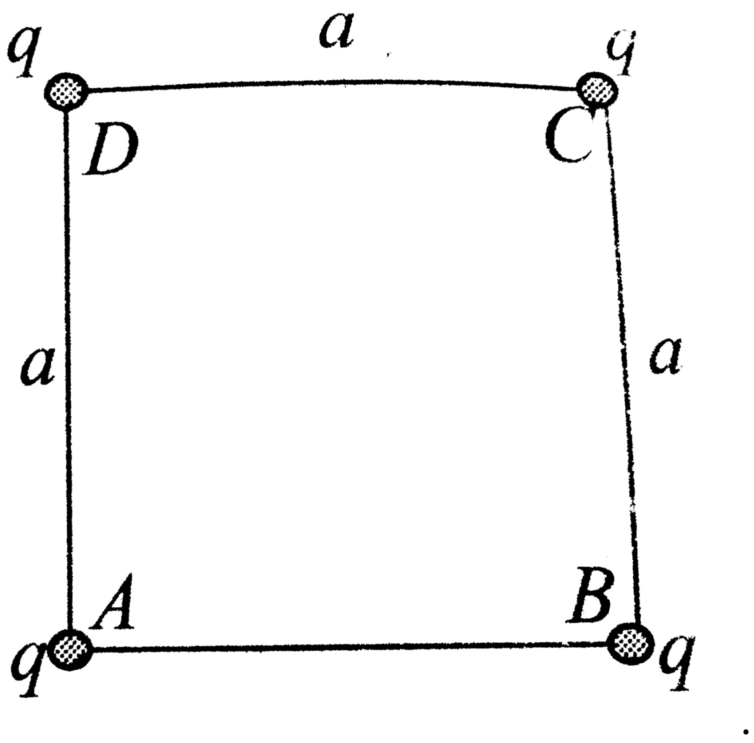
14. Four identical charges q are placed at the corners of a square of side a. Find the potential energy of one of the charges due to the remaining charges.



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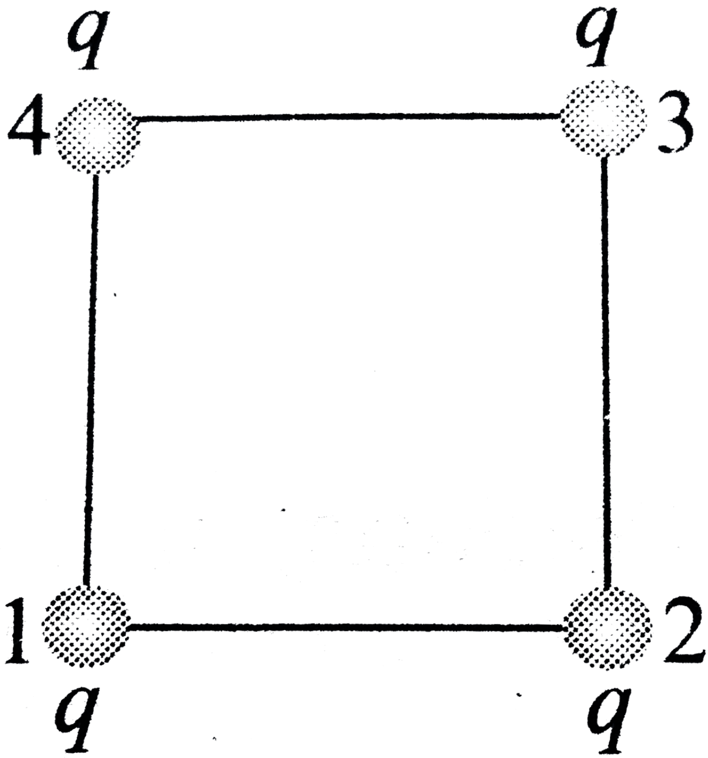
15. Four identical point charges q are placed at four corners of a square of side a. Find the potential energy of the charge system.



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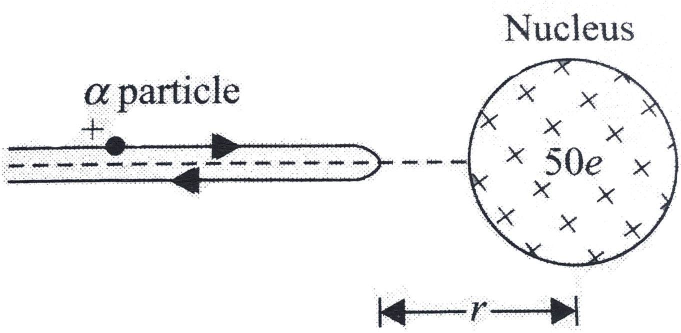
16. An alpha particle with kinetic energy $10MeV$ is heading toward a stationary tin nucleus of atomic number 50. Calculate the distance of closest approach (Fig . 3.23).



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17. A proton moves from a large distance with a speed u m/s directly towards a free proton originally at rest. Find the distance of closest of closest approach for the two protons in terms of mass of proton m and its charge e.

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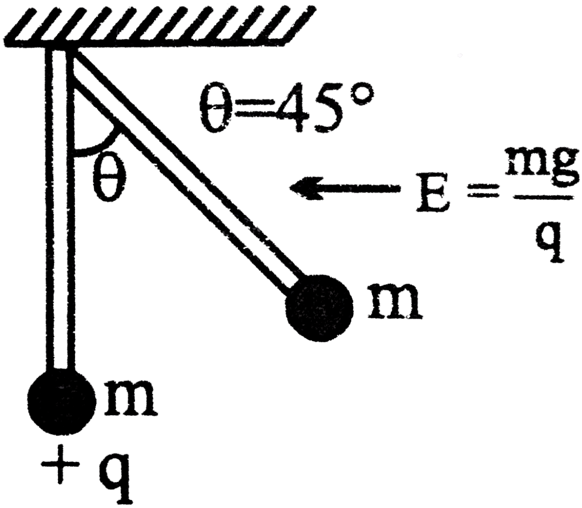
18. In space of horizontal $EF(E = (mg)/q)$ exist as shown in figure and a mass m is released at the end of a light rod. If mass m is releases from the position shown in figure find the angular velocity of the rod when it passes through the bottom most position



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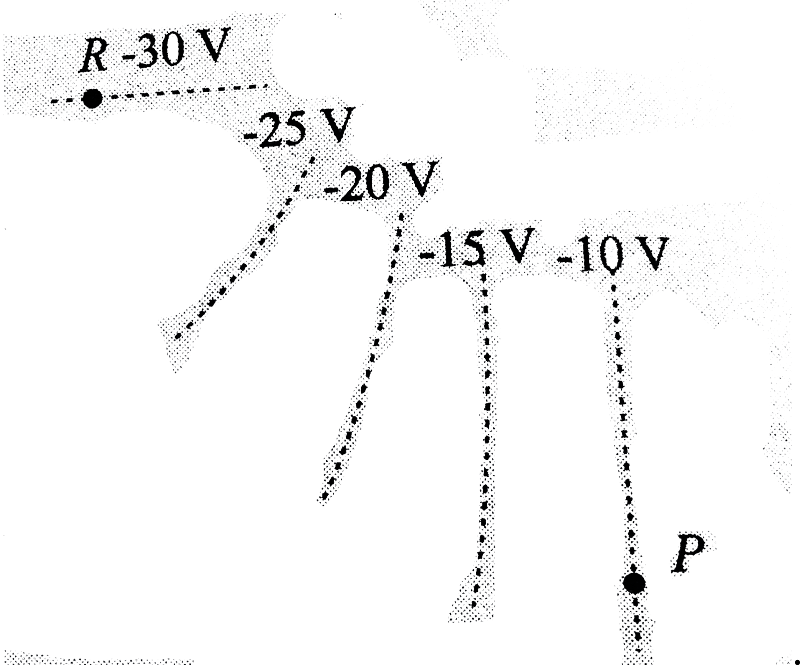
19. (Figure 3.27) shows equipotential surfaces. What is the direction of electric field $\vec{E}$ at P and R?



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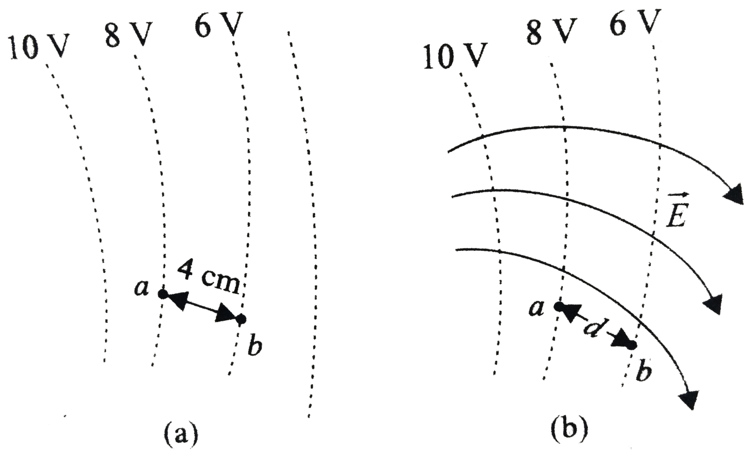
20. Three equipotential surfaces are shown in (Fig. 3.28) A. Draw the corresponding field lines and estimate the field strength at a point A where the distance between the surfaces is 4 cm.

a. 

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21. Consider a spherical surface of radius 4 m cenred at the origin. Point charges +q and - 2q are fixed at points A(2 m, 0,0) and B(8 m, 0, 0), respectively. Show that every point on the shperical surface is at zero potential.

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22. The potential at any point is given by $V = x(y^2 - 4x^2)$. Calculate the cartesian components of the electric field at the point.

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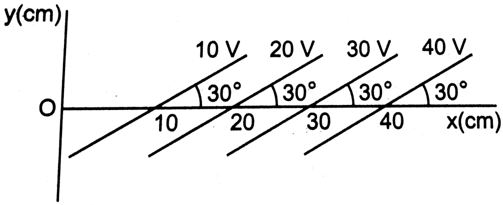
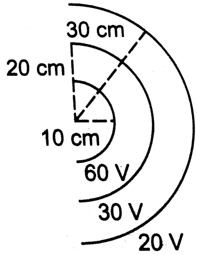
23. Some equipotential surfaces are shown in figure(29.E3) What can you say about the magnitude

and the direction of the electric field?





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24. Determine the electric field strength vector if the potential of this field depends upon x - and y - coordinates as :

(i) $V = a(x^2 - y^2)$

(ii) $V = axy$.

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25. (i) Find the field intensity if potential $V = -kxy(k > 0)$.

(ii) Draw the field pattern of the field in i.

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

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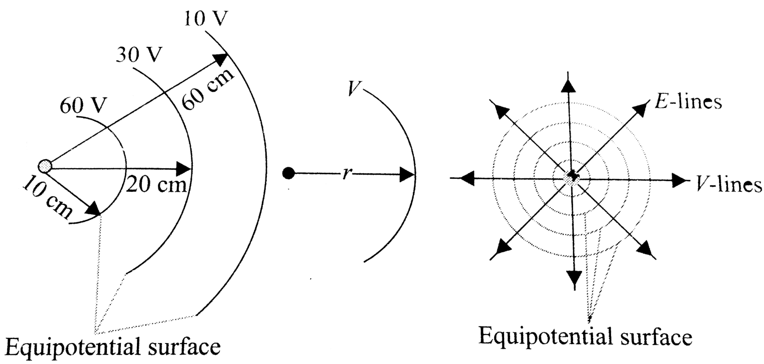
27. Referring to the spherical equipotential lines in (Fig. 3.36)A, find

(i) $\overrightarrow{E} = f(r)$

(ii) $\overrightarrow{E}$ - pattern.

a. .

b. .

c. 

(a) (b) (c) .

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28. A very small sphere of mass $80g$ having a charge q is held at a height of $9m$ vertically above the center of a fixed conducting sphere of radius $1m$, carrying an equal charge q. When released, it falls until it is repelled back just before it comes in contact with the shpere as shown in Fig. 47. Calculate the charge q. $\left[g = 10ms^{-2}\right]$.

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29. A hollow uncharged spherical conductor has inner radius A and outer radius b. A positive point charge +q is in the cavity at the center of the sphere (Fig. 3.48).

Find the potential V(r) everywhere, assuming that $V = 0$ at $r \to \infty$.

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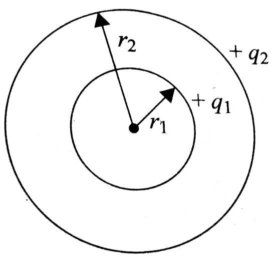
30. Figure shows two concentric conducting shells of radii r_1 and r_2 carrying uniformly distributed charges q_1 and q_2, respectively. Find an expression for the potential of each shell.



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31. A metal sphere A of radius a is charged to potential V. What will be its potential if it is enclosed by a spherical conducting shell B of radius b and the two are connected by a wire ?

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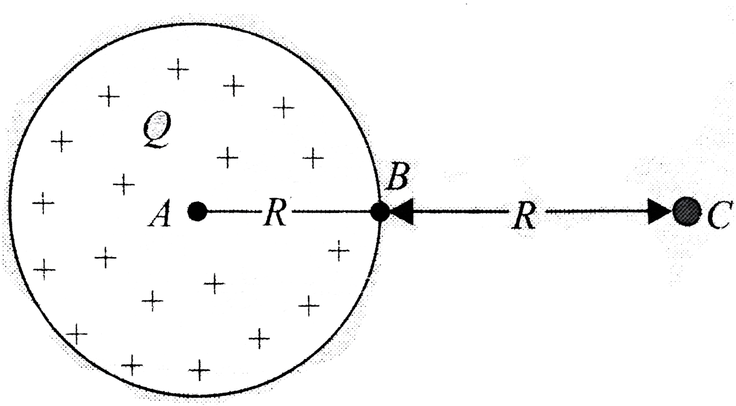
32. Find the electric work done in bringing a charge q from A to B in a sphere of charge Q distributed uniformly throughout its volume.



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33. Positive charge Q is uniformly distributed throughout the volume of a sphere of radius R. A Point mass having charge $+q$ and mass m is fired towards the centre of the sphere with velocity v from a point A at distance $r(r > R)$ from the centre of the sphere. Find the minimum, so that it can penetrate R/2 distance of the sphere. Neglect any resistance other than:e-c141::, interaction. Charge on the small mass remains constant throughout the motion

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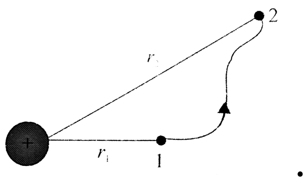
34. A charge particle q is shifted from point 1 to point 2 in the electric field of a straight long linear charge of λ.

i. Find the electric work done if $r_1 = R$ and $r_2 = 2R$

ii. Find the potential difference between 1 and 2.



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35. Two circular loops of radii 0.05 and $0.09m$, respectively, are put such that their axes coincide and their centers are $0.12m$ apart. A charge of $10^{-6}C$ is spread uniformly on each loop. Find the potential difference between the centers of the loops.

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36. A circular ring of radius R with uniform positive charge density λ per unit length is located in the y z plane with its center at the origin O. A particle of mass m and positive charge q is projected from that point $p\left(-\sqrt{3}R, 0, 0\right)$ on the negative x - axis directly toward O, with initial speed V. Find the smallest (nonzero) value of the speed such that the particle does not return to P ?

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37. A spherical shell of radius R_1 with uniform charge q is expanded to a radius R_2. Find the work performed by the electric forces in this process.

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38. A spherical shell of radius R_1 with a uniform charge q has a point charge q_0 at its center. Find the work performed by the electric forces during the shell expansion from radius R_1 to radius R_2.

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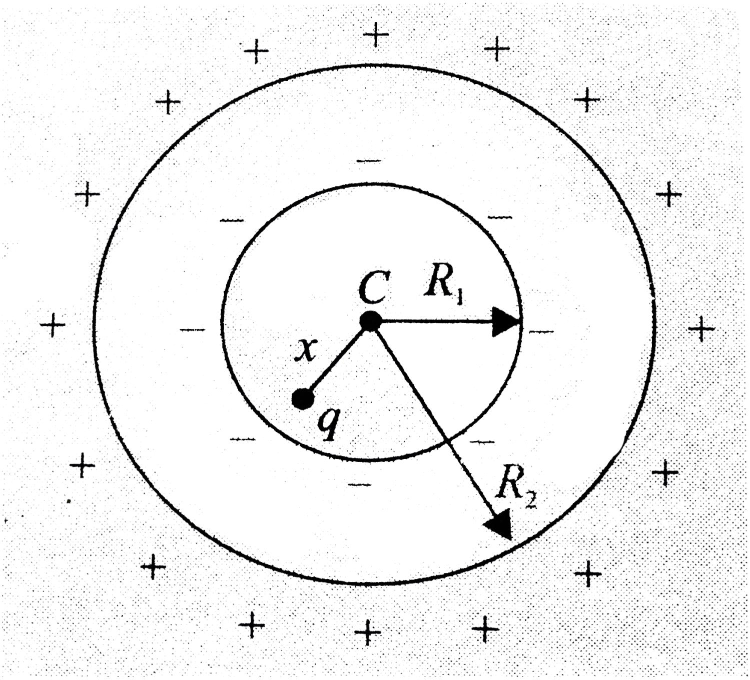
39. Inside a conducting hollow sphere of inner radius R_1 and outer radius R_2, a point charge q is placed at a distance x from the center as shown in fig. Find.



(i) electric potential at C

(ii) electric field and potential at a distance r from the center outside the shell.

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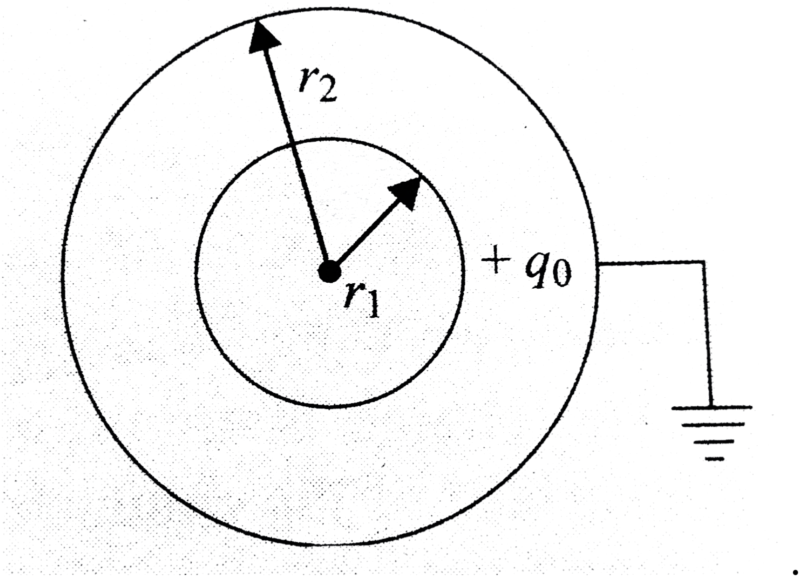
40. In (Fig. 3.73), if the inner shell has charge $+q_0$ and the outer shell is earthed, then



i. determine the charge on the outer shell, and

ii. find the potential of the inner shell.

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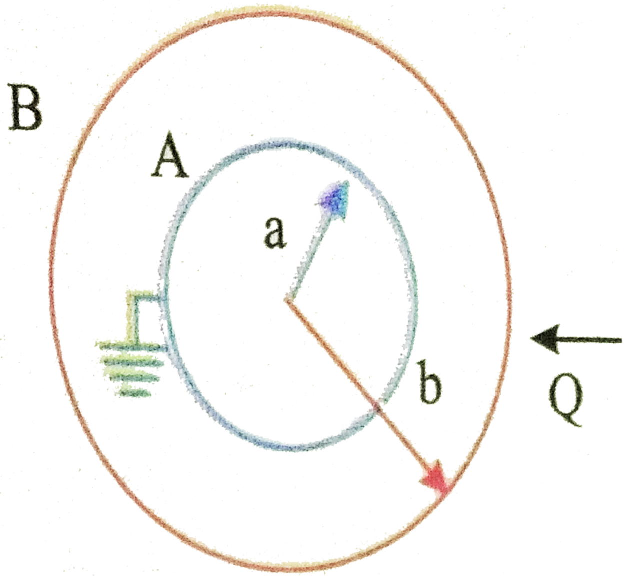
41. Consider two concentric spherical metal shells of radii $'a'$ and $b > a$ .The outer shell has charge Q but the inner shell has no charge.Now the inner shell is grounded ,This means that the inner shell will come at zero potential and that electric fields lines leave the outer shell and end on the inner shell.(a) Find the charge on the inner shell

Find the potential on outer sphere.



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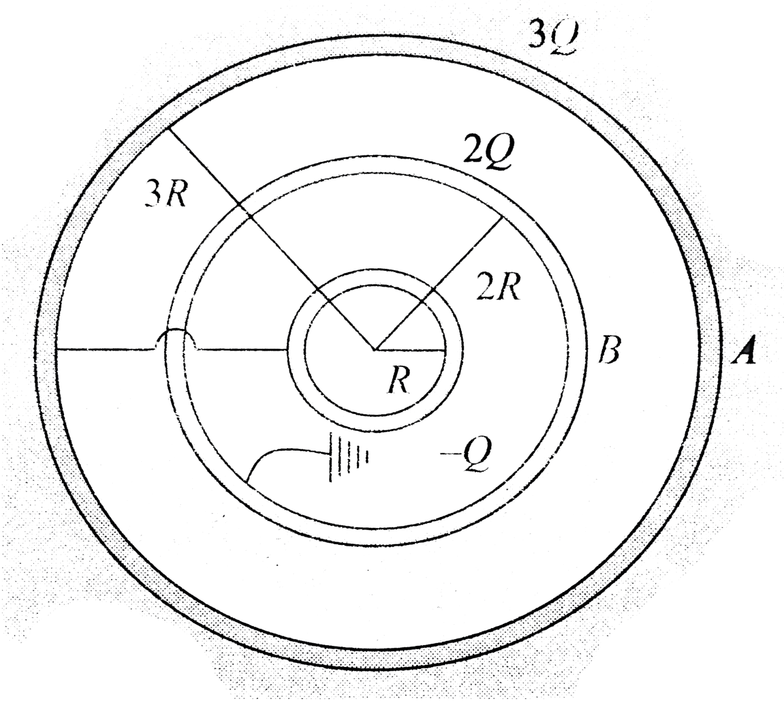
42. (Figure 3.78) shows three thin concentric spherical shells A, B and C with initial charges on A , B, and C as 3 Q, 2Q, and -Q, respectively. The shells A amd C are connected by a wire such that it does not touch B. Shell B is earthed. Determine the final charges $q_A, q_B, \text{and} q_C$.



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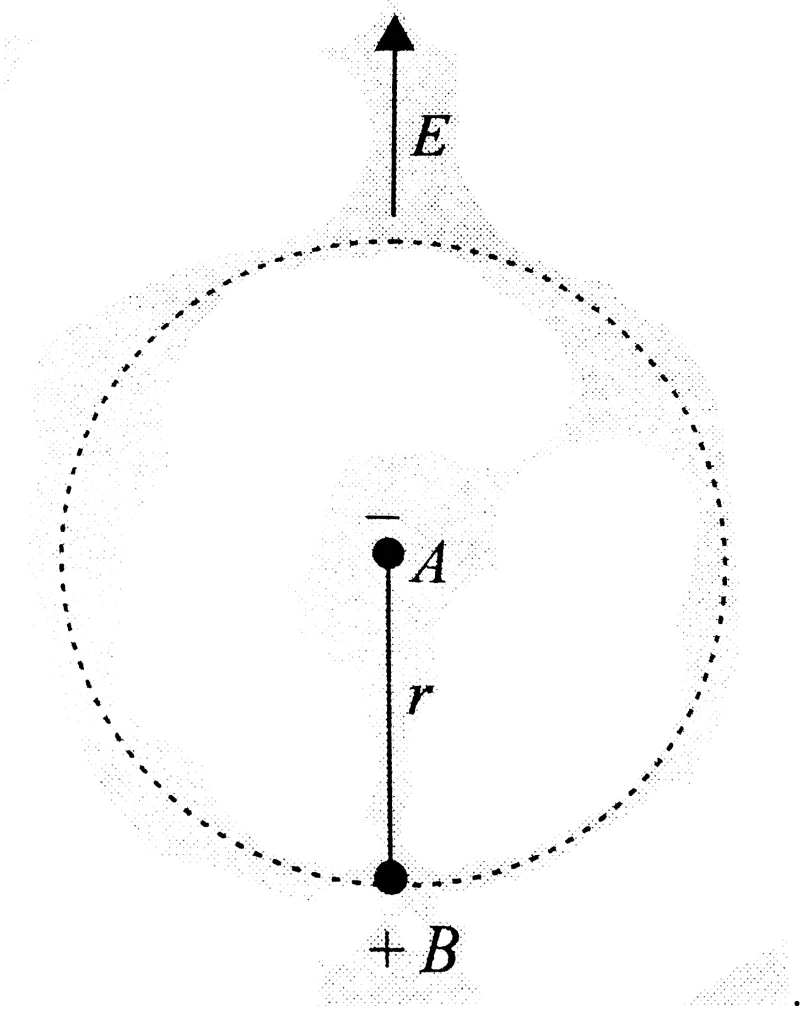
43. Two small particles A and B having masses $m = 0.5kg$ each and charges $q_1 = (-155/18\mu C)$ and $q_2 = (+100\mu C)$, respectively, are connected at the ends of a nonconducting, flexible, and inextensible string of length $r = 0.5m$.

Particle A is fixed and B is whirled along a vertical circle with center at A. if a vertically upward electric field of Strength $E = 1.1 \times 10^5 NC^{-1}$ exists in the space, calculate the minimum velocity of particle B required at the highest point so that it may just complete the circle $\left(g = 10ms^{-2}\right)$.



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44. A small sphere of mass $m = 0.6kg$ carrying a positive charge $q = 80\mu C$ is connected with a light, flexible, and inextensible string of length $r = 30cm$ and whirled in a vertical circle. If a horizontal rightward electric field of strength $E = 10^5 NC^{-1}$ exists in the space, calculate the minimum velocity of the sphere required at the highest point so that it may just complete the circle $(g = 10ms^{-2})$.

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45. Two point charges of $3.2 \times 10^{-19} C$ and $-3.2 \times 10^{-19} C$ are separated from each other by $2.4 \times 10^{-10} m$. The dipole is situated in a uniform electric field of intensity $4 \times 10^{5} V m^{-1}$. Calculate the work done in roating the dipole by 180°.

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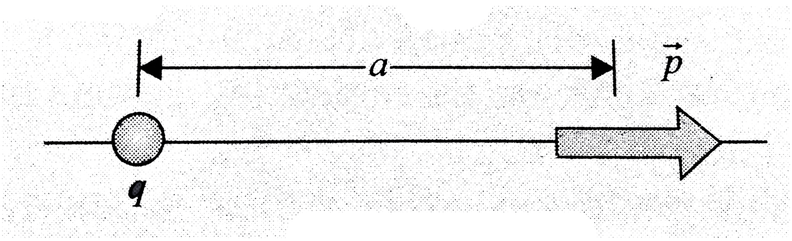
46. What is the potential energy of the charge and dipole system shown in (Fig. 3.93) ?



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Examples

1. A nonconducting disk of radius a and uniform positive surface charge density σ is placed on the ground, with its axis vertical. A particle of mass m and positive charge q is dropped, along the axis of the disk, from a height H with zero initial velocity. The particle has $q/m = 4\varepsilon_0 g/\sigma$.

(i) Find the value of H if the particle just reaches the disk.

(ii) Sketch the potential energy of the particle as a function of its height and find its equilibrium position.

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2. Three concentric conducting shells of radii a, b and c are shown in (Fig. 3.100). Charge on the shell of radius b is Q. If the key K is closed, find the charges on the innermost and outermost shells and the radio of charge densities of the shells. Given that $a : b : c = 1 : 2 : 3.$

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3. A conducting sphere S_1 of radius r is attached to an insulating handle. Another conduction sphere S_2 of radius R is mounted on an insulating stand. S_2 is initially uncharged. S_1 is given a charge Q brought into contact with S_2 and removed. S_1 is recharge such that the charge on it is again Q and it is again brought into contact with S_2 and removed. This procedure is repeated n times.

a. Find the electrostatic energy of S_2 after n such contacts with S_1.

b. What is the limiting value of this energy as $n \to \infty$?

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4. Two isolated metallic solid spheres of radii R and 2R are charged such that both of these have same charge density σ. The spheres are located far away from each other and connected by a thin conducting wire. Find the new charge density on the bigger sphere.

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5. The potential in the electric field varies as $V = -ax^2 + b$ with respect to x - coordinate, where a and b are constants. Find the charge density $\rho(x)$ in a space.

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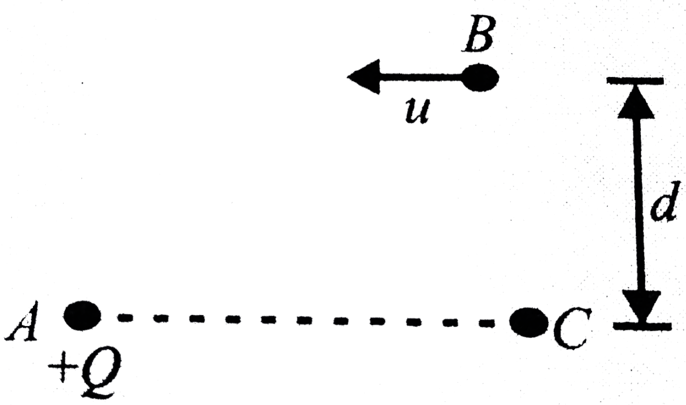
6. A positive charge $+Q$ is fixed at a point A. Another positively charged particle of mass m and charge +q is projected from a point B with velocity u as shown in (Fig. 3.103). Point B is at a large distance from A and at distance d from the line A C. The initial velocity is parallel to the line A C. The point C is at a very large distance from A. Find the minimum distance (in meter) of +q from +Q during the motion. Take $Qq = 4\pi\varepsilon_0 mu^2 d$ and $d(\sqrt{2} - 1)m$.



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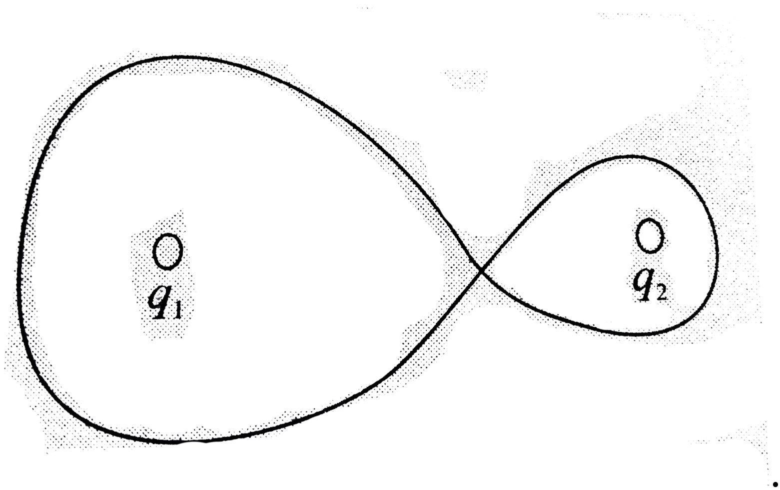
7. Two point like charges q_1 and q_2 are fixed in free space. At every point on the curve shown, the net electrostatic potential created by these charges is V. Find the separation r between the charges.



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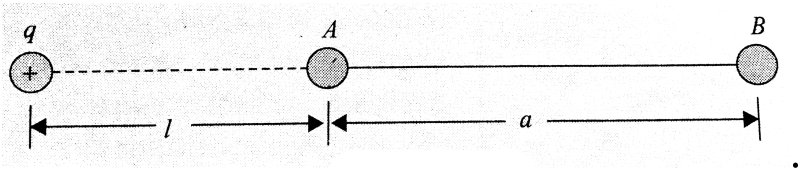
8. Two small metal spheres A and B, each of radius r and supported on insulating stands, located at a distance $a(a > > r)$ from each other are connected by a thin conducting wire. A point charge q is brought near the spheres at distance $l(l > > r)$ on the line joining the centers of the spheres. What are the moduli of charge induced on the spheres ?



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9. A particle of mass $m = 0.1kg$ and having positive charge $q = 75\mu C$ is suspended from a point by a thread of length $l = 10cm$. In the space, a uniform horizontal electric field $E = 10^4 NC^{-1}$ exists. The particle is drawn aside so that the thread becomes vertical and then it is projected horizontally with velocity v such that the particle starts to move along a circle with the same constant speed V. Calculate the radius of the circle and speed $v(g = 10ms^{-2})$.

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Exercise 3.1

1. The electric field inside a hollow charged conductor is zero. Is this true or false ?

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2. How can you check whether the electric potential in a given region of space has constant value ?

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3. Are we free to call the potential of earth (+ 100 V) instead of zero ? What effect would such an assumption have on measured values of

A potentials

B potential difference ?

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4. If you know (E) at a given point, can you calculate V at that point ? If not, what further information do you need ?

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5. Can there be a potential difference between two adjacent conductors that carry same amount of positive charge ?

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6. An electron moves from the positive to the negative terminal of a battery (9 V). How much potential energy did it gain or lose ?

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7. We want to produce a proton with kinetic energy $4.3 \times 10^{-15} J$. Through what difference of potential should we accelerate the proton to obtain this kinetic energy assuming that it starts from rest and no other forces are present ?

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8. The potential produced by a point charge is $V = kQ/r$. Use this information to determine the shape of equipotential surface ?

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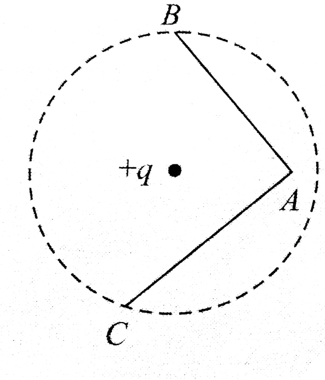
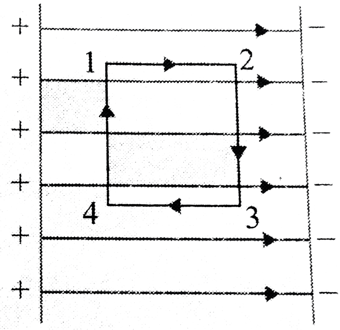
9. a. A circle is drawn with center as a charge +q. What is the work done in moving a charge +q from B to C along the circumferebce of the circle ?

B In the above question, if the charge +q is first taken from B to A and then from A to C, on which path is the magnitude of work greater?





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10. A uniform electric field E exists between two oppositely charged plates (Fig. 3.38). What will be the work done in moving a charge q along a closed rectangular path ?

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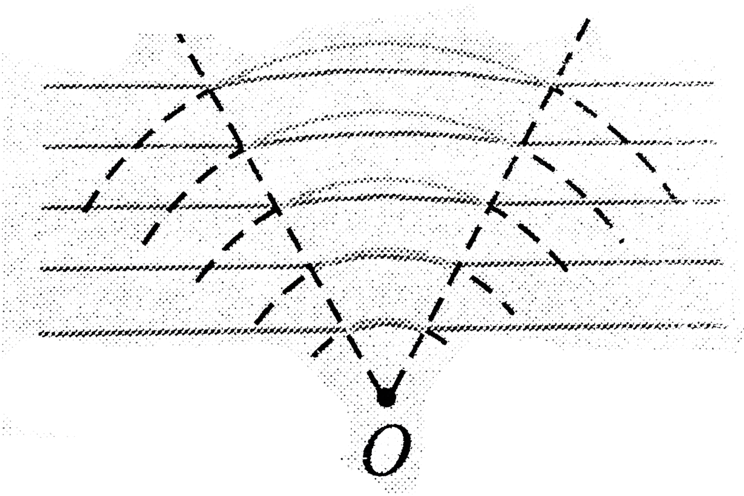
11. Show that if at some part of a field the lines of force have the from of concentric circles whose centres are at point O (as given in Fig. 3.39), the field intensity at each point in this part of the field should be inversely proportional to the distance from the point O.



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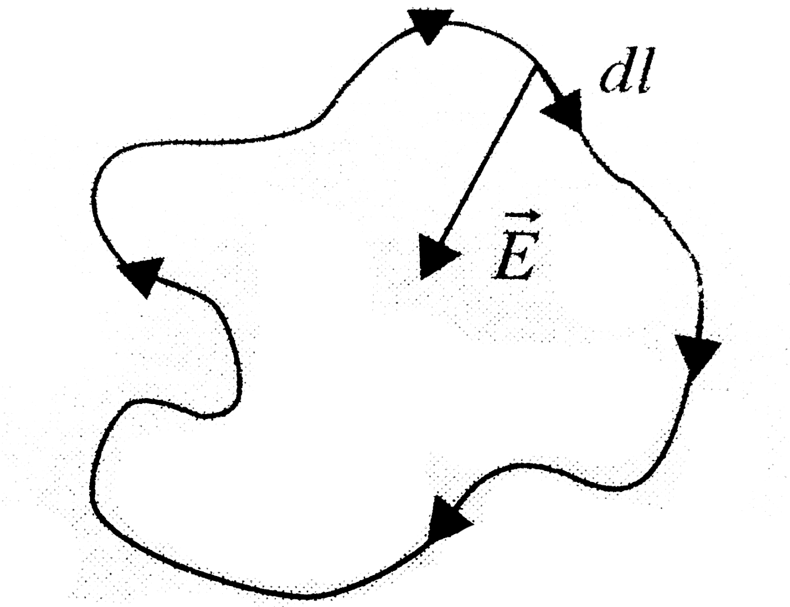
12. If you carry out the integral of the electric field $\int \vec{E} \cdot \vec{d} l$ for a closed path like that as shown in (Fig. 3.40), the integral will always be equal tom zero, independent of the shape of the path and independent of where charges may be located relative to the path. Explain why.



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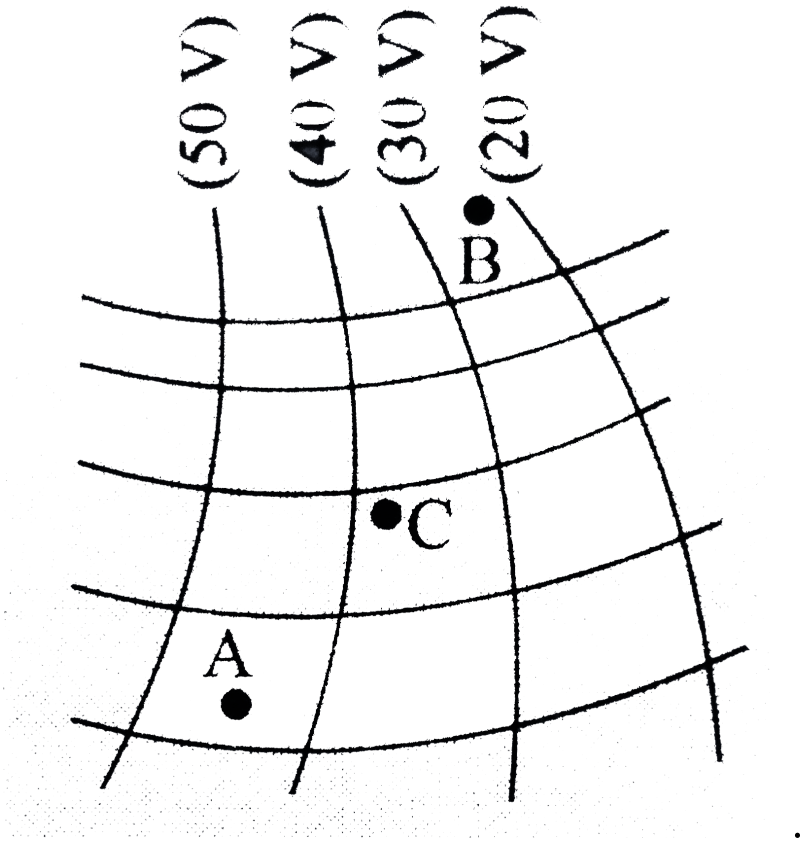
13. (Figure 3.41) shows the lines of constant potential in region in which an electric field is present. The values of potentials are written in brackets. At which points A, B or C, the electric field is greatest.



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14. A charge $2\mu C$ is taken from inifinity point in an electric field, without changing its velocity. If work done against eletrostatic forces is $-40\mu J$, then find the potential at that point.

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15. When charge $10\mu C$ is shifted from inifinity to a point in an electric field, it is found that work done by eletrotatic forces is $10\mu J$. If the charge is doubled and taken again from inifinity to the same point without accelerating it, then find the amount of work done by electric field and against electric field.

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16. A charge $3\mu C$ is released at rest from a point P where electric potential is (20 V). Find its kinetic energy when it reaches inifinity.

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17. Find out the following

a. $V_A - V_B$

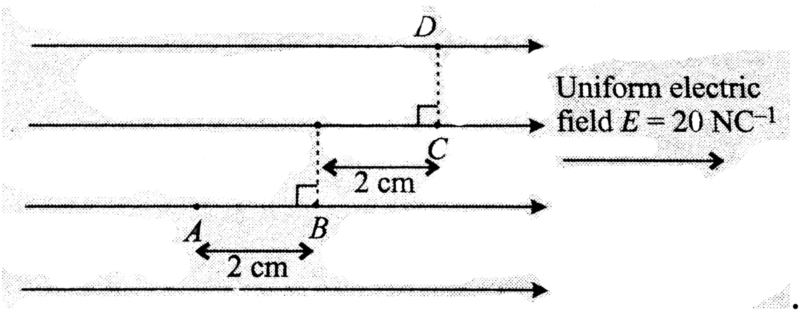
b. $V_B - V_C$

c. $V_C - V_A$

d. $V_D - V_C$

e. $V_A - V_D$

f. Arrange the order of potential for points (A, B,C and D).



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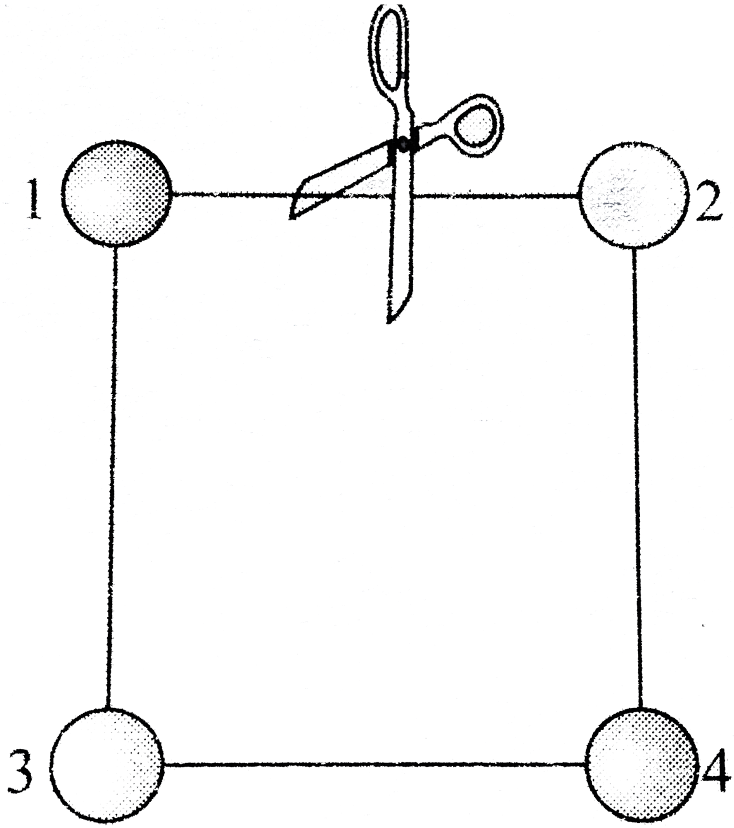
18. Four balls, each with mass m, are connected by four nonconducting strings to from a square with side with A, as shown in (Fig. 3.43.) The assembly is placed on a horizontal nonconducting frictionless surface. Balls 1 and 2 each have charge q, and balls 3 and 4 are uncharged. Find the maximum speed of balls 1 and 2 after the string connecting them is cut.



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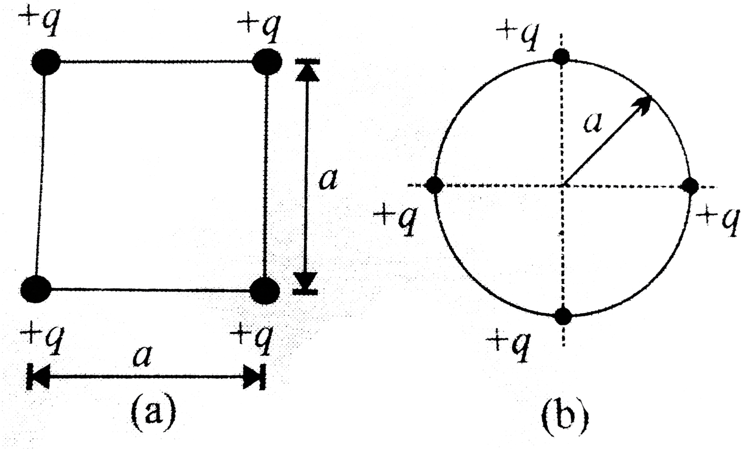
19. Consider the configuration of a system of four charges each of value (+q). Find the work done by external agent in changing the configuration of the system from (Fig. 3.44 A) to (Fig. 3.4B).

a. 

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20. The electric potential in a region is represented as

$V = 2x + 3y - z$

obtain expression for electric field strength.

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21. Find V_{ab} in an electric field

$$E = \left(2\hat{i} + 3\hat{j} + 4\hat{k}\right)\frac{N}{C}$$

where, $r_a = \left(\hat{i} - 2\hat{j} + \hat{k}\right)m$

and $r_b = \left(2\hat{i} + \hat{j} - 2\hat{k}\right)m.$

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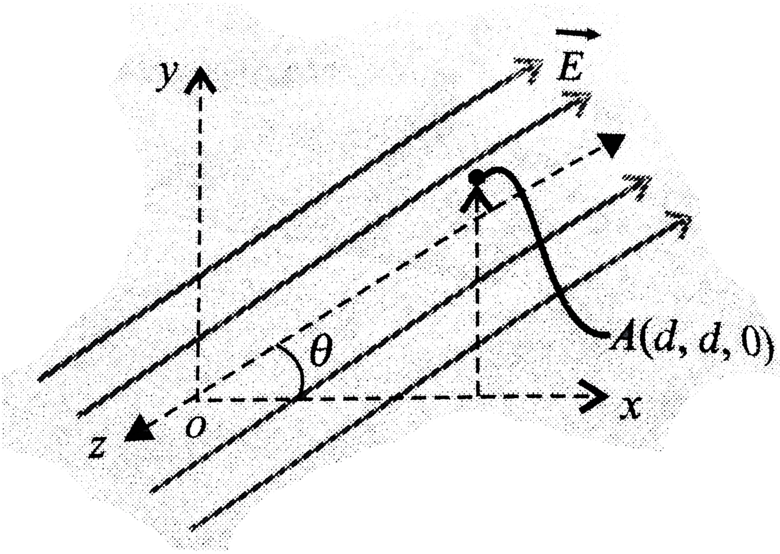
22. A uniform electric field exists in x y plane as shown in Fig. 3.45. Find the potential difference. Between origin O and $A(d, d, 0)$.



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23. The electric field in a 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.

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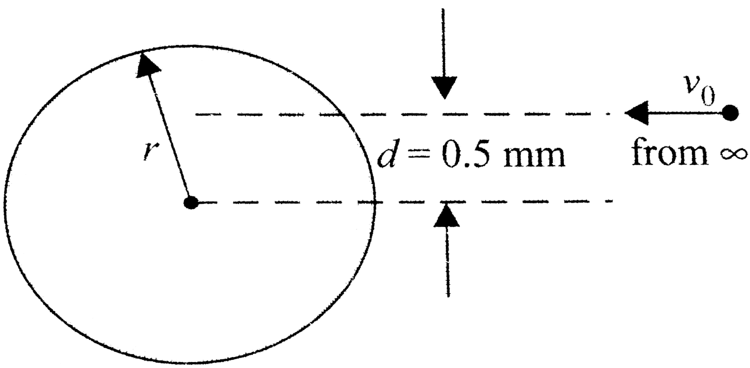
Exercise 3.2

1. A particle of mass $1kg$ and charge $1/3\mu C$ is projected toward a nonconducing fixed spherical shell of radius $r = 1mm$ having the same charge uniformly distributed on its surface. Find th minimum initial velocity of projection requires if the particle just grazes the shell.



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2. A cone made of insulating material has a total charge Q spread uniformly over its sloping surface. Calculate the work done in bringing a small test charge q from infinity to the apex of the cone. The cone has a slope length L.

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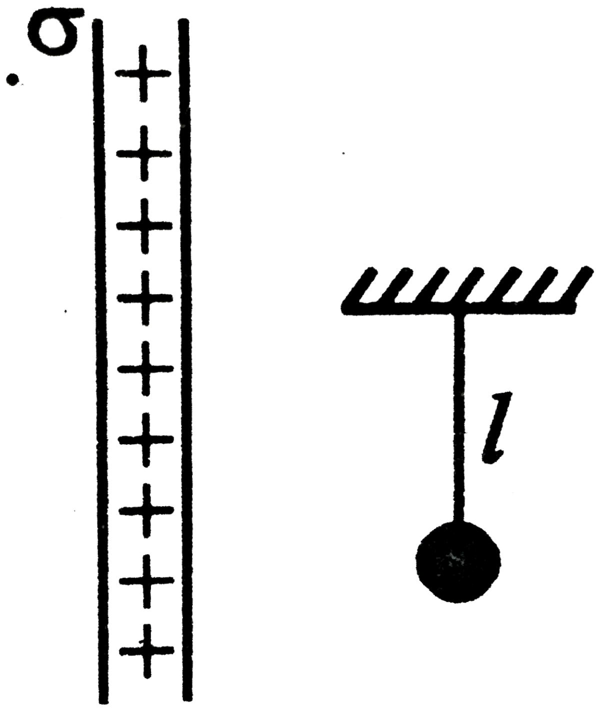
3. A simple pendulum of length l and bob mass m is hanging in front of a large nonconducting sheet having surface charge density σ. If suddenly a charge $+q$ is given to the bob $\&$ it is released from the position shown in figure. Find the maximum angle through which the string is deflected from vertical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



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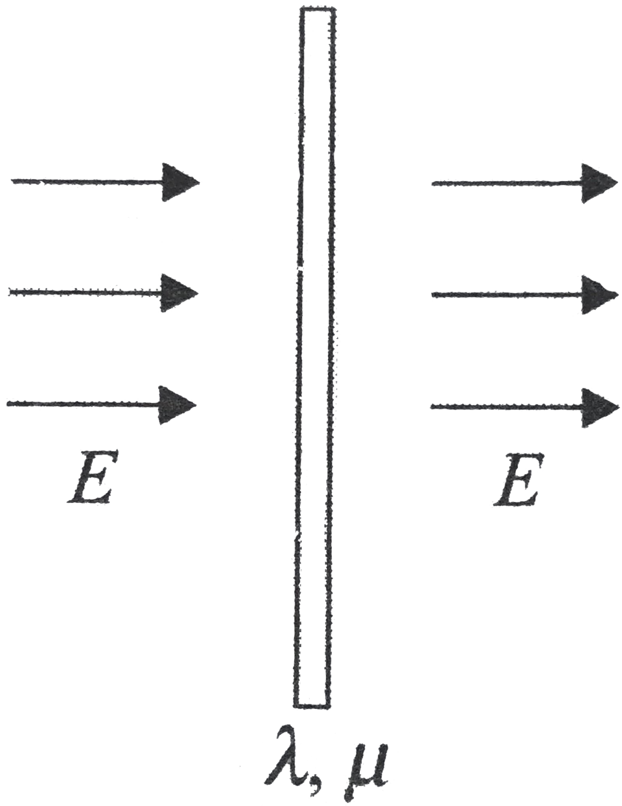
4. An insulating rod having linear charge density $\lambda = 40.0 \mu C m^{-1}$ and linear mass density $\mu = 0.100 kg m^{-1}$ is released from rest in a uniform electric field $E = 100 V m^{-1}$ directed perpendicular to the rod.

(a) Determine the speed of the rod after it has travelled 2.00 m

(b) How does your answer to part (a) change if the electric field is not perpendicular to the rod ?



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5. Three concentric spherical conductors of radii a, 2a, and 3a have charges $-Q$, $+2Q$, and $-4Q$, respectively. If r is the distance of the point under consideration from the center of the spheres, then find the electric field and potential due to the given configuration, for the values

(i) $r < a$

(ii) $a < r < 2a$

(iii) $2a < r < 3a$

$r > 3a$.

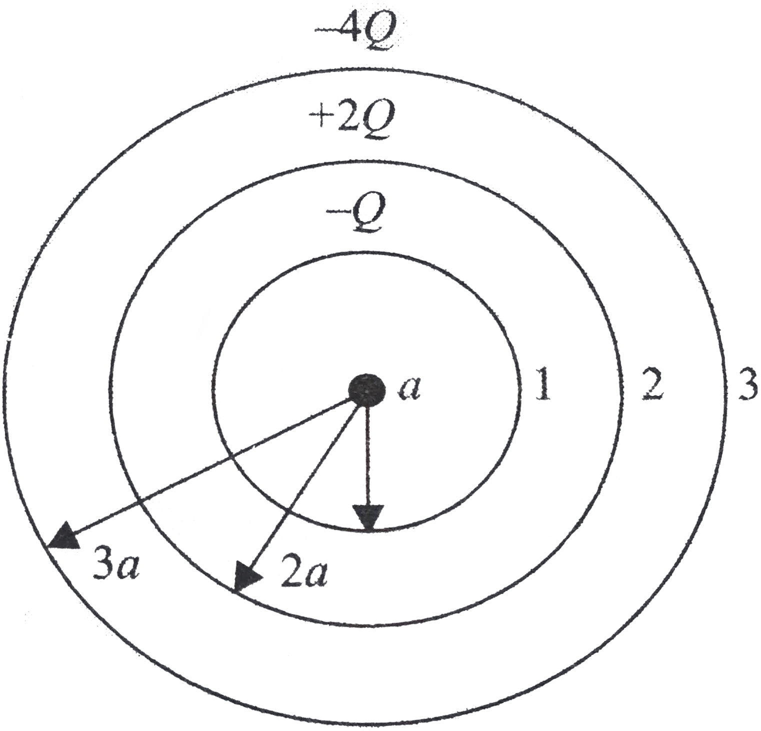

Fig. 3.89

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6. In the previous problem, if we connect the conductors 1 and 2, 2 and 3, 1 and 3, 1 and ground, 2 and ground, and 3 and ground, separately, find the charge flown in each case.

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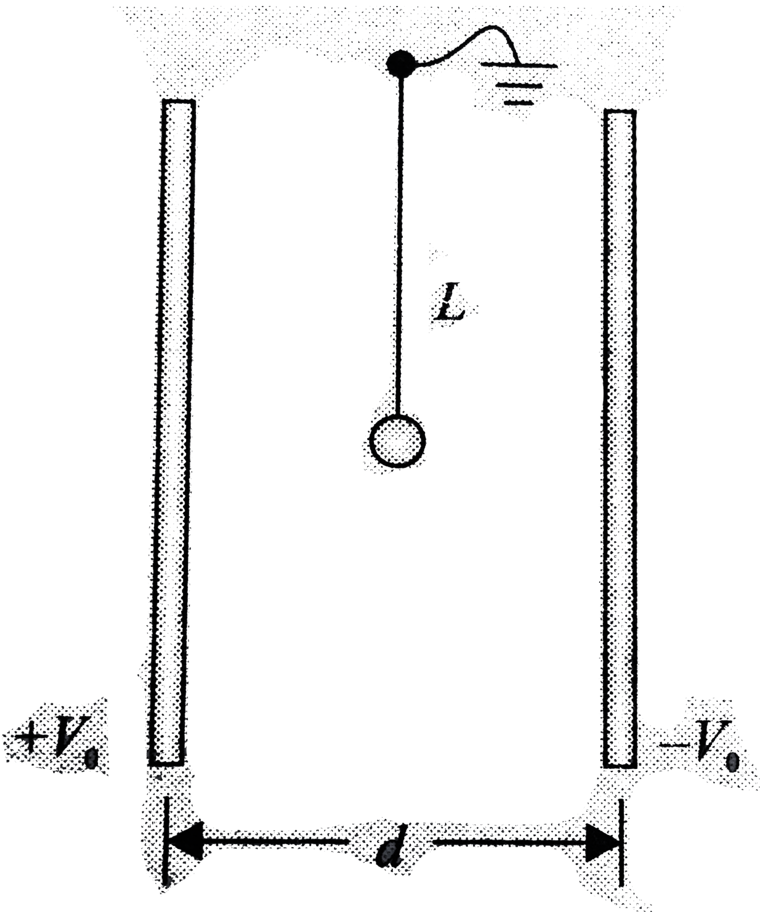
7. As shown in (Fig. 3.90), two large parallel vertical conducting plates separated by distance D are charge so that their potential are $+V_0$ and $-V_0$. A small conducting ball of mass m and radius r $(\text{where} R < \; < d)$ is hung midway between the plates. The thread of length L supporting the ball is a conducting wire connected to ground, so the potential of the ball is fixed at $V = 0$. The ball hangs straight down in stable equilibrium when V_0 is sufficiently small. Show that the equilibrium of the ball is unstable if V_0 exceeds the critical value $\left[k_e d^2 mg/(4RL)\right]^{1/2}$.



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8. Electrically charged drops of mercury fall from an altitude h into a spherical metal vessel of radius R. There is a small opening in the upper part of the vessel. The mass of each drop is m, and the charge on the drop is Q. What will be the number n of the last drop that can still enter the sphere?

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9. A small sphere of mass $m = 0.5kg$ carrying a positive charge $q = 110\mu C$ is connected with a light, flexible, and inextensible string of length of length

$r = 60 cm$ and whirled in a vertical circle. If a vertically upward electric field of strength $E = 10^5 NC^{-1}$ exists in the space, calculate the minimum velocity of the sphere required at the highest point so that it may just complete the circle $\left(g = 10 ms^{-2}\right)$.

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Exercise 3.3

1. An electric dipole of length 4 cm, when placed with its axis making an angle of 60° with a uniform electric field, experiences a torque of $4\sqrt{3} Nm$. Calculate the

a. magnitude of the electric field, and

b. potential energy of the dipole, if the dipole has charges of $\pm 8nC$.

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2. An electric dipole consists of two opposite charges each of magnitude 1 mC separated by 2 cm. The dipole is placed in an external uniform field of $10^5 NC^{-1}$ intensity. Find the

a. maximum torque exterted by the field on the dipole, and

b. work done in roating the dipole through 180° starting from the position $\theta = 0^\circ$.

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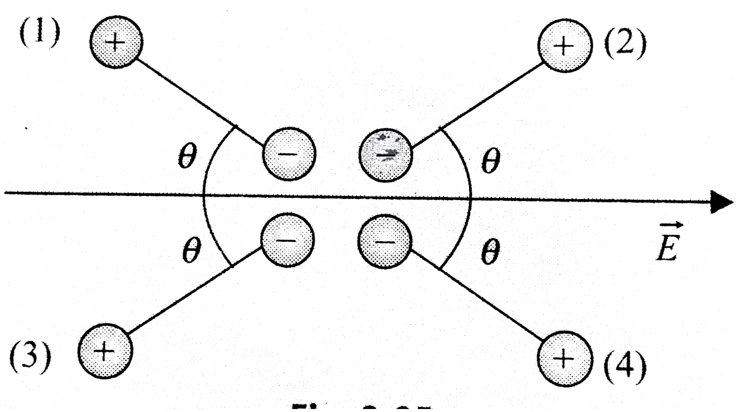
3. (Fig. 3.95) shows four orientations of an electric dipole in an external electric field. Rank the orientations acording to the

a. magnitude of the torque on the dipole, and

b. potential energy of the dipole, greatest first.



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4. A In question 3, If the dipole rotates from orientation 1 to orientation 2, is the work done on the dipole by field positive, negative, or zero ?

B If, instead, the dipole rotates from the orientation 1 to orientation 4, is the work done by the field more than, less than, the same as in (a) ?

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5. The potential energies associated with four orientations of an electric dipole in an electric field are $(1)-5U_0, (2)-7U_0, (3)3U_0,$ and $(4)5U_0$, where U_0 is positive. Rank the orientation according to the angle between the electric dipole moment $\overrightarrow{P}$ and the electric field $\overrightarrow{E}$, and B magnitude of the torque on the electric dipole, greatest first.

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6. A neutral water molecule (H_2O) in its vapour state has an electric dipole moment of magnitude $6.2 \times 10^{-30} cm.$

a. How far apart are the molecules' centers of positive and negative charge ?

b. If a molecule is placed in an electric field of $1.5 \times 10^4 NC^{-1}$, what maximum torque can the field exert on it ? (Such a field can easily be set up in the laboratory).

c. How much work must an external agent do to turn this molecule end for end in this field, starting from its fully aligned position, for which $\theta = 0$?

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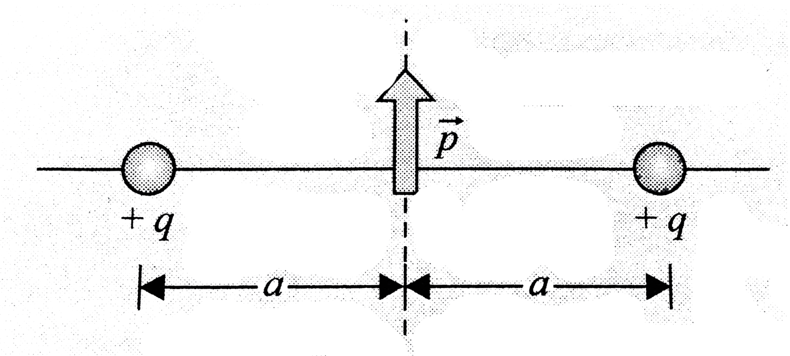
7. What is the potential energy of dipole with charge particles system as shown in (Fig. 3.96) ?



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8. State the following statements as Ture or False.

a. Electric potential at any point on the bisector of a dipole is zero.

b. A dipole experiences maximum torque at the positive where potential energy is zero.

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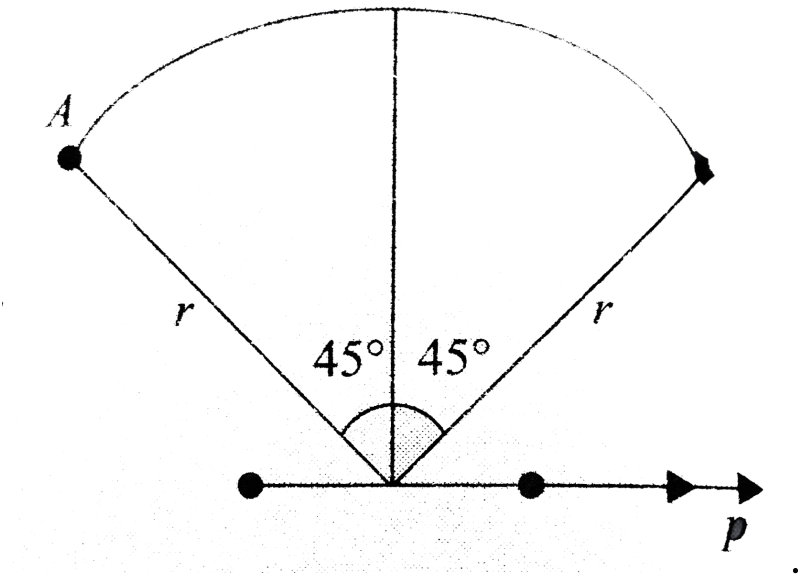
9. A charge +q is carried from point $A(r, 135^\circ)$ to point $B(r, 45^\circ)$ following a path, which is a quadrant of circle of radius r (Fig. 3.97). If the dipole moment is P, find the work done by the external agent (assume short dipole).



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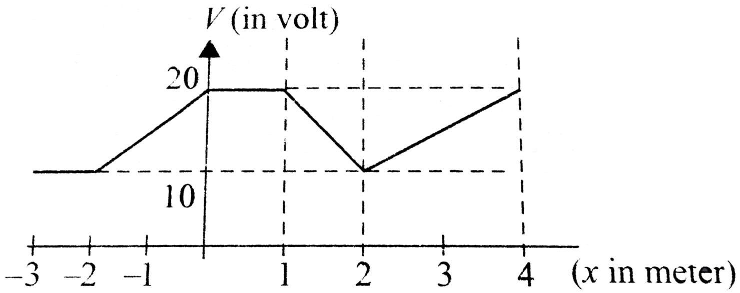
Subjective

1. The variation of electric potential for an electric field directed parallel to the x - axis is shown in (Fig. 3.110).

Draw the variation of electric field strength with the x-axis.



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2. If identical charges $(-q)$ are placed at each corner of a cube of side b, then electric potential energy of charge $(+q)$ which is placed at centre of the cube will be

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3. At s point due to a point charge, the values of electric field intensity and potential are $32NC^{-1}$ and $16JC^{-1}$, respectively. Calculate the

a. magnitude of the charge, and

b. distance of the charge from the point of observation.

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4. Four charges $+q, -q, +q$ and $-q$ are placed in order on the four consecutive corners of a square of side a. The work done in interchanging the positions of any two neighboring charges of the opposite sign is

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5. Water from a tap, maintained at a costant potential V, is allolwed to fall by drops of radius r through a small hole into a hollow conducting sphere of radius R standing on an insulating stand until it fills the entire sphere. Find the potential of the hollow conductor after it is completely filled with water.

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6. Three point charges of 0.1 C each are placed at the corners of an equilateral triangle with side 1m. If this system is supplied energy at the rate of 1 kW, how much time will be required to move one of the charges on the mid-point of the line joining the two others ?

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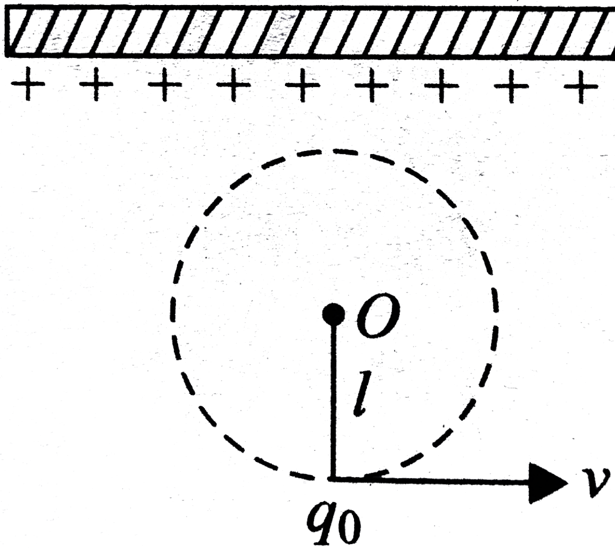
7. Figure shows a large conducting ceiling having uniform charge particle of charge density σ below which a charge particle of charge q_0 and mass m is hung from point O, through a small string of length l. Calculate the minimum horizontal velocity v required for the string to become horizontal.



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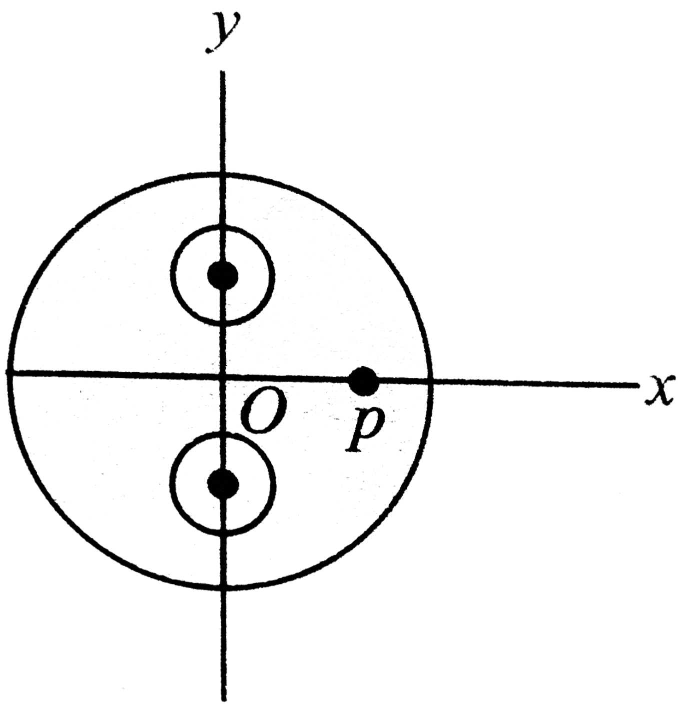
8. A nonconducting sphere of radius $R = 5cm$ has its center at the origin O of the coordinate system as shown in (Fig. 3.112). It has two spherical cavities of radius $r = 1cm$, whose centers are at $0, 3cm$ and

$0, -3cm$, respectively, and solid material of the sphere has uniform positive charge density $\rho = 1/\pi\mu Cm^{-3}$. Calculate the electric potential at point $P(4cm, 0)$.



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9. Two identical thin rings, each of radius R, are coaxially placed at a distance R. If Q_1 and Q_2 are respectively, the charges uniformly spread on the two rings, find the work done in moving a charge q from centre of ring having charge Q_1 to the other ring.

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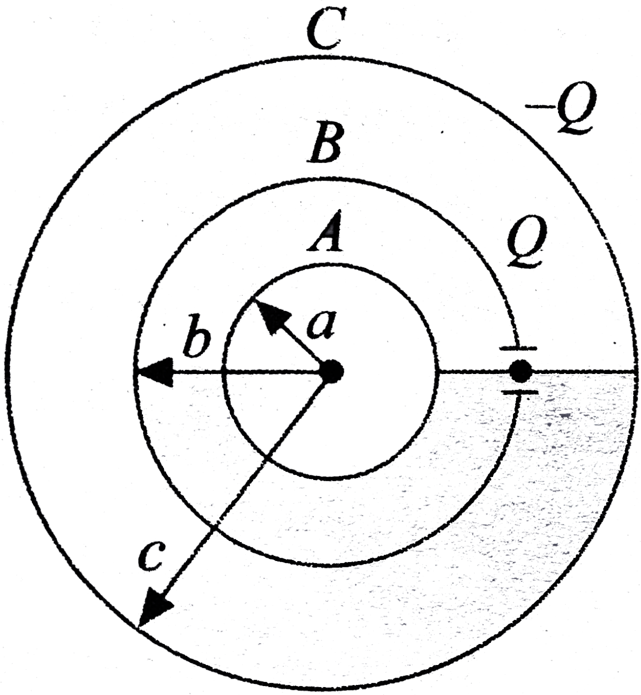
10. Three conducting spherical shells have radii (a, b, and c) such that $a < b < c$ (Fig. 3.113). Initially, the inner shell is uncharged, the middle shell has a positive charge Q, and the outer shell has a negative charge $-Q$.



a. Find the electric potential of the three shells.

b. If the inner and outer shells are now connected by a wire that is insulated as it passes through the middle shell, what is the electric potential of each of the three shells ? Also, what is the final charge on each shell ?

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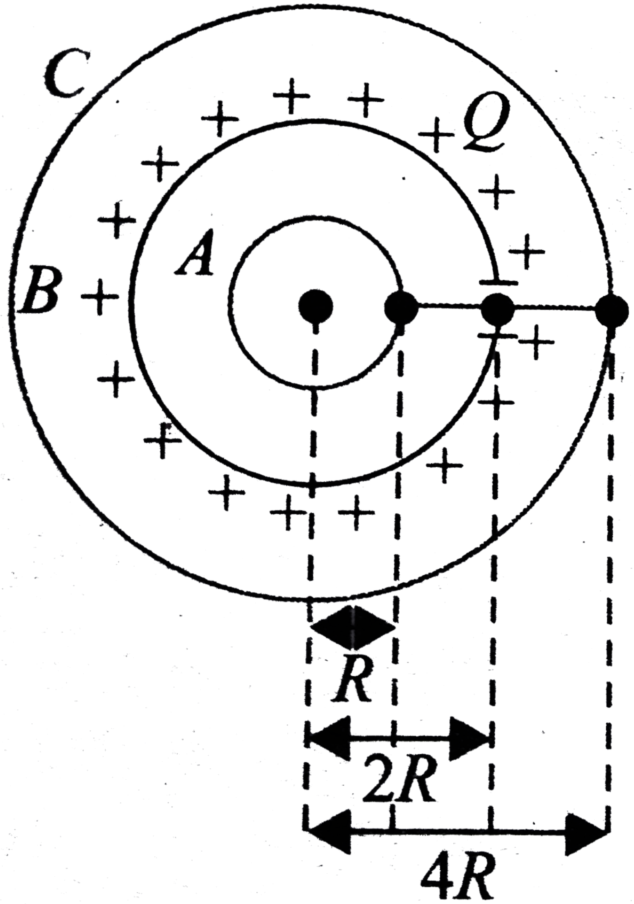
11. (Figure 3.114) shows three concentric spherical conductors $A, B,$ and C with radii $R, 2R,$ and $4R,$ respectively. A and C are connected by a conducting wire, and B is uniformly charged $(\text{charge} = +Q)$.

Find



a. charges on conductors A and C, and

b. potentials of A and B.

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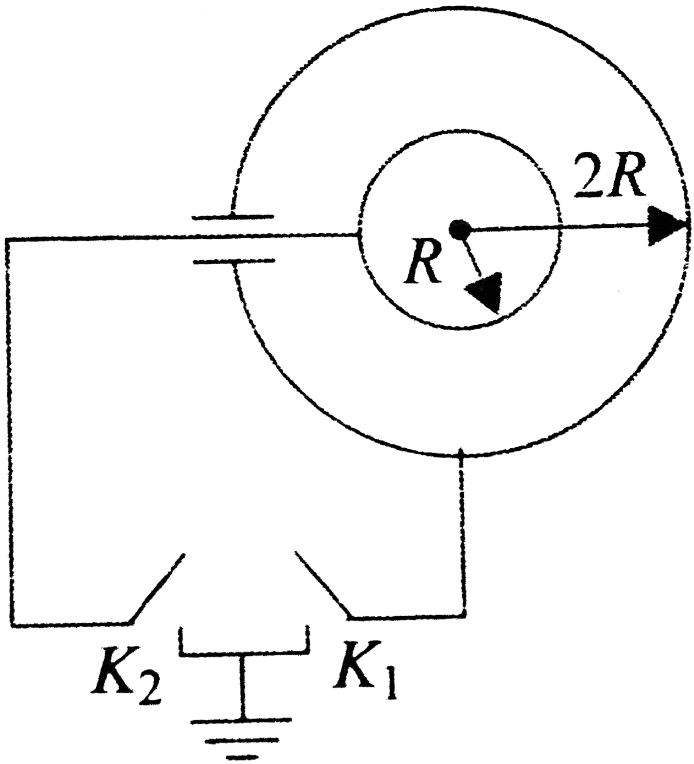
12. Two concentric shells of radii R and $2R$ are shown in (Fig. 3.115). Initially, a charge q is imparted to the inner shells. Now, key K_1 is closed and opened and then key K_2 is closed and opened. After the keys K_1 and K_2 are alterbately closed n times each, find the potential difference between the shells. Note that finally key K_2 remains closed.



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13. Three charges each of value q are placed at the corners of an equilateral triangle. A fourth charge Q is

placed at the center of the triangle.

a. Find the net force on charge q.

b. If $Q = -q$, will the charges at the corners move toward the center or fly away from it ?

c. For what value of Q at O will the charges remain stationary ?

d. In situation (c), how much work is done in removing the charges to infinity?

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14. A small ball of mass $2 \times 10^{-3} kg$, having a charge $1 \mu C$, is suspended by a string of length $0.8 m$. Another identical ball having the same charge is kept at the point of suspension. Determine the minimum horizontal velocity that should be imparted to the lower ball so that it can make a complete revolution.

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15. Two fixed charges $-2Q$ and $+Q$ are located at points $(-3a, 0)$ and $(+3a, 0)$ respectively. Then which of the following statement is correct?

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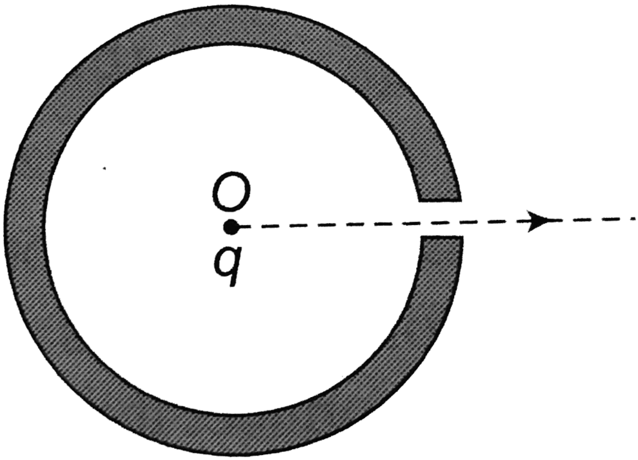
16. A point charge q is located at the centre O of a spherical uncharged coducting layer provided with small orifice. The inside and outside radii of the layer are equal to a and b respectively. The amount of work that has to be performed to slowly transfer the charge q from teh point O through the orifice and into infinity is



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17. Four point charges $+8\mu C - 1\mu C,\ -1\mu C$ and $+8\mu C$ are fixed at the points $-\sqrt{27/2}m,\ -\sqrt{3/2}m + \sqrt{3/2}m$ and $+\sqrt{27/2}m$ respectively on the Y-axis. A particle of mass 6×10^{-4} kg and charge $+0.1\mu C$ moves along the -X direction. It speed at $x = +\infty$ is v_0. Find the least value of v_0 for which the paticle will cross the origin. Find also the kinetic energy of the particle at the origin. Assume that space is gravity free.

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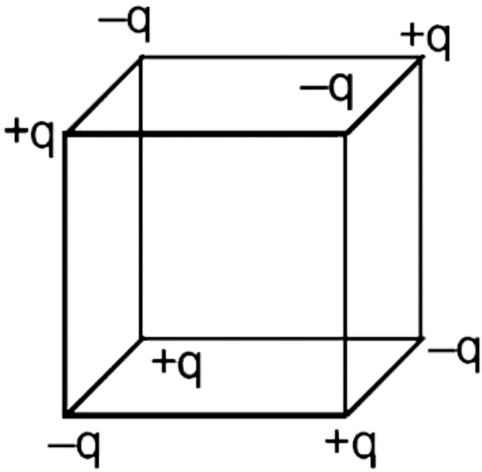
18. Charges $+q$ and $-q$ are located at the corners of a cube of side as show in the figure. Find the work done to separate the charges to infinite distance



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19. Two uniformly charged large plane sheets S_1 and S_2 having charge densities σ_1 and σ_2 $(\sigma_1 > \sigma_2)$ are placed at a distance d parallel to each other. A charge q_0 is moved along a line of length a(altd) at an angle 45° with the normal to S_1. Calculate the work done by the electric field

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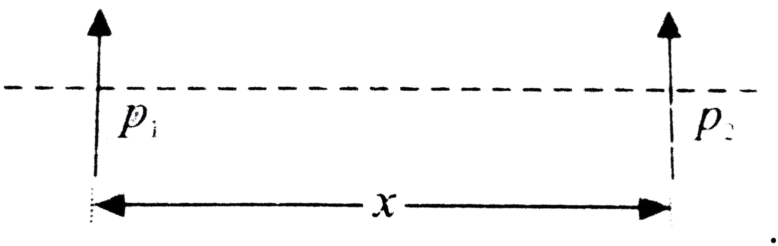
20. (Figure 3.118) shows two dipole moments parallel to each other and placed at a distance x apart. What is the magnitude of force of interaction ? What is the nature of force, attractive or repulsive ?



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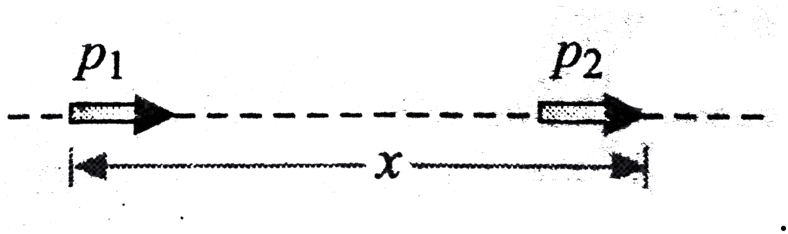
21. Two dipoles p_1 and p_2 are placed along the same axis at a distance x apart as shown in (Fig. 3.119). What is the magnitude of the force of interaction ? What is the nature of force, attractive or repulsive ?



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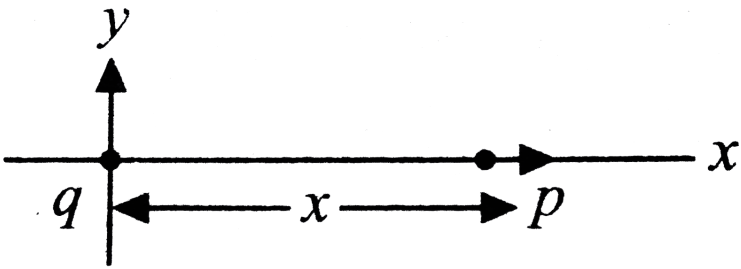
22. A short dipole is placed along the x - axis at $x = x$ (Fig. 3.120).



a. Find the force acting on the dipole due to a point charge q placed at the origin.

b. Find the force on the dipole if the dipole is rotated by 180° about the z- axis.

c. Find the force on dipole if the dipole is rotated by 90° anticlockwise about z - axis, i.e., it becomes parallel to the y - axis.

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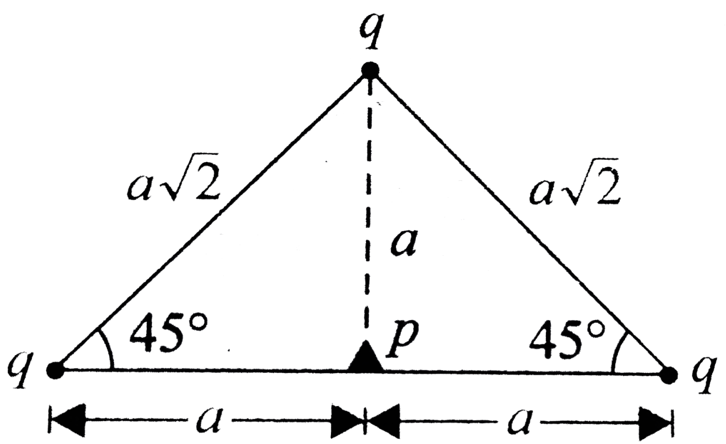
23. For the eletrostatic charge system as shown in (Fig. 3.121), find



a. the net force on electric dipole, and

b. electrostatic energy of the system.

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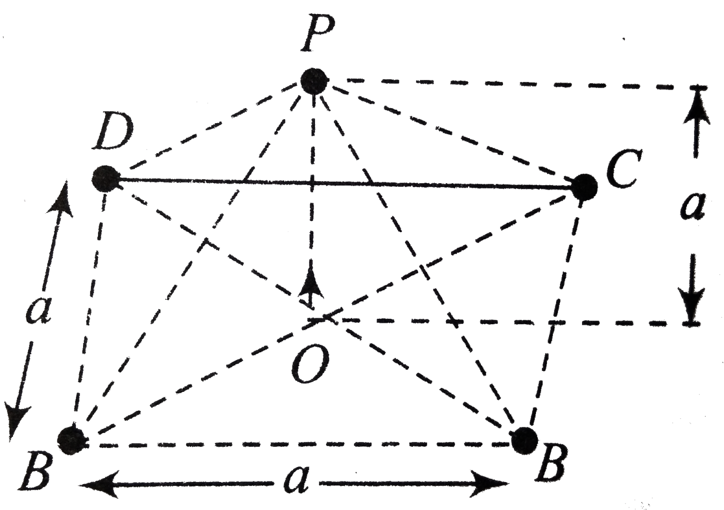
24. Four charge particles each having charge Q=1 C are fixed at the corners of the base(A,B,C, and D) of a square pyramid with slant length $a(AP = BP = PC = a = \sqrt{2}m)$, a charge -Q is fixed at point P. A dipole with dipole moment p=1 C-m is placed at the center of the bases and perpendicular to its plane as shown in fig. Force on the dipole due to the charge particles is $\frac{\square}{4\pi\varepsilon_0} N$.



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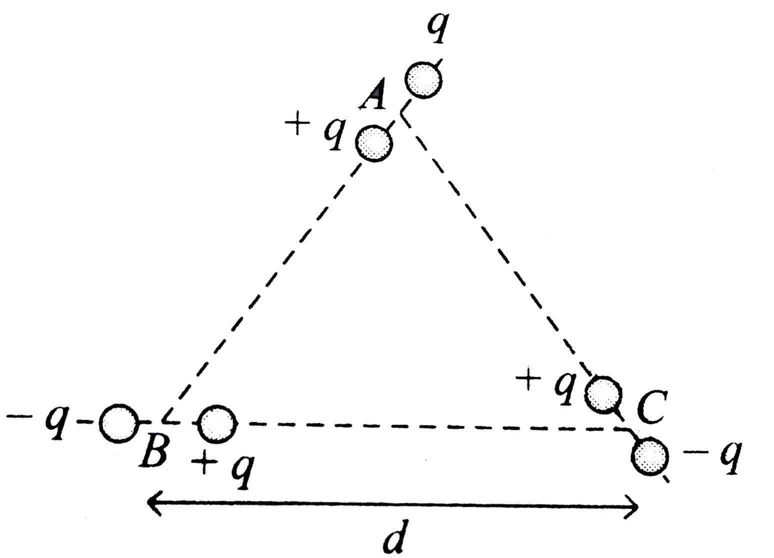
25. Three identical dipoles with charges q and $-q$, and separation A between the charges, are placed at the corners of an equilateral triangle of side D as shown in (Fig. 3.123). Find the interaction energy of the system $(a < < d)$.



26. A radioactive source, in the form of a metallic sphere of radius $10^{-2}m$ emits $\beta-$ particles at the rate of 5×10^{10} particles per second. The source is electrically insulated. How long will it take for its potential to be raised by $2V$, assuming that 40% of the emitted $\beta-$ particles escape the source.

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27. Three point charges of 0.1 C each are placed at the corners of an equilateral triangle with side 1m. If this system is supplied energy at the rate of 1 kW, how much time will be required to move one of the charges on the mid-point of the line joining the two others ?

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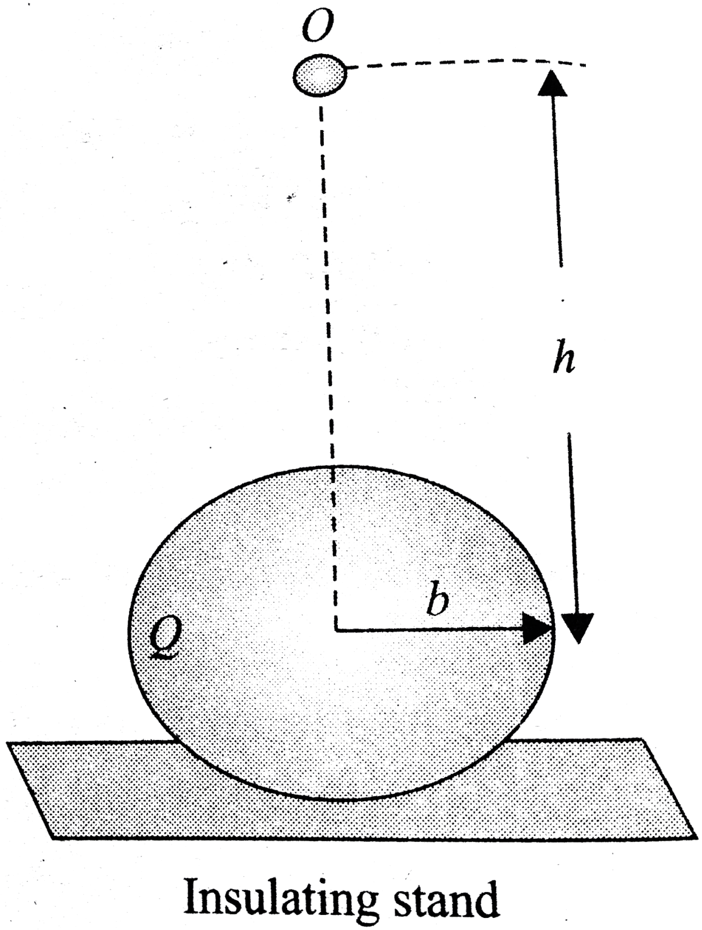
28. When a small uncharged conducting ball of radius $a = 1cm$ and mass $m = 50g$ is dropped from a height h above the center of another large conducting sphere of radius $b(= 1m)$ having charge $Q(= (100\mu C)$. It rises to a height $h_1(= 2m)$ after the collision. Find the value of h. Assume that during the impact there is no dissipation of energy.



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Single Correct

1. A large insulated sphere of radius r charged with Q units of electricity is placed in contact with a small insulated uncharged sphere of radius r' and is then separated. The charge on the smaller sphere will now be.

A. $\frac{Q(r' + r)}{r'}$

B. $\frac{Q(r' + r)}{r}$

C. $\frac{Qr}{r' + r}$

D. $\frac{Qr'}{r' + r}$

Answer: d

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2. Three charges $2q, -q, -q$ are located at the vertices of an equilateral triangle. At the centre of the triangle,

A. the field is zero but potential is nonzero.

B. the field is nonzero but potential is zero.

C. both field and potential are zero.

D. both field and potential are nonzero.

Answer: b

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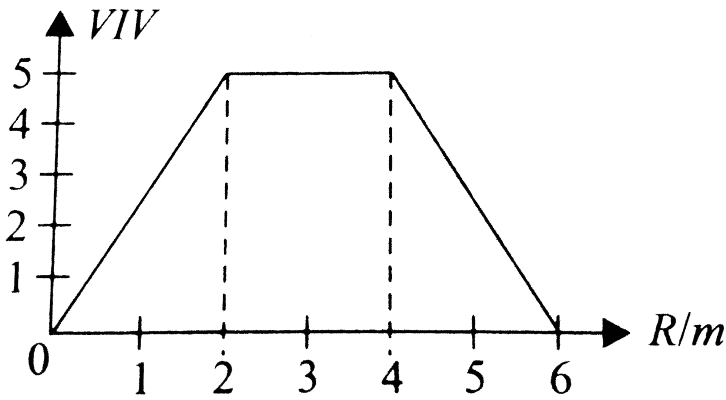
3. The variation of potential with distance R from the fixed point is shown in (Fig. 3.125).



The electric field at $R = 5m$ is.

A. $2.5Vm^{-1}$

B. $-2.5Vm^{-1}$

C. $0.4Vm^{-1}$

D. $-0.4Vm^{-1}$

Answer: a

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4. When a $2\mu C$ charge is carried from point A to point B, the amount of work done by the electric field is $50\mu J$. What is the potential difference and which point is at a higher potential ?

A. $25V, B$

B. $25V, A$

C. $20V, B$

D. both are at same potential.

Answer: b

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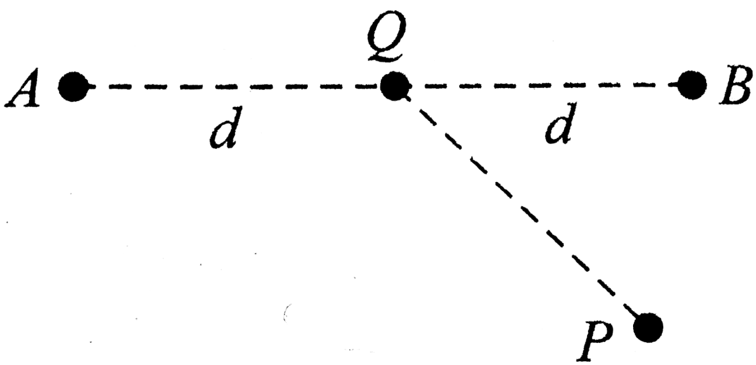
5. The work done in taking a unit positive charge from P to A is W_A and P to B is W_B. Then



A. $W_A > W_B$

B. $W_A < W_B$

C. $W_A = W_B$

D. $W_A + W_B = 0$

Answer: c

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6. The electric field at the origin is along the positive x-axis. A small circle is drawn with the centre at the origin cutting the axes at points A, B, C and D having coordinates (a,0), (0,a), (-a,0),(0,-a) respectively. Out of the points on the periphery of the circle, the potential is minimum at

A. A

B. B

C. C

D. D

Answer: a

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7. A small conducting sphere of radius a, carrying a charge $+Q$, is placed inside an equal and oppositely charged conducting shell of radius b such that their centers coincide. Determine the potential at a point which is at a distance c from center such that $a < c < b$.

A. $k(Q/c + Q/b)$

B. $k(Q/a + Q/b)$

C. $k(Q/a - Q/b)$

D. $k(Q/c - Q/b)$

Answer: d

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8. Two metal spheres $(\text{radii} r_1, r_2 \text{with} r_1 < r_2)$ are very far apart but are connected by a thin wire. If their combined charges is Q, then what is their common potential ?

A. $kQ/(r_1+r_2)$

B. $kQ/(r_1-r_2)$

C. $-kQ/(r_1+r_2)$

D. $-kQ/r_1r_2$

Answer: a

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9. Mark the correct statement :.

A. If E is zero at a certain point, then V should be zero at that point.

B. If E is not zero at a certain point, then V should not be zero at that point.

C. If V is zero at a certain point, then E should be zero at that point.

D. If V is zero at a certain point, then E may or may not be zero.

Answer: d

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10. Variation in potential is maximum if one goes.

A. along the line of force.

B. Perpendicular to the line of force.

C. in any direction.

D. none of these.

Answer: a

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11. An uncharged conductor A is brought near a positively charged conductor B. The size of the conductor A is much greater than the size of conductor B. Then,

A. the charge on B will increase, but the potential of B will not change.

B. the charge on B will not change, but the potential of B will decrease.

C. the charge on B will decrease, but the potential of B will not change.

D. the charge on B will not change, but the potential of B will increase.

Answer: b

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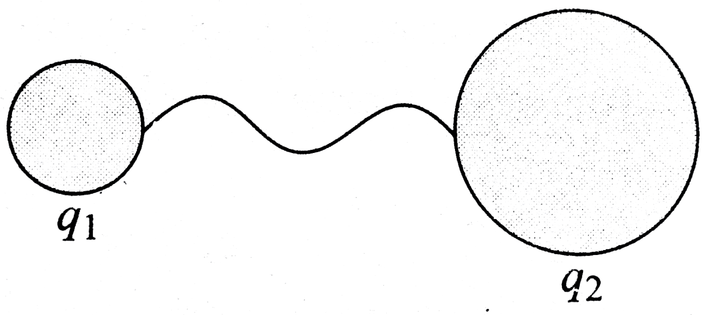
12. Two spherical conductors of radii R_1 and R_2 are separated by a distance much larger than the radius of eighter sphere. The spheres are connected by a conducting wire as shown in (Fig. 3.128). If the charges on the spheres in equilibrium are q_1 and q_2, respectively, what is the ratio of the field strength at the surfaces of the spheres ?



A. R_2 / R_1

B. R_2^2 / R_1^2

C. R_1 / R_2

D. R_1^2 / R_2^2

Answer: a

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13. There is an electric field E in x-direction. If the work done on moving a charge of $0.2C$ through a distance of 2 m along a line making an angle 60° with x-axis is 4 J, then what is the value of E?

A. $\sqrt{3}NC^{-1}$

B. NC^{-1}

C. NC^{-1}

D. $20NC^{-1}$

Answer: d

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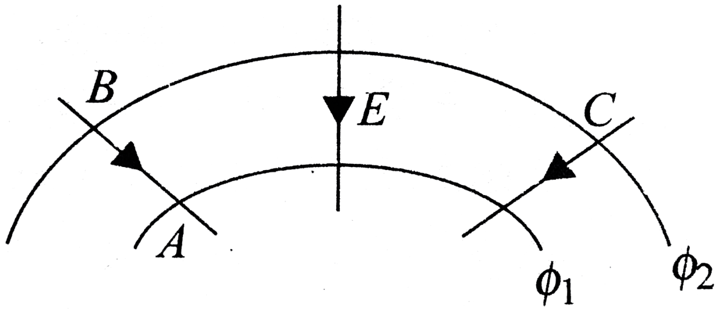
14. In moving from A to B along an electric field line, the work done by the electric field on an electron is $6.4 \times 10^{-19} J$. If ϕ_1 and ϕ_2 are equipotential surfaces, then the potential difference $V_C - V_A$ is.



A. $-4V$

B. $4V$

C. zero

D. $6.4V$

Answer: b

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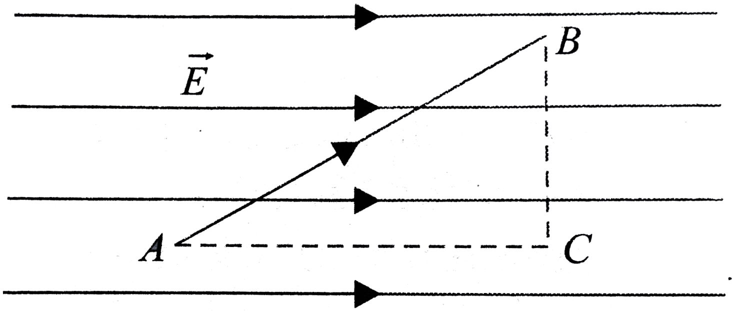
15. An electron is taken from point A to point B along the path A B in a uniform electric field of intensity $E=10Vm^{-1}$ side $AB=5m$, and side $BC=3m$. Then, the amount of work done on the electron by us is.



A. 50 eV

B. 40 eV

C. $-50eV$

D. $-40eV$

Answer: b

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16. Two identical rings P and Q of radius $0.1m$ are mounted coaxially at a distance $0.5m$ apart. The charges on the two rings are $2\mu C$ and $4\mu C$, respectively. The work done in transferring a charge of $5\mu C$ from the center of P to that of Q is.

A. 1.28 J

B. 0.72 J

C. 0.144 J

D. 2.24 J

Answer: b

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17. n charged drops, each of radius r and charge q, coalesce to from a big drop of radius R and charge Q. If V is the electric potential and E is the electric field at the surface of a drop, then.

A. $E_{big} = n^{2/3} E_{small}$

B. $V_{big} = n^{1/3} V_{small}$

C. $E_{small} = n^{2/3} E_{big}$

D. $V_{big} = n^{2/3} V_{small}$

Answer: d

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18. At a point in space, the eletric field points toward north. In the region surrounding this point, the rate of change of potential will be zero along.

A. north

B. south

C. north - south

D. east - west

Answer: d

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19. A spherical charged conductor has surface density of charge as σ. The electric field intensity on its surface is E. If the radius of the surface is doubled, keeping σ uncharged, what will be the electric field intensity on the new sphere ?

A. $E/2$

B. $E/4$

C. $2E$

D. E

Answer: d

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20. In the previous question, if V is the electric potential of the first sphere, what would be the electric potential of the second sphere ?

A. 2 V

B. $V/2$

C. $V/4$

D. V

Answer: a

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21. The electric field lines are closer together near object A than they are near object B. We can conclude that.

A. the potential near A is greater than the potential near B.

B. the potential near A is less than the potential near B.

C. the potential near A is equal to the potential near B.

D. nothing about the relative potentials near A and B.

Answer: a

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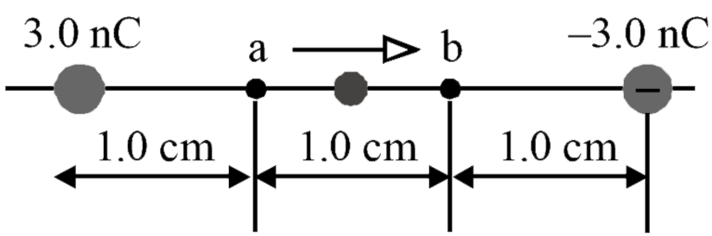
22. As shown in figure a dust particle with mass m = 5.0 × 10–9 kg and charge q0 = 2.0 nC starts from rest at point a and moves in a straight line to point b . What is its speed v at point b?



A. $26ms^{-1}$

B. $34ms^{-1}$

C. $46ms^{-1}$

D. $14ms^{-1}$

Answer: c

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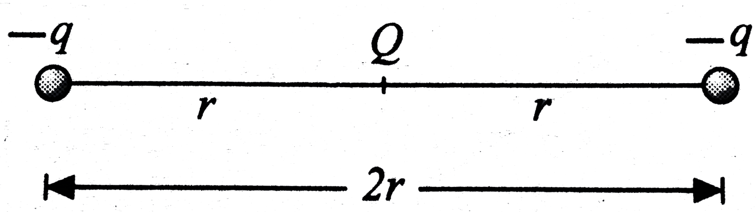
23. Charges $-q, Q,$ and $-q$ are placed at an equal distance on a straight liner. If the total potential energy of the system of three charges is zero, then find the ratio Q/q.



A. $1/2$

B. $1/4$

C. $2/3$

D. $3/4$

Answer: b

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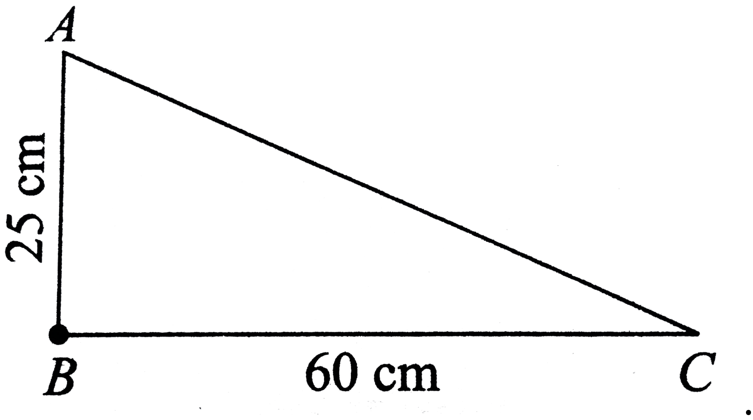
24. ABC is a right - angled triangle, where AB and BC are $25cm$ and $60cm$, respectively. A metal sphere of $2cm$ radius charged to a potential of $9 \times 10^5 V$ is placed at B as in (Fig. 3.133). Find the amount of work done in carrying a positive charge of 1 coulomb from C to A.



A. 21 k J

B. 42 k J

C. 14 k J

D. 52 k J

Answer: b

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25. Two charged particles having charges 1 and $-1\mu C$ and of mass $50g$ each are held at rest while their separation is $2m$. Now the charges are released. Find the speed of the particles when their separation is $1m$.

A. $\frac{1}{5}ms^{-1}$

B. $\frac{3}{5}ms^{-1}$

C. $\frac{3}{10}ms^{-1}$

D. $\frac{2}{7}ms^{-1}$

Answer: c

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26. An electron is fired directly towards the center of a large metal plate that has excess negative charge with surface charge density $= 2.0 \times 10^{-6} C / m^2$. If the initial kinetic energy of electron is 100 eV and if it is to stop due to repulsion just as it reaches the plate, how far from the plate must it be fired ?

A. 0.44 mm

B. 0.20 mm

C. 1 mm

D. 0.30 mm

Answer: a

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27. A solid sphere of radius R has charge q uniformly distributed over its volume. The distance from it surfce at which the electrostatic potential is equal to half of the potential at the centre is

A. R

B. $R/2$

C. $R/3$

D. $2R$

Answer: c

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28. Four identical charges are placed at the points $(1, 0, 0), (0, 1, 0), (-1, 0, 0)$, and $(0, -1, 0)$. Then,

A. the potential at the origin is zero

B. the electric field at the origin is not 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.

Answer: d

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29. When the separation between two charges is increase the electric potential energy of the charges.

A. increases

B. decreases

C. remains the same.

D. may increase or decrease

Answer: d

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30. Mark the correct statement :.

A. An electron and a proton when released from rest in uniform electric field experience the same force and the same acceleration.

B. Two equipotential surfaces may intersect.

C. A solid conducting sphere holds more charge than a hollow conducting sphere of the same radius.

D. No work is done in taking a positive charge from one point to another inside a negatively charged metallic sphere.

Answer: d

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31. Two point charges Q and $-Q/4$ placed along the x - axis are separated by a distance r. Take $-Q/4$ as origin and it is placed at the right of Q. Then the potential is zero.

A. at $x = r/3$ only

B. at $x = -r/5$ only

C. both at $x = r/3$ and at $x = -r/5$

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

Answer: c

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32. The electric potential decreases unifromly from 120 V to 80 V as one moves on the x-axis from x=-1 cm to x=+1 cm. The electric field at the origin

A. must be equal to $20 V cm^{-1}$

B. must be equal to $20 V m^{-1}$

C. may be greater than $20 V m^{-1}$

D. may be less than $20 V cm^{-1}$

Answer: c

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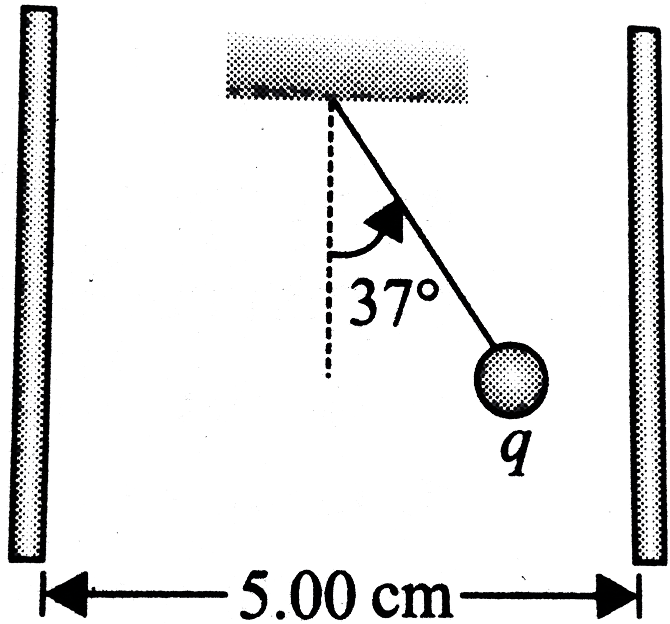
33. A small sphere with mass $1.2g$ hangs by a thread between two parallel vertical plates $5.00cm$ apart. The plates are insulating and have uniform surface charge densities $+\sigma \text{ and } -\sigma$. The charge on the sphere is $q = 9 \times 10^{-6}C$. What potential difference between the plates will cause the thread to assume an angle of

37° with the vertical as shown in (Fig. 3.134) ?



A. 30 V

B. 12 V

C. 50 V

D. 25 V

Answer: c

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34. A particle of mass m carrying charge q is projected with velocity v from point P toward aninfinite line of charge from a distance a . Its speed reduces to zero momentarily at point Q, which is at a distance $a/2$ from the line of charge. If another particle with mass m and charge $-q$ is projected with the same velosity v from P toward the line of charge, what will be its speed at Q ?

A. $v_1 = \sqrt{2}v$

B. $v_1 = 2v$

C. $v_1 = \sqrt{v}$

D. $v_1 = \sqrt{2}$

Answer: a

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35. Charge Q is given a displacement $\overrightarrow{r} = a\hat{i} + b\hat{j}$ in an electric field $\overrightarrow{E} = E_1\hat{i} + E_2\hat{j}$. The work done is.

A. $Q(E_1a + E_2b)$

B. $Q\sqrt{(E_1a)^2 + (E_2b)^2}$

C. $Q(E_1 + E_2)\sqrt{a^2 + b^2}$

D. $Q\sqrt{\left(E_1^2 + E_2^2\right)^2}\sqrt{a^2 + b^2}$

Answer: a

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36. A point charge q is placed inside a conducting spherical shell of inner radius 2R and outer radius 3R at a distance of R from the centre of the shell. The electric potential at the centre of shell will be $\frac{1}{4\pi\varepsilon_0}$ times

A. $\frac{1}{4\pi\varepsilon_0}\frac{q}{2R}$

B. $\frac{1}{4\pi\varepsilon_0}\frac{4q}{3R}$

C. $\frac{1}{4\pi\varepsilon_0}\frac{5q}{6R}$

D. $\frac{1}{4\pi\varepsilon_0}\frac{2q}{3R}$

Answer: c

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37. An electric field is expressed as $\overrightarrow{E} = 2\hat{i} + 3\hat{j}$. Find the potential difference $(V_A - V_B)$ between two points A and B whose position vectors are given by $r_A = \hat{i} + 2\hat{j}$ and $r_B = 2\hat{i} + \hat{j} + 3\hat{k}$.

A. $-1V$

B. 1 V

C. 2 V

D. 3 V

Answer: a

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38. The potentaial function of an electrostatic field is given by $V = 2x^2$. Determine the electric field strength at the point $(2m, 0, 3m)$.

A. $\vec{E} = 4\hat{i}(NC^{-1})$

B. $\vec{E} = -4\hat{i}(NC^{-1})$

C. $\vec{E} = 8\hat{i}(NC^{-1})$

D. $\vec{E} = -8\hat{i}(NC^{-1})$

Answer: d

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39. A conducting sphere A of radius a, with charge Q, is placed concentrically inside a conducting shell B of radius b. B is earthed. C is the common center of A and B. Study the following statements.

(i) The potential at a distance r from C, where

$a \leq r \leq b, is \frac{1}{4\pi\varepsilon_0}\left(\frac{q}{r}\right)$

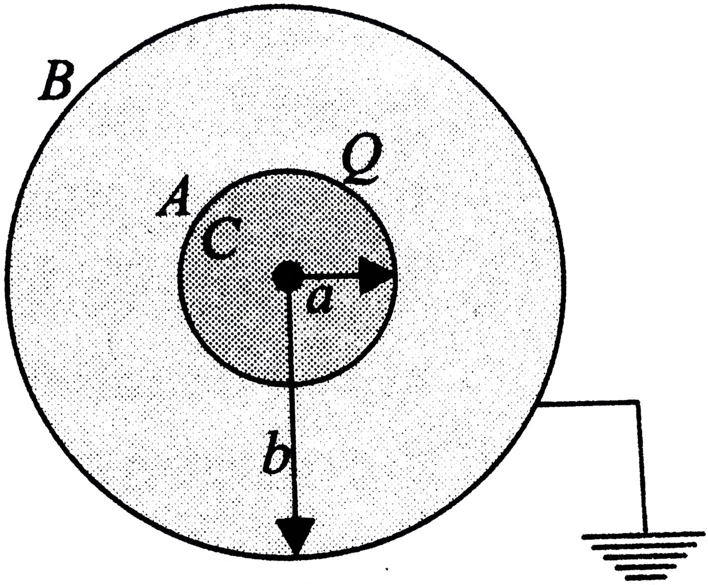
(ii) The potential difference between A and B is

$\frac{1}{4\pi\varepsilon_0}Q\left(\frac{1}{r}-\frac{1}{B}\right)$

(iii) The potential at a distance $romC$, where

$a \leq r \leq b, is \frac{1}{4\pi\varepsilon_0}Q\left(\frac{1}{r}-\frac{1}{B}\right)$

Which of the following statements are correct ?



A. Only (i) and (ii)

B. Only (ii) and (iii)

C. Only (i) and (iii)

D. All

Answer: b

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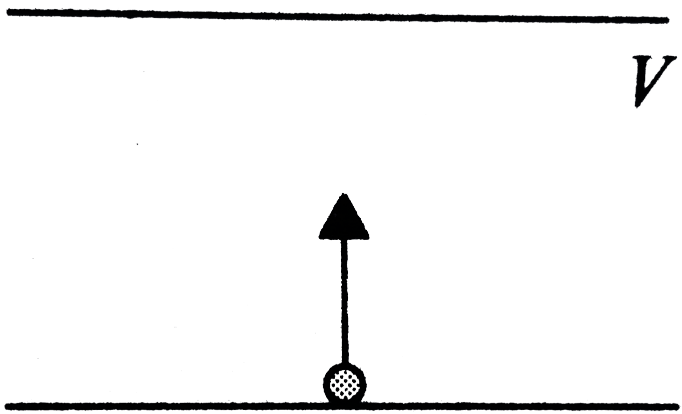
40. An electron having charge e and mass m starts from the lower plate of two metallic plates separated by a distance d. If the potential difference between the plates is V, the time taken by the electron to reach the upper plate is given by



A. $\sqrt{\frac{2md^2}{eV}}$

B. $\sqrt{\frac{md^2}{eV}}$

C. $\sqrt{\frac{md^2}{2eV}}$

D. $\frac{2md^2}{eV}$

Answer: a

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41. There is an infinite straight chain of alternating charges q and $-q$. The distance between the neighbouring charges is equal to a. Find the interaction energy of each charge with all the others.

Instruction . Make use of the expansion of In $(1+\alpha)$ in a power series in α.

A. $-\frac{2q}{4\pi\varepsilon_0 a}$

B. $\frac{2q^2 \log_e 2}{4\pi\varepsilon_0 a}$

C. $-\frac{2q^2 \log_e 2}{4\pi\varepsilon_0 a}$

D. none of these.

Answer: c

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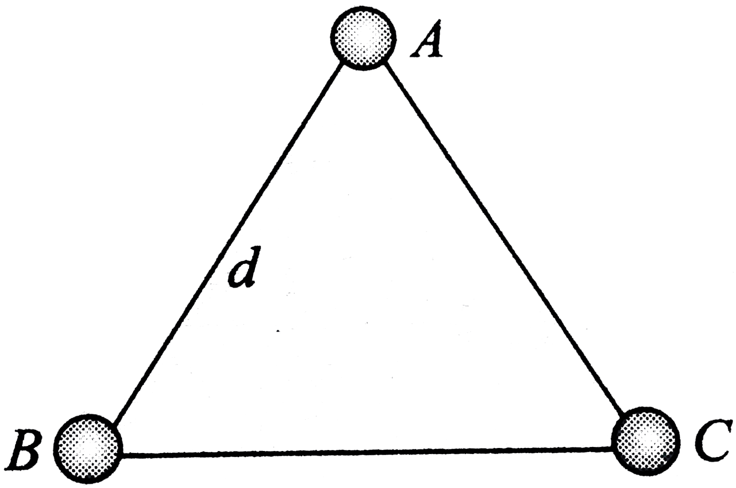
42. Three identical metallic uncheged spheres A, B, and C, each of radius a, are kept at the corners of an equilateral triangle of side $d(d > > a)$ as shown in (Fig. 3.137). The fourth sphere (of radius a), which has a charge q, touches A and is then removed a position far away. B is earthed and then the earth connection is removed. C is then earthed. The charge on C is



A. $\frac{qa}{2d}\left(\frac{2d-a}{2d}\right)$

B. $\frac{qa}{2d}\left(\frac{2d-a}{d}\right)$

C. $-\frac{qa}{2d}\left(\frac{d-a}{d}\right)$

D. $-\frac{2qa}{d}\left(\frac{d-a}{2d}\right)$

Answer: c

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43. A solid conducting sphere of radius 10 cm is enclosed by a thin metallic shell of radius 20 cm. A charge $q = 20\mu C$ is given to the inner sphere. Find the heat generated in the process, the inner sphere is connected to the shell by a conducting wire.

A. 12 J

B. 9 J

C. 24 J

D. zero

Answer: b

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44. Find the potential V of an electrostatic field $\overrightarrow{E} = a\left(y\hat{i} + x\hat{j}\right)$, where a is a constant.

A. $axy + C$

B. $-axy + C$

C. axy

D. $-axy$

Answer: b

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45. We have three identical metallic spheres $A, B,$ and C. A is given a charge $Q,$ and B and C are uncharged. The following processes of touching of two spheres are carried out in succession. Each process is carried out with sufficient time. ltbgt i. A and B

ii. B and C

iii. C and A

iv. A and B

v. B and C

The final charges on the spheres are.

A. $\frac{11Q}{32}, \frac{5Q}{16}, \frac{11Q}{32}$

B. $\frac{11Q}{32}, \frac{11Q}{32}, \frac{5Q}{16}$

C. $\frac{8Q}{8}, \frac{5Q}{16}, \frac{5Q}{16}$

D. $\frac{5Q}{16}, \frac{11Q}{32}, \frac{11Q}{32}$

Answer: d

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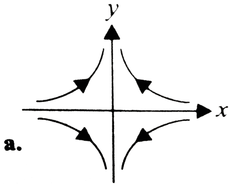
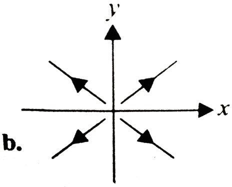
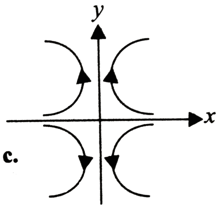
46. Determine the electric field strength vector if the potential of this field depends upon x - and y - coordinates as :

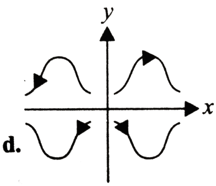
(i) $V = a(x^2 - y^2)$

(ii) $V = axy$.

A. 

B. 

C. 

D. 

Answer: a

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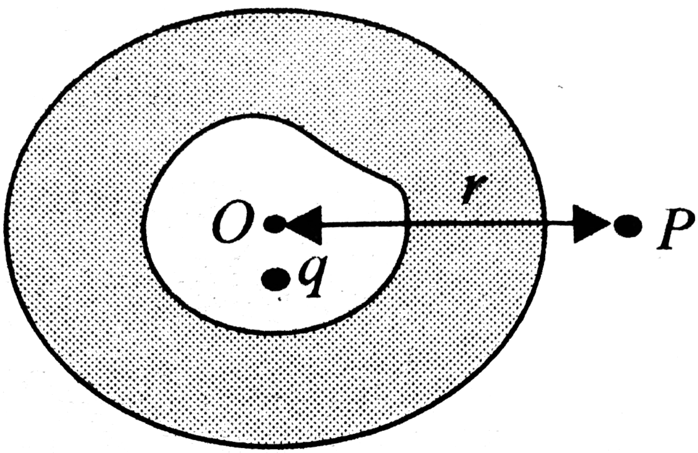
47. The point charge q is within the cavity of an electrically neutral conducting shell whose outer surface has spherical shape. Find the potential V at a point P lying outside the shell at distance r from the center O of the outer sphere.



A. $V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$

B. $V = \frac{1}{2\pi\varepsilon_0}\frac{q}{r}$

C. $V = \frac{1}{\pi\varepsilon_0}\frac{q}{r}$

D. $V = \frac{3}{4\pi\varepsilon_0}\frac{q}{r}$

Answer: a

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48. Two concentric conducting spherical shells of radii a_1 and $a_2 (a_2 > a_1)$ are charged to potentials ϕ_1 and ϕ_2, respectively. Find the charge on the inner shell.

A. $q_1 = 4\pi\varepsilon_0\left(\frac{\phi_1 - \phi_2}{a_2 - a_1}\right)a_1 a_2$

B. $q_1 = 4\pi\varepsilon_0\left(\frac{\phi_1 + \phi_2}{a_2 + a_1}\right)a_1 a_2$

C. $q_1 = \pi\varepsilon_0\left(\frac{\phi_1 - \phi_2}{a_2 + a_1}\right)a_1 a_2$

D. $q_1 = 2\pi\varepsilon_0\left(\frac{\phi_1 + \phi_2}{a_2 - a_1}\right)a_1a_2$

Answer: a

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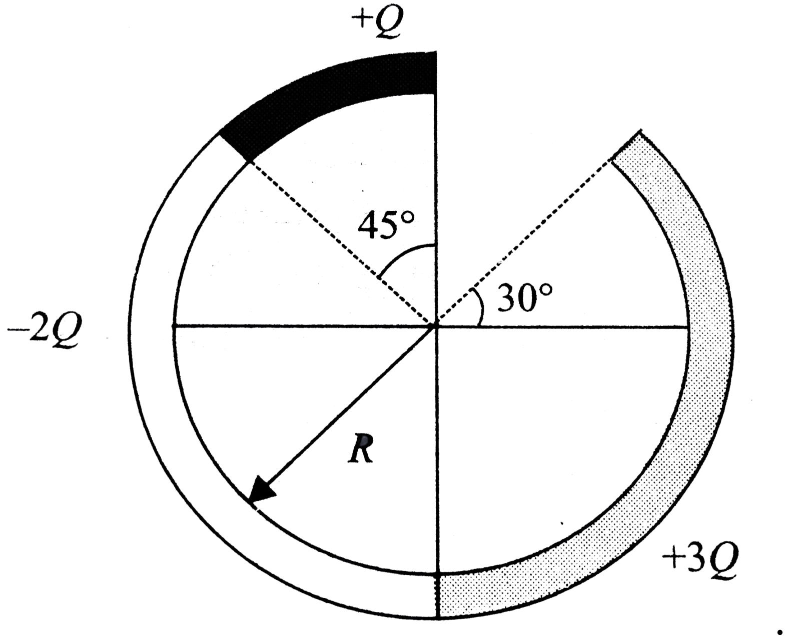
49. (Figure 3.139) shows three circular arcs, each of radius R and total charge as indicated. The net electric potential at the center of curvature.



A. $\dfrac{Q}{2\pi\varepsilon_0 R}$

B. $\dfrac{5Q}{12\pi\varepsilon_0 R}$

C. $\dfrac{3Q}{32\pi\varepsilon_0 R}$

D. none of these.

Answer: a

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50. When the positively charged hanging pendulum bob is made fixed, the work done in slowly shifting a unit positive charge from infinity to P is V. If the pendulum is free to move, the corresponding work done id V'. Then.

A. $V = V'$

B. $V > V'$

C. $V < V'$

D. $V \leq V'$

Answer: b

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51. The potential V is varying with x as $V = \frac{1}{2}(y^2 - 4x)$ volt. The field at $x = 1m, y = 1m$, is.

A. 1. $2\hat{i} + \hat{j}Vm^{-1}$

B. 2. $-2\hat{i} + \hat{j}Vm^{-1}$

C. 3. $2\hat{i} - \hat{j}Vm^{-1}$

D. 4. $-2\hat{i} + 2\hat{j}Vm^{-1}$

Answer: c

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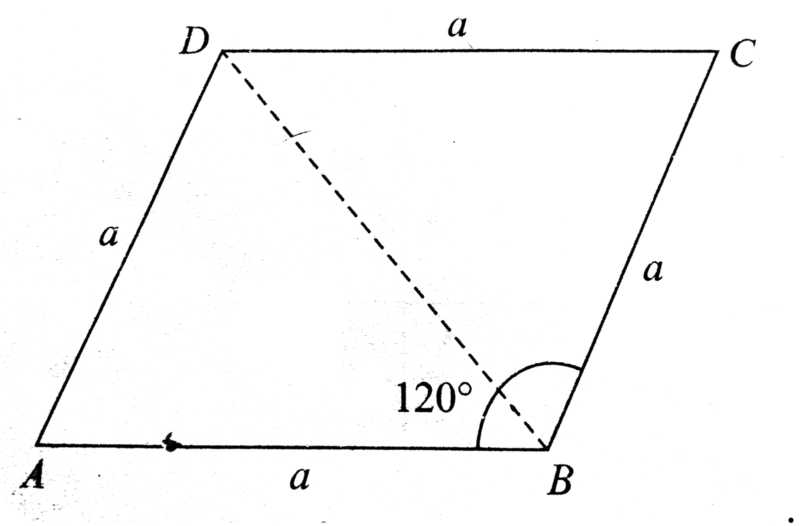
52. A charge $+Q$ at A as shown produces electric field E and electric potential V at D. If we now put charges $-3Q$ and $+Q$ at B and C, respectively, then the electric field and potential at D will be



A. E and 0

B. 2 E and - V

C. $\sqrt{2}E$ and $\frac{V}{\sqrt{2}}$

D. 2 E and V

Answer: b

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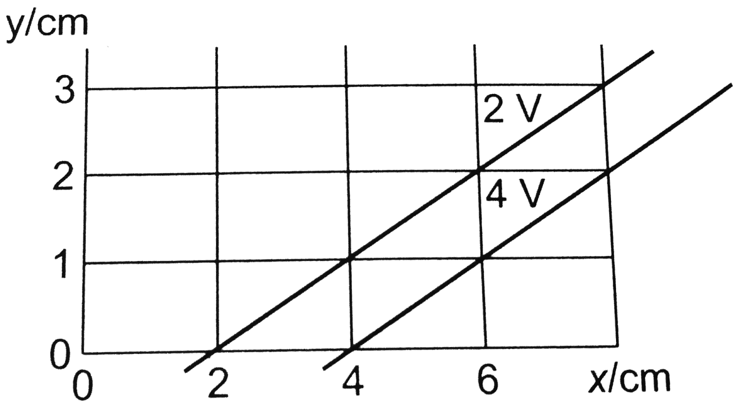
53. Figure shown two equipotential lies x, y plane for an electric field. The scales are market. The x-component E_x and y-component E_y of the field in the space between these equipotential lines are respectively



A. $+100Vm^{-1}, \ -200Vm^{-1}$

B. $-100Vm^{-1}, \ +200Vm^{-1}$

C. $+200Vm^{-1}, \ +100Vm^{-1}$

D. $-200Vm^{-1}, \ -400Vm^{-1}$

Answer: b

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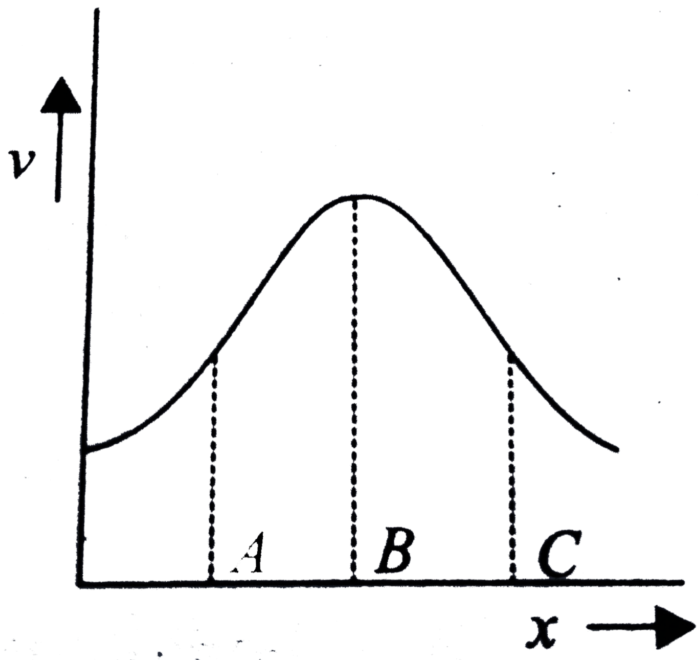
54. Variation of electrostatic potential along the x - direction is shown in (Fig. 3.142). The correct statement about electric field is



A. x - component at point B is maximum

B. x - component at point A is toward positive x - axis

C. x - component at point C is along negative x - axis

D. x - component at point C is along positive x - axis

Answer: d

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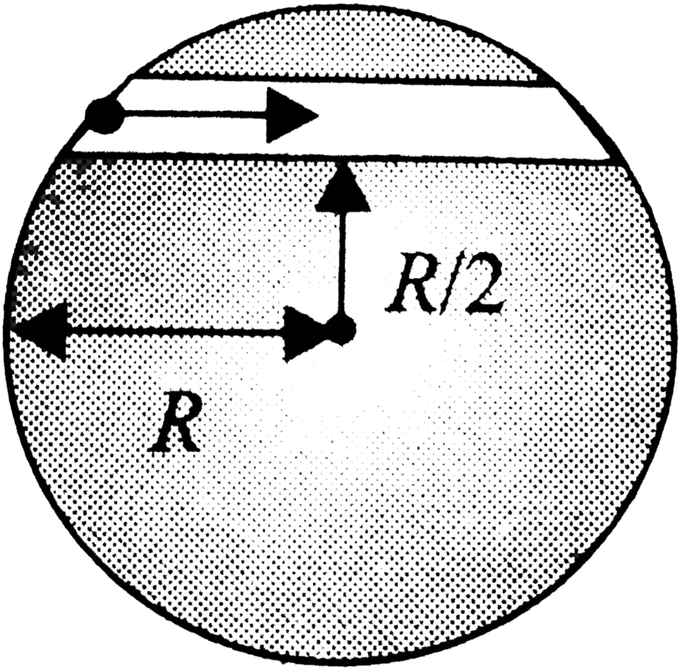
55. A unit positive point charge of mass m is projected with a velocity V inside the tunnel as shown. The tunnel has been made inside a uniformly charged nonconducting sphere. The minimum velocity with which the point charge should be projected such that it can reach the opposite end of the tunnel is equal to



A. $\left[\rho R^2 / 4m\varepsilon_0\right]^{1/2}$

B. $\left[\rho R^2 / 24m\varepsilon_0\right]^{1/2}$

C. $\left[\rho R^2 / 6m\varepsilon_0\right]^{1/2}$

D. zero because the initial and the final points are at same potential.

Answer: a

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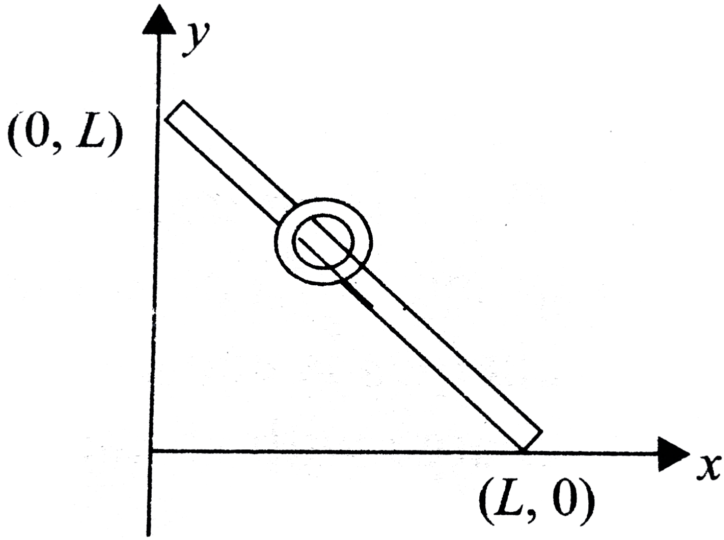
56. Electric field given by the vector $\overrightarrow{E}=x\hat{i}+y\hat{j}$ is present in the x y plane. A small ring carrying $+Q$, which can freely slide on a smooth nonconducting rod, is projected along the rod from the point $(0, L)$ such that it can reach the other end of the rod. What minimum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

(Assume zero gravity).



A. $\left(QL^2/m\right)^{1/2}$

B. $2\left(QL^2/m\right)^{1/2}$

C. $4\left(QL^2/m\right)^{1/2}$

D. $\left(QL^2/2m\right)^{1/2}$

Answer: d

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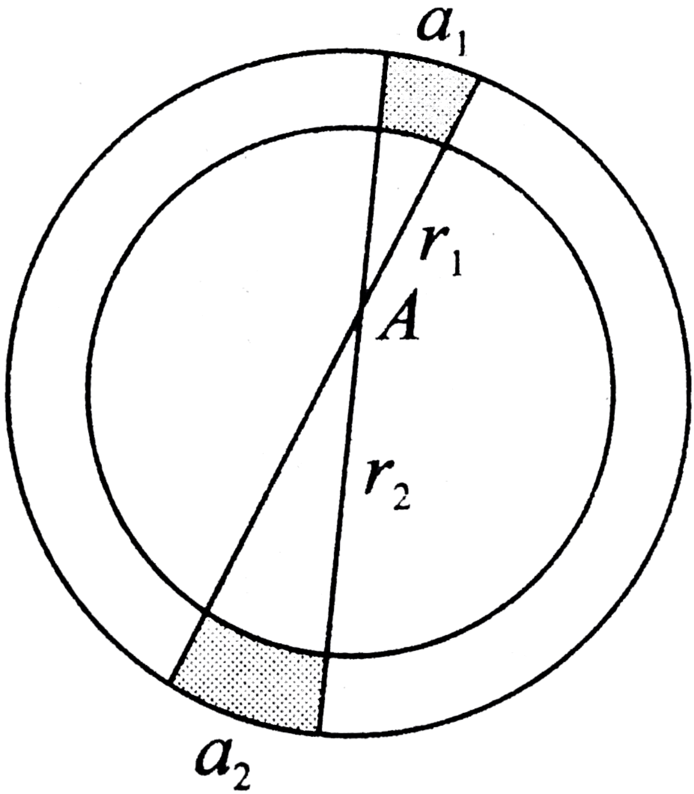
Multiple Correct

1. A wire having a uniform linear charge density λ is bent in the form of a ring of radius R. Point A as shown in (Fig. 3.145) is in the plane of the ring but not at the center. Two elements of the ring of lengths a_1 and a_2 subtend very small same angle at point A. they are at distances r_1 and r_2 from point A, respectively

$(r_2 > r_1)$.



A. The ratio of charges of element a_1 to that of element a_2 is r_1 / r_s.

B. The element a_1 produced greater magnitude of electric field at A than elements a_2.

C. The same elements a_1 and a_2 produce same potential at A

D. The direction of the net electric field produced by the elements only at A is toward element a_2.

Answer: a.,b.,c.,d.

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2. Two point charges of different magnitudes and of opposite signs are separated by some distance. There can be.

A. only on the point in space where net electric field intensity is zero.

B. only two points in space where net electric potential is zero

C. infinite number of points in space where net electric field intensity is 0

D. infinite number of points in space where net electric potential is zero.

Answer: a.,d.

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3. Two infinite parallel,non- conducting sheets carry equal positive charge density σ ,One is placed in the yz plane other at distance $x = a$ Take potential $V = 0$ at $x = 0$ then

A. for $0 \leq x \leq a$, potential $V = 0$

B. for $x \geq a$, potential $V = \dfrac{\sigma}{\varepsilon_0}(x - a)$

C. for $x \geq a$, potential $V = \dfrac{\sigma}{\varepsilon_0}(x - a)$

D. for $x \leq 0$, potential $V = \dfrac{\sigma}{\varepsilon_0}x$

Answer: a.,c.,d.

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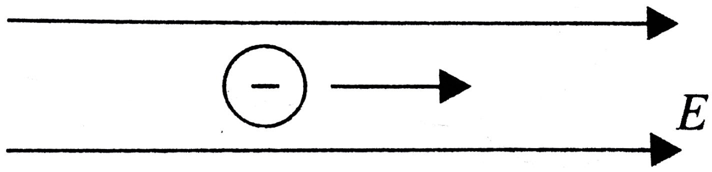
4. A negative charge is moved by an external agent in the direction of electric field. Then



A. Potential energy of the charge increases.

B. Potential energy of the charge decreases.

C. Positive work is done by the electric field

D. negative work is done by the electric field

Answer: a.,d.

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5. If a charged conductor is enclosed by a hollow charged conducting shell (assumed concentric and spherical in shape), and they are connected by a conducting wire, then which of the following statement (s) would be correct ?

A. Potential difference between the two conductors becomes zero.

B. If charge on the inner conductor is q and on the outer conductor is $2q$, then finally charge on the outer conductor will be $3q$.

C. The charge on the inner conductor is totally transferred to the outer conductor.

D. If charge on the inner conductor is q and charge on the outer conductor is zero, then finally the charge on each conductor will be $q/2$.

Answer: b.,d.

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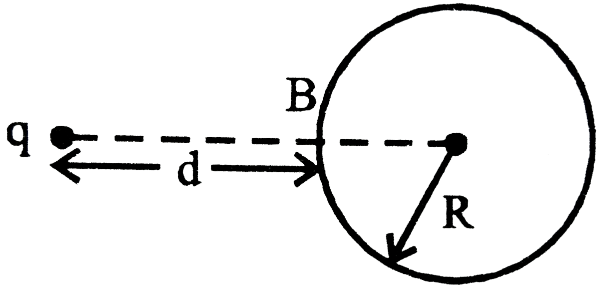
6. For the situation shown in the figure below mark out the correct statement (s) -



Hollow neutral conductor

A. Potential of the conductor is $q/[4\pi\varepsilon_0(d+R)]$.

B. Potential of the conductor is $q/4\pi n\varepsilon_0 d$.

C. Potential of the conductor cannot be determined as the nature of distribution of induced charges is not known.

D. Potential at point B due to the induced charges is $-qR/[4\pi\varepsilon_0(d+R)d]$.

Answer: a.,d.

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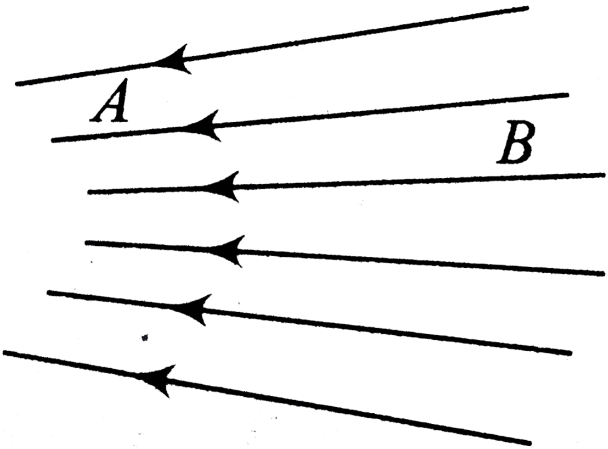
7. Which of the following is true for the figure showing electric lines of force ? (E is electrical field, and V is potential).



A. $E_A > E_B$

B. $E_B > E_A$

C. $V_A > V_B$

D. $V_B > V_A$

Answer: a.,d.

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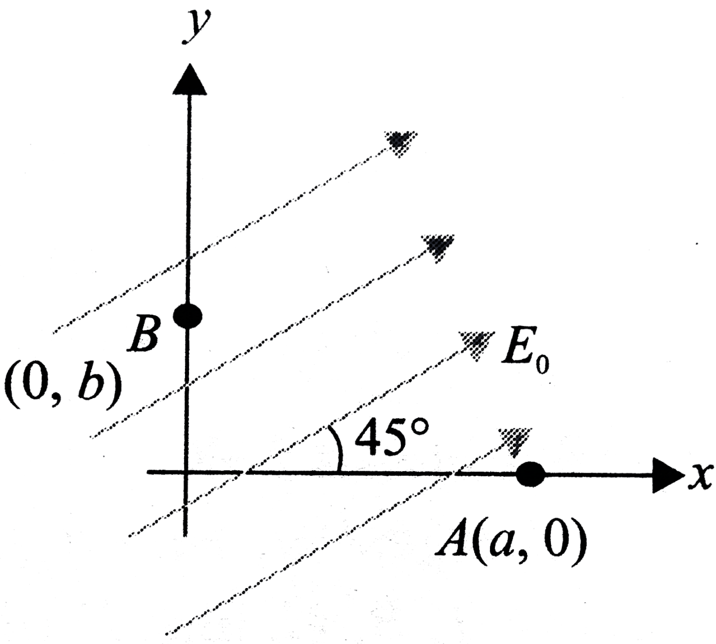
8. A uniform electric field E_0 exists in a region at angle 45° with the x - axis. There are two point $A(a, 0)$ and $B(0, b)$ having potential V_A and V_B, respectively, then



A. $a < b$

B. $a > b$

C. can't say

D. $a = b$

Answer: a.,b.,d.

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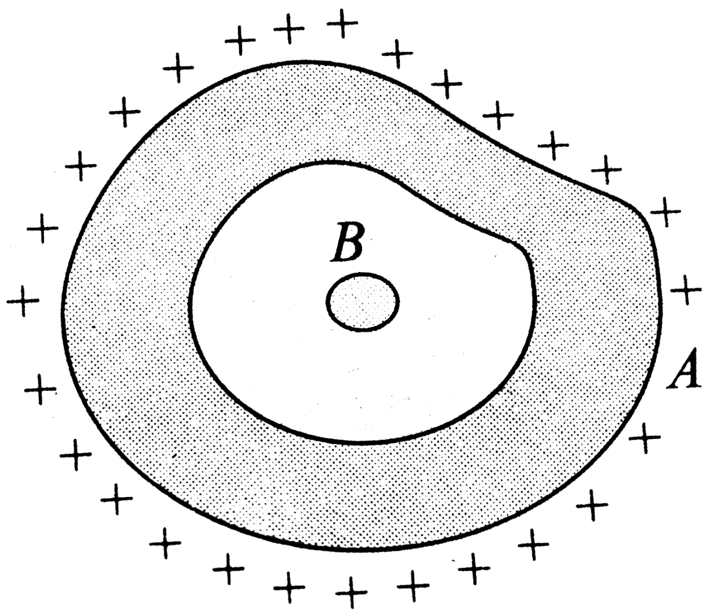
9. An uncharged conducting ball B lies inside a charged conductor A as shown in (Fig. 3.150). B is isolated from A.



A. When B touches the inner surface of A, then potential of B will change.

B. No net charge is inside the cavity.

C. There is an induced charge on B.

D. Potentials of $A \text{ and } B$ are same.

Answer: b.,d.

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10. At a distance of$5cm$ and $10cm$ from surface of a uniformly charge solid sphere, te potentials are $100V$ and $75V$ respectivley. Then

A. Potential at its surface is $150 V$

B. the charge on the sphere is $(5/3) \times 10^{-10} C$

C. the electric field on the surface is $1500 V m^{-1}$

D. the electric potential at its center is $0 V$

Answer: a.,c.

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Comprehension

1. Two point charges are located on the x - axis :

$q_1 = -e$ at $x = 0$ and $q_2 = +e$ at $x = a$.

The work done by an external force to bring a third point charge $q_3 = +e$ from infinity to $x = 2a$ is.

A. $\frac{e^2}{4\pi\varepsilon_0 a}$

B. $\frac{e^2}{8\pi\varepsilon_0 a}$

C. $\frac{-e^2}{8\pi\varepsilon_0 a}$

D. $\frac{-e^2}{4\pi\varepsilon_0 a}$

Answer: B

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2. Two point charges are located on the x - axis : $q_1 = -e$ at $x = 0$ and $q_2 = +e$ at $x = a$. A third charge $q_3 = +e$ is brought to $x = 2a$.

The total potential energy of the system of three charges.

A. $\frac{e^2}{4\pi\varepsilon_0 a}$

B. $\frac{e^2}{8\pi\varepsilon_0 a}$

C. $\frac{-e^2}{8\pi\varepsilon_0 a}$

D. $\frac{-e^2}{4\pi\varepsilon_0 a}$

Answer: C

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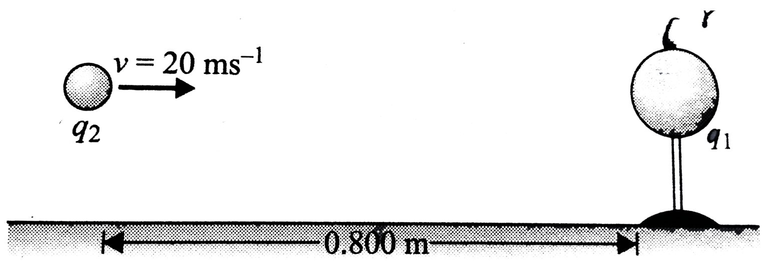
3. A small metal sphere, carrying a net charge $q_1 = -2\mu C$, is held in a stationary position by insulating supports. A second small metal sphere, with a net charge of $q_2 = -8\mu C$ and mass $1.50g$, is projected toward q_1. When the two spheres are $0.800m$ apart, q_2 is moving toward q_1 with speed $20ms^{-1}$ as shown in (Fig. 3.151). Assume that the two spheres can be treated as point charges. You can ignore the force of gravity.



The speed of q_2 when the spheres are $0.400m$ apart is.

A. $2\sqrt{10}ms^{-1}$

B. $2\sqrt{6}ms^{-1}$

C. $4\sqrt{10}ms^{-1}$

D. $4\sqrt{6}ms^{-1}$

Answer: C

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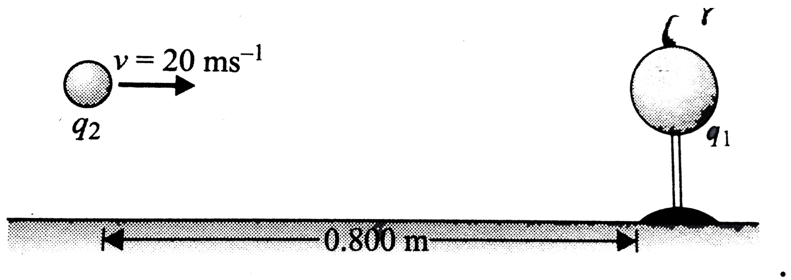
4. A small metal sphere, carrying a net charge $q_1 = -2\mu C$, is held in a stationary position by insulating supports. A second small metal sphere, with a net charge of $q_2 = -8\mu C$ and mass $1.50g$, is projected toward q_1. When the two spheres are

$0.800m$ apart, q_2 is moving toward q_1 with speed $20ms^{-1}$ as shown in (Fig. 3.151). Assume that the two spheres can be treated as point charges. You can ignore the force of gravity.



How close does q_2 get to q_1 ?

A. 0.20 m

B. 0.30 m

C. 0.10 m

D. 0.15 m

Answer: B

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5. Four charges $+q, +q, -q,$ and $-q$ are placed, respectively, at the corners $A, B, C,$ and D of a square of side a, arranged in the given order. If O is the center of square.

The electric field at O is.

A. $\dfrac{q}{\sqrt{2}\pi\varepsilon_0 a^2}$

B. $\dfrac{q}{\sqrt{3}\pi\varepsilon_0 a^2}$

C. $\dfrac{\sqrt{3}q}{\pi\varepsilon_0 a^2}$

D. $\dfrac{\sqrt{2}q}{\pi\varepsilon_0 a^2}$

Answer: D

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6. Four charges $+q, +q, -q,$ and $-q$ are placed, respectively, at the corners $A, B, C,$ and D of a square of side a, arranged in the given order. E and F are the midpoints of sides BC and CD, respectively, O is the center of square.

The electric potential at O is.

A. $\frac{\sqrt{2}q}{\pi\varepsilon_0 a}$

B. $\frac{\sqrt{3}q}{\pi\varepsilon_0 a}$

C. $\frac{q}{\pi\varepsilon_0 a}$

D. zero

Answer: D

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7. Four charges $+q, +q, -q,$ and $-q$ are placed, respectively, at the corners $A, B, C,$ and D of a square of side a, arranged in the given order. E and F are the midpoints of sides BC and CD, respectively, O is the center of square.

The work done in carrying a charge e from O to E is.

A. $\dfrac{\sqrt{2}qe}{\pi\varepsilon_0 a}$

B. $\dfrac{qe}{\pi\varepsilon_0 a}\left[\dfrac{1}{\sqrt{5}} - 1\right]$

C. $\dfrac{qe}{\pi\varepsilon_0 a}\left[\dfrac{1}{\sqrt{5}} + 1\right]$

D. zero

Answer: D

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8. Four charges $+q, +q, -q,$ and $-q$ are placed, respectively, at the corners $A, B, C,$ and D of a square of side a, arranged in the given order. E and F are the midpoints of sides BC and CD, respectively, O is the center of square.

The work done in carrying a charge e from O to F is.

A. $\frac{\sqrt{2}qe}{\pi\varepsilon_0 a}$

B. $\frac{qe}{\pi\varepsilon_0 a}\left[\frac{1}{\sqrt{5}}-1\right]$

C. $\frac{qe}{\pi\varepsilon_0 a}\left[\frac{1}{\sqrt{5}}+1\right]$

D. zero

Answer: B

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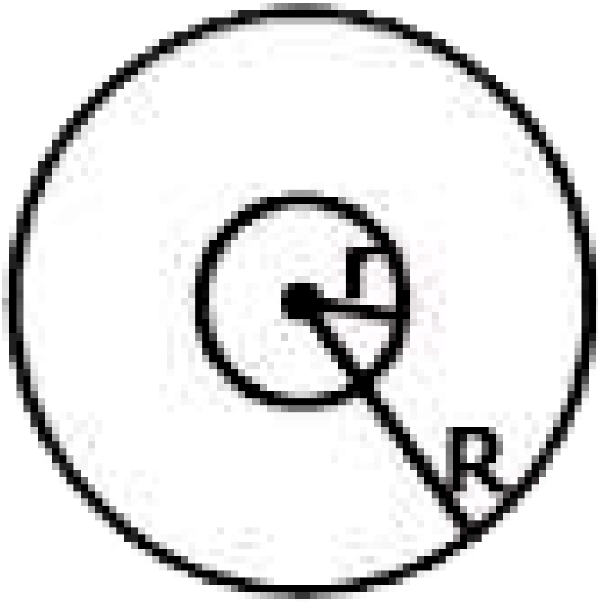
9. A charge Q is distributed over two concentric conducting thin spherical shells radii r and R $(R > 1)$. If the surface charge densities on the two shells are equal, the electric potential at the common centre is:



A. $\frac{Qr^2}{r^2+R^2}$ and $\frac{QR^2}{r^2+R^2}$. Respectively

B. $Q\left(1+\frac{r^2}{R^2}\right)$ and $Q\left(1+\frac{R^2}{r^2}\right)$, respectively

C. $Q\left(1-\frac{r^2}{R^2}\right)$ and $Q\left(1-\frac{R^2}{r^2}\right)$, respectively

D. $\frac{QR^2}{r^2+R^2}$ and $Q\frac{Qr^2}{r^2+R^2}$, respectively

Answer: A

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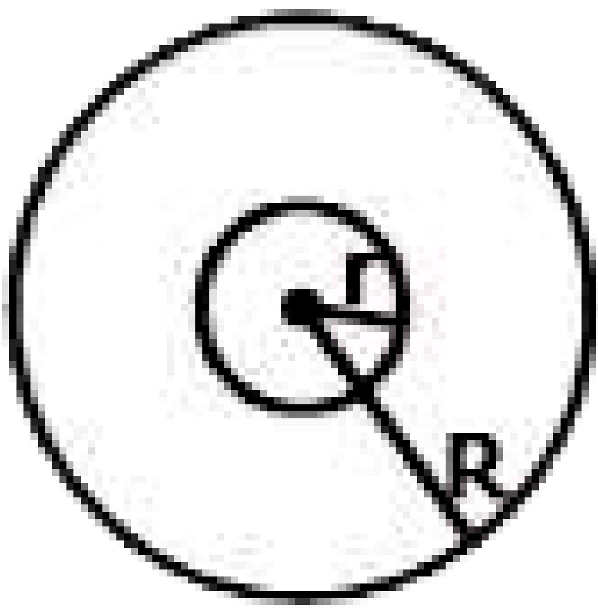
10. A charge Q is distributed over two concentric conducting thin spherical shells radii r and R $(R > 1)$. If the surface charge densities on the two shells are equal, the electric potential at the common centre is:



A. $\dfrac{\sqrt{2}}{\pi\varepsilon_0}\dfrac{Q(R+r)}{(R^2+r^2)}$

B. $\dfrac{1}{2\pi\varepsilon_0}\dfrac{Q(R+r)}{(R^2+r^2)}$

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

D. $\dfrac{1}{\pi\varepsilon_0}\dfrac{Q(R-r)}{(R^2+r^2)}$

Answer: C

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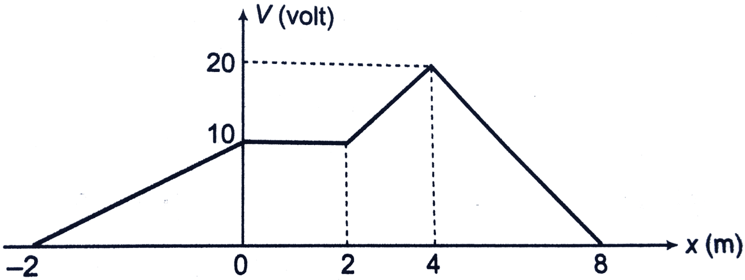
11. The electrical potential function for an electrical field directed parallel to the x-axis is shown in the given graph.



Draw the graph of electric field strength.

A. $-2 \leq x \leq 0, 4 \leq x \leq 8$, and $0 \leq x \leq 2$

B. $-2 \leq x \leq 0$ and $0 \leq x \leq 2$

C. $-2 \leq x \leq 0, 2 \leq x \leq 4$, and $\leq x \leq 8$

D. $0 \leq x \leq 2$ and $4 \leq x \leq 8$

Answer: C

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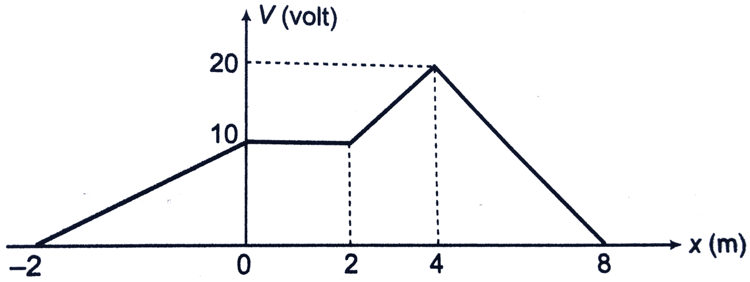
12. The electrical potential function for an electrical field directed parallel to the x-axis is shown in the given graph.



Draw the graph of electric field strength.

A. $2.5NC^{-1}$

B. $5NC^{-1}$

C. $-2.5NC^{-1}$

D. $-5NC^{-1}$

Answer: B

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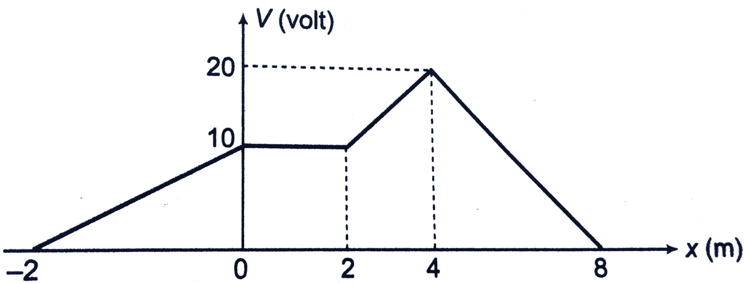
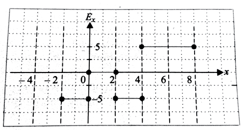
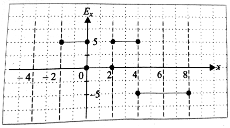
13. The electrical potential function for an electrical field directed parallel to the x-axis is shown in the given graph.



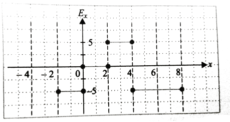
Draw the graph of electric field strength.

A. 

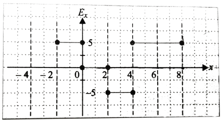
B. b.



C. c.



D. d.



Answer: A

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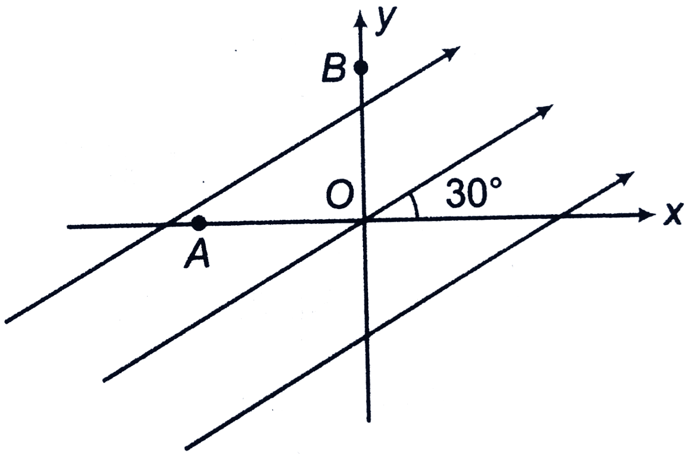
14. A uniform electric field of $100V/m$ is directed at 3° with the positive x-axis as shown in figure. Find the potential difference V_{BA} if $OA = 2$m and $OB = 4m$.



A. $100\sqrt{3}V$

B. $200\sqrt{3}V$

C. $-100\sqrt{3}V$

D. $-200\sqrt{3}V$

Answer: C

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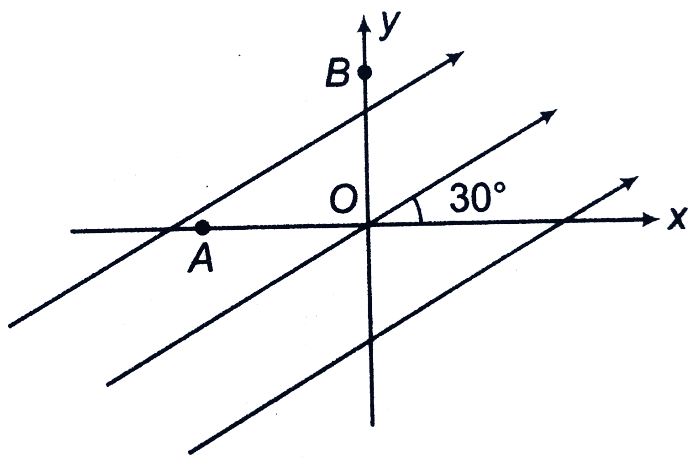
15. A uniform electric field of $100V/m$ is directed at 30° with the positive x-axis as shown in figure. Find the potential difference V_{BA} if $OA = 2\text{m}$ and $OB = 4m$.



A. $-100\left[2+\sqrt{3}\right]V$

B. $100\left[2+\sqrt{3}\right]V$

C. $100\left[2-\sqrt{3}\right]V$

D. $-100[2-\sqrt{3}]V$

Answer: A

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16. The electric potential varies in space according to the relation $V = 3x + 4y$. A particle of mass 10 kg starts from rest from point $(2, 3.2)$ m under the influence of this field. Find the velocityr,f the particle when it crosses the x-axis. The charge on the particle is $+1\mu C$. Assume V (x, y)are in SI units.

A. $-3Vm^{-1}$

B. $4Vm^{-1}$

C. $5Vm^{-1}$

D. $8Vm^{-1}$

Answer: A

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17. The electric potential varies in space according to the relation $V = 3x + 4y$. A particle of mass 10 kg starts from rest from point $(2, 3.2)$ m under the influence of this field. Find the velocityr,f the particle when it crosses the x-axis. The charge on the particle is $+1\mu C$. Assume V (x, y)are in SI units.

A. $3Vm^{-1}$

B. $-4Vm^{-1}$

C. $5Vm^{-1}$

D. $8Vm^{-1}$

Answer: B

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18. The electric potential varies in space according to the relation $V = 3x + 4y$. A particle of mass 10 kg starts from rest from point $(2, 3.2)$ m under the influence of this field. Find the velocityr,f the particle when it crosses the x-axis. The charge on the particle is $+1\mu C$. Assume V (x, y)are in SI units.

A. 20 s

B. 40 s

C. 200 s

D. 400 s

Answer: D

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19. The electric potential varies in space according to the relation $V = 3x + 4y$. A particle of mass 10 kg starts from rest from point $(2, 3.2)$ m under the influence of this field. Find the velocityr,f the particle when it crosses the x-axis. The charge on the particle is $+1\mu C$. Assume V (x, y)are in SI units.

A. $20 \times 10^{-3} ms^{-1}$

B. $40 \times 10^{-3} ms^{-1}$

C. $30 \times 10^{-3} ms^{-1}$

D. $50 \times 10^{-3} ms^{-1}$

Answer: A

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20. Three concentric spherical metallic shells $A, B,$ and C of radii $a, b,$ and $c(a < b < c)$ have surface charge densities $\sigma, -\sigma$ and σ, respectively.

If V_A, V_B and V_C are potential of shells A, B and C, respectively, match the columns

Column A		Column B
a. V_A	i.	$\frac{\sigma}{\varepsilon_0}\left[\frac{a^2-b^2+c^2}{c}\right]$
b. V_B	ii.	$\frac{\sigma^2}{\varepsilon_0}\left[\frac{a^2}{b}-b+c\right]$
c. V_C	iii.	$\frac{\sigma}{\varepsilon_0}[a-b+c]$

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21. Three concentric spherical metallic shells A, B and C of radii a, b and c (a < b < c) have surface charge densities $\sigma, -\sigma$ and σ respectively.

`(i) Find the potential of the three shells A, B and C.

(ii) If the shells A and C are at the same potential, obtain the relation between the radii a, b and c.

A. $a = b + c$

B. $c = a + b$

C. $b + a + c$

D. $2a = b - c$

Answer: B

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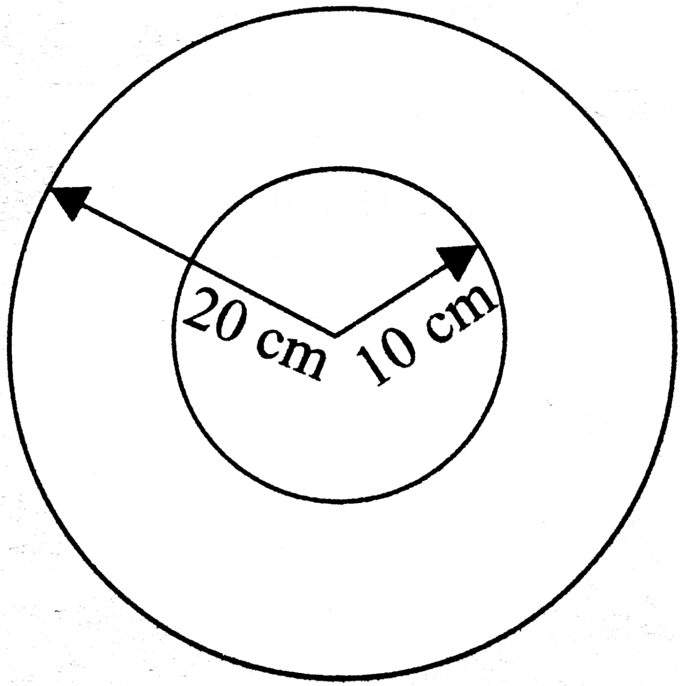
22. We have an isolated conducting spherical shell of radius $10cm$. Some positive charge is given to it so that the resulting electric field has a maximum intensity of $1.8 \times 10^6 NC^{-1}$. The same amount of negative charge is given to another isolated conducting spherical shell of radius $20cm$. Now, the first shell is placed inside the second so that both are concentric as shown in (Fig. 3.154).



The electric potential at any point inside the first shell is.

A. $18 \times 10^{4} V$

B. $9 \times 10^{4} V$

C. $4.5 \times 10^{4} V$

D. $1.8 \times 10^{4} V$

Answer: B

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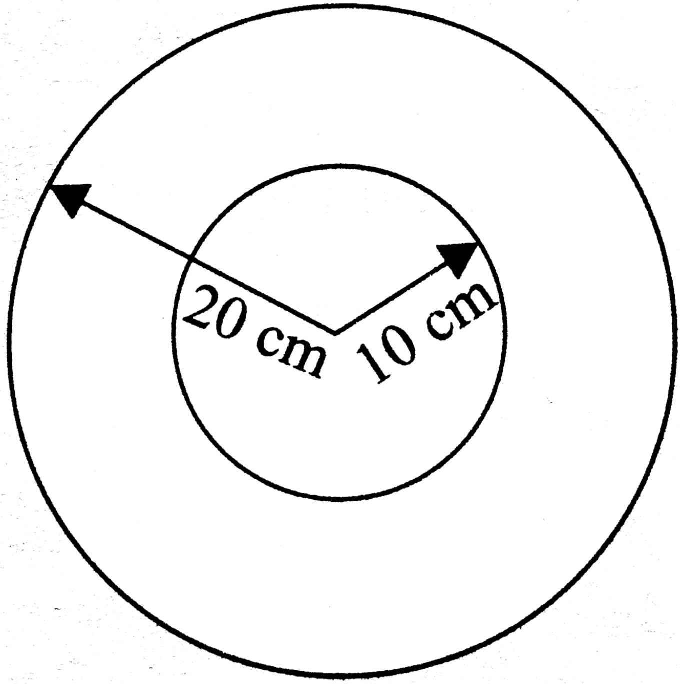
23. We have an isolated conducting spherical shell of radius $10cm$. Some positive charge is given to it so that the resulting electric field has a maximum intensity of $1.8 \times 10^6 NC^{-1}$. The same amount of negative charge is given to another isolated conducting spherical shell of radius $20cm$. Now, the first shell is placed inside the second so that both are concentric as shown in (Fig. 3.154).



The electric field intensity just inside the outer sphere.

A. $4.5 \times 10^5 NC^{-1}$

B. $9 \times 10^5 NC^{-1}$

C. $4.5 \times 10^4 NC^{-1}$

D. $5 \times 10^4 NC^{-1}$

Answer: A

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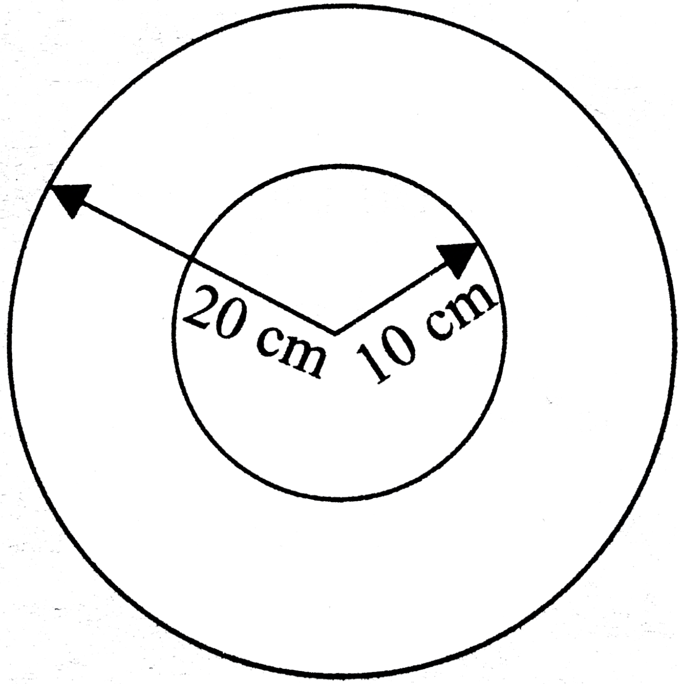
24. We have an isolated conducting spherical shell of radius $10cm$. Some positive charge is given to it so that the resulting electric field has a maximum intensity of $1.8 \times 10^6 NC^{-1}$. The same amount of negative charge is given to another isolated conducting spherical shell of radius $20cm$. Now, the first shell is placed inside the second so that both are concentric as shown in (Fig. 3.154).



The electrostatic energy stored in the system is.

A. 1.0 J

B. 0.045 J

C. 0.09 J

D. 1.8 J

Answer: C

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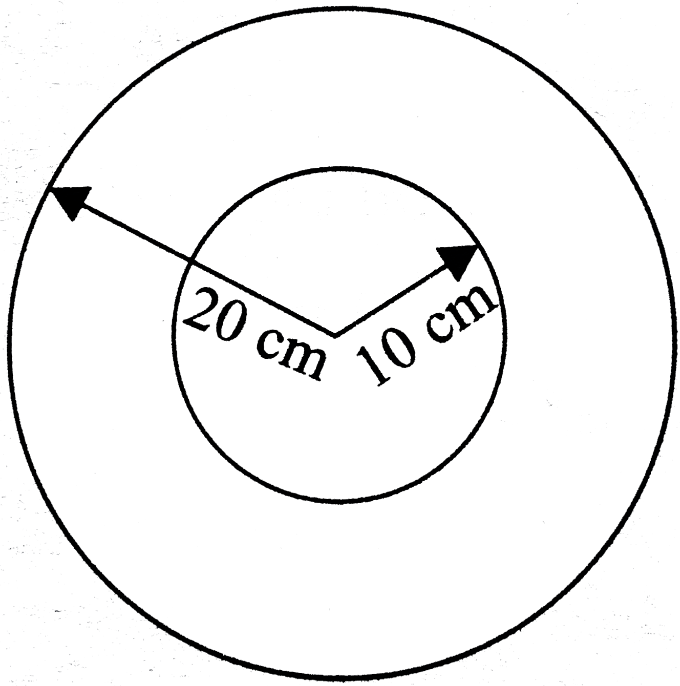
25. We have an isolated conducting spherical shell of radius $10cm$. Some positive charge is given to it so that the resulting electric field has a maximum intensity of $1.8 \times 10^{6} NC^{-1}$. The same amount of negative charge is given to another isolated conducting spherical shell of radius $20cm$. Now, the first shell is placed inside the second so that both are concentric as shown in (Fig. 3.154).



If both the spheres are connected by a conducting wire, then.

A. nothing will happen.

B. some part of the energy stored in the system will convert into heat.

C. charge on both spheres will be positive.

D. entire amount of the energy stored in the system will convert into heat.

Answer: D

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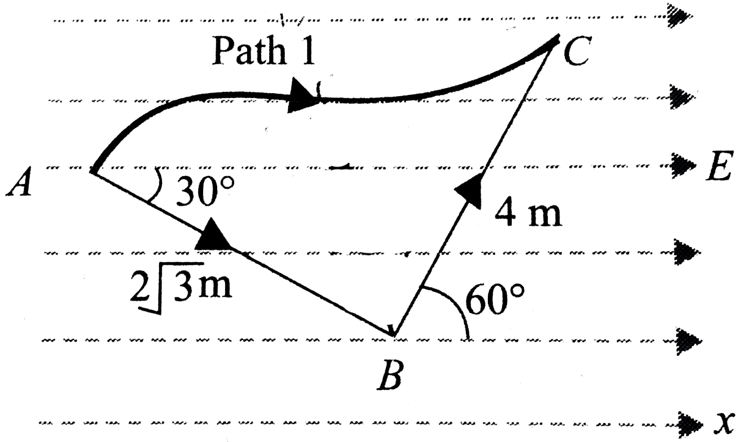
26. In a certain region, electric field E exists along the x - axis which is uniform. Given $B = 2\sqrt{3}m$ and $BC = 4m$. Points A, B, and C are in xy plane.



Find the potential difference $V_A - V_B$ between the points A and B.

A. 3 E

B. 4 E

C. E

D. 2 E

Answer: A

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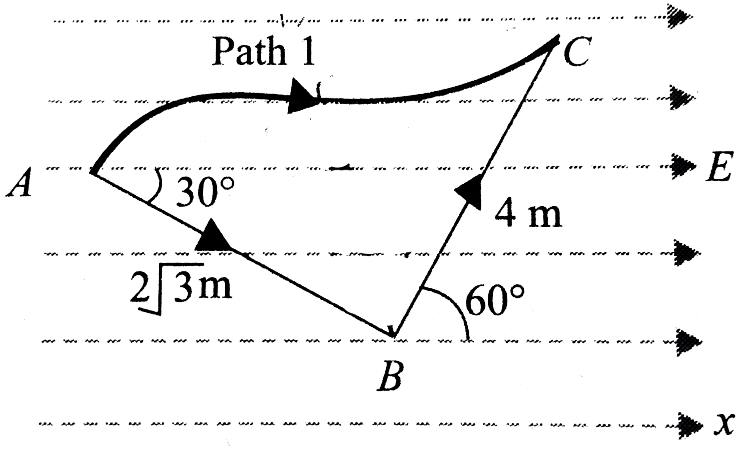
27. In a certain region, electric field E exists along the x - axis which is uniform. Given $AB = 2\sqrt{3}m$ and $BC = 4m$. Points A, B, and C are in xy plane.



find the potential difference $V_C - V_B$ between the points C and B.

A. 2 E

B. 3 E

C. $-E$

D. $-2E$

Answer: D

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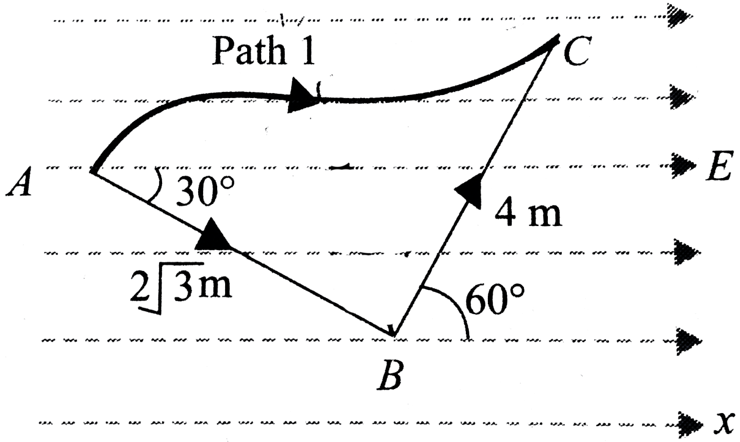
28. In a certain region, electric field E exists along the x - axis which is uniform. Given $AB = 2\sqrt{3}m$ and $BC = 4m$. Points A, B, and C are in xy plane.



A charged particle q is moved from A to C as shown in path 1. What is the work done by electric field in this process ?

A. 2 q E

B. 5 q E

C. q E

D. 4 q e

Answer: B

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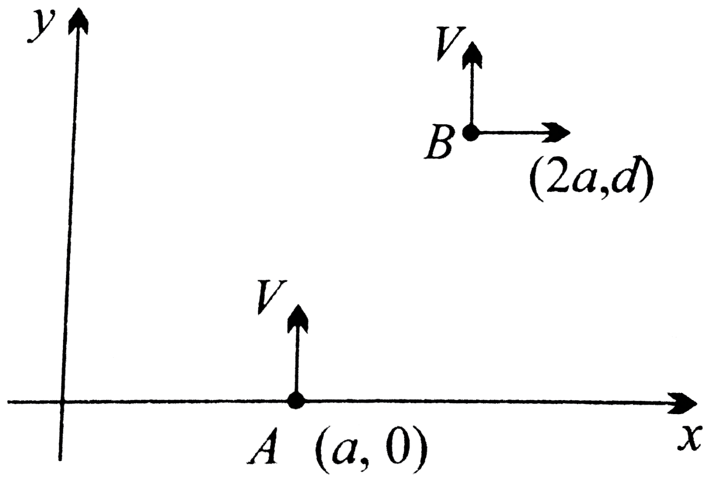
29. An uniform electric field of strength E exists in a region. An electron of mass m enters a point A perpendicular to x - axis with velocity V. It moves through the electric field and exists at point B. The components of velocity at B are shown in (Fig. 3.156). At B the y - component of velocity remain uncharged.



Find electric field.

A. $\frac{2maV^2}{ed^2}$

B. $\frac{maV^2}{ed^2}$

C. $\frac{maV^2}{2ed^2}$

D. $\frac{2maV^3}{ed^3}$

Answer: A

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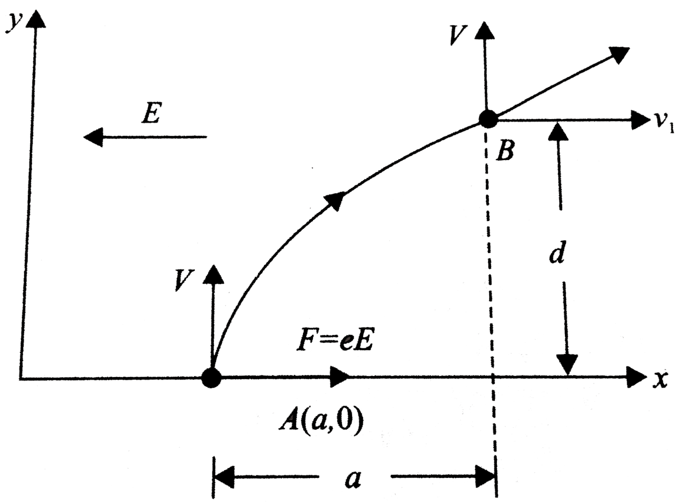
30. An uniform electric field of strength E exists in a region. An electron of mass m enters a point A perpendicular to x - axis with velocity V. It moves through the electric field and exists at point B. The components of velocity at B are shown in (Fig. 3.156). At B the y - component of velocity remain uncharged.



Find velocity at B.

A. $V\sqrt{1-\left(\frac{2a}{d}\right)^2}$

B. $V\sqrt{1+\left(\frac{2a}{d}\right)^2}$

C. $V\sqrt{1+\left(\frac{a}{d}\right)^2}$

D. $V\sqrt{2+\left(\frac{2a}{d}\right)^2}$

Answer: B

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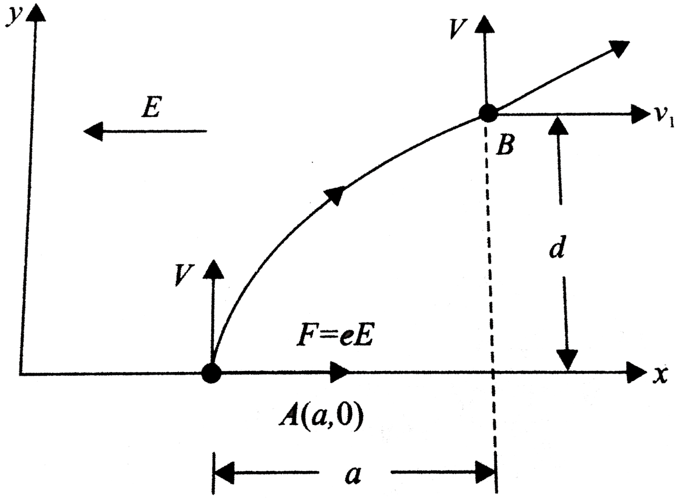
31. An uniform electric field of strength E exists in a region. An electron of mass m enters a point A perpendicular to x - axis with velocity V. It moves through the electric field and exists at point B. The components of velocity at B are shown in (Fig. 3.156).

At B the y - component of velocity remain uncharged.



Find the rate of work done by the field at B.

A. $\dfrac{2ma^2V^3}{d^3}$

B. $\dfrac{ma^2V^3}{2d^3}$

C. $\dfrac{4ma^2V^3}{d^3}$

D. $\dfrac{ma^2V^3}{d^3}$

Answer: (c)

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Integer

1. There are 27 drops of a conducting fluid. Each drop has radius r, and each of them is charged to the same potential V_1. They are then combined to from a bigger drop. The potential of the bigger drop is V_2. Find the ratio V_2 / V_1. Ignore the change in density of the fluid on combining the drops.

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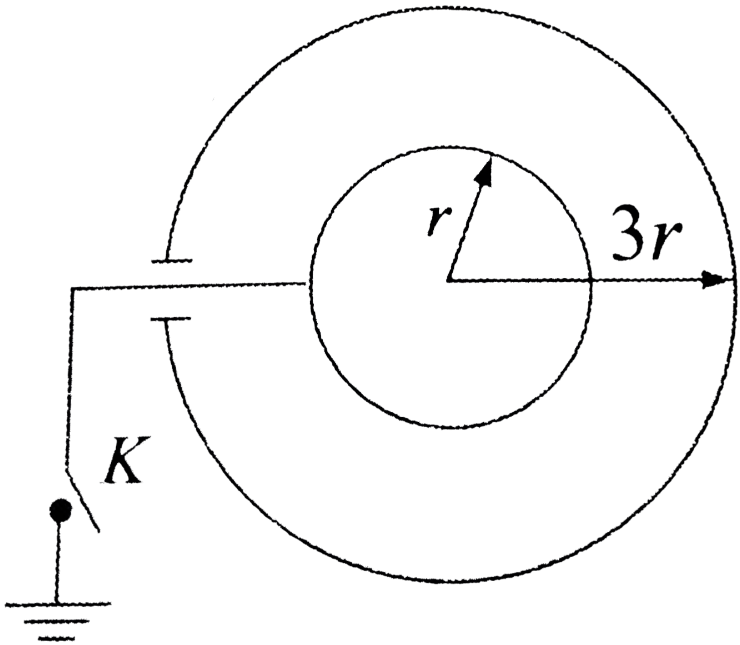
2. Figure shows two conducting thin concentric shells of radii r and $3r$. The outer shell carries charge q and the inner shell is neutral . The amount of charge that flows from the inner shell to the earth after the key K is closed is equal to $(1/n)^{th}$ of the charge on the outer shell. What is the value of n ?



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3. A charge of $5\mu C$ is placed at the center of a square $ABCD$ of side $10cm$. Find the work done $(\text{in}\mu J)$ in moving a charge of $1\mu C$ from A to B.

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4. The linear charge density on a dielectric ring of radius R vanes with θ as $\lambda = \lambda_0 \cos\theta/2$, where λ_0 is constant. Find the potential at the center O of the ring [in volt].

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5. Three point charges $q, \ -2q$ and $\ -2q$ are plaed at the vertices of an equilateral triangle of side a. The work done by some external force to increase their separation to 2a will be

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DPP 3.1

1. There is an electric field E in the x - direction. If the work done by the electric field in moving a charge of $0.2C$ through a distance of $2m$ along a line making an angle 60° with the x- axis is $4J$, then what is the value of E ?

A. $\sqrt{3}N/C$

B. $4N/C$

C. $5N/C$

D. None of these

Answer: D

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2. Four equal charges q each are placed at four corners of a square of a square of side a each. Work done incarrying a charge -q from its centre to infinity is

A. 0

B. $\dfrac{\sqrt{2}Q^2}{4\pi\varepsilon_0 a}$

C. $\dfrac{\sqrt{2}Q^2}{\pi\varepsilon_0 a}$

D. $\dfrac{Q^2}{2\pi\varepsilon_0 a}$

Answer: C

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3. Charges of $+\dfrac{10}{3}\times 10^{-9}C$ are placed at each of the four corners of a square of side $8cm$. The potential at the intersection of the diagonals is

A. $150\sqrt{2}$ volt

B. $1500\sqrt{2}$ volt

C. $900\sqrt{2}$ volt

D. 900 volt

Answer: B

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4. Three charges $2q, -q, -q$ are located at the vertices of an equilateral triangle. At the centre of the triangle,

A. the field is zero but potential is non-zero

B. the field is non-zero but potential is zero

C. both field and potential are zero

D. both field and potential are non-zero

Answer: B

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5. Two electric charges $12\mu C$ and $-6\mu C$ are placed $20cm$ apart in air. There will be a point P on the line joining these charges and outside the region between them, at which the electric potential is zero. The distance of P from $6\mu C$ charge is

A. 0.10 m

B. 0.15 m

C. 0.20 m

D. 0.25 m

Answer: C

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6. A spherical conductor of radius 2 m is charged to a potential of 120 V. It is now placed inside another hollow spherical conductor of radius 6 m. Calculate the potential to which the bigger sphere would be raised

A. 20 V

B. 60 V

C. 80 V

D. 40 V

Answer: D

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7. Two point charges $100\mu C$ and $5\mu C$ are placed at points A and B respectively with $AB = 40cm$. The work done by external froce in displacing the charge $5\mu C$ from B to C, where $BC = 30cm$, angle $ABC = \frac{\pi}{2}$ and $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 Nm^2/C^2$

A. $9J$

B. $\frac{81}{20}J$

C. $\frac{9}{25}J$

D. $-\frac{9}{4}J$

Answer: D

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8. In the rectangle shown below, the two corners have charges $q_1 = -5\mu C$ and $q_2 = +2.0\mu C$. The work done in moving a charge $+3.0\mu C$ from B to A is

A. $2.8J$

B. $3.5J$

C. $4.5J$

D. $5.5J$

Answer: A

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9. A charge $(-q)$ and another charge (Q) are kept at two points A and B respectively. Keeping the charge $(+Q)$ fixed at B, the charge $(-q)$ at A is moved to another point C such that ABC forms an equilateral triangle of side l. The net work done in moving teh charge $(-q)$ is

A. $\frac{1}{4\pi\varepsilon_0}\frac{Qq}{l}$

B. $\frac{1}{4\pi\varepsilon_0}\frac{Qq}{l^2}$

C. $\frac{1}{4\pi\varepsilon_0}Qql$

D. Zero

Answer: D

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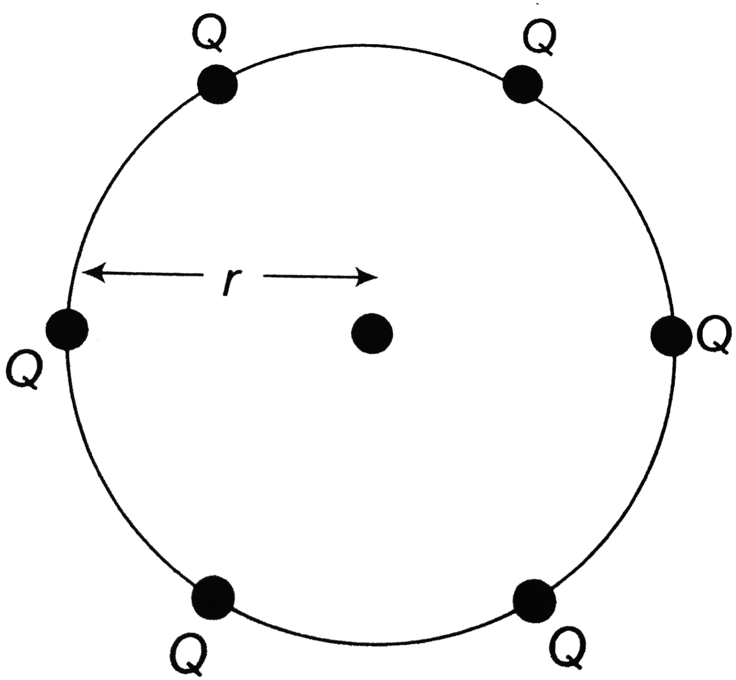
10. A point charge is surrounded symmetrically by six identical charges at distance r as shown in the figure

How much work is done by the froces of electrostatic repulsion when the point charge at the centre is removed to infinity ?



A. Zero

B. $6q^2 / 4\pi\varepsilon r$

C. $q^2 / 4\pi\varepsilon_0 r$

D. $12q^2 / 4\pi\varepsilon_0 r$

Answer: B

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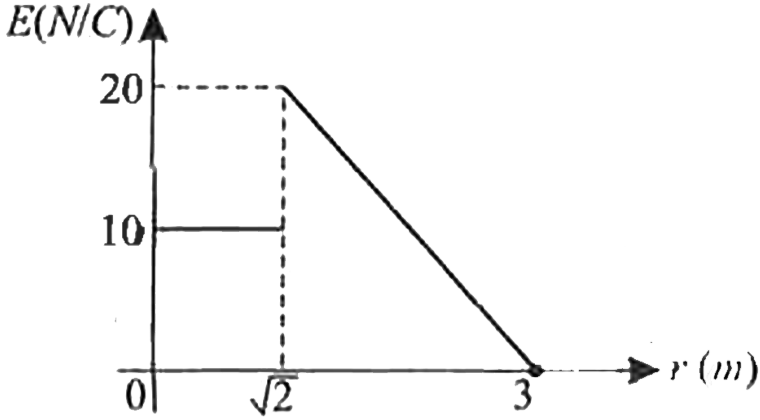
11. An electric field 'E' whose direction is radially outward varies as distance from origin 'r' as shown in the graph E is taken as positive if its direction is away from the origin. Then the work done by electric field on a 2 C charge if it is taken from $(1, 1, 0)$ to $(3, 0, 0)$ is :



A. $20(3+\sqrt{2})J$

B. $-60J$

C. $60J$

D. $20(3-\sqrt{2})J$

Answer: D

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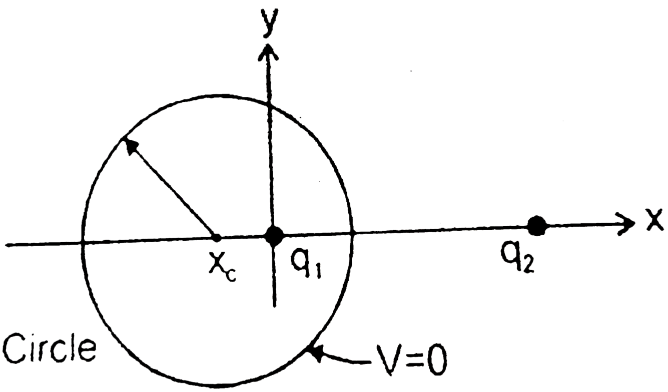
12.



A point charge $q_1 = +6e$ fixed at the origin of a coordinate system, and another point charge $q_2 = -10e$ is fixed at $x = 8nm, y = 0$ the locus of all points in the xy plane for which potential $V = 0$ (other man inifinity) is a circle centered on the x-axis as shown.

Q. Radius R of the circle is

A. 3 nm

B. 6 nm

C. 7.5 nm

D. 9 nm

Answer: C

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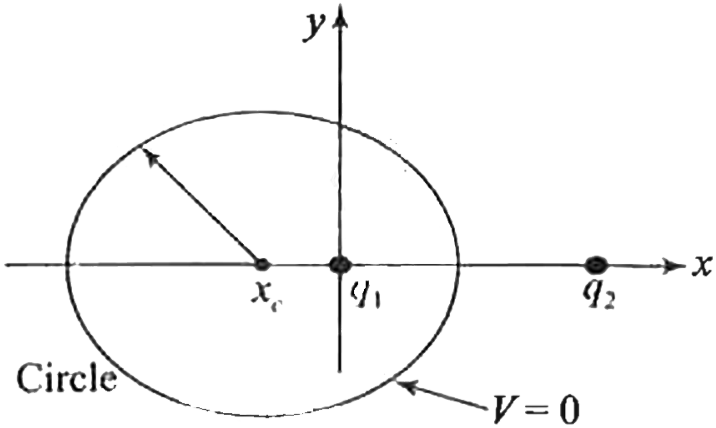
13. A point charge $q_1 = +6e$ fixed at the origin of a conducting system, and another point charge $q_2 = -10e$ is fixed at $x = 8$ nm, $y = 0$. The locus of all points in the xy plane for which potential $V = 0$ (other than infinity) is a circle contered on the x-axis, as shown



x-coordinate of the centre of the circle is

A. -2 nm

B. -3 nm

C. -4.5 nm

D. -7.5 nm

Answer: C

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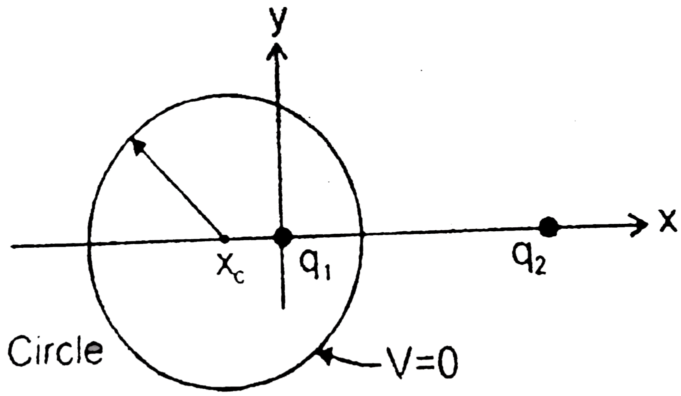
14. 

A point charge $q_1 = +6e$ fixed at the origin of a coordinate system, and another point charge $q_2 = -10e$ is fixed at $x = 8nm, y = 0$ the locus of all points in the xy plane for which potential $V = 0$ (other man inifinity) is a circle centered on the x-axis as shown.

Q. The potential at the centre of the circle is

A. 0.32 V

B. 0.77 V

C. 1.2 V

D. $-1.2V$

Answer: B

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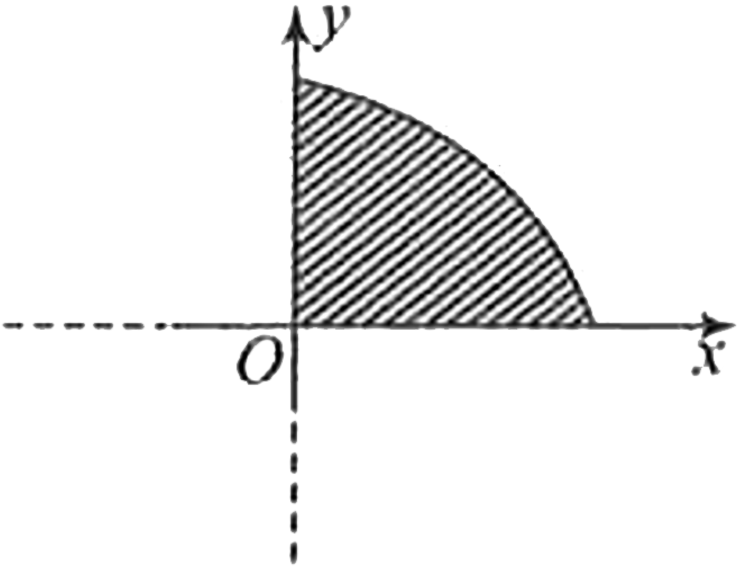
DPP 3.2

1. A uniform surface charge of density σ is given to a quarter of a disc extending up to infinity in the first quadrant of $x-y$ plane. The centre of the disc is at the origin O. Find the z-component of the electric field at the point $(0, 0, z)$ and the potential difference between the point $(0, 0, d)$ and $(0, 0, 2d)$



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2. The electric potential V at any point x,y,z (all in metre) in space is given by $V = 4x^2$ volt. The electric field at the point $(1m, 0, 2m)$ is .... $\frac{V}{m}$.

A. 8 along negative X-axis

B. 8 along positive X-axis

C. 16 along negative X-axis

D. 16 along positive Z-axis

Answer: A

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3. Electric potential is given by

$V = 6x - 8xy^2 - 8y + 6yz - 4z^2$

Then electric force acting on $2C$ point charge placed on origin will be

A. 2 N

B. 6 N

C. 8 N

D. 20 N

Answer: D

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4. Consider two points 1 and 2 in a region outside a charged sphere. Two points are not very far away from the sphere. If E and V respresent the electric fileld vector and the electric potential. Which of the following is not possible ?

A. $\left|\vec{E}_1\right| = \left|\vec{E}_2\right|, V_1 = V_2$

B. $\vec{E}_1 \neq \vec{E}_2, V_1 \neq V_2$

C. $\vec{E}_1 \neq \vec{E}_2, V_1 = V_2$

D. $\left|\vec{E}_1\right| = \left|\vec{E}_1\right|, V_1 \neq V_2$

Answer: D

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5. Electric potential at any point is $V = -5x + 3y + \sqrt{15}z$, then the magnitude of the electric field is

A. $3\sqrt{2}$

B. $4\sqrt{2}$

C. $5\sqrt{2}$

D. 7

Answer: D

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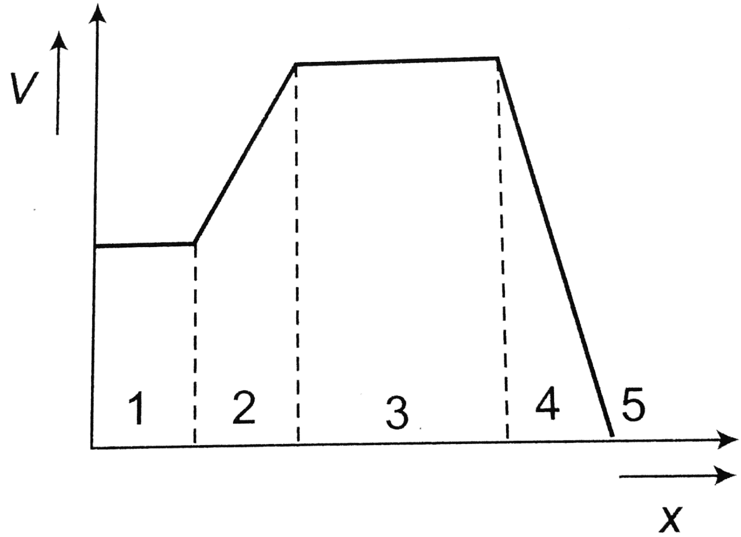
6. The figure gives the electric potential V as a function of distance through five regions on x-axis. Which of the following is true for the electric E in these regions ?



A. $E_1 > E_2 > E_3 > E_4 > E_5$

B. $E_1 = E_3 = E_5$ and $E_2 < E_4$

C. $E_2 = E_4 = E_5$ and $E_1 < E_2$

D. $E_1 < E_2 < E_3 < E_4 < E_5$

Answer: B

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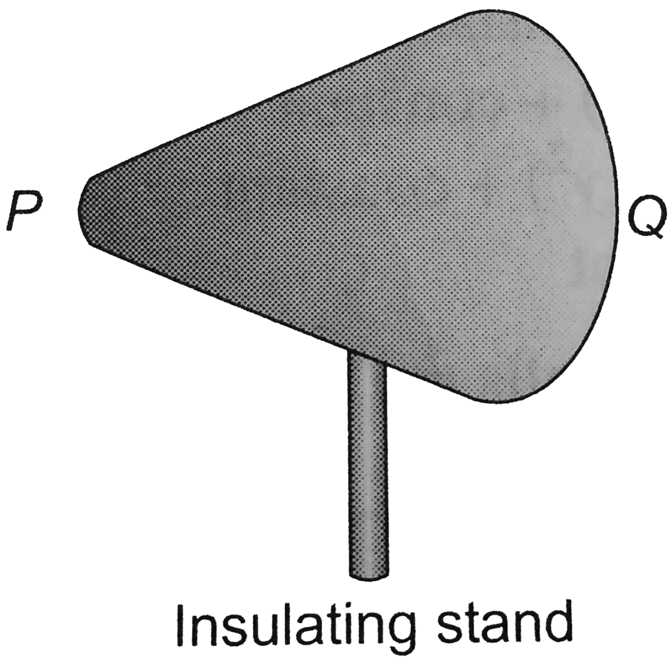
7. Figure shown a charged conductor resting on an insulating stand. If at the point P the charge density is σ, the potential is V and the electric field strength is E, what are the values of these quantities at point Q ?



	Charge density	Potential	Electric intensity
A.	$> \sigma$	$> V$	$> E$
B.	$> \sigma$	V	$> E$
C.	$< \sigma$	V	E
D.	$< \sigma$	V	$< E$

Answer: D

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8. The electrostatic potential on the surface of a charged conducting sphere is 100 V. Two statements are made in this regard

S_1 : At any point inside the sphere, electric intensity is zero.

S_2 : At any point inside the sphere, the electrostatic potential is 100 V.

Which of the following is a correct statement ?

A. S_1 is true but S_2 is false

B. Both S_1 and S_2 are false

C. S_1 is true, S_2 is also true and S_1 is the cause of S_2

D. S_1 is true, S_2 is also true but the statements are independent

Answer: C

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9. If unifrom electric filed $\overrightarrow{E} = E_0\hat{i} + 2E_0\hat{j}$, where E_0 is a constant, exists in a region of space and at $(0, 0)$ the electric potential V is zero, then the potential at $(x_0, 0)$ will be.

A. Zero

B. $-E_0x_0$

C. $-2E_0x_0$

D. $-\sqrt{5}E_0x_0$

Answer: B

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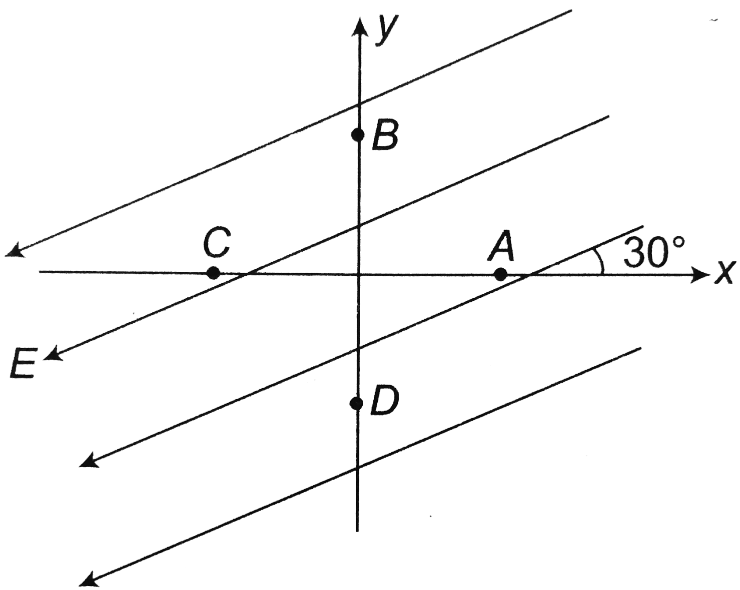
10. There exists a uniform electric filed in the space as shown. Four points A, B, C and D are marked which are equildistant from the origin. If and V_D are their potentials respectively, then



A. $V_B > V_A > V_C > V_D$

B. $V_A > V_B > V_D > V_C$

C. $V_A = V_A > V_C = V_D$

D. $V_B > V_C > V_A > V_D$

Answer: B

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11. The potential of an electric field $\overrightarrow{E} = \left(y\hat{i} + x\hat{j}\right)$ is

A. $V = -xy +$ constant

B. $V = -(x+y) +$ constant

C. $V = -\left(x^2 + y^2\right) +$ constant

D. V = constant

Answer: A

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12. A uniform electric field exists in $x - y$ plane. The potential of points $A(-2m, 2m)$, $B(-2m, 2m)$ and $C(2m, 4m)$ are $4V$, $16V$ and $12V$ respectively. The electric field is

A. $\left(4\hat{i} + 5\hat{j}\right)\frac{V}{m}$

B. $\left(3\hat{i} + 4\hat{j}\right)\frac{V}{m}$

C. $-\left(3\hat{i} + 4\hat{j}\right)\frac{V}{m}$

D. $\left(3\hat{i} - 4\hat{j}\right)\frac{V}{m}$

Answer: D

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13. Four similar charges each of charge $+q$ are placed at four corners of a square of side a. Find the value of integral $-\int_{\infty}^{a/\sqrt{2}} \overrightarrow{E} \cdot \overrightarrow{d} r$. (in volts) if value of integral $-\int_{a/\sqrt{2}}^{0} \overrightarrow{E} \cdot \overrightarrow{dr} = \frac{\sqrt{2}Kq}{a}\left(\text{where} K = \frac{1}{4\pi\varepsilon_0}\right)$

A. $\frac{4Kq}{a}$

B. $\frac{3Kq}{a}$

C. $\frac{3\sqrt{2}Kq}{a}$

D. $\frac{4\sqrt{2}Kq}{a}$

Answer: C

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14. Two infinite, parallel, nonconducting sheets carry equal positive charges density σ. One is placed in the yz plane and the other at distance $x = a$. Take potential $V = 0$ at $x = 0$. Then.

A. For $0 \leq x \leq a$, potential $V_x = 0$

B. For $x \geq a$, potential $V_x = -\frac{\sigma}{\varepsilon_0}(x - a)$

C. For $x \geq a$ potential $V_x = \frac{\sigma}{\varepsilon_0}(x - a)(X - a)$

D. For $x \leq 0$ potential $V_X = \frac{\sigma}{\varepsilon_0}x$

Answer: A::B::D

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15. About an electric field which of the following statements are not true ?

A. If $E = 0$, V must be zero

B. If $V = 0$, E must be zero

C. If $E \neq 0$, V cannot be zero

D. If $V \neq 0$, E cannot be zero

Answer: A::B::C::D

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DPP 3.3

1. Two metal spheres, one of radius R and the other of radius 2R, both have same surface charge density σ. If they are brought in contact and separated, then the new surface charge densities on each of the sphere are respectively

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2. Two charges q_1 and q_2 are placed at (0,0,d) and (0,0,-d) respectively. Find locus of points where the potential is zero.

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3. Equipotentials at a great distance from a collection of charges whose total sum is not zero are approximately.

A. spheres

B. planes

C. paraboloids

D. ellipoids

Answer: A

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4. Figure shows ome equipotential lines distributed in space. A charged object is moved from point A to point B.

A. The work done in Fig (i) is the greatest

B. The work done in Fig. (ii) is the least

C. The work done is the same in Fig. (i), Fig. (ii) and Fig. (iii)

D. The work done in Fig (iii) is greater than Fig. (ii) but equal to that in Fig. (i)

Answer: C

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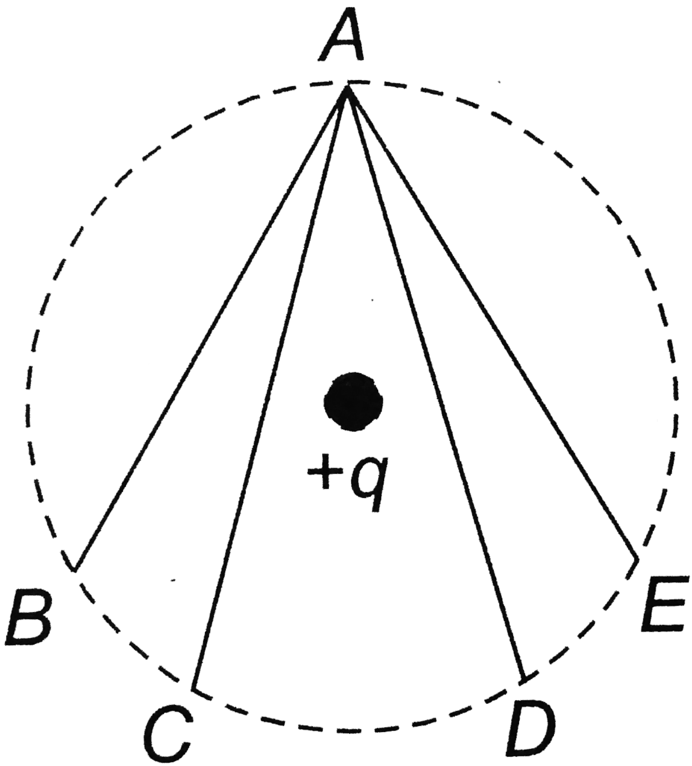
5. In the electric field of a point chargde q, a cetrain charge is carried from point A to B, C, D and E. Then the work done



A. is least along the path AB

B. is least along the path AD

C. is zero along all the paths AB,AC,AD and AE

D. is least along AE

Answer: C

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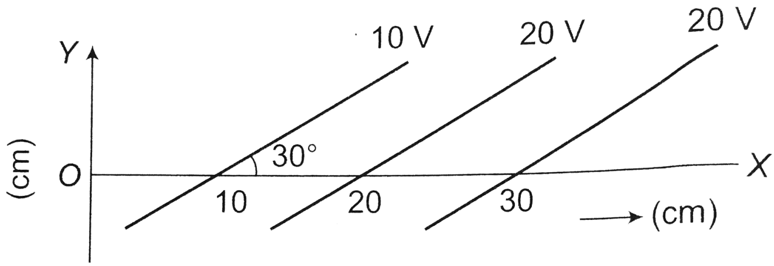
6. Equipotential surfaces are shown in figure. Then the electric field strength will be



A. $100 \mathrm{Vm}^{-1}$ along X-axis

B. $100 \mathrm{Vm}^{-1}$ along Y-axis

C. $200 \mathrm{Vm}^{-1}$ at an angle 120° will X-axis

D. $50 \mathrm{Vm}^{-1}$ at an angle 120° with X-axis

Answer: C

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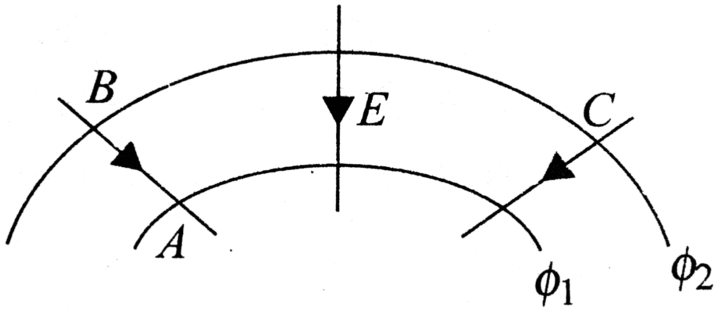
7. In moving from A to B along an electric field line, the work done by the electric field on an electron is $6.4 \times 10^{-19} J$. If ϕ_1 and ϕ_2 are equipotential surfaces, then the potential difference $V_C - V_A$ is.



A. $-4V$

B. $4V$

C. Zero

D. $64V$

Answer: B

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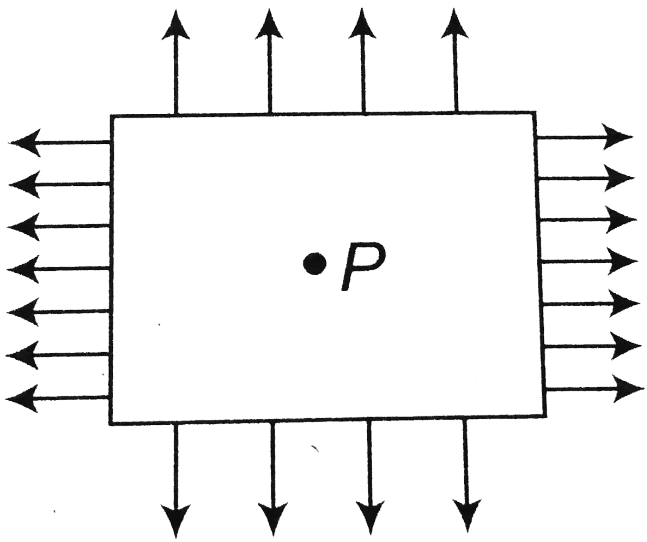
8. Electric lines of force are as shown in the figure. Then potential at point P



A. is zero

B. is not zero

C. may be zero also

D. is not defined

Answer: B

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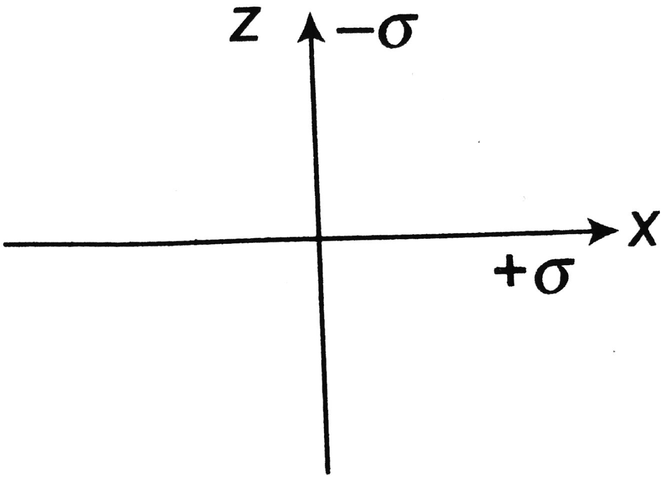
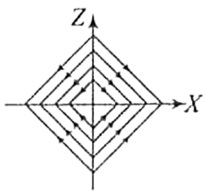
9. Two infinitely large charged planes having uniform suface charge density $+\sigma$ and $-\sigma$ are placed along $x-y$ plane and yz plane respectively as shown in the figure. Then the nature of electric lines of forces in

$x - z$ plane is given by:



A.



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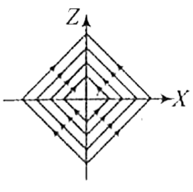
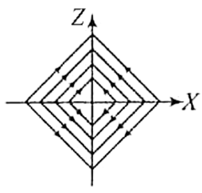
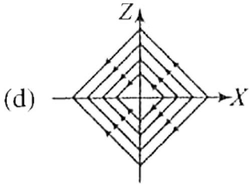


C.



D. 

Answer: C

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10. Equipotential surfaces

A. are closer in regions of large electric fields compared to regions of lower electric fields

B. will be more crowded near sharp edges of a conductor

C. will be more crowded ner regions of large charge densities

D. will always be equally spaced

Answer: A::B::C

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11. Consider a uniform electric field in the z-direction. The potential is a constant

A. in all space

B. for any x for a given z

C. for any y for a given z

D. on the $x - y$ plane for a given z

Answer: B::C::D

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12. Across the surface of a charged conductor, the electric

A. field is continuous

B. potential is continuous

C. field is discontinous

D. potential is discontinuous

Answer: B::C

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13. Mark the correct statements.

A. a given conducting sphere can be charged to any extent

B. a given conducting sphere cannot be charged to a potential greater than a certain value

C. a given conducting sphere cannot be charged to a potential less than a certain minimum value

D. none of the above

Answer: B::C

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14. A conducting sphere of radius R has a charge. Then,

A. the charge is uniformly distributed over its surface. If there is no external electric field

B. distribution of charge over its surface will be non-uniform, if an external electric field exists in the space.

C. the electric field strength inside the space will be equal to zero only when no external electric field exists

D. potential at every point of the sphere must be the same

Answer: A::D

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15. Consider two conducting spheres of radii R_1 and R_2 with $R_1 > R_2$. If the two are at the same potential, the larger sphere has more charge than the smaller sphere. State whetehr the charge density of the smaller sphere is more or less than that of the larger oe.

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16. Free electrons travel to reion of higher potential or lower potential.

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17. Assertion: Two adjacent conductors of unequal dimensions, carrting the same positive charge have a potential difference between them.

Reason : The potential of a conductor depends upon the charge given to it.

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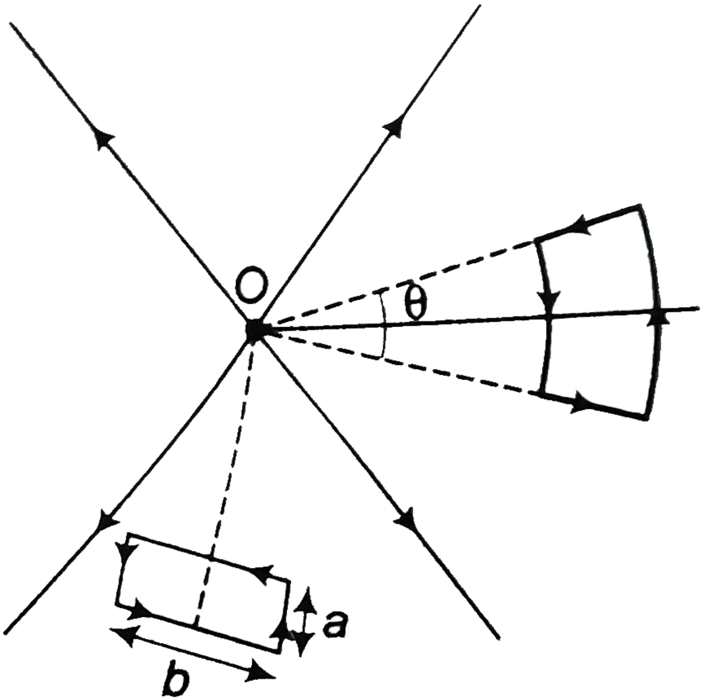
18. A test charge q is made to move in the electric field of a point cahrge Q along two different clsoed parths [figure first path has sections along and perpendicular to lines of electric field. Second path is a rectangular loop of the same area as the first loop. how does the work done compare in the two cases?



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19. Prove that a closed equipotential surface with no charge within itself must enclose a equipotential volume.

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20. Prove that, if an insulated, uncharged conductor is plated near a charged conductor and no other conductors are present, the uncharged body must intermediate in potential between that of the charged body and that of infinity.

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DPP 3.4

1. Two charges $-q$ each are separated by distance $2d$. A third charge $+q$ is kept at mid-point O. Find potential energy of $+q$ as a function of small distance x from O due to $-q$ charges. Prove that the charge at O is in an unstable equilibrium.

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2. A positively charged particle is released from rest in an uniform electric field. The electric potential energy of the charge.

A. remains a constant because the electric field is uniform

B. increases because the charge moves along the electric field

C. decreases because the charge moves along electric field

D. decreases because the charge moves opposite to the electric field.

Answer: C

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3. If identical charges $(-q)$ are placed at each corner of a cube of side b, then electric potential energy of charge $(+q)$ which is placed at centre of the cube will be

A. $\frac{8\sqrt{2}q^2}{4\pi\varepsilon_0 b}$

B. $\frac{-8\sqrt{2}q^2}{\pi\varepsilon_0 b}$

C. $\frac{-4\sqrt{2}q^2}{\pi\varepsilon_0 b}$

D. $\frac{-4q^2}{\sqrt{3}\pi\varepsilon_0 b}$

Answer: D

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4. Two charges q_1 and q_2 are placed 30 cm apart, as shown in figure. 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

A. $8q_2$

B. $8q_1$

C. $6q_2$

D. $6q_1$

Answer: A

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5. A charged particle of charge Q is held fixed another charged particle of mass m and charge the same sign is released from a distance r impulse of the force exerted by the external agent the fixed charge by the time when distance between Q and q becomes $2r$ is

A. $\sqrt{Qq/4\pi\varepsilon_0 mr}$

B. $\sqrt{Qqm/4\pi\varepsilon_0 r}$

C. 0

D. cannot determine

Answer: B

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6. A very large sphere having charge Q uniformly distributed on the surface s compressed uniformly till its radius reduces to R. The work done by the electric force in this process is :

A. $\frac{Q^2}{8\pi\varepsilon_0 R}$

B. $\frac{-Q^2}{8\pi\varepsilon_0 R}$

C. ∞

D. 0

Answer: B

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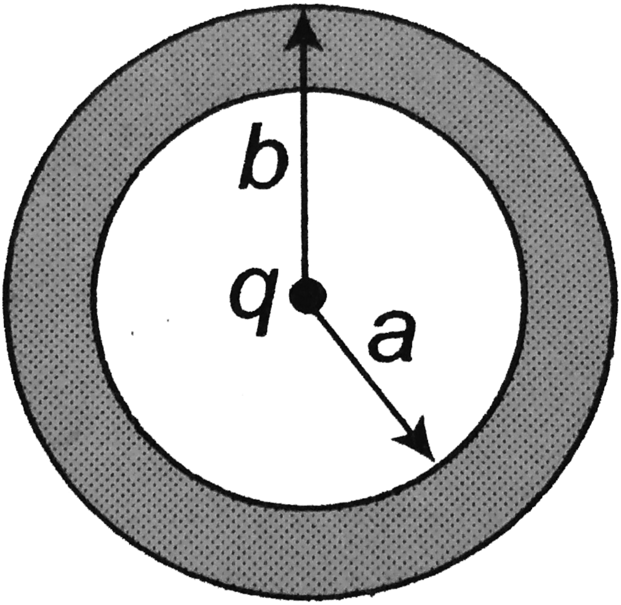
7. In the figure shown the elctric potential energy of the system is : (q is at the centre of the conducting neutral spherical shell of inner radius a and outer radius b)



A. 0

B. $\frac{kq^2}{2b}$

C. $\frac{kq^2}{2b} - \frac{kq^2}{2a}$

D. $\frac{kq^2}{2a} - \frac{kq^2}{2b}$

Answer: C

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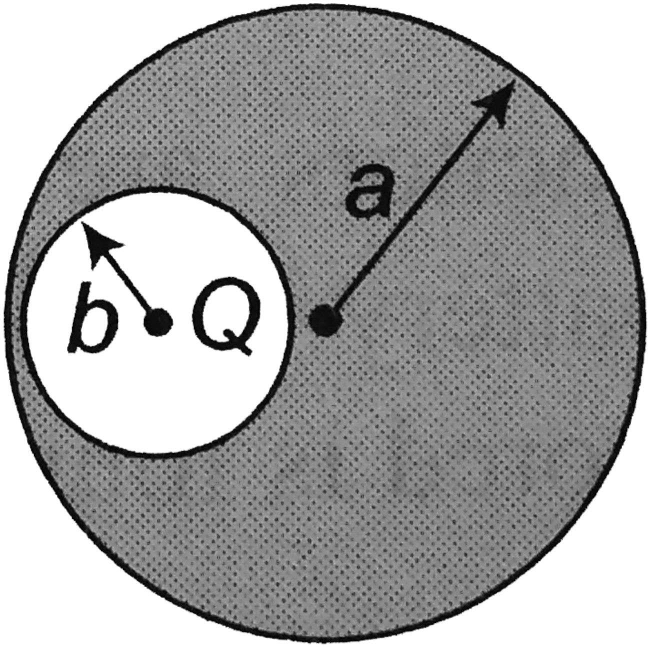
8. A point charge 'Q' is placed at the centre of a spherical cavity of radius 'b' carved inside a solid conducting sphere of radius 'a'. Then total energy of the system is:

$$\left[k = \frac{1}{4\pi \in_0}\right]$$



A. $\frac{kQ^2}{2a} - \frac{kQ^2}{2b}$

B. $\frac{kQ^2}{2a} + \frac{kQ^2}{2b}$

C. $\frac{kQ^2}{a} + \frac{kQ^2}{b}$

D. $\frac{kQ^2}{a} - \frac{kQ^2}{b}$

Answer: A

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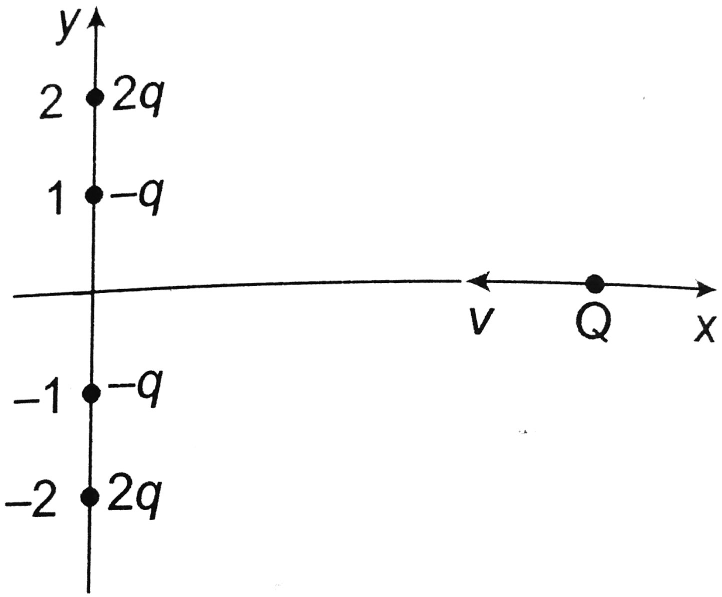
9. Four charges are rigidly fixed along the Y-axis as shown. A positive charge approches the system along the Xaxis with initial speed just enough to cross the origin. Then its total energy at the origin is



A. Zero

B. positive

C. negative

D. data insufficient

Answer: B

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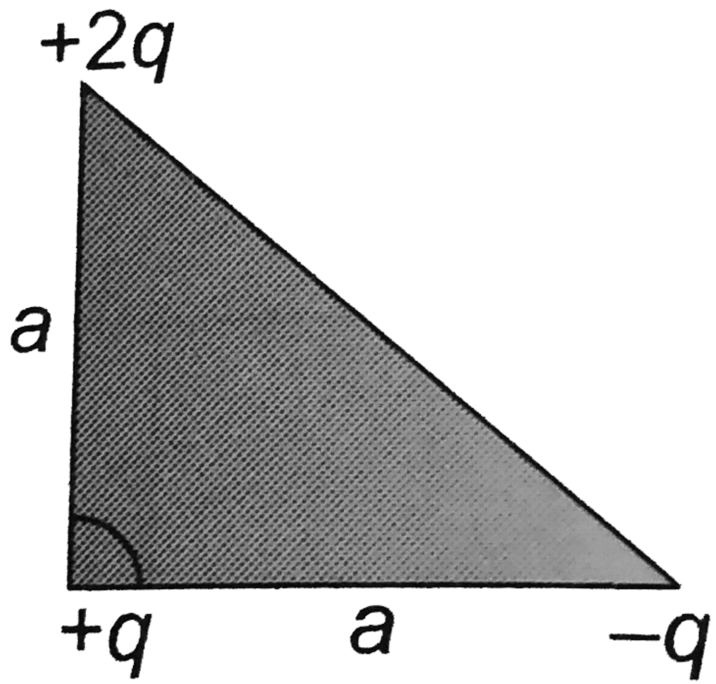
10. Three charge $+q, \ -q$, and $+2q$ are placed at the vertices of a right angled triangle (isosceles triangle)as shown. The net electrostatic energy of the configuration is:



A. $-\frac{Kq^2}{a}(\sqrt{2}-1)$

B. $\frac{Kq^2}{a}(\sqrt{2}+1)$

C. $-\frac{Kq^2}{a}(\sqrt{2}-1)$

D. None of these

Answer: C

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11. Three equal charges Q are placed at the three vertices of an equilateral triangle. What should be the va,ue of a charge, that when placed at the centroid, reduces the interaction energy of the system to zero ?

A. $\frac{-Q}{2}$

B. $\frac{-Q}{3}$

C. $\frac{-Q}{2\sqrt{3}}$

D. $\frac{-Q}{\sqrt{3}}$

Answer: D

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12. You are moving a negative charge $q < 0$ at a small constant speed away from a uniformly charged non-conducting spherical shell on which resides a negative charge $Q < 0$. The electrostatic, field of Q is E. Let U be the total energy of the system, W_a the work done by the force F_a you exert on q, W_E the work done by the electrostaitc force F_E on q. Then, as q is being moved :

A. $W_a = -W_E$, there U remains constant

B. $F_a = -F_E$

C. U increases

D. U decreases

Answer: D

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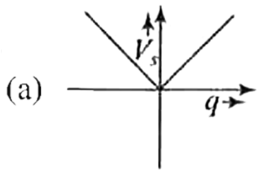
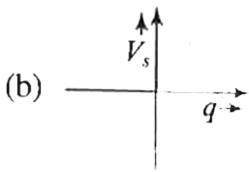
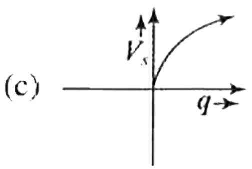
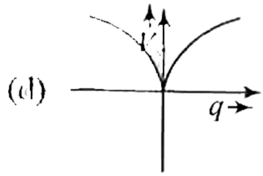
13. A negative charge Q is distributed uniformly in volume of a sphere is radius R and a point charge particle (may be negative or positive) is present on the surface of this sphere then variation of escape velocity (v_s) of charge 'q' as a function of 'q' will be [negect gravitational interaction].

A. 

B. 

C. 

D. 

Answer: C

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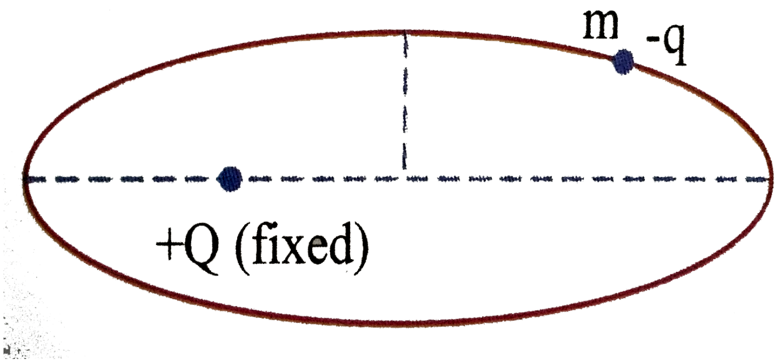
14. A positive point charge $+Q$ is fixed in space .A negative point charge $-q$ of mass m revolves around a fixed charge in elliptical orbits .The fixed charge $+Q$ is at one focus of the ellipse.The only force acting on negative charge is the electrostatic force due to positive charge is the electrostatic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



A. Linear momentum of negative point charge is conserved

B. Angular momentum of negative point charge about fixed positive charge is conserved

C. Total kinetic energy of negative point charge is conserved

D. The sum of electrosatatic potential energy and kinetic energy of system of both point charges is conserved.

Answer: B::D

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15. Small identical balls with equal charges are fixed at the vertices of a regular polygon of N sides, each of length d. At a certain instant, one of the ball is released. After long time interval, the adjacent ball to the previous one is released. The difference in kinetic energies of the two released balls is K at a sufficiently long distance from the polygon.

A. Final kinetic energy of the first ball is greater than that of the second ball

B. Final kinetic energy of the second ball is greater thn that of the first ball

C. Charge on each ball is $\sqrt{2\pi\varepsilon_0 dK}$

D. Charge on each ball is $\sqrt{4\pi\varepsilon_0 dK}$

Answer: A::D

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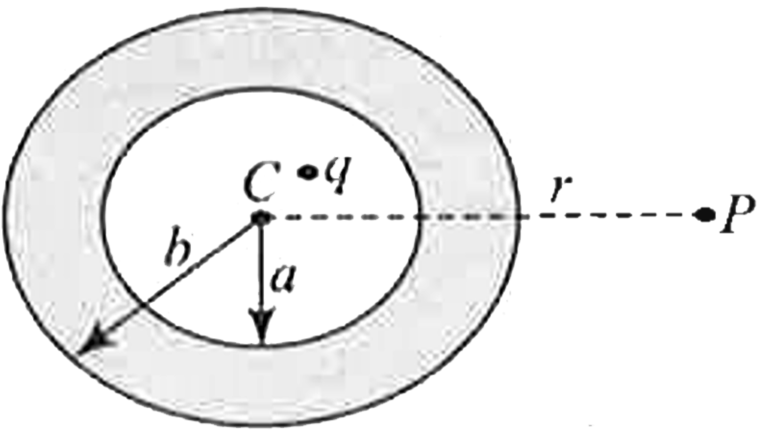
DPP 3.5

1. In the figure shown a conducting sphere of inner radius 'a' and outer radius 'b' is given a charge Q. A point charge 'q' is placed in the cavity of this sphere at distance $'x'(<a)$ away from the centre. Find the electric field intensity and electric potentials at point P (outside the sphere) at distance $r>b$. Also find the electric potential at point C



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2. A point charge Q is situated (outside) at a distance r from the centre of an uncharged conducting solid sphere of radius R. The potential due to induced charges (on the conductor) at a point B inside the conductor whose distance form the point charge is d is ______

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3. Find the electric field potentail and strength at the centre of a hemisphere fo raidus R ahcged uniformly with the the surface density σ.

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4. There are three concentric conducting spherical shells. All of them are charged. The innermost sphere is connected by a conducting wire to the outermost sphere. Prove that the final charge on the innermost sphere is independent of the initial charge of outermost sphere.

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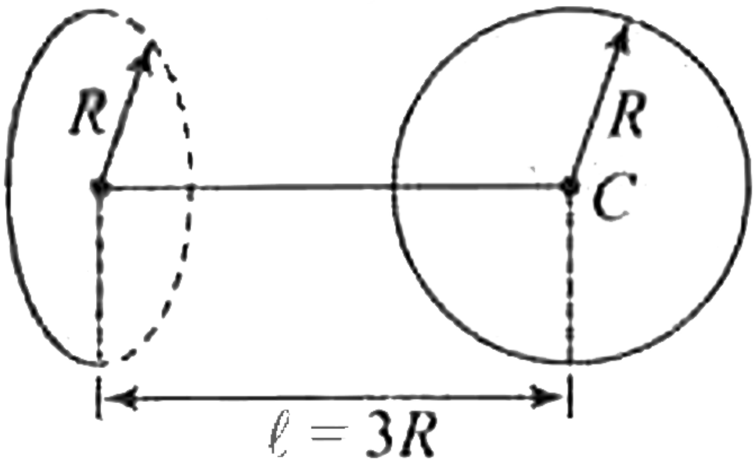
5. Both the ring and the conducting sphere are given the same charge Q. Determine the potential of the sphere. Assume that the centre of the sphere lies on the axis of th ring. Is it necessary that the charge on the ring be uniformly distributed to answer the above question ?



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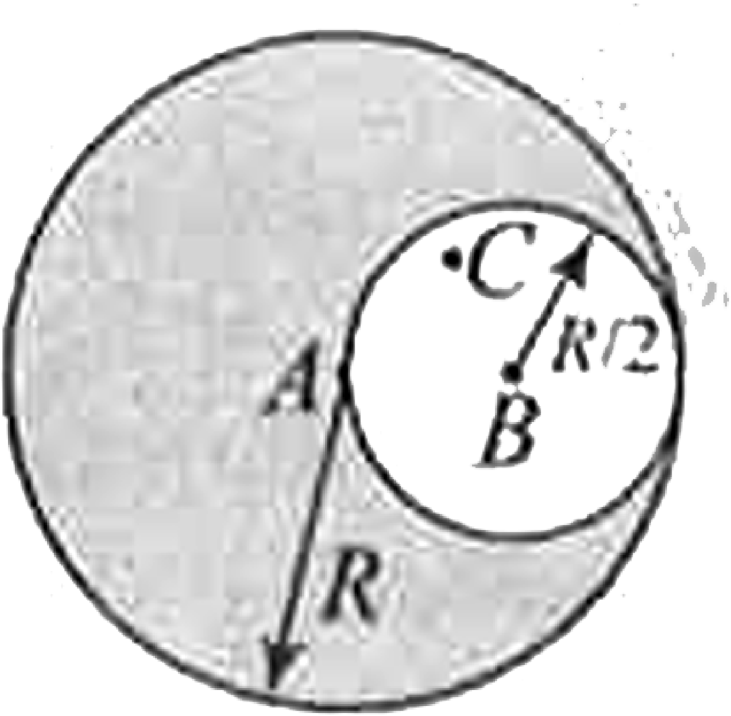
6. A solid sphere of radius 'R' has a cavity of radius $\frac{R}{2}$. The solid part has a uniform charge density $'\rho'$ and cavity has no charge. Find the electric potential at point 'A'. Also find the electric field (only magnetude) at point 'C' inside the cavity



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7. A thibn spherical conducting shell of radius R has a charge q. Another charge Q is placed at the centr of the shell. The electrostatic potential at a point P a distance R/2 from the centre of the shell is

A. $\frac{(q+Q)}{4\pi\varepsilon_0}\frac{2}{R}$

B. $\frac{2Q}{4\pi\varepsilon_0 R}$

C. $\frac{2Q}{4\pi\varepsilon_0 R}-\frac{2q}{4\pi\varepsilon_0 R}$

D. $\frac{2Q}{4\pi\varepsilon_0 R}+\frac{q}{4\pi\varepsilon_0 R}$

Answer: D

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8. An arc of radius r carries charge. The linear density of charge is λ and the arc subtends an angle $\frac{\pi}{3}$ at the centre.

A. $\frac{\lambda}{4\varepsilon_0}$

B. $\frac{\lambda}{8\varepsilon_0}$

C. $\frac{\lambda}{12\varepsilon_0}$

D. $\frac{\lambda}{16\varepsilon_0}$

Answer: C

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9. Two identical thin rings, each of radius R, are coaxially placed at a distance R. If Q_1 and Q_2 are respectively, the charges uniformly spread on the two rings, find the work done in moving a charge q from centre of ring having charge Q_1 to the other ring.

A. Zero

B. $\frac{q(Q_1 - Q_2)\left(\sqrt{2}-1\right)}{\sqrt{2}.4\pi\varepsilon_0 R}$

C. $\frac{2\sqrt{2}(Q_1 + Q_2)}{4\pi\varepsilon_0 R}$

D. $\frac{q(Q_1 + Q_2)\left(\sqrt{2}+1\right)}{\sqrt{2}.4\pi\varepsilon_0 R}$

Answer: B

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10. If the electric potential of the inner metal shell is 10 V and that of the outer shell is 5 V, then the potential at the centre will be

A. 10 volt

B. 5 volt

C. 15 volt

D. 0

Answer: A

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11. Potential difference beween centre and surface of the sphere of radius R and uniorm volume charge density ρ within it will be

A. $\frac{\rho R^2}{6\varepsilon_0}$

B. $\frac{\rho R^2}{4\varepsilon_0}$

C. 0

D. $\frac{\rho R^2}{2\varepsilon_0}$

Answer: A

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12. A mercury drop has potential 'V' on its surface. 1000 such drops combine to form a new drop. Find the potential on the surface of the new drop.

A. V

B. 10 V

C. 100 V

D. 1000 V

Answer: C

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

The charge on solid sphere is

A. $-\frac{q}{2}$

B. $-\frac{q}{4}$

C. $-\frac{q}{8}$

D. $-\frac{q}{16}$

Answer: B

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

Pick up the correct statement.

A. Charge on surface of inner sphere is non-uniformly distributed

B. Charge on inner surface of outer shell is non-uniformly distributed

C. Charge on outer surface of outer shell is non-uniformly distributed

D. All the above statements are false

Answer: C

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

The potential of outer shell is

A. $\frac{q}{32\pi\varepsilon_0 a}$

B. $\frac{q}{16\pi\varepsilon_0 a}$

C. $\frac{q}{8\pi\varepsilon_0 a}$

D. $\frac{q}{4\pi\varepsilon_0 a}$

Answer: A

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