



## PHYSICS

### BOOKS - DC PANDEY ENGLISH

### ELECTROSTATICS

#### Example

1. How many electrons are there in on coulomb of negative charge?



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2. If we comb our hair on a dry day and bring the comb near small pieces of paper, the comb attracts the pieces, why?



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3. Does the attraction between the comb and the piece of papers last for longer period of time?



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4. Can two similarly charged bodies attract each other?



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5. Does in charging the mass of a body change?



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6. Why a third hole in a socket provided for grounding?



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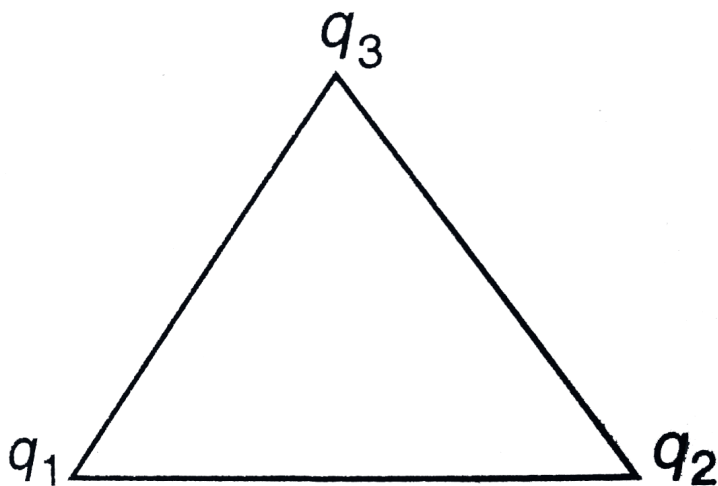
7. What is the smallest electric force between two charges placed at a distance of  $1.0\text{m}$ ?



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8. Three charges  $q_1 = 1\mu\text{C}$ ,  $q_2 = 2\mu\text{C}$  and  $q_3 = 3\mu\text{C}$  are placed on the vertices of an equilateral triangle of side  $1.0\text{ m}$ . Find the net

electric force acting on charge  $q_1$



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**9.** Two identical balls each having a density  $\rho$  are suspended from a common point by two insulating strings of equal length. Both the balls have equal mass and charge. In equilibrium each

string makes an angle  $\theta$  with vertical. Now, both the balls are immersed in a liquid. As a result the angle  $\theta$  does not change. The density of the liquid is  $\sigma$ . Find the dielectric constant of the liquid.



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**10.** An electric field of  $10^5 \text{ N/C}$  points due west at a certain spot. What are the magnitude and direction of the force that acts on a charge of  $+2\mu\text{C}$  and  $-5\mu\text{C}$  at this spot?



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11. Two positive point charges  $q_1 = 16\mu C$  and  $q_2 = 4\mu C$  are separated in vacuum by a distance of  $3.0m$ . Find the point on the line between the charges where the net electric field is zero.-



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12. As charge  $q = 1\mu C$  is placed at point  $(1m, 2m, 4m)$ . Find the electric field at point  $P(0, -4m, 3m)$



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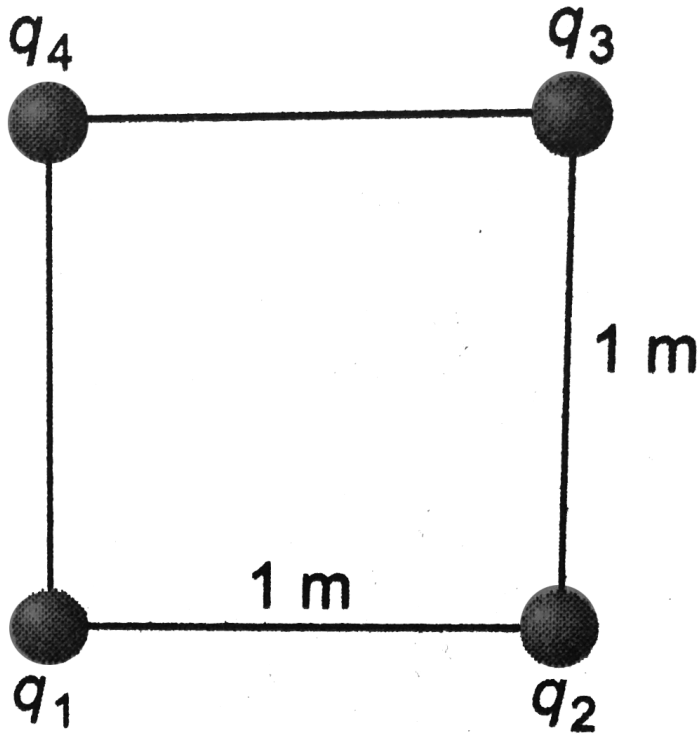
**13.** A uniform electric field  $E_0$  is directed along positive y-direction. Find the change in electric potential energy of a positive test charge  $q_0$  when it is displaced in this field from  $y_i = a$  to  $y_f = 2a$  along the y-axis.



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**14.** For charges  $q_1 = 1\mu C$ ,  $q_2 = 2\mu C$ ,  $q_3 = -3\mu C$  and  $q_4 = 4\mu C$  are kept on the vertices of a square of side  $1m$ . Find the electric potential energy of this

system of charges.



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**15.** Two points charges are located on the x-axis,

$q_1 = -1\mu\text{C}$  at  $x = 0$  and  $q_2 = +1\mu\text{C}$  at

$$x = 1m.$$

a. Find the work that must be done by an external force to bring a third point charge  $q_3 = +1\mu C$  from infinity to  $x = 2m$ .

b. Find the total potential energy of the system of three charges.



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**16.** Two point charges  $q_1 = q_2 = 2\mu C$  are fixed at

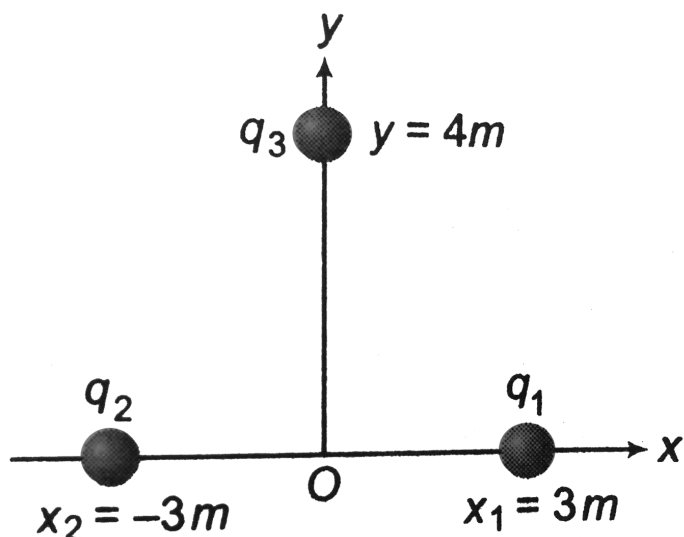
$x_1 = +3m$  and  $x_2 = -3m$  as shown in figure.

A third particle of mass 1 g and charge

$q_3 = -4\mu C$  are released from rest at  $y = 4.0m$



.Find the speed of the particle as it reaches the origin.



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17. The electric potential at point  $A$  is  $20\text{V}$  and at  $B$  is  $-40\text{V}$ . Find the work done by an external

and electrostatic force in moving an electron slowly from B to A.



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**18.** Find the work done by some external force in moving a charge  $q = 2\mu C$  from infinity to a point where electric potential is  $10^4$  V.



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**19.** Three point charge  $q_1 = 1\mu C$ ,  $q_2 = -2\mu C$  and  $q_3 = 3\mu C$  are placed at

$(1m, 0, 0)$ ,  $(0, 2m, 0)$  and  $(0, 0, 3m)$  respectively.

Find the electric potential at as origin.



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**20.** A charge  $q = 10\mu C$  is distributed uniformly over the circumference of a ring of radius  $3m$  placed on x-y plane with its centre at origin.

Find the electric potential at a point  $P(0, 0, 4m)$



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21. Find out the points on the line joining two charges  $+q$  and  $-3q$  (kept at a distance of  $1.0\text{m}$ ) where electric potential is zero.



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22. The electric potential in a region is represented as

$$V = 2x + 3y - z$$

obtain expression for electric field strength.



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**23.** 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 .....  $\frac{V}{m}$ .



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**24.** Find the  $V_{ab}$  in an electric field

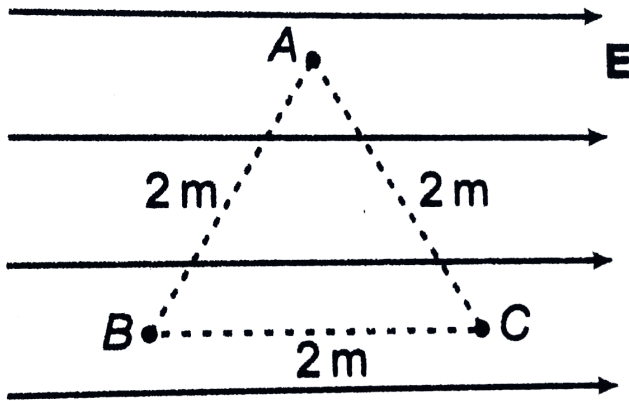
$$E = (2\hat{i} + 3\hat{j} + 4\hat{k}) \frac{N}{C}, \quad \text{where}$$

$$r_a = (\hat{i} - 2\hat{j} + \hat{k})m \text{ and } r_b = (2\hat{i} + \hat{j} - 2\hat{k})m$$



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25. In uniform electric field  $E = 10\text{ N/C}$ , find



a.  $V_A - V_B$ , b.  $V_B - V_C$

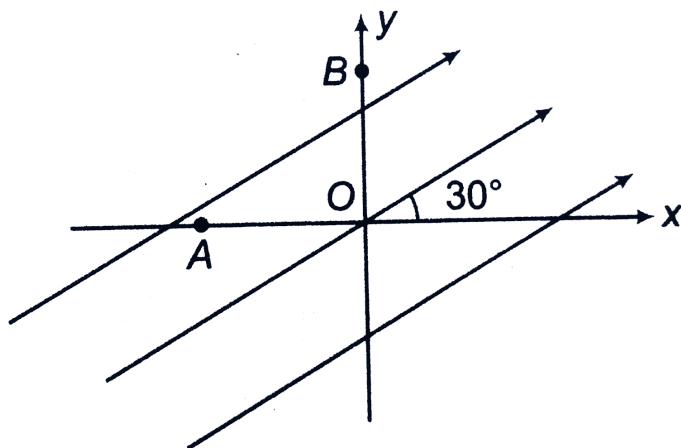


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26. A uniform electric field of  $100\text{ V/m}$  is directed at  $3^\circ$  with the positive x-axis as shown in figure.

Find the potential difference  $V_{BA}$  if  $OA = 2\text{ m}$

and  $OB = 4m$ .



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27. A uniform electric field pointing in positive  $x$ -direction exists in a region. Let A be the origin, B be the point on the  $x$ -axis at  $x = +1\text{cm}$  and C be the point on the  $y$ -axis at  $y = +1\text{cm}$ . then

the potential at the points A,B and C satisfy

a.  $V_A < V_B$ , b.  $V_A > V_B$  c.  $V_A < V_C$  d.  $V_A > V_C$



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**28.** A non-conducting ring of radius  $0.5m$  carries a total charge of  $1.11 \times 10^{-10}C$  distributed non-uniformly on its circumference producing an electric field  $E$  everywhere in space. The value of

the integral  $\int_{l=\infty}^{l=0} -E \cdot dI$  ( $l=0$  being centre of the ring) in volt is

A.  $+2$



B.  $-1$

C.  $-2$

D. zero

**Answer: A**



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**29.** What is the total charge of a system containing five charges  $+1$ ,  $+2$ ,  $-3$ ,  $+4$  and  $-5$  in some arbitrary unit ?



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**30.** How many electrons are there in one coulomb of negative charge?



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**31.** A sphere of lead of mass 10 g has net charge  $-25 \times 10^{-9} C$ .

(i) Find the number of excess electrons on the sphere.

(ii) How many excess electrons are per lead atom ? Atomic number of lead is 82 and its atomic mass is 207 g/mol.



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**32.** A proton and an electron are placed 1.6 cm apart in free space. Find the magnitude and nature of electrostatic force between them.



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**33.** The electrostatic force on a small sphere of charge  $0.4 \mu\text{C}$  due to another small sphere of charge  $-0.8 \mu\text{C}$  in air is 0.2 N. (a) What is the

distance between the two spheres? (b) What is the force on the second sphere due to the first?



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**34.** Nucleus  ${}_{92}\text{U}^{238}$  emits  $\alpha$ -particle ( ${}_{2}\text{He}^4$ ).

$\alpha$  – particle has atomic number 2 and mass number 4. At any instant  $\alpha$  – particle is at distance of  $9 \times 10^{-15}\text{m}$  from the centre of nucleus of uranium. What is the force on  $\alpha$  – particle at this instant?



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**35.** (a) Two identical spheres having positive charges are placed  $3m$  apart and repel each other with a force  $8 \times 10^{-3} N$ . Now the spheres are connected by a metallic wire, they begin to repel each other with a force of  $9 \times 10^{-3} N$ . Find initial charges on the spheres.

(b) Two identical spheres having charges of opposite sign are placed  $3m$  apart and attract each other with a force  $2.4 \times 10^{-3} N$ . Now the spheres are touched and then placed at original separation and repel with a force  $10^{-3} N$ . Find initial charges on the spheres.



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**36.** (a) Two protons are placed at some separation in vacuum. Find the ratio of electric and gravitational force acting between them.

(b) Two point charges are placed at separation  $3m$  in vacuum. What can be the minimum force between them.

(c ) A charge  $Q$  is to be divided on two objects. What should be the value of the charges in the objects so that the force between them is maximum ?

(d) Two insulating small spheres are rubbed

against each other and placed  $1.6\text{cm}$  apart. If they attract each other with a force of  $0.9\text{N}$ , how many electrons were transferred from one sphere to the other during rubbing ?



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**37.** Equal charges each of  $20\mu\text{C}$  are placed at  $x = 0, 2, 4, 8, 16\text{cm}$  on X-axis. Find the force experienced by the charge at  $x = 2\text{cm}$ .



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**38.** Five point charge each of value  $+q$  are placed on five vertices of a regular hexagon of side a metre. What is the magnitude of the force on a point charge of value  $-q$  coulomb placed at the centre of the hexagon?



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**39.** Two fixed charges  $+4q$  and  $+q$  are at a distance 3 m apart. At what point between the charge, a third charge  $+q$  must be placed to keep it in equilibrium ?

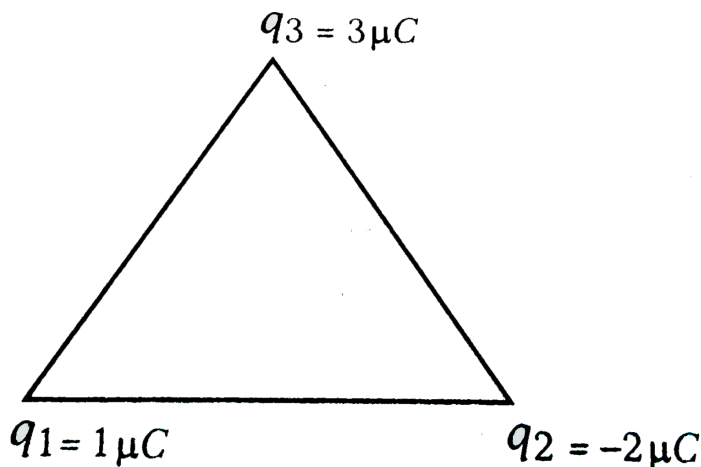




**40.** Three charges  $q_1 = 1\mu C$ ,  $q_2 = -2\mu C$  and  $q_3 = 3\mu C$  are placed on the vertices of an equilateral triangle of side 1.0 m. find the net electric force acting on charge  $q_1$ .

How to proceed Charge  $q_2$  will attract charge  $q_1$  (along the line joining them) and charge  $q_3$  will repel charge  $q_1$ . Therefore, two forces will act on  $q_1$ , one due to  $q_2$  and another due to  $q_3$ . Since , the force is a vector quantity both of these force (say  $F_1$  and  $F_2$ ) will be added by vector method.

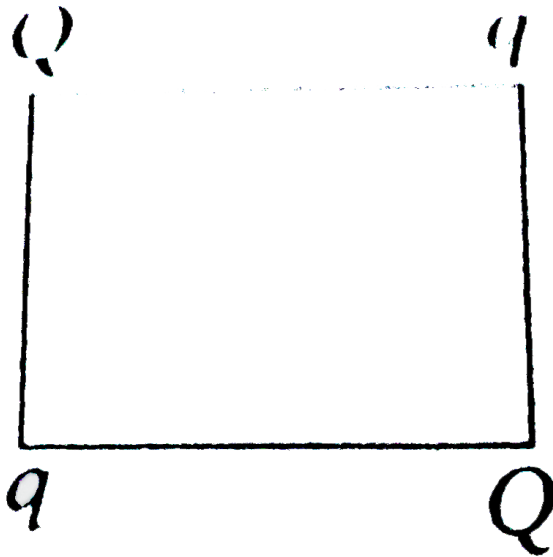
Following are two methods of their addition



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**41.** Four charge  $Q$ ,  $q$ ,  $Q$  and  $q$  are kept at the four corners of a square as shown below. What is the relation between  $Q$  and  $q$ , so that the net force

on a charge  $q$  is zero ?



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**42.** Two identical helium filled balloons A and B fastened to a weight of 5 g by threads floats in equilibrium as shown in figure. Calculate the

charge on each balloons, assuming that they carry equal charge.



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**43.** Two identical pith balls, each carrying charge  $q$ , are suspended from a common point by two strings of equal length  $l$ . Find the mass of each ball if the angle between the strings is  $2\theta$  in equilibrium.



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**44.** Two identical balls , each having a charge  $q$  and mass  $m$  , are suspended from a common point by two insulating strings each of length  $L$ . The balls are held at a separation  $x$  and then released. Find

- (a) the electric force on each ball
- (b) the component of the resultant force on a ball along and perpendicular to string
- (c ) the tension in the string
- (d) the acceleration of one of the balls. Consider the situation only for the instant just after the release.



**45.** A particle A having charge  $q$  and mass  $m$  is placed at the bottom of a smooth inclined plane of inclination  $\theta$ . Where should a block B, having same charge and mass, be placed on the incline, so that it may remain in equilibrium?



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**46.** Two identical balls each having a density  $\rho$  are suspended from a common point by two insulating strings of equal length. Both the balls

have equal mass and charge. In equilibrium each string makes an angle  $\theta$  with vertical. Now, both the balls are immersed in a liquid. As a result the angle  $\theta$  does not change. The density of the liquid is  $\sigma$ . Find the dielectric constant of the liquid.



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**47.** An electric field of  $10^5 \text{ N/C}$  points due west at a certain spot. What are the magnitude and direction of the force that acts on a charge of  $+2\mu\text{C}$  and  $-5\mu\text{C}$  at this spot?



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**48.** Calculate the magnitude of the electric field which can just balance a deuteron of mass  $3.2 \times 10^{-27} \text{ kg}$



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**49.** Electric field strength due to a point charge of  $5\mu\text{C}$  at a distance 80 cm from the charge is



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50. Two positive point charges  $q_1 = 16\mu C$  and  $q_2 = 4\mu C$  are separated in vacuum by a distance of  $3.0m$ . Find the point on the line between the charges where the net electric field is zero.-



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51. As charge  $q = 1\mu C$  is placed at point  $(1m, 2m, 4m)$ . Find the electric field at point  $P(0, -4m, 3m)$



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**52.** A ball having charge  $q$  and mass  $m$  is suspended from a string of length  $L$  between two parallel plates where a vertical electric field  $E$  is established . Find the time period of simple pendulum if electric field is directed (a) downward and (b) upward.



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**53.** A ball of mass  $m$  having a charge  $q$  is released from rest in a region where a horizontal electric field  $E$  exists.

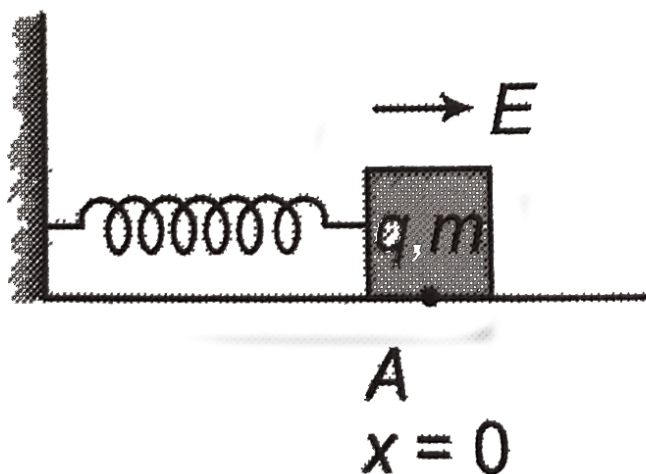
- (a) Find the resultant force acting on the ball.
- (b) Find the trajectory followed by the ball.



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**54.** A block of mass  $m$  having charge  $q$  is attached to a spring of spring constant  $k$ . This arrangement is placed in uniform electric field  $E$  on smooth horizontal surface as shown in the figure. Initially spring is unstretched. Find the extension of spring in equilibrium position and

maximum extension of spring.



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**55.** An infinite number of charges each equal to  $q$ , are placed along the X-axis at  $x = 1, x = 2, x = 4, x = 8, \dots$  and so on.

(i) find the electric field at a point  $x = 0$  due to

this set up of charges.

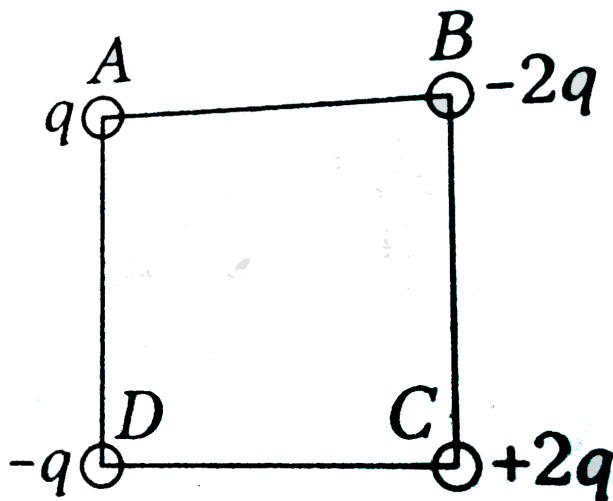
(ii) What will be the electric field if the above setup, the consecutive charges have opposite signs.



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**56.** Four charge are placed at the corners of a square of side 10 cm as shown in figure having. If  $q$  is  $1\mu C$ , then what will be electric field intensity

at the centre of the square?



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57. What charge would be required to electrify a sphere of radius 25 cm, so as to get a surface charge density of  $\frac{3}{\pi} Cm^{-2}$ ?



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**58.** Sixty four spherical drops each of radius  $2\text{cm}$  and carrying  $5\text{C}$  charge combine to form a bigger drop. Its capacity is.



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**59.** A charge of  $4 \times 10^{-9}\text{C}$  is distributed uniformly over the circumference of a conducting ring of radius  $0.3\text{m}$ . Calculate the field intensity at a point on the axis of the ring at  $0.4\text{m}$  from its centre, and also at the centre.



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**60.** Charges  $\pm 20nC$  are separated by  $5mm$ . Calculate the magnitude and direction of dipole moment.



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**61.** A system has two charges  $qA = 2.5 \times 10^{-7}C$  and  $qB = -2.5 \times 10^{-7}C$  located at points A: (0, 0, -15 cm) and B: (0,0, +15



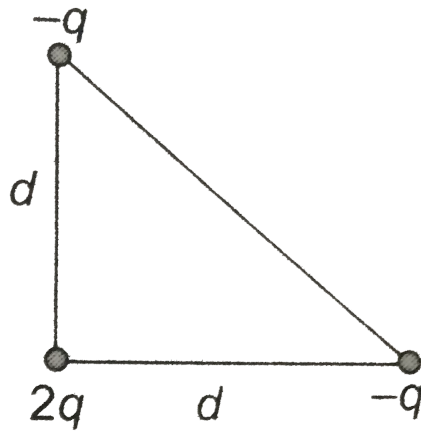
cm), respectively. What are the total charge and electric dipole moment of the system?



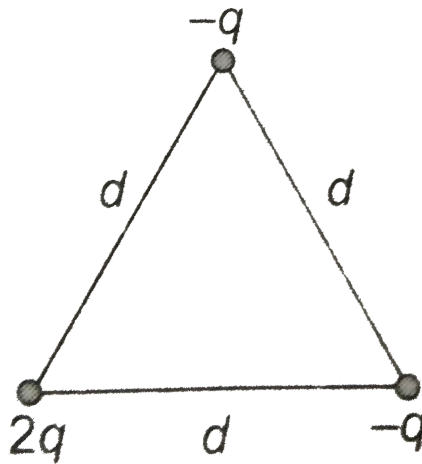
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**62.** Three charges are placed as shown . Find dipole moment of the arrangements .

(a)



(b)



(a)



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**63.** Two opposite charges each of magnitude  $2\mu C$  are 1 cm apart. Find electric field at a distance of 5 cm from the mid-point on axial line of the dipole. Also, find the field on equatorial line at the same distance from mid-point



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**64.** What is the magnitude of electric intensity due to a dipole of moment  $2 \times 10^{-8} C - m$  at a point distant  $1m$  from the centre of dipole, when

line joining the point to the center of dipole makes an angle of  $60^\circ$  with dipole axis ?



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**65.** An electric dipole with dipole moment  $4 \times 10^{-9} \text{ C m}$  is aligned at  $30^\circ$  with the direction of a uniform electric field of magnitude  $5 \times 10^4 \text{ NC}^{-1}$ . Calculate the magnitude of the torque acting on the dipole.



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66. An electric dipole of dipole moment  $p = 5 \times 10^{-18} \text{ C} \cdot \text{m}$  lying along uniform electric field  $E = 4 \times 10^4 \text{ NC}^{-1}$ . Calculate the work done in rotating the dipole by  $60^\circ$ .



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67. The electric field in a region is given by  $E = a\hat{i} + b\hat{j}$ . Hence  $a$  and  $b$  are constants. Find the net flux passing through a square area of side  $l$  parallel to  $y$ - $z$  plane.



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**68.** A rectangular surface of sides  $10\text{cm}$  and  $15\text{cm}$  is placed inside a uniform electric field of  $25\text{Vm}^{-1}$ , such that normal to the surface makes an angle of  $60^\circ$  with the direction of electric field. Find the flux of electric field through the rectangular surface.



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**69.** The electric field in a region is given by  $\vec{E} = \frac{E_0}{a} x \hat{i}$ . Find the electric flux passing

through a cubical volume bounded by the surfaces  $x = 0, x = a, y = 0, y = a, z = 0$  and  $z = a$ .



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**70.** A cylinder of radius  $R$  and length  $L$  is placed in a uniform electric field  $E$  parallel to the axis. The total flux for the surface of the cylinder is given by



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**71.** A uniformly charged conducting sphere of 2.4m diameter has a surface density of  $80.0\mu C/m^2$ . (a) Find the charge on the sphere  
(b) What is the total electric flux leaving the surface of the sphere ?



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**72.** A point charge causes an electric flux of  $-1.0 \times 10^3 Nm^2/C$  to pass through a spherical Gaussian surface of 10.0 cm radius centred on the charge. (a) If the radius of the Gaussian surface



were doubled, how much flux would pass through the surface ? (b) What is the value of the point charge ?



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**73.** A point charge  $q$  is placed at the centre of a cube. What is the flux linked.

a with all the faces of the cube?

b. with each face of the cube?

c. if charge is not at the centre, then what will be the answer of parts a and b ?



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**74.** If a point charge  $q$  is placed at one corner of a cube, what is the flux linked with the cube?



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**75.** A hemispherical body of radius  $R$  is placed in a uniform electric field  $E$ . What is the flux linked with the curved surface if, the field is (a) parallel to the base, (b) perpendicular to the base.



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**76.** An infinite line charge produces a field of  $9 \times 10^4 \frac{N}{C}$  at a distance of 2cm. Calculate the linear charge density.



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**77.** A long cylindrical wire carries a positive charge of linear density  $\lambda$ . An electron ( $-e, m$ ) revolves around it in a circular path under the influence of the attractive electrostatic force. Find the speed of the electron.



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**78.** A large plane sheet of charge having surface charge density  $5 \times 10^{-16} \text{ cm}^{-2}$  lies in XY plane. Find electric flux through a circular area of radius 1cm Given normal to the circular area makes an angle of  $60^\circ$  with Z-axis.



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**79.** Two large, thin metal plates are parallel and close to each other. On their faces, the plates have surfaces charge densities of opposite sign and of magnitude  $.177 \times 10^{-11}$  coulomb per

square metre. What is electric field

(i) to the left of the plates ?

(ii) to the right of the plates ?

(iii) in between the plates ?



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**80.** A thin spherical shell of metal has a radius of 0.25 m and carries charge of 0.2 micro coulomb. Calculate the electric intensity at 3.0 m from the centre of the shell.



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**81.** An electric dipole is placed at the centre of a spherical shell. Find the electric field at an external point of the shell.



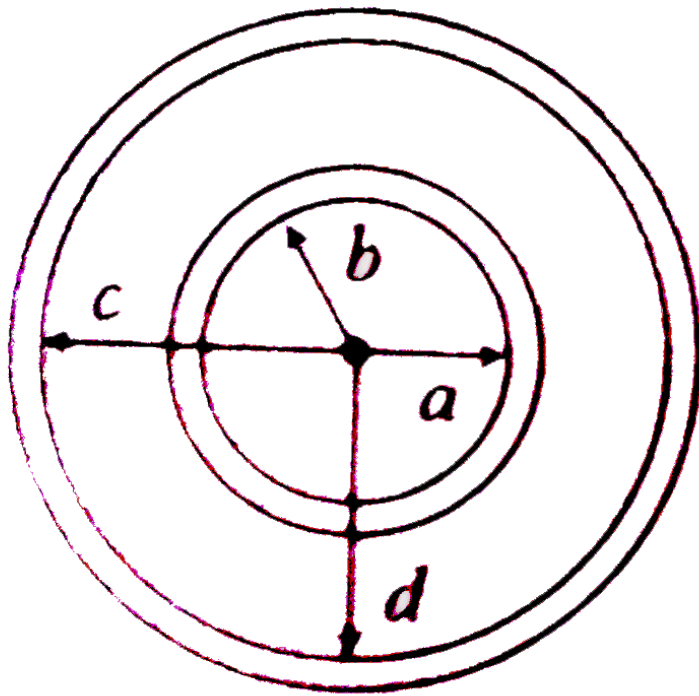
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**82.** A small conducting spherical shell with inner radius  $a$  and outer radius  $b$  is concentric with a larger conducting spherical shell with inner radius  $c$  and outer radius  $d$ . The inner shell has total charge  $+2q$  and the outer shell has charge  $+4q$ .

(i) What is the total charge on the (a) inner surface of the small shell, (b) outer surface of the small shell (c) inner surface of the large shell, (d) outer surface of the large shell ?

(ii) Calculate the electric field in terms of  $q$  and the the distance  $r$  from the common centre of two shells for (a)  $r < a$ , (b)  $a < r < b$ , (c)

$b < r < c$ , (d)  $c < r < d$ , (e)  $r > d$



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**83.** At a point  $20\text{cm}$  from the centre of a uniformly charged dielectric sphere of radius  $10\text{cm}$ , the



electric field is  $100V/m$ . The electric field at  $3cm$  from the centre of the sphere will be



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**84.** Two non-conducting sphere of radius  $R$  have charge  $Q$  uniformly distributed. The centres of sphere are  $x = 0$  and  $x = 3R$ . Find the magnitude and direction of the net electric field on the X-axis

(i)  $x = 0$

(ii)  $x = \frac{R}{2}$

$$(iii) \ x = \frac{3R}{2}$$

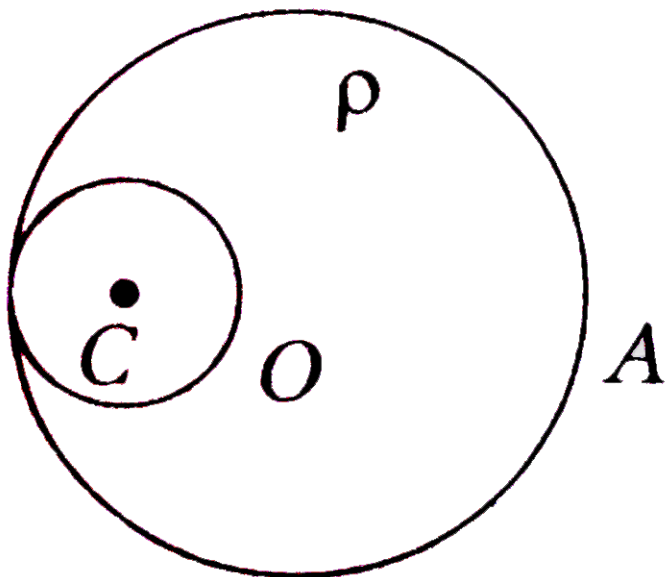
$$(iv) \ x = 4R$$



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**85.** A non-conducting sphere of radius  $R$  has a spherical cavity of radius  $R/2$  as shown. The solid part of the sphere has a uniform volume charge density  $\rho$ . Find the magnitude and direction of

electric field at point (a) O and (b) A.



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Example Type 5

1. Equipotential spheres are drawn round a point charge. As we move away from charge will the spacing between two spheres having a constant potential difference decrease, increase or remain constant.



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2. Draw electric lines of forces due to an electric dipole.



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3. Along the axis of a dipole, direction of electric field is always in the direction of electric dipole moment  $p$ . Is this statement true or false?



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4. At a far away distance  $r$  along the axis from a electric dipole electric field is  $E$ . Find the electric field at distance  $2r$  along the perpendicular bisector.



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5. An electric dipole is placed at the centre of a sphere. Find the electric flux passing through the sphere.



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## Example Type 6

1. A point charge  $q$  is placed at the centre of a cube. What is the flux linked.

a. with all the faces of the cube?

b. with each face of the cube?

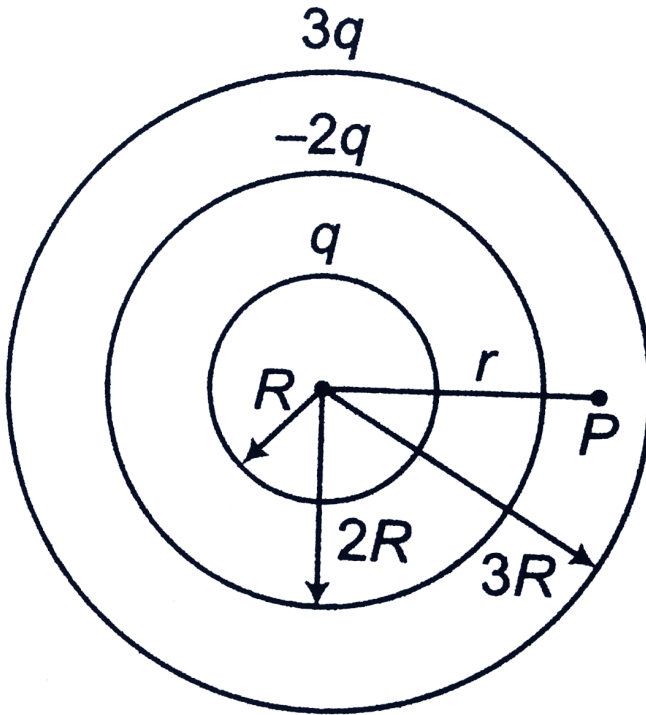
c. if charge is not at the centre, then what will be the answer of parts a and b ?



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2. Three conducting spherical shells have charges  $q$ ,  $-2q$  and  $3q$  as shown in figure. Find electric

Potential at point P as shown in figure.

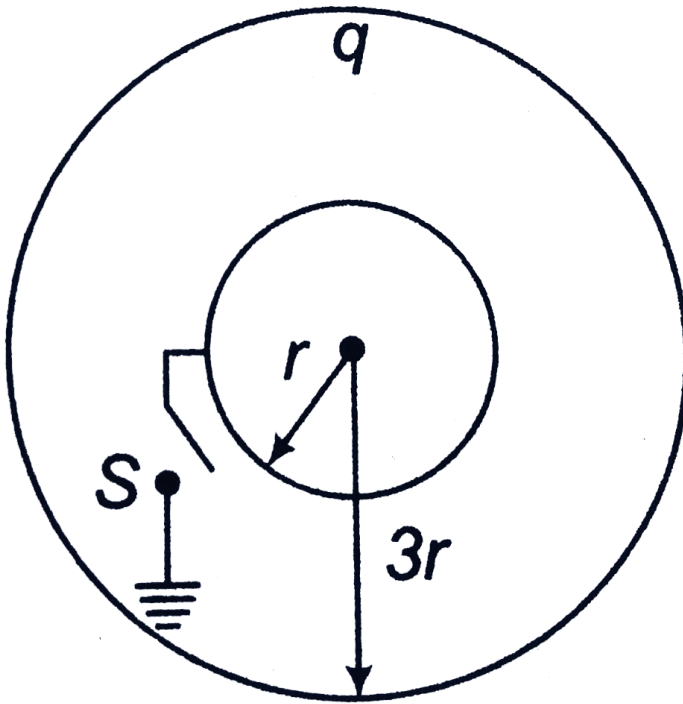


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3. Figure shows two conducting thin concentric shells of radii  $r$  and  $3r$ . The outer shell carries a

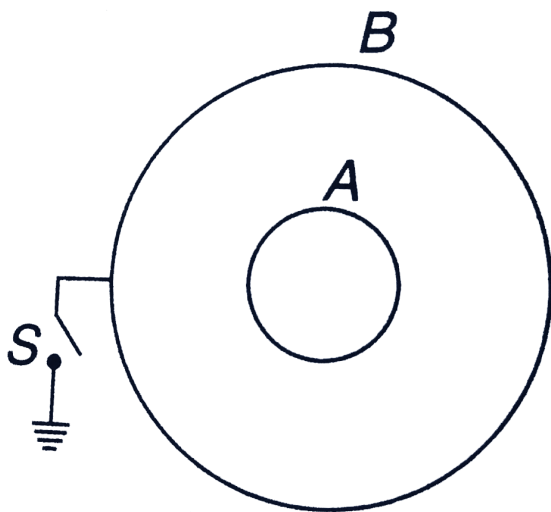


charge  $q$ . Inner shell is neutral. Find the charge that will flow from inner shell to earth the switch  $S$  is closed.



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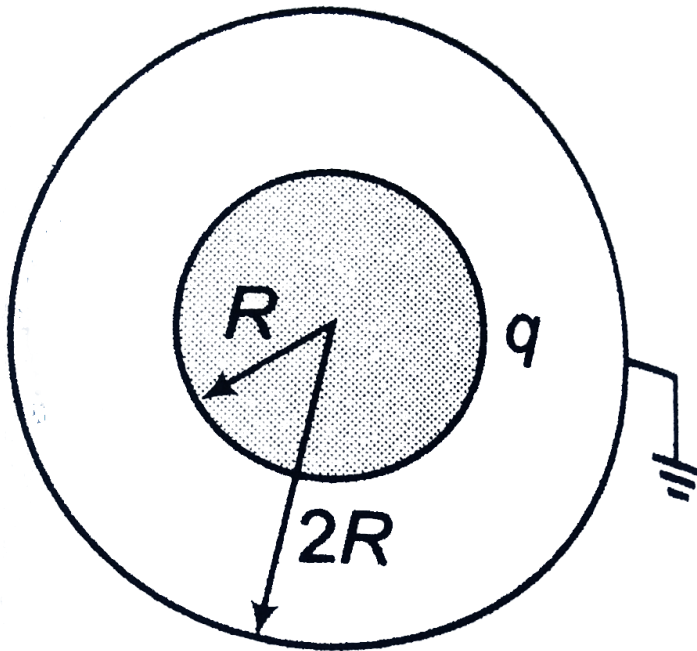
4. Initially the spheres A and B are at potentials  $V_A$  and  $V_B$ . Find the potential of A when sphere B is earthed.



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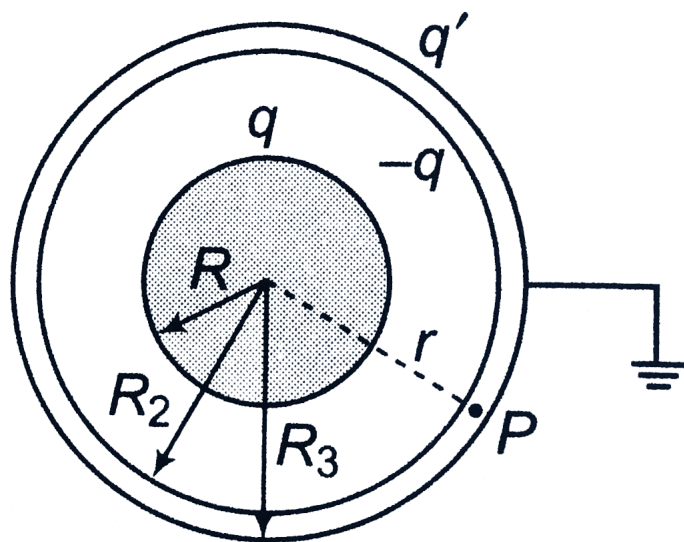
**Example Type 8**

1. A charge  $q$  is distributed uniformly on the surface of a solid sphere of radius  $R$ . It is covered by a concentric hollow conducting sphere of radius  $2R$ . Find the charges on the inner and outer surface of the hollow sphere if it is earthed.



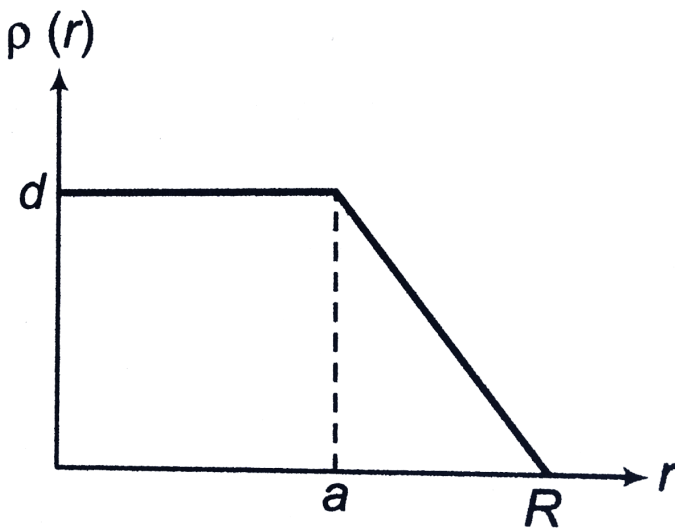
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2. Solve the above problem if thickness of the hollow sphere is considerable.



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3. The nuclear charge ( $Ze$ ) is non uniformly distribute with in a nucleus of radius  $r$ . The charge densilty  $\rho(r)$  (charge per unit volume) is dependent only on the radial distance  $r$  form the centre of the nucleus s shown in figure. The electric field is only along the radial direction.



The electric field within the nucleus is generally

observed to be linearly dependent on  $r$ . This implies

- A. independent of  $a$
- B. directly proportional to  $a$
- C. directly proportional to  $a^2$
- D. inversely proportional to  $a$

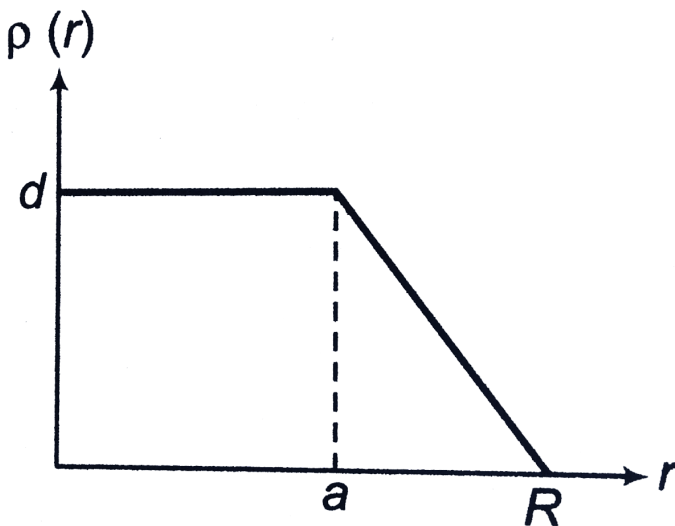
**Answer: A**



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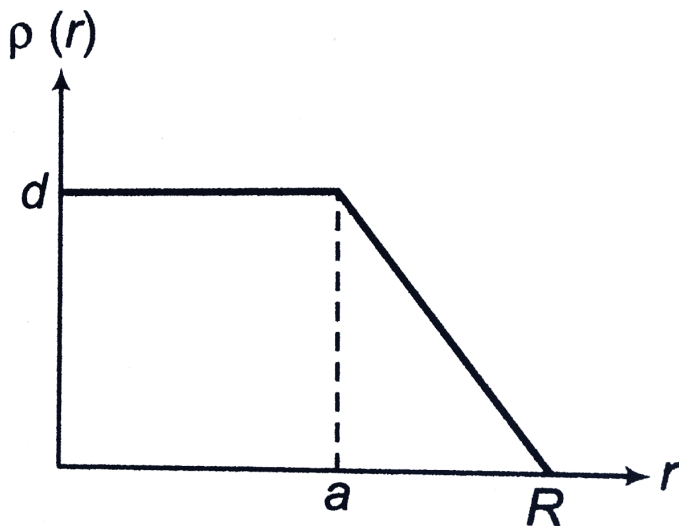
**Level 2 Single Correct**

1. The nuclear charge ( $Ze$ ) is non uniformly distribute with in a nucleus of radius  $r$ . The charge density  $\rho(r)$  (charge per unit volume) is dependent only on the radial distance  $r$  form the centre of the nucleus s shown in figure. The electric field is only along the radial direction.



For  $a=0$  the value of  $d$  (maximum value of  $\rho$  as

shown in the figure) is



A.  $\frac{3Ze}{4\pi R^3}$

B.  $\frac{3Ze}{\pi R^3}$

C.  $\frac{4Ze}{3\pi R^3}$

D.  $\frac{Ze}{3\pi R^3}$

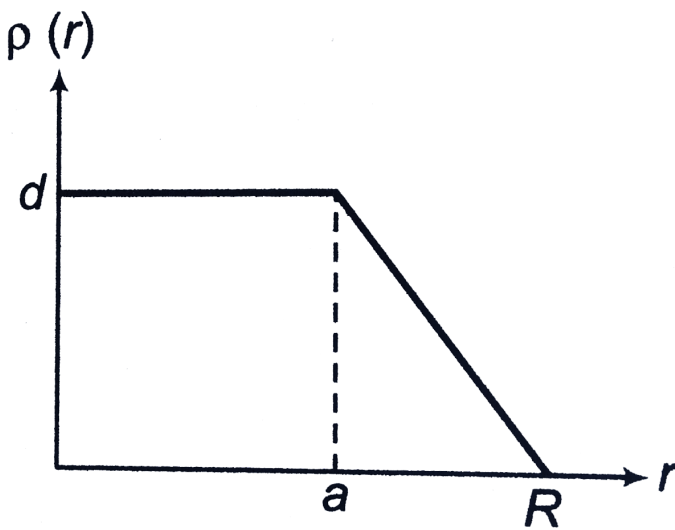
**Answer: B**





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2. The nuclear charge ( $Ze$ ) is non uniformly distribute with in a nucleus of radius  $r$ . The charge densilty  $\rho(r)$  (charge per unit volume) is dependent only on the radial distance  $r$  form the centre of the nucleus s shown in figure. The electric field is only along the radial direction.



The electric field within the nucleus is generally observed to be linearly dependent on  $r$ . This implies

A.  $a = 0$

B.  $a = \frac{R}{2}$

C.  $a = R$

D.  $a = \frac{2R}{3}$

**Answer: C**



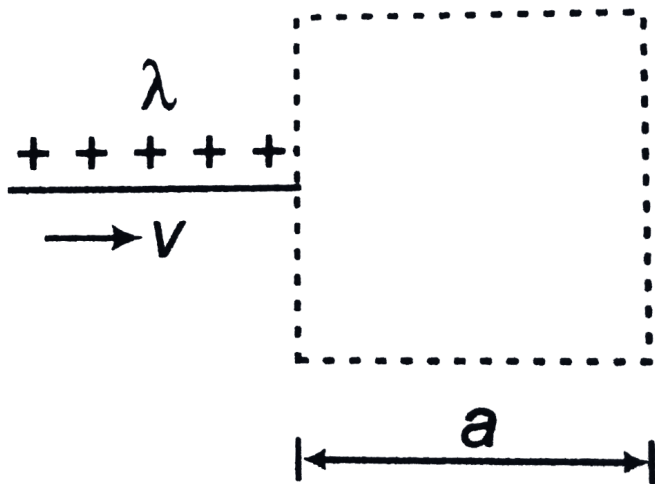
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3. The electric field in a region is given by  $E = a\hat{i} + b\hat{j}$ . Hence  $a$  and  $b$  are constants. Find the net flux passing through a square area of side  $l$  parallel to  $y$ - $z$  plane.



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4. Figure shows an imaginary cube of side  $a$ . A uniformly charged rod of length  $a$  moves towards right at a constant speed  $v$ . At  $t = 0$  the right end of the rod just touches the left face of the cube. Plot a graph between electric flux passing through the cube versus time.



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5. The electric field in a region is given by

$E = \alpha x \hat{i}$ . Here  $\alpha$  is a constant of proper

dimensions. Find

a. the total flux passing through a cube bounded

by the surface

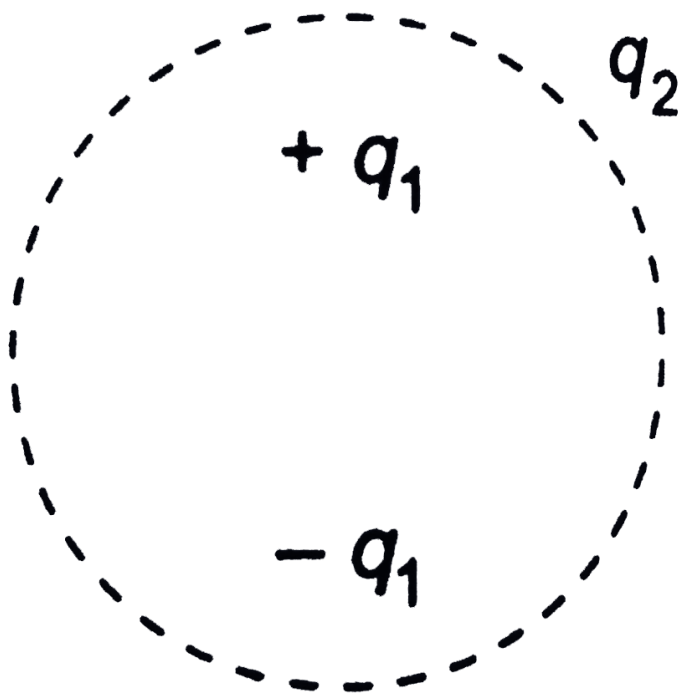
$x = l, x = 2l, y = 0, y = l, z = 0, z = l$ .

b. the charge contained inside in above cube.



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6. Consider the charge configuration and a spherical Gaussian surface as shown in the figure. When calculating the flux of the electric field over the spherical surface, the electric field will be due to.



A.  $q_2$

B. only the positive charges

C. all the charges

D.  $+q_1$  and  $-q_1$

**Answer: C**



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7. A point charge  $q$  is placed on the top of a cone of semi vertex angle  $\theta$ . Show that the electric flux through the base of cone is  $\frac{q(1 - \cos \theta)}{2\epsilon_0}$



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8. Draw  $E - r$  and  $V - r$  graphs due to two point charges  $+q$  and  $-2q$  kept at some along the line joining these two charges.



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9. Draw  $E-r$  and  $V-r$  graphs due to two charged spherical shells as shown in figure (along the line

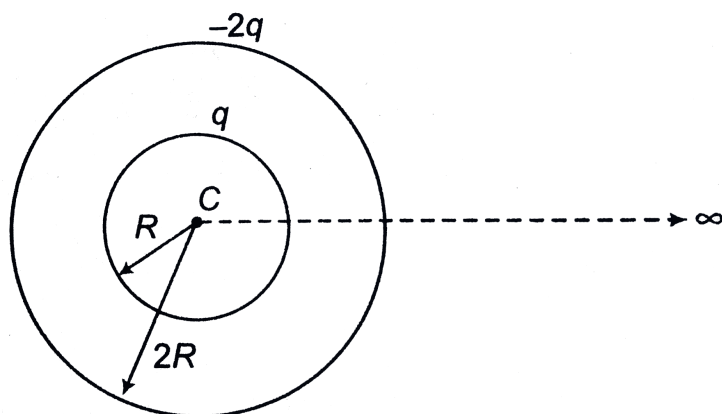


between

$C$

and

$\propto )$



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**10.** An electron with a speed  $5.00 \times 10^6$  m/s enters an electric field of magnitude  $10^3$  N/C, travelling along the field lines in the direction that retards its motion.

a. How far will the electron travel in the field

before stopping momentarily?

b. How much time will have elapsed?

c. If the region with the electric field is only 8.00 mm long (too short from the electron to stop with in it), what fraction of the electron's initial kinetic energy will be lost in that region.



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**11.** A charged particle of mass  $m = 1 \text{ kg}$  and charge  $q = 2\mu\text{C}$  is thrown for a horizontal ground at an angle  $\theta = 45^\circ$  with speed  $20\text{ m/s}$ . In space a horizontal electric field  $E = 2 \times 10^7 \text{ V/m}$  exist.

Find the range on horizontal ground of the projectile thrown.



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**12.** Find the potential difference  $V_{AB}$  between  $A(2m, 1m, 0)$  and  $B(0, 2m, 4m)$  in an electric field,

$$E = (x\hat{i} - 2y\hat{j} + z\hat{k}) \frac{V}{m}$$



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**13.** Find potential difference  $V_{AB}$  between  $A(0, 0, 0)$  and  $B(1\text{m}, 1\text{m}, 1\text{m})$  in an electric field a.  $E = y\hat{i} + x\hat{j}$  b.  $E = 3x^2y\hat{i} + x^3\hat{j}$



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**14.** An electric dipole of dipole moment  $p$  is placed in a uniform electric field  $E$  in stable equilibrium position. Its moment of inertia about the centroidal axis is  $I$ . If it is displaced slightly from its mean position, find the period of small oscillations.



15. Two identical thin ring, each of radius  $R$  meters, are coaxially placed a distance  $R$  metres apart. If  $Q_1$  coulomb, and  $Q_2$  coulomb, are repectively the charges uniformly spread on the two rings, the work done in moving a charge  $q$  from the centre of one ring to that of the other is

A. zero

B. 
$$\frac{q(Q_1 - Q_2)(\sqrt{2} - 1)}{\sqrt{2}(4\pi\epsilon_0 R)}$$

C. 
$$\frac{q\sqrt{2}(Q_1 + Q_2)}{(4\pi\epsilon_0 R)}$$

$$\text{D. } q \left( \frac{Q_1}{Q_2} \right) (\sqrt{2} + 1) \sqrt{2} (4\pi\epsilon_0 R)$$

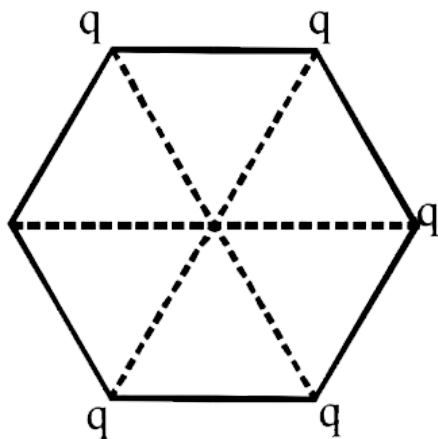
**Answer: B**



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**16.** Five point charges, each of value  $+q$  coul, are placed on five vertices of a regular hexagon of side  $L$  meters. The magnitude of the force on the point charge of value  $-q$  coul, placed at the centre

of the hexagen is.....



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**17.** A point charge  $q_1 = 9.1\mu C$  is held fixed at origin. A second point charge  $q_2 = -0.42\mu C$  and a mass  $3.2 \times 10^{-4}kg$  is placed on the x-axis,  $0.96m$  from the origin. The second point charge is

released at rest. What is its speed when it is  $0.24m$  from the origin?



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**18.** A point charge  $q_1 = -5.8\mu C$  is held stationary at the origin. A second point charge  $q_2 = +4.3\mu C$  moves from the point  $(0.26m, 0, 0)$  to  $(0.38m, 0, 0)$ . How much work is done by the electric force on  $q_2$ ?



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**19.** A uniformly charged thin ring has radius  $10.0\text{cm}$  and total charge  $+12.0\mu\text{C}$ . An electron is placed on the ring's axis a distance  $25.0\text{cm}$  from the centre of the ring and is constrained to stay on the axis of the ring. The electron is then released from rest.

- a. describe the subsequent motion of the electron
- b. find the speed of the electron when it reaches the centre of the ring



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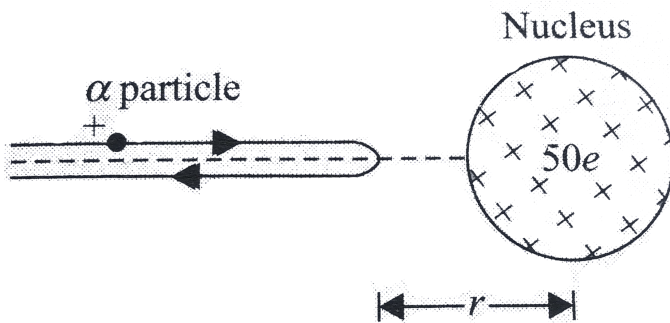
20. Two points A and B are 2 cm apart and a uniform electric field  $E$  acts along the straight line  $AB$  directed A to B with  $E = 200\text{ N/C}$ . A particle of charge  $+10^{-6}\text{ C}$  is taken from A to B along AB, Calculate

- a. the force on the charge
- b. the potential difference  $V_A - V_B$  and
- c. the work done on the charge by  $E$



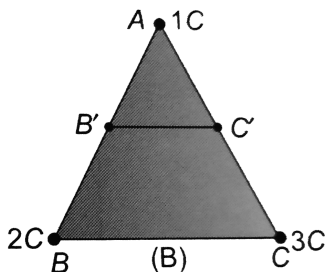
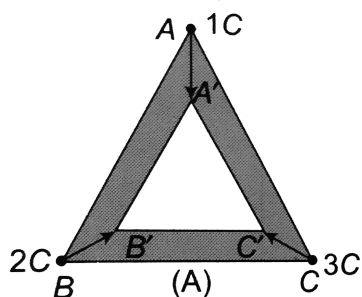
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21. An alpha particle with kinetic energy  $10\text{MeV}$  is heading toward a stationary tin nucleus of atomic number 50. Calculate the distance of closest approach (Fig . 3.23).



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22. Three point charges  $1C$ ,  $2C$  and  $3C$  are placed at the corners of an equilateral triangle of side  $1m$ . The work required to move these charges to the corners of a smaller equilateral triangle of side  $0.5m$  in two different ways as in fig. (A) and fig. (B) are  $W_a$  and  $W_b$  then:



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**23.** Consider a spherical surface of radius 4 m centred 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 spherical surface is at zero potential.



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**24.** The intensity of an electric field depends only on the coordinates  $x$  and  $y$  as follows,

$$E = \frac{a(x\hat{i} + y\hat{j})}{x^2 + y^2} \text{ where, } a \text{ is constant and } \hat{i} \text{ and } \hat{j} \text{ are the unit vectors of the } x \text{ and } y \text{ axes. Find the}$$

charges within a sphere of radius  $R$  with the centre at the origin.



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**25.** Find the electric field caused by a disc of radius  $a$  with a uniform surface charge density  $\sigma$  (charge per unit area) at a point along the axis of the disc a distance  $x$  from its centre.



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**26.** A nonconducting disk of radius  $a$  and uniform positive surface charge density  $\sigma$  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  $q/m = 4\epsilon_0 g / \sigma$ .

(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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27. Four point charges  $+8\mu C$ ,  $-1\mu C$ ,  $-1\mu C$  and  $+8\mu C$  are fixed at the points  $-\sqrt{27/2m}$ ,  $-\sqrt{3/2m}$ ,  $+\sqrt{3/2m}$  and  $+\sqrt{27/2m}$  respectively on the y-axis. A particle of mass  $6 \times 10^{-4} kg$  and  $+0.1\mu C$  moves along the x-direction. Its speed at  $x = +\infty$  is  $v_0$ . find the least value of  $v_0$  for which the particle will cross the origin. find also the kinetic energy of the particle at the origin in this case. Assume that there is no force part from electrostatic force.



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28. Potential difference between centre and surface of the sphere of radius  $R$  and uniform volume charge density  $\rho$  within it will be

A.  $\frac{\rho R^2}{6\epsilon_0}$

B.  $\frac{\rho R^2}{4\epsilon_0}$

C.  $\frac{\rho R^2}{3\epsilon_0}$

D.  $\frac{\rho R^2}{2\epsilon_0}$

**Answer: A**



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29. A positively charged disc is placed on a horizontal plane. A charged particle is released from a certain height on its axis. The particle just reaches the centre of the disc. Select the correct alternative.

A. particle has negative charge on it

B. total potential energy

(gravitational+electrostatic) of the particle

first increases, then decreases

C. total potential energy of the particle first

decreases, then increases

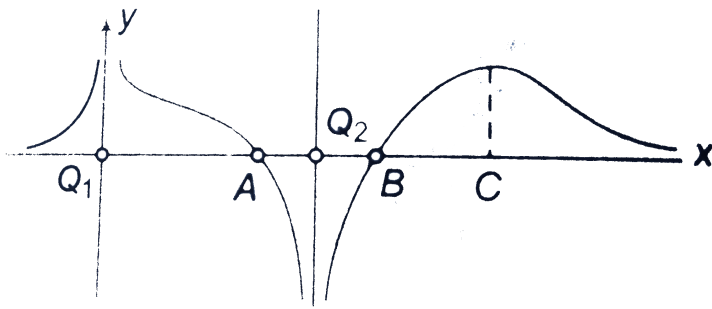
D. total potential energy of the particle  
continuously decreases

**Answer: C**



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**30.** The curve represents the distribution of potential along the straight line joining the two charges  $Q_1$  and  $Q_2$  (separated by a distance  $r$ ) then which of the following statements are correct?



1.  $|Q_1| > |Q_2|$
2.  $Q_1$  is positive in nature
3. A and B are equilibrium points
4. C is a point of unstable equilibrium

A. 1 and 2

B. 1,2,and 3

C. 1,2 and 4

D. 1,2,3 and 4

**Answer: A**



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**31.** A point charge  $q_1 = q$  is placed at point P. Another point charge  $q_2 = -q$  is placed at point Q. At some point  $R (R \neq P, R \neq Q)$ , electric potential due to  $q$  is  $V_1$  and electric potential due to  $q_2$  is  $V_2$ . Which of the following is correct

A. only for some points  $V_1 > V_2$

B. only for some points  $V_2 > V_1$

C. for all points  $V_1 > V_2$

D. for all points  $V_2 > V_1$

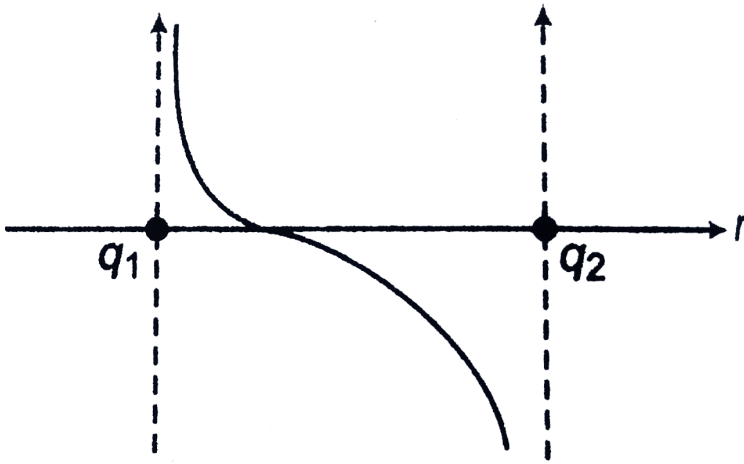
**Answer: C**



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**32.** The variation of electric field between two charge  $q_1$  and  $q_2$  along the line joining the charges is plotted against distance from  $q_1$  (taking rightward direction of electric field as positive) as shown in the figure. Then the correct

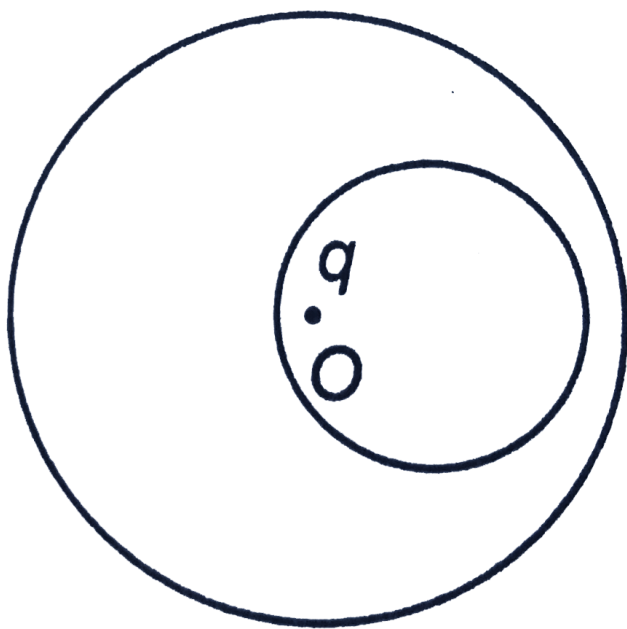
statement is



- A.  $q_1$  and  $q_2$  are positive and  $q_1 < q_2$
- B.  $q_1$  and  $q_2$  are positive and  $q_1 > q_2$
- C.  $q_1$  is positive and  $q_2$  is negative  $q_1 < |q_2|$
- D.  $q_1$  and  $q_2$  are negative and  $|q_1| < |q_2|$

**Answer: A**

**33.** A charge  $q$  is placed at  $O$  in the cavity in a spherical uncharged conductor. Points  $S$  is outside the conductor. If  $q$  is displaced from  $O$  towards  $S$  (still remaining within the cavity)





- A. electric field at S will increase
- B. electric field at S will decrease
- C. electric field at S will first increase and then decrease
- D. electric field at S will not change

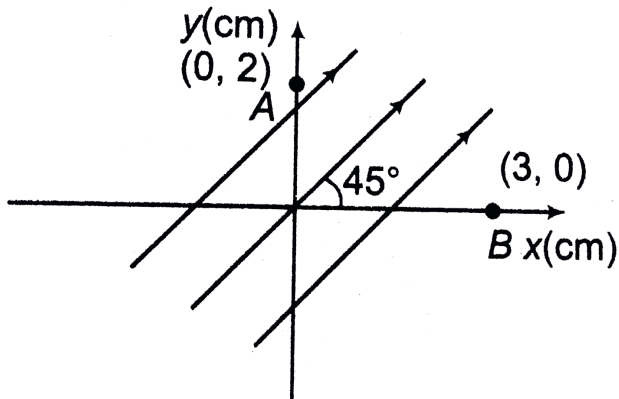
**Answer: D**



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**34.** A uniform electric field of  $400 \frac{V}{m}$  is directed at  $45^\circ$  above the x-axis as shown in the figure. The

potential difference  $V_A - V_B$  is given by



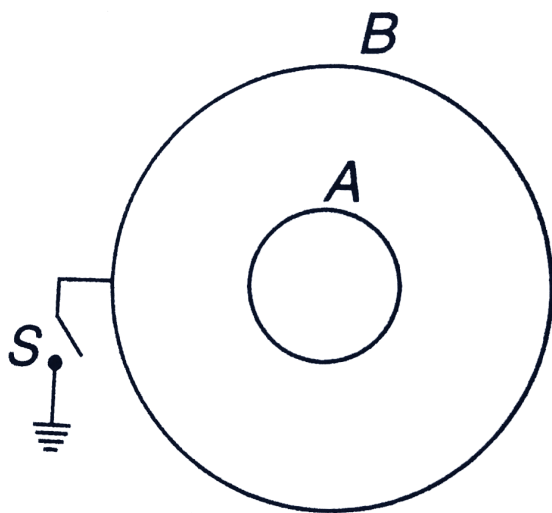
- A. 0
- B.  $4V$
- C.  $6.4V$
- D.  $2.8V$

**Answer: D**



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**35.** Initially the spheres A and B are at potentials  $V_A$  and  $V_B$ . Find the potential of A when sphere B is earthed.



A. 0

B.  $V_A$

C.  $V_A - V_B$

D.  $V_B$

**Answer: C**



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**36.** A particle of mass  $m$  and charge  $q$  is fastened to one end of a string fixed at point O. The whole system lies on a frictionless horizontal plane. Initially, the mass is at rest at A. A uniform electric field in the direction shown is then switched on.

Then



A. the speed of the particle when it reaches B

is  $\sqrt{\frac{2qEl}{m}}$

B. the speed of the particle when it reaches B

is  $\sqrt{\frac{qEl}{m}}$

C. the tension in the string when the particle

reaches at B is  $qE$

D. the tension in the string when the particle

reaches at B is zero

**Answer: B**



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**37.** A charged particle of mass  $m$  and charge  $q$  is released from rest the position  $(x_0, 0)$  in a uniform electric field  $E_0 \hat{j}$ . The angular momentum of the particle about origin.

A. is zero

B. is constant

C. increases with time

D. decreases with time

**Answer: C**



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**38.** A charge  $+Q$  is uniformly distributed in a spherical volume of radius  $R$ . A particle of charge  $+q$  and mass  $m$  projected with velocity  $v_0$  the surface of the spherical volume to its centre inside a smooth tunnel dug across the sphere. The minimum value of  $v_0$  such that it just reaches the centre (assume that there is no resistance on the

particle except electrostatic force) of the sphericle  
volume is

A.  $\sqrt{\frac{Qq}{2\pi\epsilon_0 mR}}$

B.  $\sqrt{\frac{Qq}{\pi\epsilon_0 mR}}$

C.  $\sqrt{\frac{2Qq}{\pi\epsilon_0 mR}}$

D.  $\sqrt{\frac{Qq}{4\pi\epsilon_0 mR}}$

**Answer: D**



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**39.** Two identical coaxial rings each of radius  $R$  are separated by a distance of  $\sqrt{3}R$ . They are uniformly charged with charges  $+Q$  and  $-Q$  respectively. The minimum kinetic energy with which a charged particle (charge  $+q$ ) should be projected from the centre of the negatively charged ring along the axis of the rings such that it reaches the centre of the positively charged ring is

A.  $\frac{Qq}{4\pi\epsilon_0 R}$

B.  $\frac{Qq}{2}\pi\epsilon_0 R$

C.  $\frac{Qq}{8\pi\epsilon_0 R}$

D.  $\frac{3Qq}{4\pi\epsilon_0 R}$

**Answer: A**



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**40.** A uniform electric field exists in x-y plane. The potential of points  $A(2m, 2m)$ ,  $B(-2m, 2m)$  and  $C(2m, 3m)$  are  $4V$ ,  $16V$  and  $12V$  respectively. The electric field is

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

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

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

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

**Answer: D**



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**41.** Two fixed charges  $-2Q$  and  $+Q$  are located at points  $(-3a, 0)$  and  $(+3a, 0)$  respectively.

Then which of the following statement is correct?

A. Points where the electric potential due to the two charges is zero in x-y plane, lie on a

circle radius  $4a$  and centre  $(5a, 0)$

B. potential is zero at  $x = a$  and  $x = 9a$

C. both a and b are wrong

D. both a and b are correct

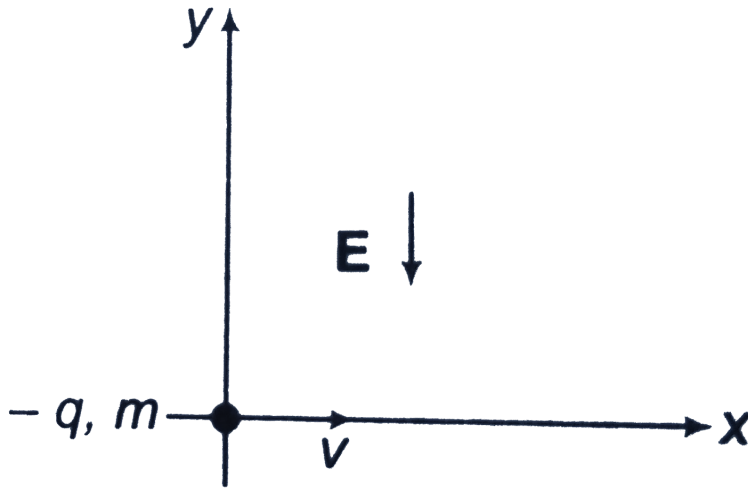
**Answer: D**



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**42.** A particle of mass  $m$  and charge  $-q$  is projected from the origin with a horizontal speed  $v$  into an electric field of intensity  $E$  directed

downward. Choose the wrong statement. Neglect gravity



A. The kinetic energy after a displacement  $y$  is

$$qEy$$

B. The horizontal and vertical components of

$$\text{acceleration of } a_x = 0, a_y = \frac{qE}{m}$$

C. the equation of trajectory is

$$y = \frac{1}{2} \left( \frac{qEx^2}{mv^2} \right)$$

D. The horizontal and vertical displacements

x and y after a time t  $x=vt$  and  $y = \frac{1}{2} a_y t^2$

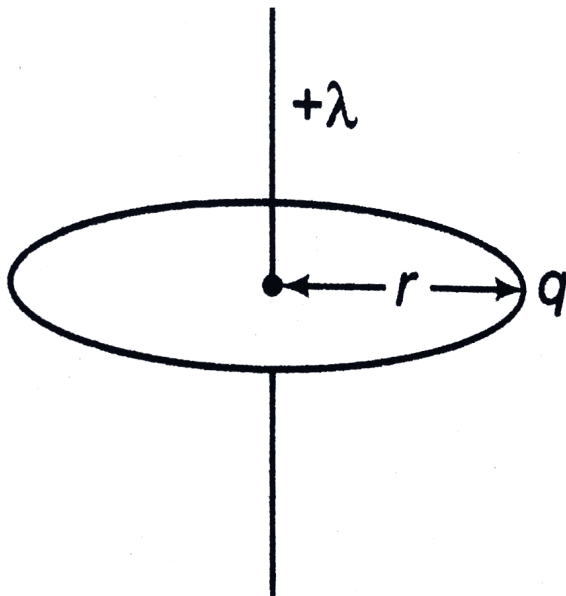
**Answer: A**



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**43.** A particle of charge  $-q$  and mass  $m$  moves in a circle of radius  $r$  around an infinitely long line charge of linear charge density  $+\lambda$ . Then, time

period will be



where ,

$$k = \frac{1}{4} \pi \epsilon_0$$

$$\text{A. } T = 2\pi r \sqrt{\left( \frac{m}{2k\lambda q} \right)}$$

$$\text{B. } T^2 = \frac{4\pi^2 m}{2k\lambda q} r^3$$

$$\text{C. } T = \frac{1}{2\pi r} \sqrt{\frac{2k\lambda w}{m}}$$

$$\text{D. } T = \frac{1}{2\pi r} \sqrt{\frac{m}{2k\lambda q}}$$

**Answer: A**

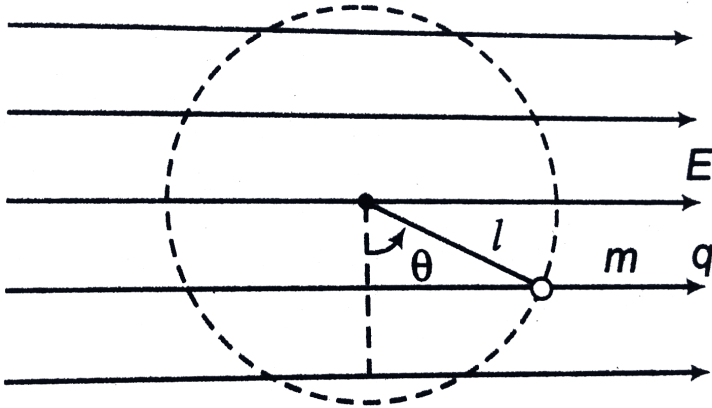


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**44.** A small ball of mass  $m$  and charge  $+q$  tied with a string of length  $l$ , rotating in a vertical circle under gravity and a uniform horizontal electric field  $E$  as shown. The tension in the string will be



minimum for

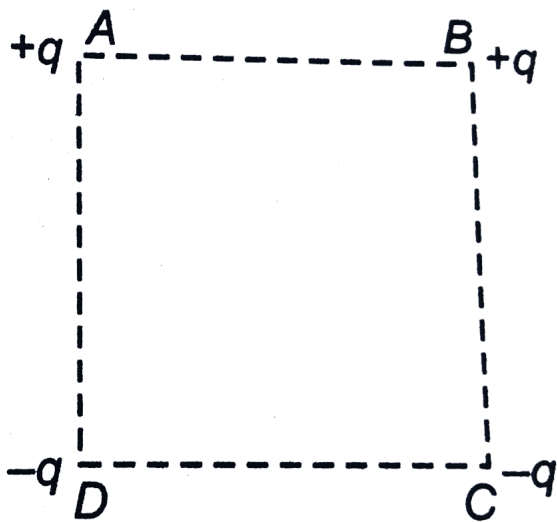


- A.  $\theta = \tan^{-1} \left( \frac{qE}{mg} \right)$
- B.  $\theta = \pi$
- C.  $\theta = 0^\circ$
- D.  $\theta = \pi + \tan^{-1} \left( \frac{qE}{mg} \right)$

**Answer: D**



45. For charges A, B, C and D are placed at the four corners of a square of a side  $a$ . The energy required to take the charges C and D to infinity (they are also infinitely separated from each other) is



A.  $\frac{q^2}{4\pi\epsilon_0 a}$

B.  $\frac{2q^2}{\pi\epsilon_0 a}$

C.  $\frac{q^2}{4\pi\epsilon_0 a} (\sqrt{2} + 1)$

D.  $\frac{q^2}{4\pi\epsilon_0 a} (\sqrt{2} - 1)$

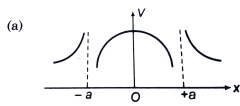
**Answer: C**



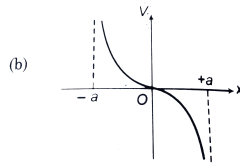
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**46.** Two identical positive charges are placed at  $x = -a$  and  $x = a$ . The correct variation of potential  $V$  along the  $x$ -axis is given by

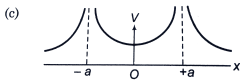
A.



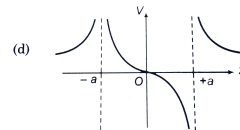
B.



C.



D.



Answer: C



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47. Two identical charges are placed at the two corners of an equilateral triangle. The potential energy of the system is  $U$ . The work done in bringing an identical charge from infinity to the third vertex is

A.  $U$

B.  $2U$

C.  $3U$

D.  $4U$

**Answer: B**



48. A charged particle  $q$  is shot from a large distance towards another charged particle  $Q$  which is fixed, with speed  $v$ . It approaches  $Q$  up to as closed distance  $r$  and then returns. If  $q$  were given a speed  $2v$ , the distasnce of approach would be



A.  $r$

B.  $2r$

C.  $r / 2$

D.  $r / 4$

**Answer: D**



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**49.** Two identical charged spheres are suspended by strings of equal lengths. The strings make an angle of  $30^\circ$  with each other. When suspended in a liquid of density  $0.8 \text{ g cm}^{-3}$ , the angle remains the same. If density of the material of the sphere

is  $1.6\text{gcm}^{-3}$ , the dielectric constant of the liquid is

A. 2

B. 4

C. 2.5

D. 3.5

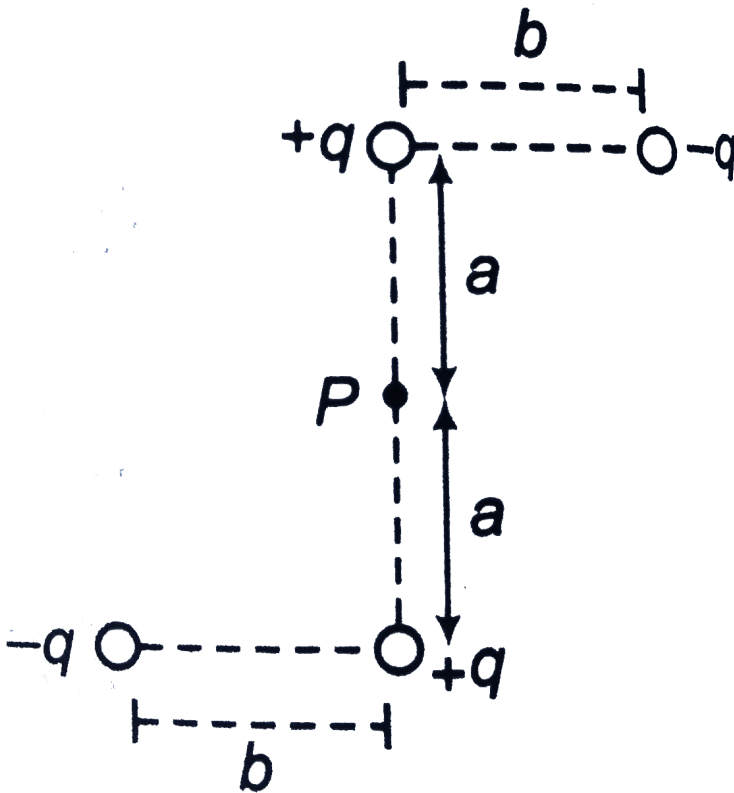
**Answer: A**



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50. The electrostatic potential due to the charge configuration at point P as shown in figure for  $b \ll a$  is



A.  $\frac{2q}{4\pi\epsilon_0 a}$

B.  $\frac{2qb^2}{4\pi\epsilon_0 a^3}$

C.  $\frac{qb^2}{4\pi\epsilon_0 a^3}$

D. zero

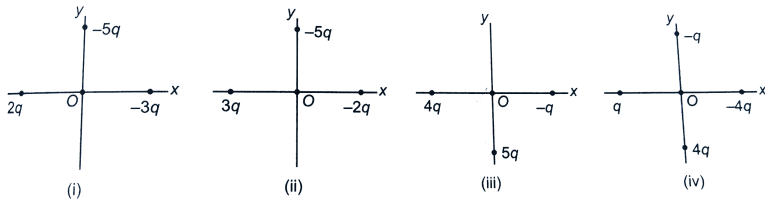
**Answer: C**



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**51.** The figure show four situations in which charged particles are at equal distances from the origin. If  $E_1$ ,  $E_2$ ,  $E_3$  and  $E_4$  be the magnitude of the net electric field at the origin in four situations

i, ii, iii and iv respectively then



A.  $E_1 = E_2 = E_3 = E_4$

B.  $E_1 = E_2 > E_3 > E_4$

C.  $E_1 < E_2 < E_3 = E_4$

D.  $E_1 > E_2 = E_3 > E_4$

**Answer: A**



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52. An isolated conduction sphere sphere whose radius  $R = 1$  m has a charge  $q = \frac{1}{9}nC$ . The energy density at the surfasce of the sphere is

A.  $\frac{\epsilon_0}{2} J / m^3$

B.  $\epsilon_0 J / m^3$

C.  $2\epsilon_0 J / m^3$

D.  $\epsilon_0 / 3Jm^3$

**Answer: A**



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**53.** Two conducting concentric, hollow spheres A and B have radii  $a$  and  $b$  respectively, with A inside B. Their common potential is  $V$ . A is now given some charge such that its potential becomes zero. The potential of B will now be

A. 0

B.  $V(1 - a/b)$

C.  $Va/b$

D.  $Vb/a$

**Answer: B**



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

A. 0

B.  $4V$

C.  $8V$

D.  $10V$

**Answer: B**



55. There are two uncharged identical metallic spheres 1 and 2 of radius  $r$  separated by a distance  $d$  ( $d > r$ ). A charged metallic sphere of same radius having charge  $q$  is touched with one of the sphere. After some time it is moved away from the system. Now, the uncharged sphere is earthed. Charge on earthed sphere is

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

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

C.  $-\frac{qr}{2d}$

D.  $-\frac{qd}{2r}$

**Answer: C**

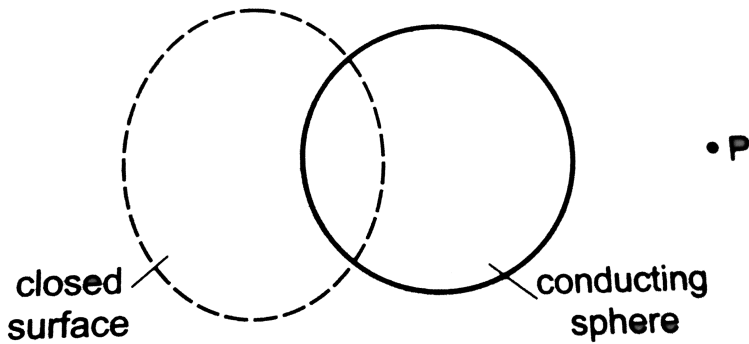


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**56.** Figure shown a closed surface which intersects a conducting sphere. If a positive charge is placed at the point P, the flux of the



electric field through the closed surface



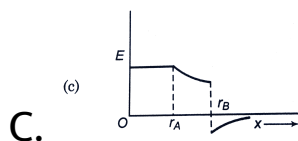
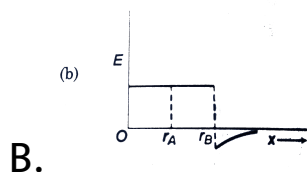
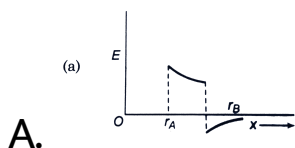
- A. will remain zero
- B. will become positive
- C. will become negative
- D. data insufficient

**Answer: C**



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57. Two concentric conducting thin spherical shells A and B having radii  $r_A$  and  $r_B$  ( $r_B > r_A$ ) are charged to  $Q_A$  and  $-Q_B$  ( $|Q_B| > |Q_A|$ ). The electrical field along a line passing through the centre is



D. none of these

**Answer: A**



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**58.** The electric potential at a point  $(x, y)$  in the  $x$ - $y$  plane is given by  $V = -kxy$ . The field intensity at a distance  $r$  in this plane, from the origin is proportional to

A.  $r^2$

B.  $r$

C.  $1/r$

D.  $1/r^2$

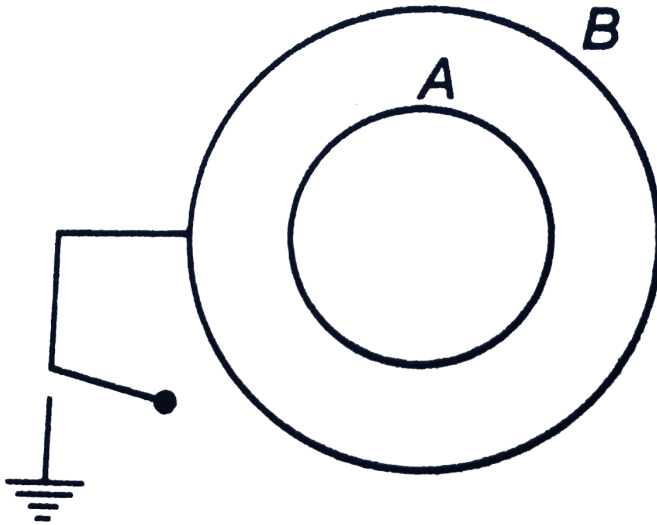
**Answer: B**



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**59.** Two concentric shells have radii  $R$  and  $2R$  charges  $q_A$  and  $q_B$  and potentials  $2V$  and  $\left(\frac{3}{2}\right)V$  respectively. Now, shell B is earthed and let

charges on them become  $q_A'$  and  $q_B'$ . Then,



A.  $q_A / q_B = \frac{1}{2}$

B.  $q_A' / q_B' = 1$

C. potential of AS after earthing becomes

$$\left(\frac{3}{2}\right)V$$

D. potential difference between A and B after earthing becomes  $V/2$

**Answer: A::D**



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**60.** A particle of mass 2 kg charge 1 mC is projected vertically with velocity  $10\text{ms}^{-1}$ . There is as uniform horizontal electric field of  $10^4\text{N/C}$ , then

A. the horizontal range of the particle is  $10\text{m}$

B. the time of flight of the particle is  $2s$

C. the maximum height reached is  $5m$

D. the horizontal range of the particle is  $5m$

**Answer: A::B::C**



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**61.** At a distance of  $5cm$  and  $10cm$  outward from the surface of a uniformly charged solid sphere, the potentials are  $100V$  and  $75V$ , respectively. Then.

A. potential at its surface is  $150V$

B. the charge on the shre is  $\frac{50}{3} \times 10^{-10}C$

C. the electric field on the surface is  $1500V/m$

D. the electric potential at its centre is  $25V$

**Answer: A::B::C**



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**62.** Three charged particle sare in equilibrium under their electrostatic forces only. Then

A. the particles must be collinear



B. all the charges cannot have the same magnitude

C. all the charges cannot have the same sign

D. the equilibrium is unstable

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



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**63.** Charges  $Q_1$  and  $Q_2$  lie inside and outside, respectively, of a closed surface  $S$ . Let  $E$  be the

field at any point on  $S$  and  $\phi$  be the flux of  $E$  over  $S$ .

A. If  $Q_1$  changes both  $E$  and  $\phi$  will change

B. If  $Q_2$  changes,  $E$  will change but  $\phi$  will not change

C. If  $Q_1 = 0$  and  $Q_2 \neq 0$ , then  $E \neq 0$  but  $\phi = 0$

D. If  $Q_1 \neq 0$  and  $Q_2 = 0$ , then  $E = 0$  but  $\phi \neq 0$

**Answer: A::B::C**



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**64.** An electric dipole is placed at the centre of a sphere. Mark the correct options:

A. the flux of the electric field through the sphere is zero

B. the electric field is zero at every point of the sphere

C. the electric field is not at any where on the sphere

D. the electric field is zero on a circle on the sphere

**Answer: A::C**



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**65. Mark correct options**

A. Gauss's law is valid only for uniform charge distributions

B. Gauss's law is valid only for charges placed in vacuum

C. the electric field calculated by Gauss's law is the field due to all the charges

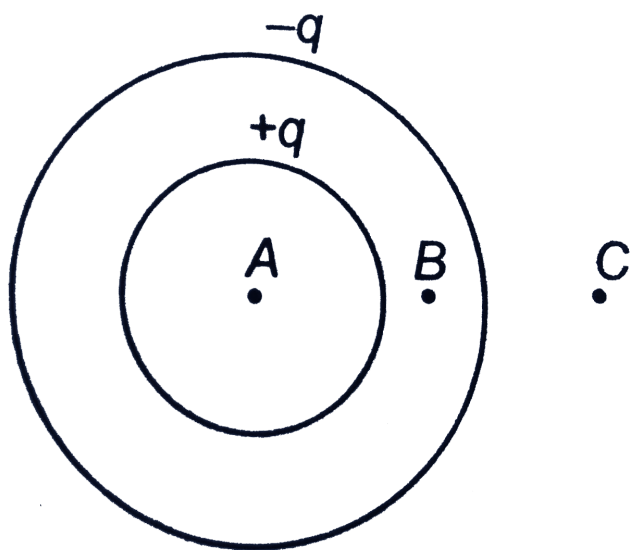
D. The flux of the electric field through a closed surface due to all the charges is equal to the flux due to the charges enclosed by the surface

**Answer: C::D**



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66. Two concentric spherical shells have charges  $+q$  and  $-q$  as shown in figure. Choose the correct options.



A. At a electric field is zero but electric potential is non zero

B. At B electric field and electric potential both are non zero

C. At C electric field is Zero but electric potential is non zero

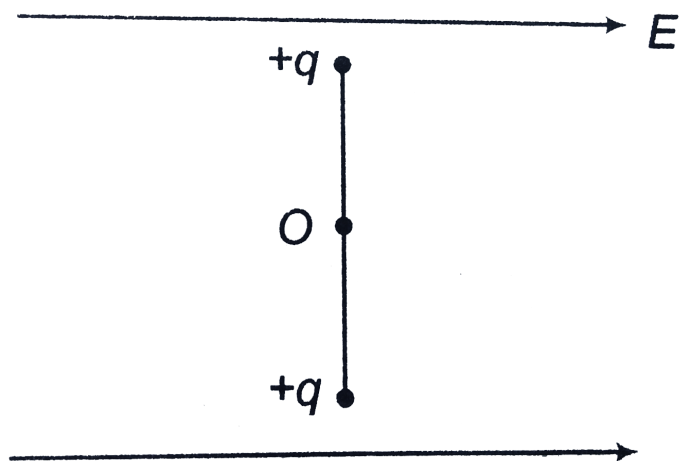
D. At C electric field and electric potential both are zero

**Answer: A::B::D**



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67. A rod is hinged (free to rotate) at its centre  $O$  as shown in figure. Two point charge  $+q$  and  $+q$  are kept at its two ends. Rod is placed in uniform electric field  $E$  as shown. Space is gravity free. Choose the correct options.



A. net force from the hinge on the rod is zero



B. net force from the hinge on the rod is  
leftwards

C. Equilibrium of rod is neutral

D. Equilibrium of rod is stable

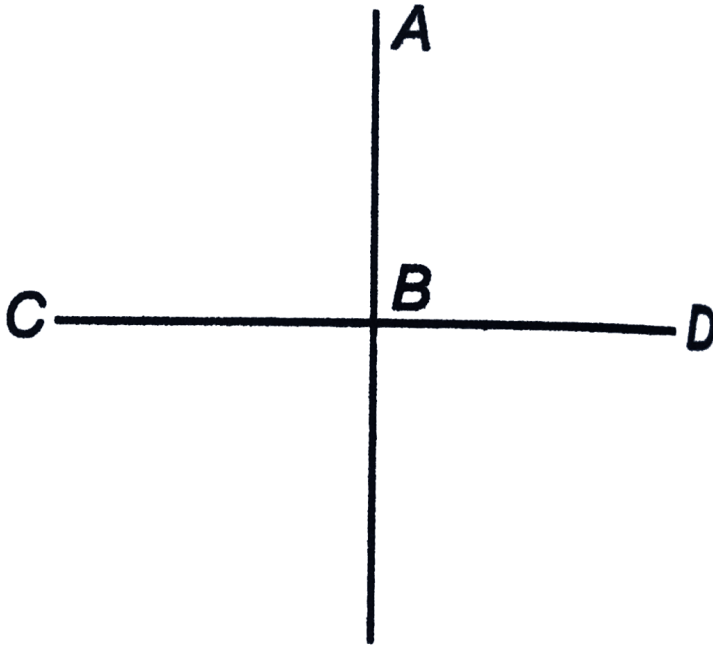
**Answer: B::C**



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**68.** Two charges  $+Q$  each are fixed at points C and D. Line AB is the bisector line of CD. A third

charge  $+q$  is moves from A to B, then from B to C



A. From A to B electrostatic potential energy

wil decrease

B. from A to B electrostastic potential ennergy

wil increase

C. From B to C electrostatic potential energy  
will increase

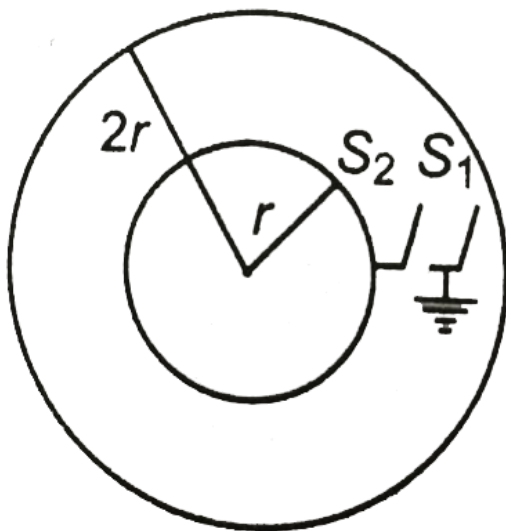
D. From B to C electrostatic potential energy  
will decrease

**Answer: B::C**



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**69.** There are two concentric spherical shell of radii  $r$  and  $2r$ . Initially, a charge  $Q$  is given to the inner shell and both the switches are open.



If switch  $S_1$  is closed and then opened, charge on the outer shell will be

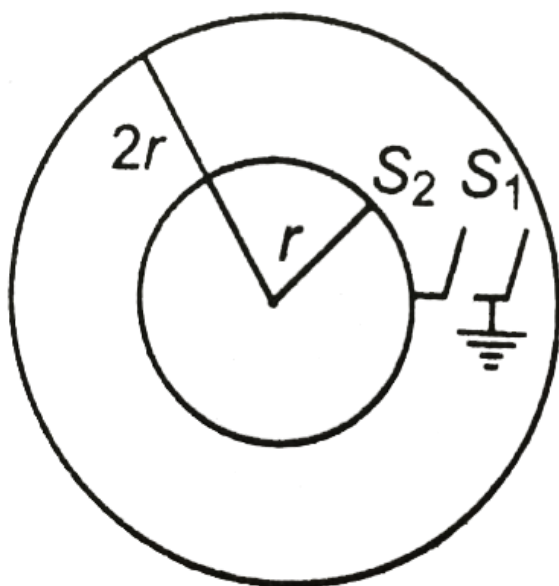
- A.  $Q$
- B.  $Q/2$
- C.  $-Q$
- D.  $-Q/2$

Answer: C



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70. There are two concentric spherical shell of radii  $r$  and  $2r$ . Initially, a charge  $Q$  is given to the inner shell and both the switches are open.



Now,  $S_2$  is closed and opened. The charge flowing through the switch  $S_2$  in the process is

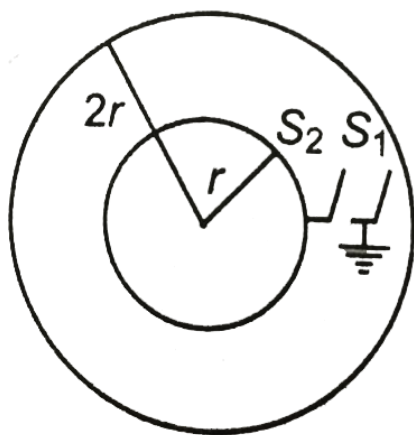
- A.  $Q$
- B.  $Q/4$
- C.  $Q/2$
- D.  $2Q/3$

**Answer: C**



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71. There are two concentric spherical shell of radii  $r$  and  $2r$ . Initially, a charge  $Q$  is given to the inner shell and both the switches are open.



The two steps of the above two problems are repeated  $b$  times, the potential differences between the shells will be

A.  $\frac{1}{2^{n+1}} \left[ \frac{Q}{4\pi\epsilon_0 r} \right]$

B.  $\frac{1}{2^n} \left[ \frac{Q}{4\pi\epsilon_0 r} \right]$

C.  $\frac{1}{2^n} \left[ \frac{Q}{4\pi\epsilon_0 r} \right]$

D.  $\frac{1}{2^{n-1}} \left[ \frac{Q}{2\pi\epsilon_0 r} \right]$

**Answer: A**



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**72.** A sphere of charges of radius  $R$  carries a positive charge whose volume charge density depends only on the distance  $r$  from the ball's centre as  $\rho = \rho_0 \left(1 - \frac{r}{R}\right)$ , where  $\rho_0$  is constant. Assume epsilon as the permittivity of space.



The magnitude of electric field as a function of the distance  $r$  inside the sphere is given by

$$\text{A. } E = \frac{\rho_0}{\varepsilon} \left[ \frac{r}{3} - \frac{r^2}{4R} \right]$$

$$\text{B. } E = \frac{\rho_0}{\varepsilon} \left[ \frac{r}{4} - \frac{r^3}{3R} \right]$$

$$\text{C. } E = \frac{\rho_0}{\varepsilon} \left[ \frac{r}{3} + r^2(4R) \right]$$

$$\text{D. } E = \frac{\rho_0}{\varepsilon} \left[ \frac{r}{4} + \frac{r^2}{3R} \right]$$

**Answer: A**



**Watch Video Solution**

**73.** A sphere of charges of radius  $R$  carries a positive charge whose volume charge density depends only on the distance  $r$  from the ball's centre as  $\rho = \rho_0 \left(1 - \frac{r}{R}\right)$ , where  $\rho_0$  is constant.

Assume epsilon as the permittivity of space.

The magnitude of the electric field as a function of the distance  $r$  outside the ball is given by

A.  $E = \frac{\rho_0 R^3}{8\epsilon r^2}$

B.  $E = \frac{\rho_0 R^3}{12\epsilon r^2}$

C.  $E = \frac{\rho_0 R^2}{8\epsilon r^3}$

D.  $E = \frac{\rho_0 R^2}{12\epsilon r^3}$

**Answer: B**



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**74.** A sphere of charges of radius  $R$  carries a positive charge whose volume charge density depends only on the distance  $r$  from the ball's centre as  $\rho = \rho_0 \left(1 - \frac{r}{R}\right)$ , where  $\rho_0$  is constant.

Assume epsilon as the permittivity of space.

The value of distance  $r_m$  at which electric field intensity is maximum is given by

A.  $r_m = \frac{R}{3}$

B.  $r_m = \frac{3R}{2}$

C.  $r_m = \frac{2R}{3}$

D.  $r_m = \frac{4R}{3}$

**Answer: C**



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**75.** A sphere of charges of radius  $R$  carries a positive charge whose volume charge density depends only on the distance  $r$  from the ball's centre as  $\rho = \rho_0 \left(1 - \frac{r}{R}\right)$ , where  $\rho_0$  is constant.

Assume epsilon as the permittivity of space.

the maximum electric field intensity is

A.  $E_m = \frac{\rho_0 R}{9\epsilon}$

B.  $E_m = \frac{\rho_0 \epsilon}{9R}$

C.  $E_m = \frac{\rho_0 \epsilon}{3R}$

D.  $E_m = \frac{\rho_0 R}{6\epsilon}$

**Answer: A**



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76. A solid metallic sphere of radius  $a$  is surrounded by a conducting spherical shell of radius  $b$  ( $b > a$ ). The solid sphere is given a charge  $Q$ . A student measures the potential at the surface of the solid sphere as  $V$  and the potential at the surface of spherical shell as  $V_b$ . After taking these readings, he decides to put charge of  $-4Q$  on the shell. He then noted the readings of the potential of solid sphere and the shell and found that the potential difference is  $\Delta V$ .

He then connected the outer spherical shell to the earth by a conducting wire and found that the charge on the outer surface of the shell as He

then decides to remove the earthing connection from the shell and earthed the inner solid sphere. Connecting the inner sphere with the earth he observes the charge on the solid sphere as  $q_2$ . He then wanted to check what happens if the two are connected by the conducting wire. So he removed the earthing connection and connected a conducting wire between the solid sphere and the spherical shell. After the connections were made he found the charge on the outer shell as  $q_3$ .

Potential difference (  $\Delta CV$  ) measured by the student between the inner solid sphere and outer shell after putting a charge  $-4Q$  is

A.  $V_a - 3V_b$

B.  $3(V_a - V_b)$

C.  $V_a$

D.  $V_a - V_b$

**Answer: D**



**Watch Video Solution**

**77.** A solid metallic sphere of radius  $a$  is surrounded by a conducting spherical shell of radius  $b$  ( $b > a$ ). The solid sphere is given a



charge  $Q$ . A student measures the potential at the surface of the solid sphere as  $V$  and the potential at the surface of spherical shell as  $V_b$ . After taking these readings, he decides to put charge of  $-4Q$  on the shell. He then noted the readings of the potential of solid sphere and the shell and found that the potential difference is  $\Delta V$ .

He then connected the outer spherical shell to the earth by a conducting wire and found that the charge on the outer surface of the shell as  $q_1$ . He then decides to remove the earthing connection from the shell and earthed the inner solid sphere. Connecting the inner sphere with the earth he observes the charge on the solid sphere as  $q_2$ . He

then wanted to check what happens if the two are connected by the conducting wire. So he removed the earthing connection and connected a conducting wire between the solid sphere and the spherical shell. After the connections were made he found the charge on the outer shell as  $q_3$ .

$q_2$  is

A.  $Q$

B.  $Q\left(\frac{a}{b}\right)$

C.  $-4Q$

D. zero

**Answer: B**



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**78.** A solid metallic sphere of radius  $a$  is surrounded by a conducting spherical shell of radius  $b$  ( $b > a$ ). The solid sphere is given a charge  $Q$ . A student measures the potential at the surface of the solid sphere as  $V$  and the potential at the surface of spherical shell as  $V_b$ . After taking these readings, he decides to put charge of  $-4Q$  on the shell. He then noted the readings of the potential of solid sphere and the shell and found

that the potential difference is  $\Delta V$ .

He then connected the outer spherical shell to the earth by a conducting wire and found that the charge on the outer surface of the shell as He then decides to remove the earthing connection from the shell and earthed the inner solid sphere. Connecting the inner sphere with the earth he observes the charge on the solid sphere as  $q_2$ . He then wanted to check what happens if the two are connected by the conducting wire. So he removed the earthing connection and connected a conducting wire between the solid sphere and the spherical shell. After the connections were made he found the charge on the outer shell as

$q_3$ .

$q_3$  is

A.  $\frac{Q(a + b)}{a - b}$

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

C.  $\frac{Q(a - b)}{b}$

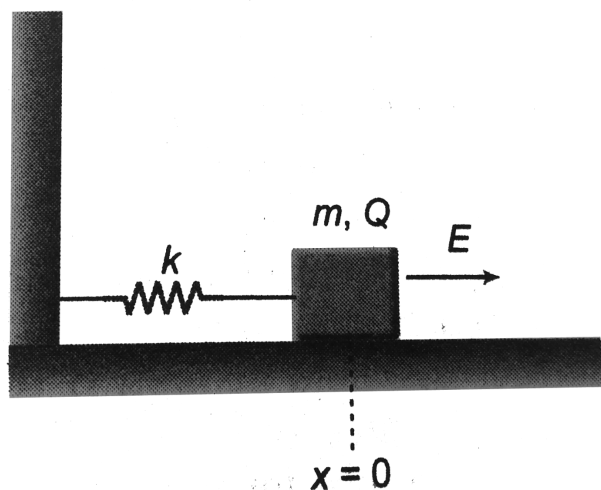
D.  $-\frac{Qb}{a}$

**Answer: C**



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**79.** A  $4.00\text{ kg}$  block carrying a charge  $Q = 50.0\mu\text{C}$  is connected to a spring for which  $k = 100\text{ N/m}$ . The block lies on a frictionless horizontal track, and the system is immersed in a uniform electric field of magnitude  $E = 5.00 \times 10^5 \frac{\text{V}}{\text{m}}$ , directed as shown in figure. If the block is released from rest when the spring is unstretched (at  $x = 0$ ).



(a) By what maximum amount does the spring

expand?

(b) What is the equilibrium position of the block?

(c) Show that the block's motion is simple harmonic and determine its period.

(d) Repeat part (a) if the coefficient of kinetic friction between block and surface is 0.2.



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**80.** A particle of mass  $m$  and charge  $-Q$  is constrained to move along the axis of a ring of radius  $a$ . The ring carries a uniform charge density  $+\lambda$  along its length. Initially, the particle is in the

centre of the ring where the force on it is zero.

Show that the period of oscillation of the particle when it is displaced slightly from its equilibrium position is given by

$$T = 2\pi sq \sqrt{\frac{2\epsilon_0 m a^2}{\lambda Q}}$$



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**81.** Three identical conducting plain parallel plates, each of area  $A$  are held with equal distance between successive surfaces. Charges  $Q$ ,  $2Q$ , and  $3Q$  are placed on them. Neglecting edge effects,



find the distribution of charges on the six surfaces.



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**82.** A long non-conducting, massless rod of length  $L$  pivoted at its centre and balanced with a weight  $w$  at a distance  $x$  from the left end. At the left and right ends of the rod are attached small conducting spheres with positive charges  $q$  and  $2q$  respectively. A distance  $h$  directly beneath each of these spheres is a fixed sphere with positive charge  $Q$ .

(a) Find the distance  $x$  where the rod is horizontal and balanced. b. What value should  $h$  have so that the rod exerts no vertical force on the bearing when the rod is horizontal and balanced?



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**83.** 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 velocity of the particle when it crosses the  $x$ -axis. The charge on

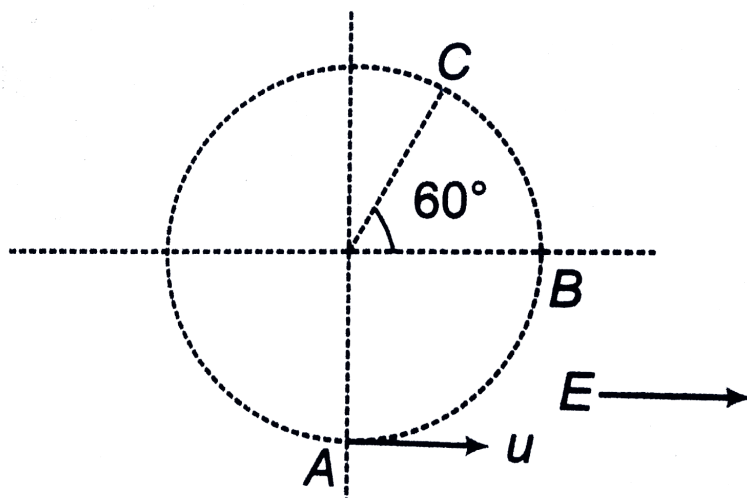
the particle is  $+1\mu C$ . Assume  $V(x, y)$  are in SI units.



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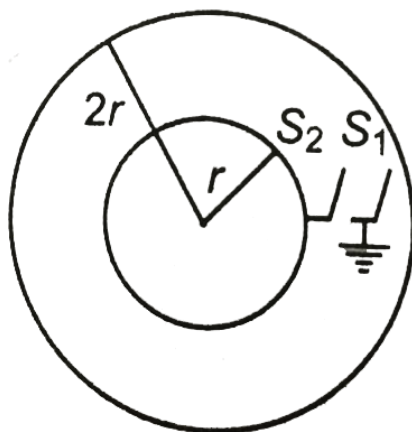
**84.** A simple pendulum with a bob of mass  $m = 1$  kg, charge  $q = 5\mu C$  and string length  $l$  is given a horizontal velocity  $a$  in a uniform electric field  $E = 2 \times 10^6 \frac{V}{m}$  at its bottommost point A, as shown in figure. It is given that the speed  $a$  is such that the particle leaves the circle at point C.

Find the speed  $u$  (Take  $g = 10 \frac{m}{s^2}$ )



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**85.** There are two concentric spherical shell of radii  $r$  and  $2r$ . Initially, a charge  $Q$  is given to the inner shell and both the switches are open.



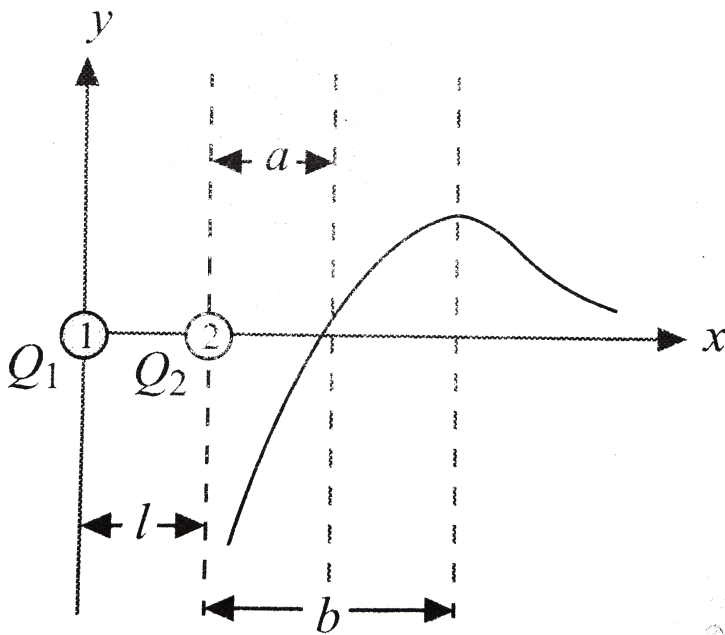
The two steps of the above two problems are repeated  $b$  times, the potential differences between the shells will be



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**86.** Two point like charges  $Q_1$  and  $Q_2$  are positioned at point 1 and 2. The field intensity to

the right of the charge  $Q_2$  on the line that passes through the two charges varies according to a law that is represented schematically in fig. The field intensity is assumed to be positive if its direction coincides with the positive direction on the x-axis. The distance between the charges is  $l$ .



The ratio of the absolute values of the charges

$|Q_1 / Q_2|$  is



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**87.** 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  $n \rightarrow \infty$ ?



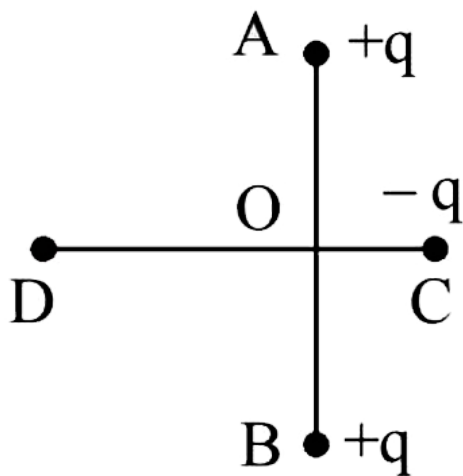
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**88.** Two fixed, equal, positive charges, each of magnitude  $5 \times 10^{-5}$  coul are located at points A and B separated by a distance of 6m. An equal and opposite charge moves towards them along the line COD, the perpendicular bisector of the



line AB.

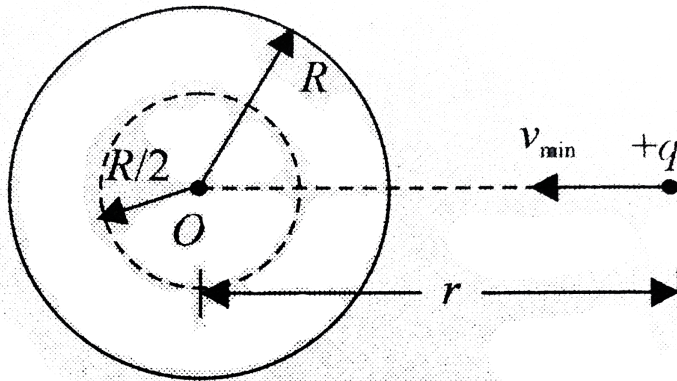
The moving charge, when it reaches the point C at a distance of 4m from O, has a kinetic energy of 4 joules. Calculate the distance of the farthest point D which the negative charge will reach before returning towards C.



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**89.** A positive charge  $Q$  is uniformly distributed throughout the volume of a dielectric sphere of radius  $R$ . A point mass having charge  $+q$  and mass  $m$  is fired toward the center of the sphere with velocity  $v$  from a point at distance  $r$  ( $r > R$ ) from the center of the sphere. Find the minimum velocity  $v$  so that it can penetrate  $(R/2)$  distance of the sphere. Neglect any resistance other than electric interaction. Charge on the small mass

remains constant throughout the motion.



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90. A point charge  $-q$  revolves around a fixed charge  $+Q$  in elliptical orbit. The minimum and maximum distance of  $q$  from  $Q$  are  $r_1$  and  $r_2$ , respectively. The mass of revolving particle is  $m$ ,  $Q > q$  and assume no gravitational effects. Find

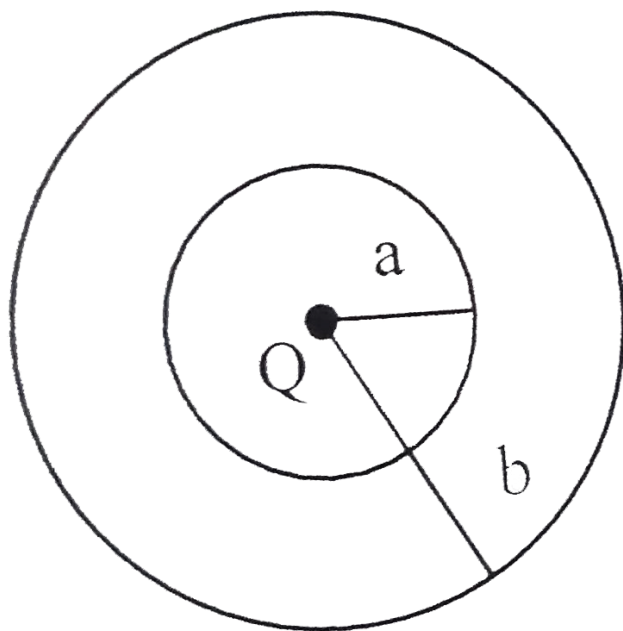
the velocity of  $q$  at positions when it is at  $r_1$  and  $r_2$  distance from  $Q$ .



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

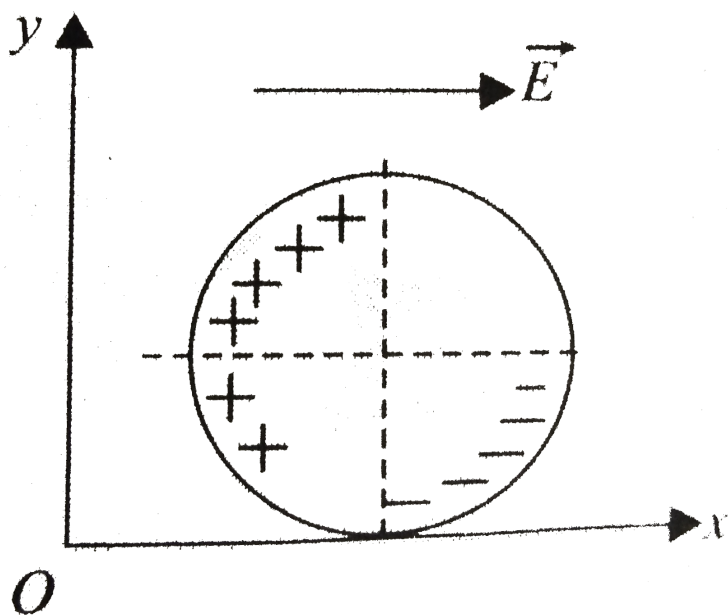
between the spheres will be constant, is :



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**92.** A nonconducting ring of mass  $m$  and radius  $R$ , with charge per unit length  $\lambda$  is shown in fig. It is then placed on a rough nonconducting horizontal plane. At time  $t=0$ , a uniform electric field  $\vec{E} = E_0 \hat{i}$  is switched on and the ring starts rolling without sliding. Determine the friction force (magnitude and direction ) acting on the

ring.



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**93.** A rectangular tank of mass  $m_0$  and charge  $Q$  is placed over a smooth horizontal floor. A horizontal electric field  $E$  exist in the region. Rain

drops are falling vertically in the tank at the constant rate of  $n$  drops per second. Mass of each drop is  $m$ . Find velocity of tank as function of time.

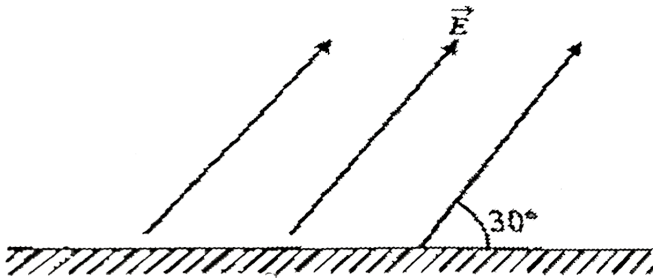


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**94.** In a region an electric field is set up with its strength  $E = 15 \text{ N/C}$  and it makes an angle of  $30^\circ$  with the horizontal plane as shown in figure. A ball having a charge  $2\text{C}$ , mass  $3\text{kg}$  and coefficient of restitution with ground  $0.5$  is projected at an angle of  $30^\circ$  with the horizontal



along the direction of electric field with speed 20 m/s. Find the horizontal distance travelled by ball from first hit with the ground to the second time when it hits the ground.



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## Exercise 24.1

1. Is attraction a true test of electrification?



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2. Is repulsion a true test of electrification?



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3. Why does a phonograph record attract dust particles just after it is cleaned?



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4. What is the total charge, in coulombs, of all the electrons in three gram mole of hydrogen atom?



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## Exercise 24.2

1. The mass of an electron is  $9.11 \times 10^{-31}$  kg, that of a proton is  $1.67 \times 10^{-27}$  kg. Find the ratio  $F_e / F_g$  of the electric force and the gravitational force exerted by the proton on the electron.-



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2. Find the dimensions and units of  $\epsilon_0$



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3. Three point charges  $q$  are placed at three vertices of an equilateral triangle of side  $a$ . Find magnitude of electric force on any charge due to the other two.



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4. Three point charges each of value  $+q$  are placed on three vertices of a square of side a metre. What is the magnitude of the force on a point charge of value  $-q$  coulomb placed at the centre of the square?



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5. Coulomb's law states that the electric force becomes weaker with increasing distance. Suppose that instead, the electric force between two charged particles were independent of

distance. In this case, would a neutral insulator still be attracted towards the comb.



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6. A metal sphere is suspended from a nylon thread. Initially, the metal sphere is uncharged. When a positively charged glass rod is brought close to the metal sphere, the sphere is drawn towards the rod. But if the sphere touches the rod, it suddenly flies away from the rod. Explain, why the sphere is first attracted then repelled?



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7. Is there any lower limit to the electric force between two particles placed at a certain distance?



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8. Does the force on a charge due to another charge depend on the charges present nearby?



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9. The electric force on a charge  $q_1$  due to  $q_2$  is  $(4\hat{i} - 3\hat{j})\text{ N}$ . What is the force on  $q_2$  due to  $q_1$



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### Exercise 24.3

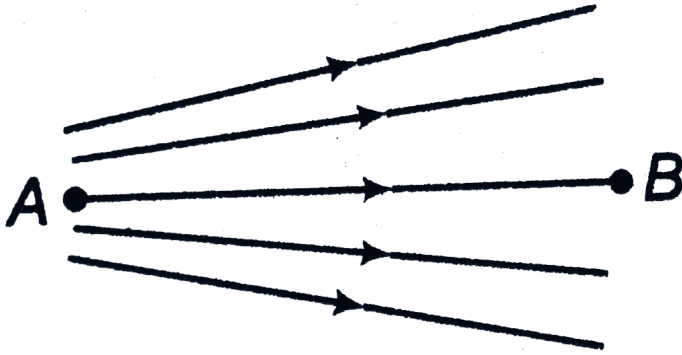
1. The electric field of a point charge is uniform. Is it true or false?



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2. Electric field lines are shown in figure. State whether the electric potential is greater at A or B.



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3. A charged particle always move in the direction of electric field. Is this statement true or false?



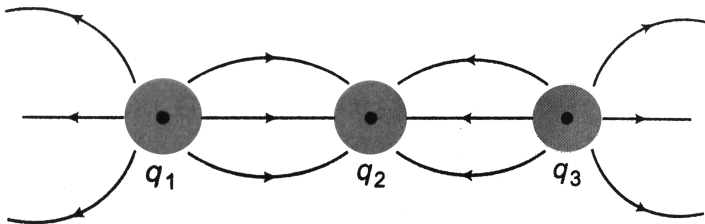
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4. The trajectory of a charged particle is the same as a field line. Is this statement true or false?



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5. Figure shows some of the electric field lines due to three point charges  $q_1, q_2$  and  $q_3$  of equal magnitude. What are the signs of each of the three charges?



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## Exercise 24.4

1. Four particles each having a charge  $q$  are placed on the four vertices of a regular pentagon. The distance of each corner from the centre is ' $a$ '. Find the electric field at the centre of pentagon.

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2. A charge  $q = -2.0\mu C$  is placed at origin. Find the electric field at  $(3m, 4m, 0)$ .



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3. A point charge  $q_1 = 1.0\mu C$  is held fixed at origin. A second point charge  $q_2 = -2.0\mu C$  and a mass  $10^{-4}$  kg is placed on the x-axis, 1.0 m from the origin. The second point charge is released from rest. What is its speed when it is 0.5 m from the origin?



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4. A point charge  $q_1 = -1.0\mu C$  is held stationary at the origin. A second point charge  $q_2 = +2.0\mu C$  moves from the point  $(1.0m, 0, 0)$  to  $(2.0m, 0, 0)$ . How much work is done by the electric force on  $q_2$ ?



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## Exercise 24.5

1. A point charge  $q_1$  is held stationary at the origin. A second charge  $q_2$  is placed at a point a, and the electric potential energy of the pair of charges is  $-6.4 \times 10^{-8} J$ . When the second charge is moved to point b, the electric force on the charge does  $4.2 \times 10^{-8} J$  of work. What is the electric potential energy of the pair of charges when the second charge is at point b?



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2. Is it possible to have an arrangement of two point charges separated by finite distances such that the electric potential energy of the arrangement is the same as if the two charges were infinitely far apart? What if there are three charges?



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3. Find  $V_{ba}$ , if  $12J$  of work has to be done against an electric field to take a charge of  $10^{-2} \text{ C}$  from a to b.

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## Exercise 24.6

1. A rod of length  $L$  lies along the  $x$ -axis with its left end at the origin. It has a non-uniform charge density  $\lambda = \alpha x$ , where  $\alpha$  is a positive constant.

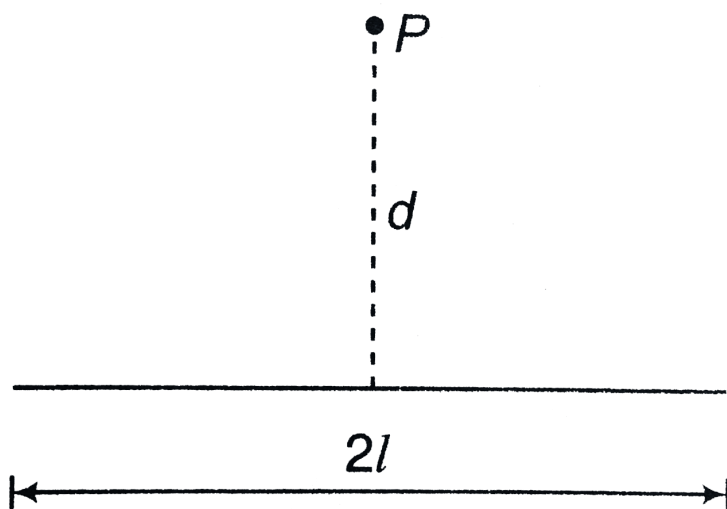
(a) What are the units of  $\alpha$ ?

(b) Calculate the electric potential at point A where  $x = -d$ .

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2. A charge  $q$  is uniformly distributed along an insulating straight wire of length  $2l$  as shown in Fig. Find an expression for the electric potential at a point located a distance  $d$  from the distribution along its perpendicular bisector.



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## Exercise 24.7

1. 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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2. Determine the electric field strength vector if the potential of this field depends on  $x$ , coordinates as

(a)  $V = a(x^2 - y^2)$  (b)  $V = axy$

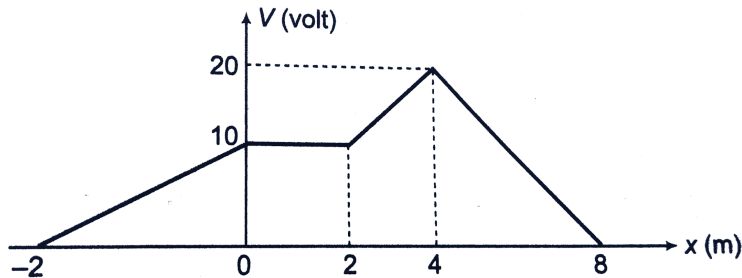
where,  $a$  is a constant.



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## Level 1 Assertion And Reason

1. 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.



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2. The electric potential decreases uniformly from  $100V$  to  $50V$  as one moves along the  $x$ -axis from  $x = 0$  to  $x = 5m$ . The electric field at  $x = 2m$  must be equal to  $10V/m$ . Is this statement true or false.



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3. In the uniform electric field shown in figure, find

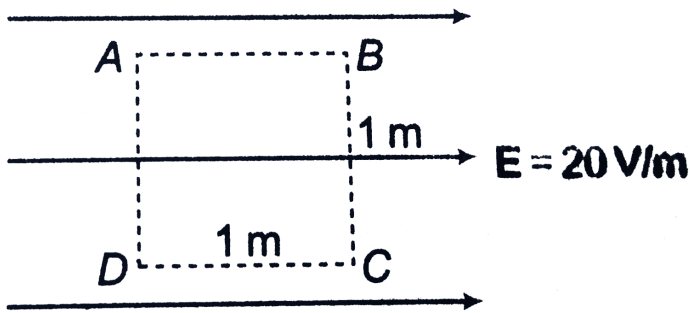
:

a.  $V_A - V_D$

b.  $V_A - V_C$

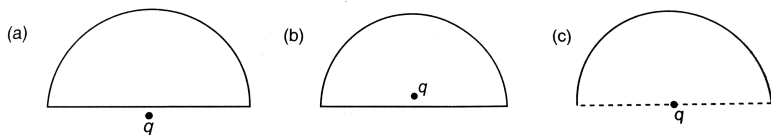
c.  $V_B - V_D$

d.  $V_C - V_D$



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4. In figure (a), a charge  $q$  is placed just outside the centre of a closed hemisphere. In figure (b), the same charge  $q$  is placed just inside the centre of the closed hemisphere and in figure (c), the charge is placed at the centre of hemisphere open from the base. Find the electric flux passing through the hemisphere in all the three cases.



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5. Net charge within an imaginary cube drawn in a uniform electric field is always zero. Is this statement true or false?



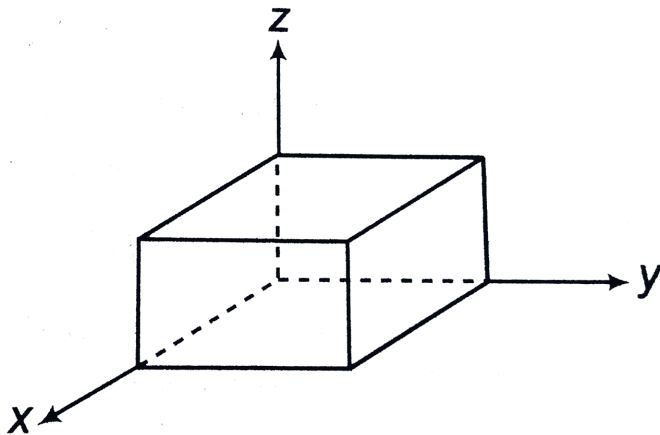
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6. A hemispherical body of radius  $R$  is placed in a uniform electric field  $E$ . What is the flux linked with the curved surface if, the field is (a) parallel to the base, (b) perpendicular to the base.



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7. A cube has sides of length  $L = 0.2\text{m}$ . It is placed with one corner at the origin as shown in figure. The electric field is uniform and given by  $E = (2.5\text{N/C})\hat{i} - (4.2\text{N/C})\hat{j}$ . Find the electric flux through the entire cube.



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8. Assertion: An independent negative charge moves itself from point A to point B. then, potential at A should be less than potential at B.

Reason: While moving from A to B kinetic energy of electron will increase

A. If both Assertion and Reason are true but

Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are true but

Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

**Answer: B**



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9. Assertion: When two unlike charges are brought nearer, their electrostatic potential energy decreases.

Reason: All conservative forces act in the direction of decreasing potential energy.

A. If both Assertion and Reason are true but Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

**Answer: A::B**



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**10.** Assertion: At a point electric potential is decreasing along x-axis at a rate of  $10V/m$ .

Therefore, x-component of electric field at this point should be  $10V/m$  along x-axis.

Reason: Magnitude of  $E_x = \frac{\partial V}{\partial x}$

A. If both Assertion and Reason are true but

Reason is the correct explanation of  
Assertion.

B. If both Assertion and Reason are true but

Reason is not the correct explanation of  
Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

**Answer: D**



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**11.** Assertion: Electric potential on the surface of a charged sphere of radius  $R$  is  $V$ . Then electric field at distance  $r = \frac{R}{2}$  from centre is  $\frac{V}{2R}$ . Charge is distributed uniformly over the volume.

Reason: From centre to surface, electric field

varies linearly with  $r$ . Here  $r$  is distance from centre.

A. If both Assertion and Reason are true but

Reason is the correct explanation of

Assertion.

B. If both Assertion and Reason are true but

Reason is not the correct explanation of

Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

**Answer: B**



**Watch Video Solution**

**12.** Assertion: Gauss's theroem can be applied only for a closed surface.

Reason: Electric flux can be obtained passing from an open surface also.

A. If both Assertion and Reason are true but Reason is the correct explanation of Assertion.

- B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
- C. If Assertion is true, but the Reason is false.
- D. If Assertion is false but the Reason is true.

**Answer: B**



**Watch Video Solution**

**13.** Assertion: In the electric field

$E = (4\hat{i} + 4\hat{j}) \text{ N/C}$  electric potential at A (4m,



0) is more than the electric potential at  $B(0, 4m)$

Reason: Electric lines of forces always travel from higher potential to lower potential.

A. If both Assertion and Reason are true but

Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are true but

Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

**Answer: D**



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**14.** Assertion: Two charges  $-q$  each are fixed points A and B. When a third charge  $-q$  moves from A to B, electrical potential energy first decreases then increases,



Reason: Along the line joining A and B, third charge is stable equilibrium position at centre.

A. If both Assertion and Reason are true but

Reason is the correct explanation of  
Assertion.

B. If both Assertion and Reason are true but

Reason is not the correct explanation of  
Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

**Answer: A::B**



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**15.** Assertion: A small electric dipole is moved translationally from higher potential to lower potential in uniform electric field. Work done by electric is positive.

Reason: When a positive charge is moved from higher potential to lower potential, work done by electric field positive.

- A. If both Assertion and Reason are true but Reason is the correct explanation of Assertion.
- B. If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
- C. If Assertion is true, but the Reason is false.
- D. If Assertion is false but the Reason is true.

**Answer: D**



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**16. Assertion:** In case of charged spherical shells,  $E$ - $r$  graph is discontinuous while  $V$ - $r$  graph is continuous

**Reason:** According to Gauss's theorem only the charge inside a closed surface can produce electric field at some point.

A. If both Assertion and Reason are true but Reason is the correct explanation of Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explanation of

Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

**Answer: C**



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**17.** Assertion: If we see along the axis of a charged ring, the magnitude of electric field is minimum at centre and magnitude of electric potential is maximum.

Reason: Electric field is a vector quantity while electric potential is scalar.

A. If both Assertion and Reason are true but

Reason is the correct explanation of

Assertion.

B. If both Assertion and Reason are true but

Reason is not the correct explanation of

Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.



**Answer: B**



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**18.** Units of electric flux are

A.  $\frac{N - m^2}{C^2}$

B.  $\frac{N}{C^2 - m^2}$

C. volt-m

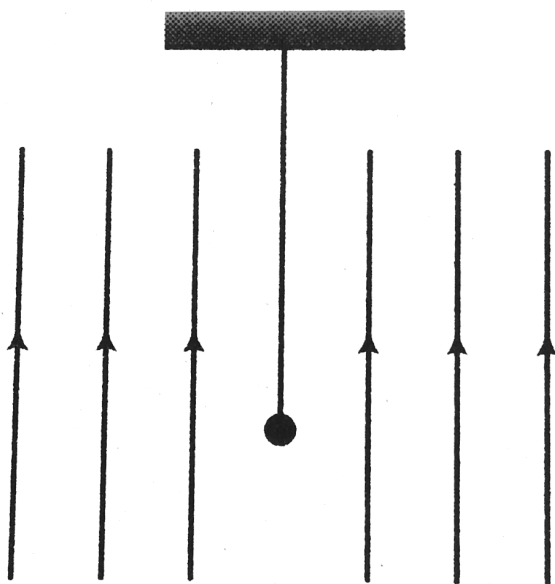
D. volt-m<sup>3</sup>

**Answer: C**



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**19.** A neutral pendulum oscillates in a uniform electric field as shown in figure. If a positive charge is given to the pendulum, then its time period



A. will increase

B. will decrease

C. will remain constant

D. will first increase then decrease

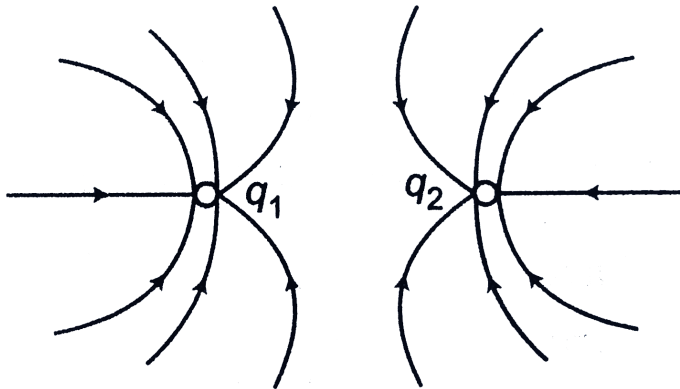
**Answer: A**



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**Level 1 Objective**

1. Identify the correct statement about the charges  $q_1$  and  $q_2$  then



- A.  $q_1$  and  $q_2$  both are positive
- B.  $q_1$  and  $q_2$  both are negative
- C.  $q_1$  is positive  $q_2$  negative
- D.  $q_2$  is positive and  $q_1$  is negative

**Answer: B**



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2. Three identical charges are placed at corners of an equilateral triangle of side  $l$ . If force between any two charges is  $F$ , the work required to double the dimensions of triangle is

A.  $-3Fl$

B.  $3Fl$

C.  $(-3/2)Fl$

D.  $(3/2)Fl$

**Answer: C**



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3. A proton a deuteron and an  $\alpha$  particle are accelerated through potentials of  $V$ ,  $2V$  and  $4V$  respectively. Their velocity will bear a ratio

A.  $1:1:1$

B.  $1:\sqrt{2}:1$

C.  $\sqrt{2}:1:1$

D.  $1:1:\sqrt{2}$

**Answer: D**



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4. Electric potential at a point P,  $r$  distance away due to a point charge  $q$  kept at point A is  $V$ . If twice of this charge is distributed uniformly on the surface of a hollow sphere of radius  $4r$  with centre at point A the potential at P now is

A.  $V$

B.  $V/2$

C.  $V/4$

D.  $V/8$

**Answer: B**



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5. 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



A.  $\frac{q^2}{4\pi\epsilon_0 a} (-4 + \sqrt{2})$

B.  $\frac{q^2}{4\pi\epsilon_0 a} (4 + 2\sqrt{2})$

C.  $\frac{q^2}{4\pi\epsilon_0 a} (4 - 2\sqrt{2})$

D.  $\frac{q^2}{4\pi\epsilon_0 a} (4 + \sqrt{2})$

**Answer: C**



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6. Two concentric spheres of radii  $R$  and  $2R$  are charged. The inner sphere has a charge of  $1\mu C$  and the outer sphere has a charge of  $2\mu C$  of the

same sign. The potential is  $9000V$  at a distance  $3R$  from the common centre. The value of  $R$  is

A.  $1m$

B.  $2m$

C.  $3m$

D.  $4m$

**Answer: A**



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7. A ring of radius  $R$  is having two charges  $q$  and  $2q$  distributed on its two half parts. The electric potential at a point on its axis at a distance of  $2\sqrt{2}R$  from its centre is  $\left(k = \frac{1}{4\pi\epsilon_0}\right)$

A.  $\frac{3kq}{R}$

B.  $\frac{kq}{3R}$

C.  $\frac{kq}{R}$

D.  $\frac{kq}{\sqrt{3}R}$

**Answer: C**



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**8.** A particle A having charge of  $2.0 \times 10^{-6}C$  and a mass of 100 g is fixed at the bottom of a smooth inclined plane of inclination  $30^\circ$ . Where should another particle B having same charge and mass, be placed on the inclined plane so that B may remain in equilibrium?

- A. 8 cm from the bottom
- B. 13 cm from the bottom
- C. 21 cm from the bottom
- D. 27 cm from the bottom

**Answer: D**



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9. Four positive charges  $(2\sqrt{2} - 1)Q$  are arranged at the four corners of a square. Another charge  $q$  is placed at the centre of the square. Resulting force acting on each corner charge is zero if  $q$  is

A.  $-\frac{7Q}{4}$

B.  $-\frac{4Q}{7}$

C.  $-Q$

D.  $-(\sqrt{2} + 1)Q$

**Answer: A**



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**10.** A proton is released from rest, 10 cm from a charged sheet carrying charged density of  $-2.21 \times 10^{-9} C/m^2$ . It will strike the sheet after the time (approximately)

A.  $4\mu s$

B.  $2\mu s$

C.  $2\sqrt{2}\mu s$

D.  $4\sqrt{2}\mu s$

**Answer: A**



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**11.** Two point charges  $+q$  and  $-q$  are placed a distance  $x$  apart. A third charge is so placed that at the three charges are in equilibrium. Then

A. unknown charge is  $-4q/9$

B. unknown charge is  $-9q/4$

C. it should be at  $(x/3)$  from smaller charge

between them

D. none of these

**Answer: D**

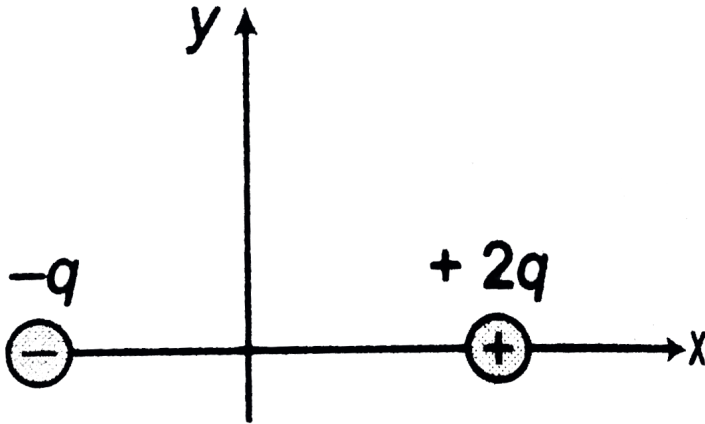


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**12.** Charge  $2q$  and  $-q$  are placed at  $(a, 0)$  and  $(-a, 0)$  as shown in the figure. The coordinates of the point at which electric field



intensity is zero will be  $(x, 0)$  where



A.  $-a < x < a$

B.  $x < -a$

C.  $x > -a$

D.  $0 < x < a$

**Answer: B**

13. Five point charge ( $+q$  each) are placed at the five vertices of a regular hexagon of side  $2a$ . what is the magnitude of the net electric field at the centre of the hexagon?

A.  $\frac{1}{4\pi\epsilon_0} \frac{q}{a^2}$

B.  $\frac{q}{16\pi\epsilon_0 a^2}$

C.  $\frac{\sqrt{2}q}{4\pi\epsilon_0 a^2}$

D.  $\frac{5q}{16\pi\epsilon_0 a^2}$

**Answer: B**



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**14.** Two identical small conducting spheres having unequal positive charges  $q_1$  and  $q_2$  are separated by a distance  $r$ . If they are now made to touch each other and then separated again to the same distance, the electrostatic force between them in this case will be

- A. less than before
- B. same as before
- C. more than before

D. zero

**Answer: C**



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**15.** Three concentric conducting spherical shells carry charges  $+4Q$  on the inner shell  $-2Q$  on the middle shell and  $+6Q$  on the outer shell. The charge on the inner surface of the outer shell is

A. 0

B.  $4Q$

C.  $-Q$

D.  $-2Q$

**Answer: D**



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**16.** 1000 drops of same size are charged to a potential of 1 V each. If they coalesce to form in single drop, its potential would be

A.  $1V$

B.  $10V$

C.  $100V$

D.  $1000V$

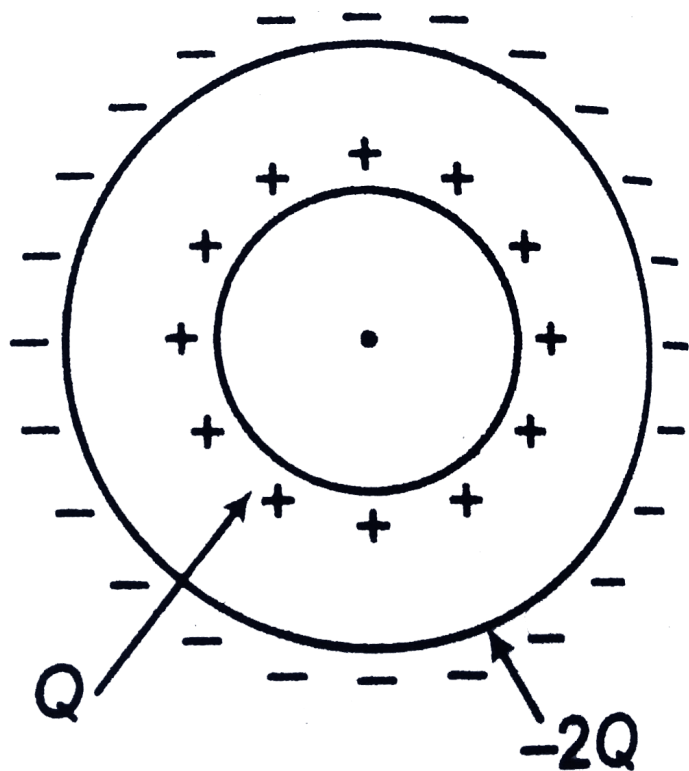
**Answer: C**



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**17.** Two concentric conducting spheres of radii  $R$  and  $2R$  are carrying charges  $Q$  and  $-2Q$ , respectively. If the charge on inner sphere is doubled, the potential difference between the two

spheres will



- A. becomes two times
- B. become four times
- C. be halved

D. remain same

**Answer: A**

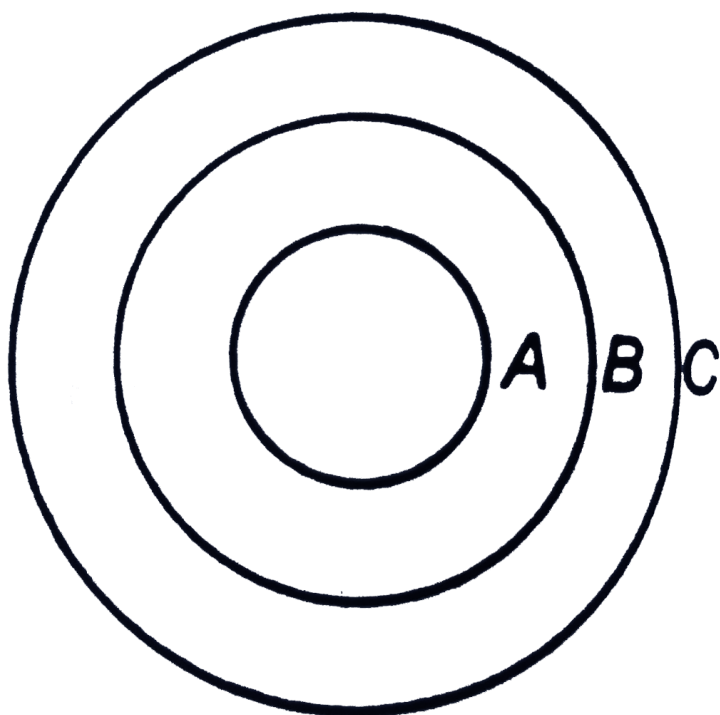


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**18.** Charges  $Q$ ,  $2Q$ , and  $-Q$  are given to three concentric conducting spherical shells  $A$ ,  $B$  and  $C$  respectively as shown in figure. The ratio of charge on the inner and outer surface of shell  $C$



will be



A.  $+\frac{3}{4}$

B.  $\frac{-3}{4}$

C.  $\frac{3}{2}$

D.  $\frac{-3}{2}$

**Answer: D**



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**19.** The electric field in a region of space is given by  $E = 5\hat{i} + 2\hat{j} \text{ N/C}$ . The flux of E due to this field through an area  $1\text{m}^2$  lying in the y-z plane, in SI units is

A. 5

B. 10

C. 2

D.  $5\sqrt{29}$

**Answer: A**



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20. A charges  $Q$  is placed at each of the two opposite corners of a square. A charge  $q$  is placed to each of the other two corners. If the resultant force on each charge  $q$  is zero, then

A.  $q = \sqrt{2}Q$

B.  $q = -\sqrt{2}Q$

C.  $q = 2\sqrt{2}Q$

D.  $q = -2\sqrt{2}Q$

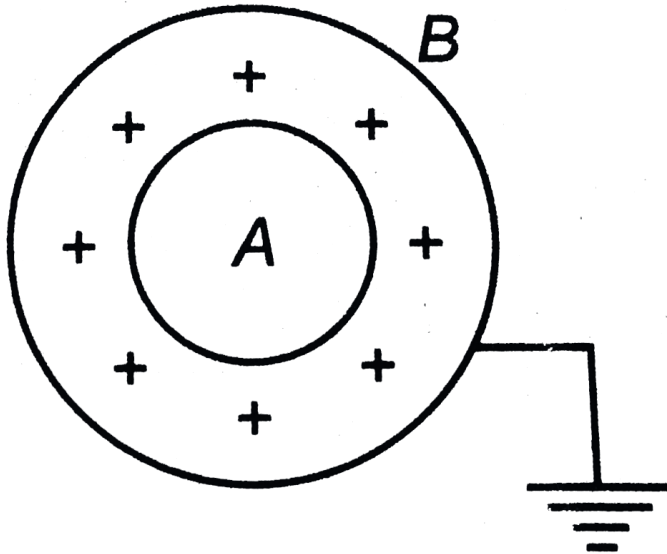
**Answer: D**



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**21.** A and B are two concentric spherical shells. If A is given a charge  $+q$  while B is earthed as shown

in figure then



A. charge on the outer surface of shell B is  
zero

B. the charge on B is equal and opposite to  
that of A

C. the field inside A and outside B is zero

D. All of the above

**Answer: D**



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

A.  $R$

B.  $2R$

C.  $\frac{R}{3}$

D.  $\frac{R}{2}$

**Answer: C**



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**23.** Four dipoles each of magnitudes of charges  $\pm e$  are placed inside a sphere. The total flux of  $E$  coming out of the sphere is

A. zero

B.  $\frac{4e}{\epsilon_0}$

C.  $\frac{8e}{\epsilon_0}$

D. none of these

**Answer: A**



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**24.** A pendulum bob of mass  $m$  charge  $q$  is at rest with its string making an angle  $\theta$  with the vertical in a uniform horizontal electric field  $E$ . The tension in the string in



A.  $\frac{mg}{\sin \theta}$

B.  $mg$

C.  $\frac{qE}{\sin \theta}$

D.  $\frac{qE}{\cos \theta}$

**Answer: C**



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**25.** Two isolated charged conducting spheres of radii  $a$  and  $b$  produce the same electric field near

their surface. The ratio of electric potentials on their surfaces is

A.  $\frac{a}{b}$

B.  $\frac{b}{a}$

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

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

**Answer: A**



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26. Two point charges  $+q$  and  $-q$  are held fixed at  $(-a, 0)$  and  $(a, 0)$  respectively of a x-y coordinate system then

- A. the electric field  $E$  at all point on the axis has the same direction.
- B.  $E$  at all points on the y-axis is along  $\hat{i}$
- C. positive work is done in bringing a test charge from infinity to the origin
- D. All of the above

**Answer: B**

27. A conducting shell  $S_1$  having a charge  $Q$  is surrounded by an uncharged concentric conducting spherical shell  $S_2$ . Let the potential difference between  $S_1$  and that  $S_2$  be  $V$ . If the shell  $S_2$  is now given a charge  $-3Q$ , the new potential difference between the same two shells is

A.  $V$

B.  $2V$

C.  $4V$

D.  $-2V$

**Answer: A**



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**28.** At a certain distance from a point charge, the field intensity is  $500\frac{V}{m}$  and the potential is  $-3000V$ . The distance to the charge and the magnitude of the charge respectively are

A.  $6m$  and  $6\mu C$

B.  $4m$  and  $2\mu C$

C.  $6m$  and  $4\mu C$

D.  $6m$  and  $2\mu C$

**Answer: D**



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**29.** Two points charges  $q_1$  and  $q_2$  are placed at a distance of 50 m from each other in air, and interact with a certain force. The same charges are now put in oil whose relative permittivity is 5.

If the interacting force between them is still the same, their separation now is

A.  $16.6m$

B.  $22.3m$

C.  $28.4m$

D.  $25.0m$

**Answer: B**



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30. An infinite line of charge  $\lambda$  per unit length is placed along the y-axis. The work done in moving a charge  $q$  from  $A(a, 0)$  to  $B(2a, 0)$  is

A.  $\frac{q\lambda}{2\pi\epsilon_0} \ln 2$

B.  $\frac{q\lambda}{2\pi\epsilon_0} \ln\left(\frac{1}{2}\right)$

C.  $\frac{q\lambda}{4\pi\epsilon_0} \ln\sqrt{2}$

D.  $\frac{q\lambda}{4\pi\epsilon_0} \ln 2$

**Answer: B**



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**31.** An electric dipole is placed perpendicular to an infinite line of charge at same distance as shown in figure. Identify the correct statement.



- A. the dipole is attracted towards the line charge
- B. the dipole is repelled away from the line charge
- C. the dipole does not experience a force
- D. the dipole experiences a force as well as a torque

**Answer: A**



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**32.** An electrical charge  $2 \times 10^{-8}$  C is placed at the point (1, 2, 4) m. At the point (4, 2, 0)m, the electric

A. potential will be 36 V

B. field will along y-axis

C. field will increase if the space between the points is filled with a dielectric

D. All of the above

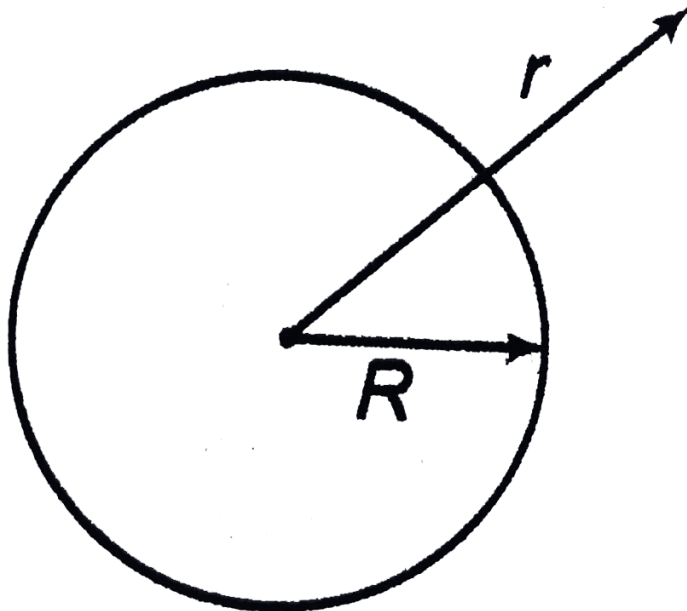
**Answer: A**



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**33.** If the potential at the centre of a uniformly charged hollow sphere of radius  $R$  is  $V$ , then electric field at a distance  $r$  from the centre of

sphere will be ( $r > R$ ).



A.  $\frac{VR}{r^2}$

B.  $\frac{Vr}{R^2}$

C.  $\frac{VR}{r}$

D.  $\frac{VR}{R^2 + r^2}$

**Answer: A**



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**34.** 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  $60^\circ$  with  $x$ -axis is 4 J, then what is the value of  $E$ ?

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

B.  $4N/C$

C.  $5N/C$

D.  $20N/C$

**Answer: D**



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**35.** Two thin wire rings each having radius  $R$  are placed at distance  $d$  apart with their axes coinciding. The charges on the two are  $+Q$  and  $-Q$ . The potential difference between the centre so the two rings is

A. zero

$$\text{B. } \frac{Q}{4\pi\epsilon_0} \left[ \frac{1}{R} - \frac{1}{\sqrt{R^2 + d^2}} \right]$$

$$\text{C. } \frac{Q}{4}\pi\epsilon_0 d^2$$

$$\text{D. } \frac{Q}{2\pi\epsilon_0} \left[ \frac{1}{R} - \frac{1}{\sqrt{R^2 + d^2}} \right]$$

**Answer: D**



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**36.** The electric field at a distance 2 cm from the centre of a hollow sphereical conducting shell of radlus 4 cm having a charge of  $2 \times 10^{-3}$  C on its surface is

A.  $1.1 \times 10^{10} \text{ V/m}$

B.  $4.5 \times 10^{-10} \text{ V/m}$

C.  $4.5 \times 10^{10} \text{ V/m}$

D. zero

**Answer: D**



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**37.** Charge  $Q$  is given a displacement  $r = a\hat{i} + b\hat{j}$

in electric field  $E = E_1\hat{i} + E_2\hat{j}$ . 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.  $Q\sqrt{E_1^2 + E_2^2}\sqrt{a^2 + b^2}$

**Answer: A**



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**38.** A certain charge  $Q$  is divided into two parts  $q$  and  $Q - q$ , which are then separated by a certain distance. What must  $q$  be in terms of  $Q$  to maximum the electrostatic repulsion between the two charges?

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**39.** An  $\alpha$ -particle is the nucleus of a helium atom. It has a mass  $m = 6.64 \times 10^{-27}$  kg and a charge  $q = +2e = 3.2 \times 10^{-19}$  C. Compare the force of the electric repulsion between two  $\alpha$ -particles with the force of gravitational attraction between them.

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**40.** What is the charge per unit area in  $C/m^2$  of an infinite plane sheet of charge if the electric field produced by the sheet of charge has magnitude  $3.0N/C$ ?



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**41.** A circular wire loop of radius  $R$  carries a total charge  $q$  distributed uniformly over its length. A small length  $x$  ( $x \ll R$ ) of the wire is cut off. Find the electric field at the centre due to the remaining wire.



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42. Two identical conducting spheres, fixed in space, attract each other with an electrostatic force of  $0.108N$  when separated by  $50.0cm$ , centre-to-centre. A thin conducting wire then connects the spheres. When the wire is removed, the spheres repel each other with an electrostatic force of  $0.0360N$ . What were the initial charges on the spheres?



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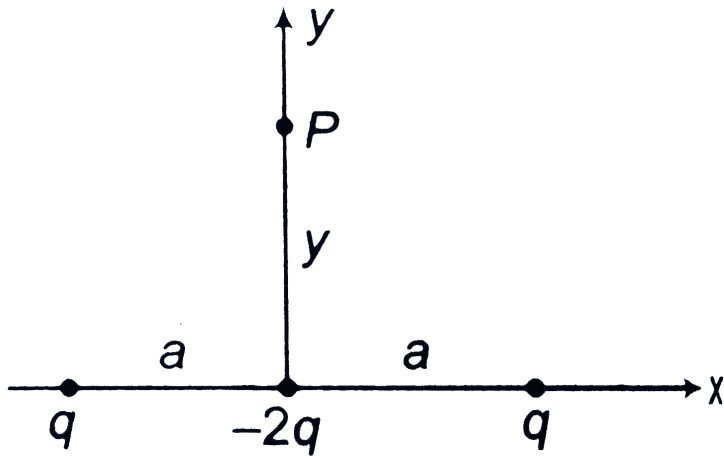
**43.** Show that the torque on an electric dipole placed in a uniform electric field is  $\tau = p \times E$  independent of the origin about which torque is calculated.



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**44.** Three point charges  $q$ ,  $-2q$  and  $q$  are located along the x-axis as shown in figure. Show that the electric field at  $P(y > a)$  along the y-axis is,

$$E = -\frac{1}{4\pi\epsilon_0} \frac{3qa^2}{y^4} \hat{j}$$

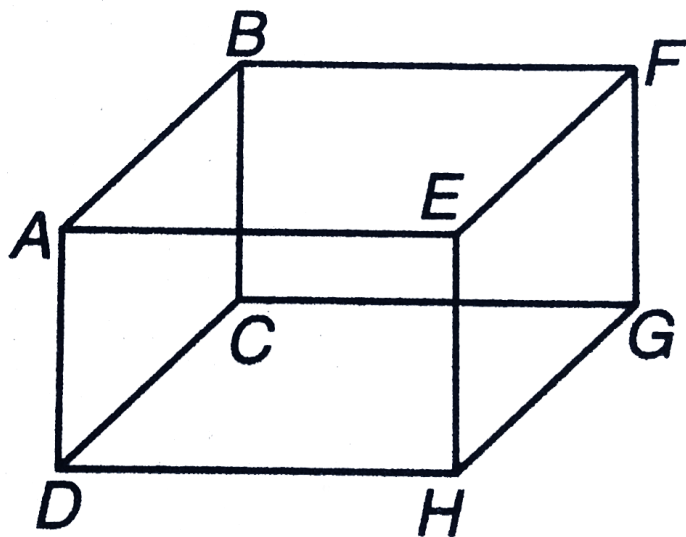


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**45.** A charge  $q$  is placed at point D of the cube.

Find the electric flux passing through the  $EFGH$

and face  $AEHD$ .



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**46.** Point charges  $q_1$  and  $q_2$  lie on the  $x$ -axis at points  $x = -a$  and  $x = +a$  respectively.

a. How must  $q_1$  and  $q_2$  be related for the net

electrostatic force on point charge  $+Q$ , placed at  $x = +\frac{a}{2}$ , to be zero?

b. With the same point charge  $+Q$  now placed at  $x = +3a/2$



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**47.** Two particles (free to move) with charges  $+q$  and  $+4q$  are a distance  $L$  apart. A third charge is placed so that the entire system is in equilibrium.

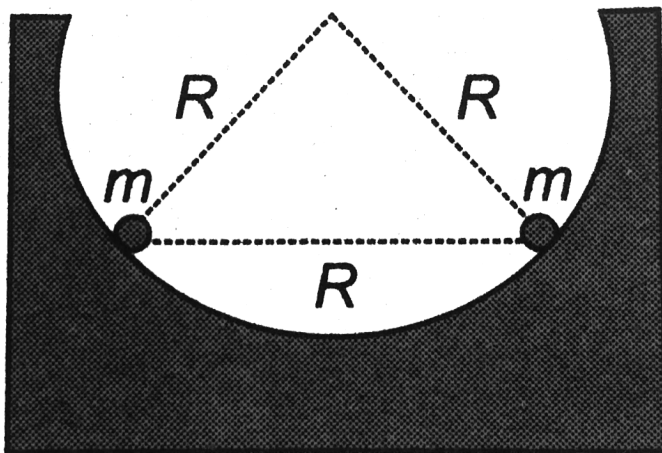
(a) Find the location, magnitude and sign of the third charge.

(b) Show that the equilibrium is unstable.





**48.** Two identical beads each have a mass  $m$  and charge  $q$ . When placed in a hemispherical bowl of radius  $R$  with frictionless, non-conducting walls, the beads move, and at equilibrium they are a distance  $R$  apart (figure). Determine the charge on each bead.





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**49.** Three identical small balls, each of mass  $0.1\text{ g}$ , are suspended at one point on silk thread having a length of  $l = 20\text{ cm}$ . What charges should be imparted to the balls for each thread to form an angle of  $\alpha = 30^\circ$  with the vertical?



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**50.** Three charges, each equal to  $q$ , are placed at the three corners of a square of side  $a$ . Find the

electric field at the fourth corner.



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**51.** A point charge  $q = -8.0nC$  is located at the origin. Find the electric field vector at the point  $x = 1.2m, y = -1.6m$ .



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**52.** Find the electric field at the centre of a uniformly charged semicircular ring of radius  $R$ . Linear charge density is  $\lambda$



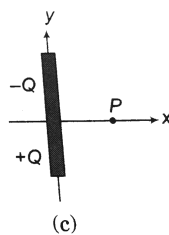
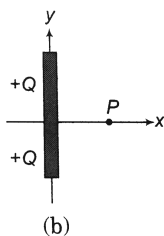
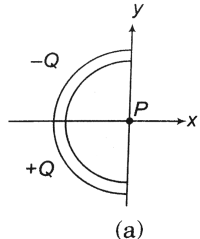
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**53.** Find the electric field at a point  $P$  on the perpendicular bisector of a uniformly charged rod. The length of the rod is  $L$ , the charge on it is  $Q$  and the distance of  $P$  from the centre of the rod is  $a$ .



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**54.** Find the direction of electric field at  $P$  for the charge distribution as shown in figure.



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**55.** A clock face has charges  $-q, -2q, \dots, -12q$  fixed at the position of the corresponding numerals on the dial. The clock hands do not disturb the net field due to point charges. At what time does the hour hand point in the direction of the electric field at the centre of the dial.



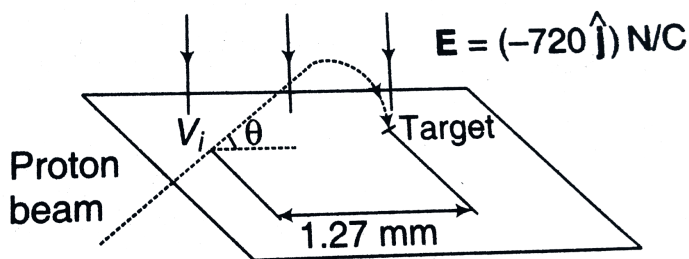
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56. A charged particle of mass  $m = 1 \text{ kg}$  and charge  $q = 2\mu\text{C}$  is thrown from a horizontal ground at an angle  $\theta = 45^\circ$  with the speed  $25\text{m/s}$ . In space, a horizontal electric field  $E = 2 \times 10^7 \text{ V/m}$  exists in the direction of motion. Find the range on horizontal ground of the projectile thrown. Take  $g = 10\text{m/s}^2$ .

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**57.** Protons are projected with an initial speed  $v_i = 9.55 \times 10^3 \text{ m/s}$  into a region where a uniform electric field  $E = (-720\hat{j}) \text{ N/C}$  is present, as shown in figure. The protons are to hit a target that lies at a horizontal distance of 1.27 mm from the point where the protons are launched. Find

- the two projection angles  $\theta$  that result in a hit
- and
- the total time of flight for each trajectory.





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**58.** At some instant the velocity components of an electron moving between two charged parallel plates are  $v_x = 1.5 \times 10^5 \text{ m/s}$  and  $v_y = 3.0 \times 10^6 \text{ m/s}$ . Suppose that the electric field between the plates is given by  $E = (120 \text{ N/C})\hat{j}$

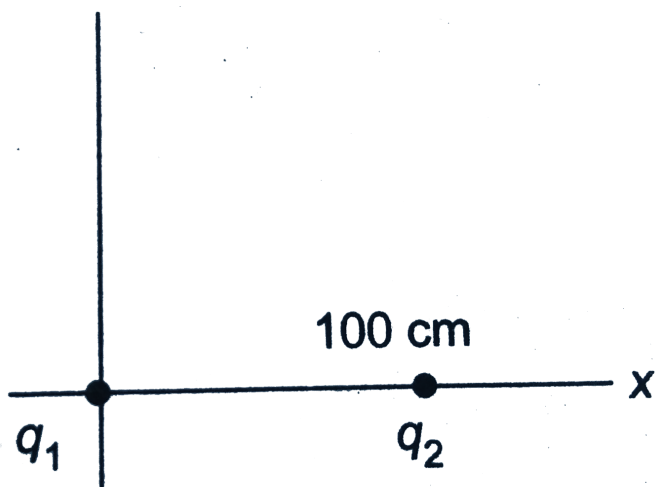
- . (a) What is the acceleration of the electron?
- (b) What will be the velocity of the electron after its x-coordinate has changed by 2.0 cm?



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59. A point charge  $q_1 = +2\mu C$  is placed at the origin of coordinates. A second charge,  $q_2 = -3\mu C$ , is placed on the x-axis at  $x = 100\text{cm}$ . At what point (or points) on the x-axis will the absolute potential be zero?



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**60.** A charge  $Q$  is spread uniformly in the form of a line charge density  $\lambda = \frac{Q}{3a}$  on the sides of an  $3a$  equilateral triangle of perimeter  $3a$ . Calculate the potential at the centroid  $C$  of the triangle.



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**61.** A uniform electric field of magnitude  $250V/m$  is directed in the positive  $x$ -direction.  $A + 12\mu C$  charge moves from the origin to the point  $(x, y) = (20.0cm, 5.0cm)$ .

(a) What was the change in the potential energy

of this charge?

(b) Through what potential difference did the charge move?



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**62.** A small particle has charge  $-5.00\mu C$  and mass  $2.00 \times 10^{-4}$  kg. It moves from point A where the electric potential is  $V_A = +200V$ . to point B, where the electric potential is  $V_B = +800V$ . The electric force is the only force acting on the particle. The particle has speed

$5.00 \frac{m}{s}$  at point A. What is its speed at point B? is it moving faster or slower at B than at A. Explain,

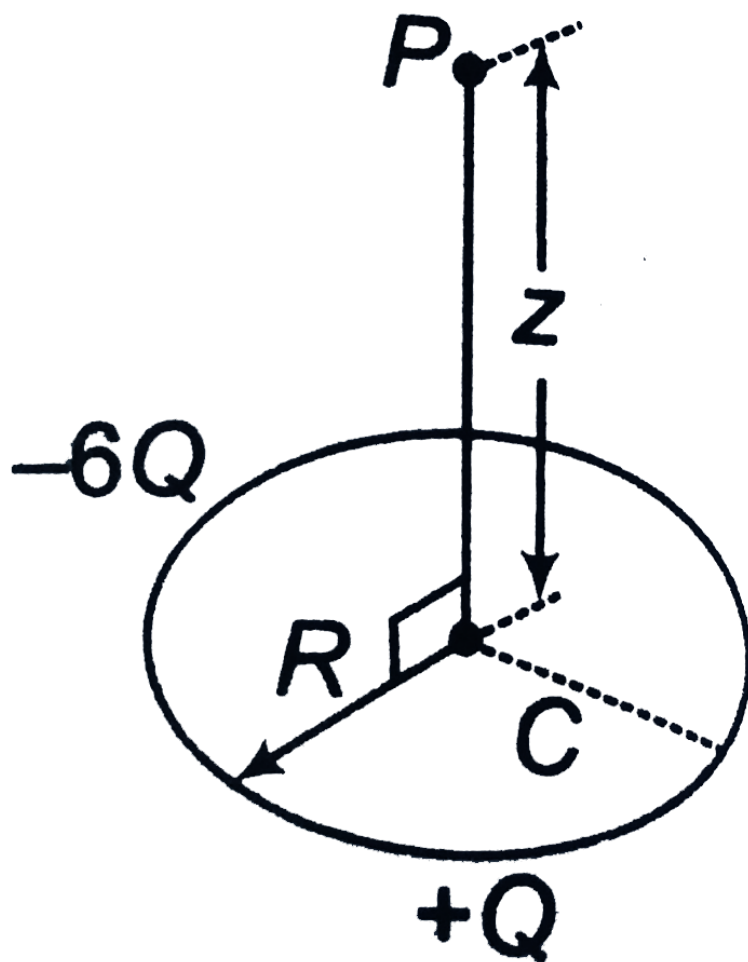


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**63.** A plastic rod has been formed into a circle of radius  $R$ . It has a positive charge  $+Q$  uniformly distributed along one-quarter of its circumference and a negative charge of  $-6Q$  uniformly distributed along the rest of the circumference (figure). With  $V = 0$  at infinity, what is the electric potential  $-6Q$

(a) at the centre C of the circle and

(b) at point P, which is on the central axis of the circle at distance  $z$  from the centre?



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**64.** A point charge  $q_1 = +2.40\mu C$  is held stationary at the origin. A second point charge  $q_2 = -4.30\mu C$  moves from the point  $x=0.150$  m,  $y=0$  to the point  $x=0.250$  m,  $y=0.250$  m. How much work is done by the electric force on  $q_2$ ?



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**65.** A point charge  $q_1 = 4.00nC$  is placed at the origin, and a second point charge  $q_2 = -3.00nC$ , placed on the x-axis at  $x = +20.0$  cm. A third point charge  $q_3 = 2.00nC$  is placed

on the X-axis between  $q_1$ , and  $q_2$ . (Take as zero the potential energy of the three charges when they are infinitely far apart).

(a) What is the potential energy of the system of the three charges if  $q_3$  is placed at  $x = +10.0$  cm?

(b) Where should  $q_3$  be placed to make the potential energy of the system equal to zero?



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**66.** Three point charges, which initially are infinitely far apart, are placed at the corners of an equilateral triangle with sides  $d$ . Two of the point

charges are identical and have charge  $q$ . If zero net work is required to place the three charges at the corners of the triangles, what must the value of the third charge be?



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**67.** The electric field in a certain region is given by  $E = (5\hat{i} - 3\hat{j}) \text{ kV/m}$ . Find the difference in potential  $V_B - V_A$ . If A is at the origin and point B is at a.  $(0,0,5)\text{m}$ , b.  $(4,0,3) \text{ m}$ .



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**68.** In a certain region of space, the electric field is along  $+y$ -direction and has a magnitude of  $400 \text{ V/m}$ . What is the potential difference from the coordinate origin to the following points?

a.  $x = 0, y = 20\text{cm}, z = 0$

b.  $x = 0, y = -30\text{cm}, z = 0$

c.  $x = 0, y = 0, z = 15\text{cm}$



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**69.** An electric field of  $20\text{N/C}$  exists along the  $x$ -axis in space. Calculate the potential difference

$V_B - V_A$  where the points A and B are given by

a.  $A = (0, 0), B = (4m, 2m)$

b.  $A = (4m, 2m), B = (6m, 5m)$



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**70.** The electric potential existing in space is

$$V(x, y, z) = A(xy + yz + zx)$$

(a) Write the dimensional formula of A.

(b) Find the expression for the electric field.

(c) If A is 10 SI units, find the magnitude of the electric field at  $(1m, 1m, 1m)$



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71. An electric field  $E = (20\hat{i} + 30\hat{j})$  N/C exists in the space. If the potential at the origin is taken be zero, find the potential at  $(2m, 2m)$ .



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72. In a certain region of space, the electric potential is  $V(x, y, z) = Axy - Bx^2 + Cy$ , where A, B and C are positive constants.

(a) Calculate the x, y and z- components of the electric field.

(b) At which points is the electric field equal to zero?



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**73.** A sphere centered at the origin has radius  $0.200m$ . A  $-500\mu C$  point charge is on the x-axis at  $x = 0.300m$ . The net flux through the sphere is  $360N \cdot m^2 / C$ . What is the total charge inside the sphere?



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**74.** A closed surface encloses a net charge of  $-3.60\mu C$ . What is the net electric flux through the surface?

(b) The electric flux through a closed surface is found to be  $780 N \cdot m^2 / C$ . What quantity of charge is enclosed by the surface?

(c) The closed surface in part (b) is a cube with sides of length 2.50 cm. From the information given in part (b), is it possible to tell where within the cube the charge is located? Explain.



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**75.** The electric field in a region is given by

$$\mathbf{E} = \frac{3}{5}E_0\hat{i} + \frac{4}{5}E_0\hat{j} \quad \text{with} \quad E_0 = 2.0 \times 10^3 \text{ N/C}.$$

Find the flux of this field through a rectangular surface of area  $0.2\text{m}^2$  parallel to the  $y$ - $z$  plane.



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**76.** The electric field in a region is given by

$$\mathbf{E} = \frac{E_0 x}{l} \hat{i}. \quad \text{Find the charge contained inside a}$$

cubical volume bounded by the surfaces

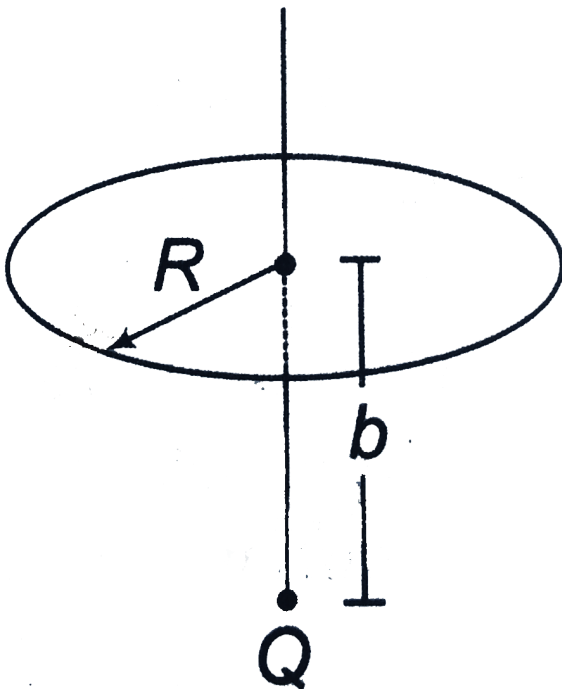
$x = 0, x = a, y = 0, y = h, z = 0$  and  $z = a$ . Take

$$E_0 = 5 \times 10^3 \text{ N/C}, l = 2\text{cm} \text{ and } a = 1\text{m}.$$



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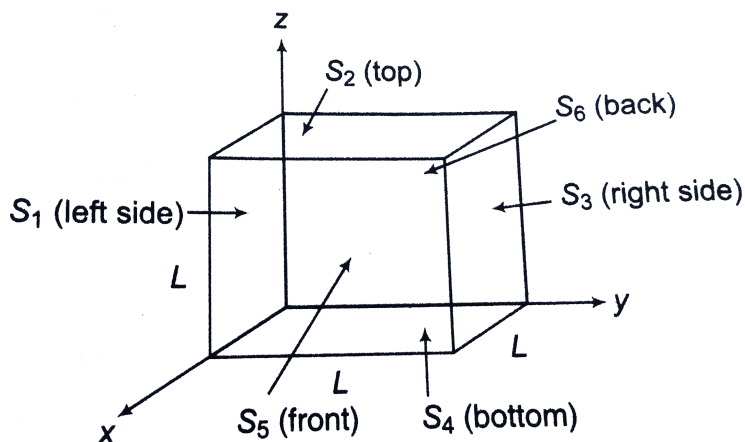
77. A point charge  $Q$  is located on the axis of a disc of radius  $R$  at a distance  $b$  from the plane of the disc (figure). Show that if one-fourth of the electric flux from the charge passes through the disc, then  $R = \sqrt{3}b$ .





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**78.** A cube has sides of length  $L$ . It is placed with one corner at the origin as shown in figure. The electric field is uniform and given by  $E = -B\hat{i} + C\hat{j} - D\hat{k}$ , where  $B$ ,  $C$  and  $D$  are positive constants.



(a) Find the electric flux through each of the six



cube faces  $S_1, S_2, S_3, S_4$  and  $S_5$  and  $S_6$ .

(b) Find the electric flux through the entire cube.



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**79.** Two point charges  $q$  and  $-q$  are separated by a distance  $2l$ . Find the flux strength vector across the circle of radius  $R$  placed with its centre coinciding with the of line joining the two charges in the perpendicular plane.



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**80.** A point charge  $q$  is placed at the origin. Calculate the electric flux through the open hemispherical surface

$$(x - a)^2 + y^2 + z^2 = a^2, x \geq a$$



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**81.** A charge  $Q$  is distributed over two concentric hollow spheres of radii  $r$  and  $R$  ( $R > r$ ) such that the surface charge densities are equal. Find the potential at the common centre.



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**82.** A charge  $q_0$  is distributed uniformly on a ring of radius  $R$ . A sphere of equal radius  $R$  constructed with its centre on the circumference of the ring. Find the electric flux through the surface of the sphere.



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**Level 1 Subjective**

1. Two concentric conducting shells A and B are of radii  $R$  and  $2R$ . A charge  $+q$  is placed at the centre of the shells. Shell B is earthed and a charge  $q$  is given to shell A. Find the charge on outer surface of A and B.



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2. 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  $\sigma$  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  $c$ .



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3. A charge  $Q$  is placed at the centre of an uncharged, hollow metallic sphere of radius  $a$ . (a) Find the surface charge density on the inner surface and on the outer surface. (b) If a charge  $q$  is put on the sphere, what would be the surface charge densities on the inner and the outer surface? (c) Find the electric field inside the

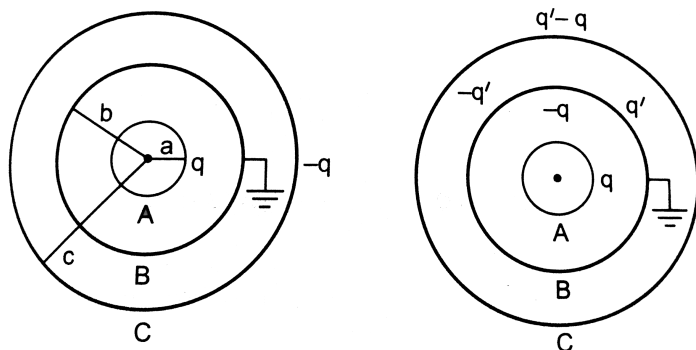
sphere at a distance  $x$  from the centre in the situations (a) and (b).



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4. Figure shows three concentric thin spherical shells A, B and C of radii  $a$ ,  $b$  and  $c$  respectively. The shells A and C are given charges  $q$  and  $-q$  respectively and the shell B is earthed. Find the

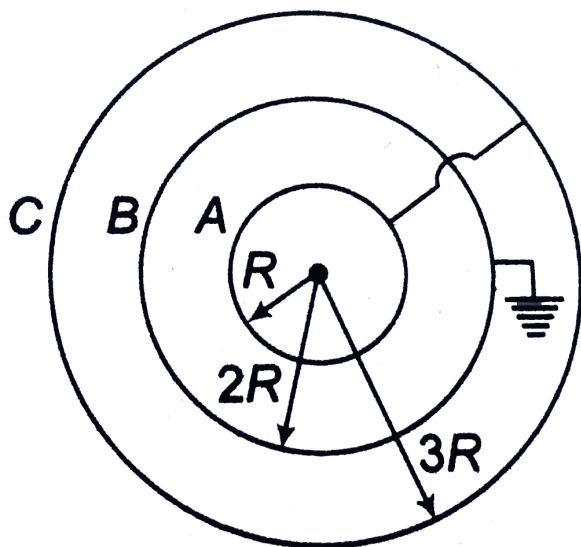
charges appearing on the surfaces of B and C.



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5. Three spherical shells have radii  $R$ ,  $2R$  and  $3R$  respectively. Total charge on A and C is  $3q$ . Find the charges on different surface of A, B and C. The

connecting wire does not touch the shell B.



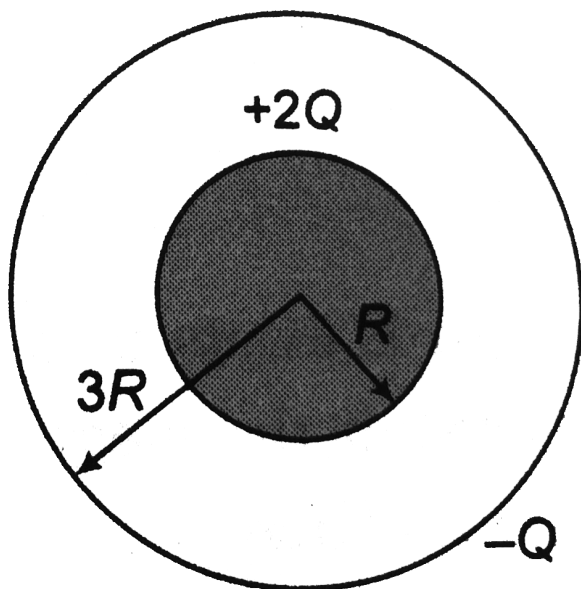
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6. In the above problem, the charges on different surfaces if a charge  $q$  is placed at the centre of the shell with all other conditions remaining the same.





7. A solid sphere of radius  $R$  has a charge  $+2Q$ . A hollow spherical concentric with the first sphere that has net charge  $-Q$ .



(a) Find the electric field between the spheres at a distance  $r$  from the centre of the inner sphere.

$$[R < r < 3R]$$

(b) Calculate the potential difference between the spheres.

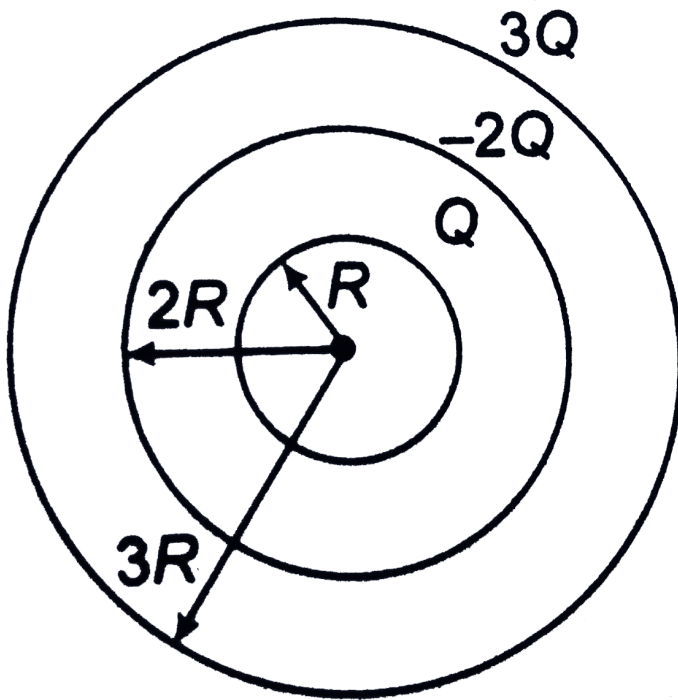
(c) What would be the final distribution of charges, if a conducting wire joins the spheres?

(d) Instead of (c), if the inner sphere is earthed, what is the charge on it?



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**8.** Three concentric conducting spherical shells of radii  $R$ ,  $2R$  and  $3R$  carry charges  $Q$ ,  $-2Q$  and  $3Q$ , respectively.



- a. Find the electric potential at  $r = R$  and  $r = 3R$  where  $r$  is the radial distance from the centre .
- b. Compute the electric field at  $r = \frac{5}{2}R$
- c. Compute the total electrostatic energy stored in the system.

The inner shell is now connected to the external

one by a conducting wire, passing through a very small hole in the middle shell.

d. Compute the charges on the spheres of radii  $R$  and  $3R$ .

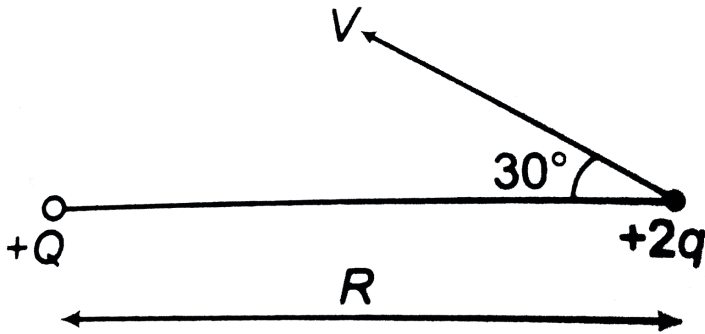
e. Compute the electric field at  $r = \frac{5}{2}R$



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**9.** In the diagram shown the charge  $+Q$  is fixed. Another charge  $+2q$  and mass  $M$  is projected from a distance  $R$  from the fixed charge. Minimum separation between the two charge if the velocity becomes  $\frac{1}{\sqrt{3}}$  time of the projected velocity, at

this moment is (Assume gravity to be absent)



A.  $\frac{\sqrt{3}}{2}R$

B.  $\frac{1}{\sqrt{3}}R$

C.  $\frac{1}{2}R$

D. none of these

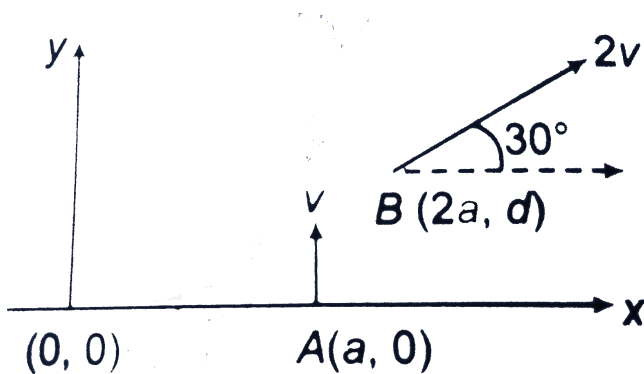
**Answer: A**



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**10.** A uniform electric field of strength  $E$  exists in region. A electron enters a point A with velocity  $v$  as shown. It moves through the electric field and reaches at point B. Velocity particle at B is  $2v$  at  $30^\circ$  with x-axis .

Then



A. electric field  $E = \frac{3mv^2}{2ea} \hat{i}$

B. rate of work done by electric field at B is

$$\frac{3mv^2}{2ea}$$

C. Both a and b are correct

D. both a and b are wrong

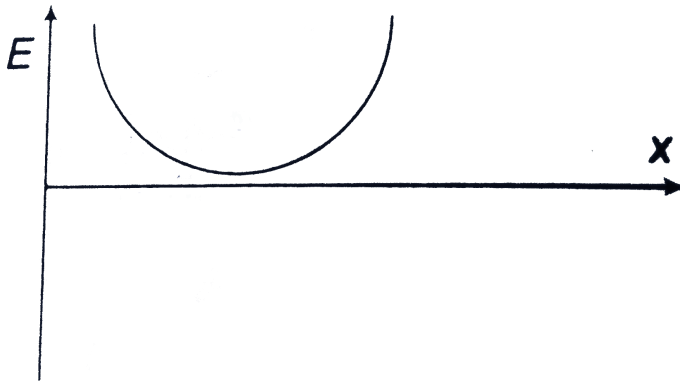
**Answer: A**



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**11.** Two point charges a and b whose magnitude are same, positioned at a certain distance along the positive x-axis from each other a is at origin.

Graph is drawn between electrical field strength and distance  $x$  from  $a$ .  $E$  is taken positive if it is along the line joining from  $a$  to  $b$ . From the graph it can be decided that



- A.  $a$  is positive  $b$  is negative
- B.  $a$  and  $b$  both are positive
- C.  $a$  and  $b$  both are negative
- D.  $a$  is negative,  $b$  is positive



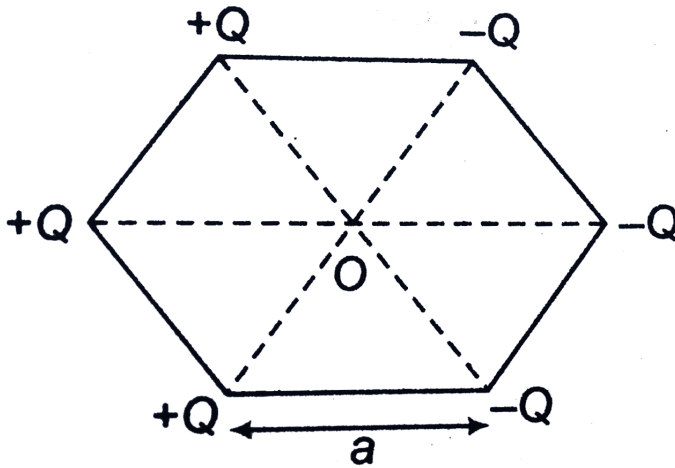
**Answer: A**



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**12.** Six charges are placed at the vertices of a rectangular hexagon as shown in the figure. The electric field on the line passing through point O and perpendicular to the plane of the figure as a function of distance  $x$  from point O is (assume

$x \gg a$ )



A. 0

B.  $\frac{Qa}{\pi\epsilon_0 x^3}$

C.  $\frac{2Qa}{\pi}\epsilon_0 x^3$

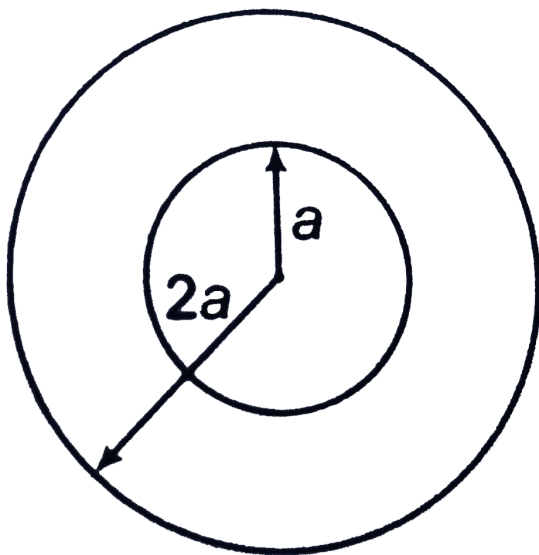
D.  $\frac{\sqrt{3}Qa}{\pi\epsilon_0 x^3}$

**Answer: B**



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



A.  $10V$

B.  $5V$

C.  $15V$

D. zero

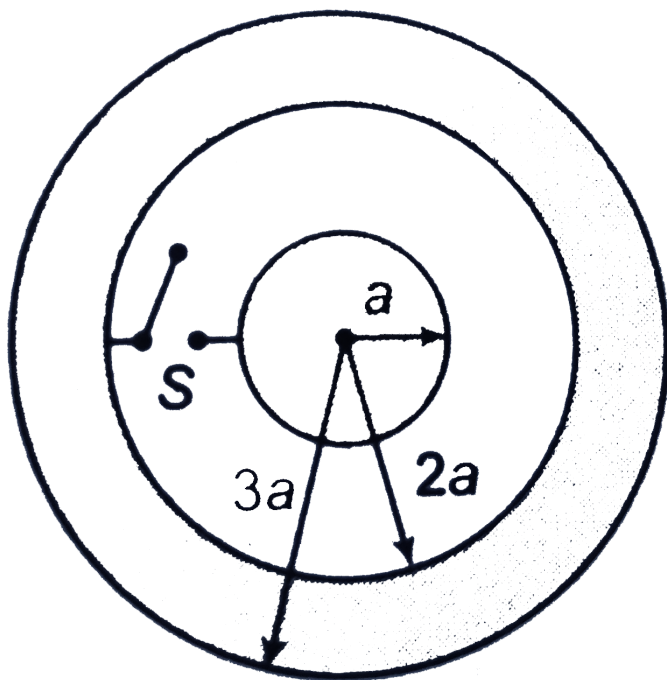
**Answer: A**



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**14.** A solid conducting sphere of radius  $a$  having a charge  $q$  is surrounded by a concentric conducting spherical shell of inner radius  $2a$  and outer radius  $3a$  as shown in figure. Find the amount of heat produced when switch is closed

$$\left(k = \frac{1}{4\pi\epsilon_0}\right)$$



A.  $\frac{kq^2}{2a}$

B.  $\frac{kq^2}{3a}$

C.  $\frac{kq^2}{4a}$

D.  $\frac{kq^2}{6a}$

**Answer: C**



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**15.** There are four concentric shells A, B, C and D of radii  $a$ ,  $2a$ ,  $3a$  and  $4a$  respectively. Shells B and D are given charges  $+q$  and  $-q$  respectively. Shell C is now earthed. The potential difference  $V_A - V_C$

is  $k = \left( \frac{1}{4\pi\epsilon_0} \right)$

A.  $\frac{kq}{2a}$

B.  $\frac{kq}{4a}$

C.  $\frac{kq}{4a}$

D.  $\frac{kq}{6a}$

**Answer: D**



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## SUBJECTIVE\_TYPE

1. Eight point charges of magnitude  $Q$  are arranged to form the corners of a cube of side  $L$ . The arrangement is made in manner such that the nearest neighbour of any charge has the

opposite sign. Initially, the charges are held at rest. If the system is let free to move, what happens to the arrangement? Does the cube-shape shrink or expand? Calculate the velocity of each charge when the side-length of the cube formation changes from  $L$  to  $nL$ . Assume that the mass of each point charge is  $m$ .



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2. A proton of mass  $m$  and accelerated by a potential difference  $V$  gets into a uniform electric field of a parallel plate capacitor parallel to plates



of length 1 at mid-point of its separation between plates. The field strength in it varies with time as  $E = at$ , where  $a$  is a positive constant. Find the angle of deviation of the proton as it comes out of the capacitor. (Assume that it does not collide with any of the plates.)



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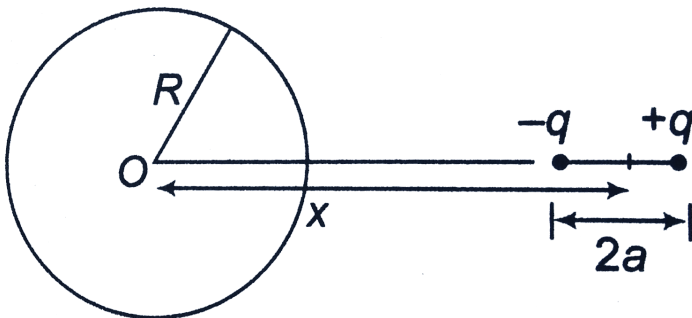
**3.** Two concentric rings placed in a gravity free region in  $yz$ -plane one of radius  $R$  carries  $a + Q$  and second of radius  $4R$  and charge  $-8Q$  distributed uniformly over it. Find the velocity

with which a point charge of mass  $m$  and charge  $+q$  should be projected from a distance  $3R$  from the centre of rings on its axis so that it will reach to the centre of the rings.



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4. An electric dipole is placed at a distance  $x$  from centre  $O$  on the axis of a charged ring of  $R$  and charge  $Q$  uniformly distributed over it.



- (a) Find the net force acting on the dipole.
- (b) What is the work done in rotating the dipole through  $180^\circ$ ?



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5. Three concentric, thin, spherical, metallic shells have radii 1, 2, and 4 cm and they are held at potentials 10, 0 and  $40V$  respectively. Taking the origin at the common centre, calculate the following:

- (a) Potential at  $r = 1.25$  cm

(b) Potential at  $r = 2.5 \text{ cm}$

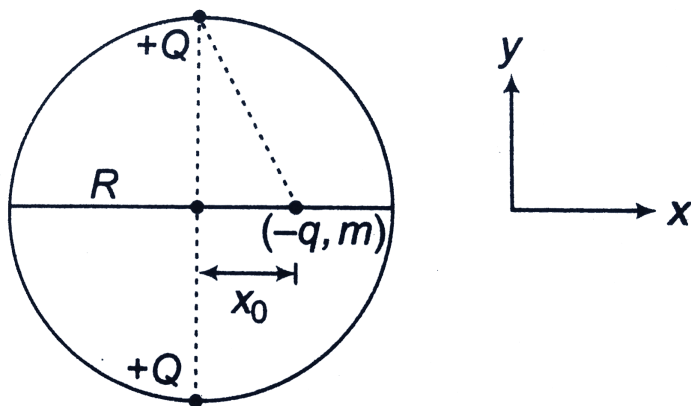
(c) Electric field at  $r = 1.25 \text{ cm}$



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6. A thin insulating wire is stretched along the diameter of an insulated circular hoop of radius  $R$ . A small bead of mass  $m$  and charge  $-q$  is threaded onto the wire. Two small identical charge  $+Q$  are tied to the hoop at points opposite to each other, so that the diameter passing through them is perpendicular to the thread (see figure). The bead is released at a point which is a distance  $x_0$ , from

the centre of the hoop. Assume that  $x_0 < R$ .



- What is the resultant acting on the charged bead?
- Describe (qualitatively) the motion of the bead after it is released.
- Use the assumption that  $x/R \ll 1$  to obtain an approximate equation of motion and find the displacement and velocity of the bead as functions of time.

d. When will the velocity of the bead will become zero for the first time?



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## Check point 1.1

1. Which of the following is correct regarding electric charge ?

(i) If a body is having positivr charge i.e. shortage of electrons

(ii) If a body is having negative charge i.e. excess of electrons

(iii) Minimum possible charge

$$= \pm 1.6 \times 10^{-19} C$$

(iv) Charge is quantised i.e.  $Q = \pm ne$ ,

where  $n = 1, 2, 3, 4, \dots$

A. both (i) and (ii)

B. Both (ii) and (iii)

C. (i), (ii), (iii)

D. All of these

**Answer: D**



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2. One metallic sphere  $A$  is given positive charge whereas another identical metallic sphere  $B$  of exactly same mass as of  $A$  is given equal amount of negative charge. Then

A. mass of  $A$  and mass of  $B$  still remain equal

B. mass of  $A$  increase

C. mass of  $B$  decrease

D. mass of  $B$  increase

**Answer: D**



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3. When  $10^{14}$  electrons are removed from a neutral metal sphere, the charge on it becomes

A. (a)  $16\mu C$

B. (b)  $-16\mu C$

C. (c)  $32\mu C$

D. (d)  $-32\mu C$

**Answer: A**



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4. A conductor has  $14.4 \times 10^{-19}$  coulombs positive charge. The conductor has : (Charge on electron  $= 1.6 \times 10^{-19}$  coulombs

- A. 9 electrons in excess
- B. 27 electrons in short
- C. 27 electrons in excess
- D. 9 electrons in short

**Answer: D**



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5. Charge on  $\alpha$  – particle is

A.  $4.8 \times 10^{-19} C$

B.  $1.6 \times 10^{-19} C$

C.  $3.2 \times 10^{-19} C$

D.  $6.4 \times 10^{-19} C$

**Answer: C**



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6. A body has  $-80$  micro coulomb of charge.

Number of additional electrons in it will be

A.  $8 \times 10^{-5}$

B.  $80 \times 10^{-17}$

C.  $5 \times 10^{14}$

D.  $1.28 \times 10^{-17}$

**Answer: C**



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7. When a glass rod is rubbed with silk, it

A. gains electrons from silk

- B. gives electrons to silk
- C. gains protons from silk
- D. given protons to silk

**Answer: B**



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**8.** If we comb our hair on a dry day and bring the comb near small pieces of paper, the comb attracts the pieces, why?

- A. comb is a good conductor

B. paper is a good conductor

C. the atoms in the paper get polarised by the charged comb

D. the comb possesses magnetic properties

**Answer: C**



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**9.** When a body is earth connected, electrons from the earth flow into the body. This means the body is ....

- A. uncharged
- B. charged positively
- C. charged negatively
- D. an insulator

**Answer: A**



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**10.** Consider a neutral conducting sphere. A positive point charge is placed outside the sphere. The net charge on the sphere is then

- A. Negative and distributed uniformly over the surface of the sphere
- B. Negative and appears only at the point on the sphere closed to the point charge
- C. Negative and distributed non-uniformly over the entire surface of the sphere
- D. zero

**Answer: D**



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## Check point 1.2

1. There are two charge  $+1\mu c$  and  $+2\mu c$  kept at certain separation ,the ratio of electrostatic forces acting on them will be in the ratio

A. 1 : 5

B. 1 : 1

C. 5 : 1

D. 1 : 25

**Answer: B**



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2. The force between two charges 0.06m apart is 5N. If each charge is moved towards the other by 0.01 m, then the force between them will become

A. 7.20 N

B. 11.25 N

C. 22.50 N

D. 45.00 N

**Answer: B**



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3. Write down the value of absolute permittivity of free space.

A.  $9 \times 10^9 NC^2 / m^2$

B.  $8.85 \times 10^{-12} N - m^2 / C^2 s$

C.  $8.85 \times 10^{-12} C^2 / N - m^2$

D.  $9 \times 10^9 C^2 / N - m^2$

**Answer: C**



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4. Two charges each equal to  $2\mu C$  are 0.5 m apart.

If both of them exist inside vacuum, then the force between them is

A. 1.89 N

B. 2.44 N

C. 0.144 N

D. 3.144 N

**Answer: C**



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5. The charges on two spheres are  $+7\mu C$  and  $-5\mu C$  respectively. They experience a force  $F$ . If each of them is given an additional charge of  $-2\mu C$ , the new force of attraction will be

A.  $F$

B.  $F / 2$

C.  $F / \sqrt{3}$

D.  $2F$

**Answer: A**



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6. Two charges of equal magnitudes and at a distance  $r$  exert a force  $F$  on each other. If the charges are halved and distance between them is doubled, then the new force acting on each charge is

A.  $F/8$

B.  $F/4$

C.  $4F$

D.  $F/16$

**Answer: D**



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7. A metallic partical having no net charge is placed near a finite metal plate carrying a positive charge. The electric force on the particale will be

- A. towards the plate
- B. away from the plate
- C. parallel to the plate
- D. zero

**Answer: A**

8. Two charge spheres separated at a distance  $d$  exert a force  $F$  on each other. If they are immersed in a liquid of dielectric constant  $K=2$ , then the force (if all conditions are same) is

A.  $\frac{F}{2}$

B.  $F$

C.  $2F$

D.  $4F$

**Answer: A**





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9. Two charges placed in air repel each other by a force of  $10^{-4} N$ . When oil is introduced between the charges, then the force becomes  $2.5 \times 10^{-5} N$

The dielectric constant of oil is

A. 2.5

B. 0.25

C. 2

D. 4

**Answer: D**



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**10.** Two point charges placed at a distance  $r$  in air experience a certain force. Then the distance at which they will experience the same force in a medium of dielectric constant  $K$  is

A.  $r$

B.  $r / K$

C.  $r / \sqrt{K}$

D.  $r\sqrt{K}$

**Answer: C**



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11.  $F_g$  and  $F_e$  represent gravitational and electrostatic force respectively between electrons situated at a distance 10 cm. The ratio of  $F_g / F_e$  is of the order of

A.  $10^{42}$

B.  $10^{-21}$

C.  $10^{24}$

D.  $10^{-43}$

**Answer: D**



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**12.** Two protons are a distance of  $1 \times 10^{-10} \text{ cm}$  from each other. The force acting on them are

A. nuclear force and gravitational force

B. nuclear force and coulomb force

C. coulomb force and gravitational force

D. nuclear, coulomb and gravitational force

**Answer: C**



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**13.** Two particle of equal mass  $m$  and charge  $q$  are placed at a distance of 16 cm. They do not experience any force. The value of  $\frac{q}{m}$  is

A.  $l$

B.  $\sqrt{\frac{\pi\epsilon_0}{G}}$

C.  $\sqrt{\frac{G}{4\pi\epsilon_0}}$

D.  $\sqrt{4\pi\epsilon_0 G}$

**Answer: D**



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**14.** A charge  $q_1$  exerts some force on a second charge  $q_2$ . If a third charge  $q_3$  is brought near  $q_2$ , then the force exerted by  $q_1$  on  $q_2$

A. decrease

B. increase

C. remains the same

D. increase, if  $q_3$  is of same sign as  $q_1$  and

decrease, if  $q_3$  is of opposite sign as  $q_1$

**Answer: C**



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**15.** Electric charge of  $1\mu C$ ,  $-1\mu C$  and  $2\mu C$  are placed in air at the corners A, B and C respectively of an equilateral triangle ABC having length of each side 10 cm. The resultant force on the charge at C is

A. 0.9 N

B. 1.8 N

C. 2.7 N

D. 3.6 N

**Answer: B**



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### Check point 1.3

1. The SI unit of electric field intensity is



A. newton/coulomb

B. joule/coulomb

C. volt-metre

D. newton/metre

**Answer: A**



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2. Which of the following is deflected by electric field ?

A. X-rays

B.  $\gamma$  – rays

C. Neutrons

D.  $\alpha$  – particles

**Answer: D**



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3. A charged particle of mass  $5 \times 10^{-5} \text{ kg}$  is held stationary in space by placing it in an electric field of strength  $10^7 \text{ NC}^{-1}$  directed vertically downwards. The charge on the particle is

A.  $-20 \times 10^{-5} \mu C$

B.  $-5 \times 10^{-5} \mu C$

C.  $5 \times 10^{-5} \mu C$

D.  $20 \times 10^{-5} \mu C$

**Answer: B**



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4. find the electric field strength due to a point charge of  $5\mu C$  at a distance of 80 cm from the charge.

A.  $8 \times 10^4 NC^{-1}$

B.  $7 \times 10^4 NC^{-1}$

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

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

**Answer: B**



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5. The electric field due to a charge at a distance of 3 m from it is  $500 NC^{-1}$ . The magnitude of the

charge is

$$\left[ \frac{1}{4\pi\epsilon_0} = 9 \times 10^9 N - m^2 / C^2 \right]$$

A.  $2.5\mu C$

B.  $2.0\mu C$

C.  $1.0\mu C$

D.  $0.5\mu C$

**Answer: D**



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6. Two charges  $+5\mu C$  and  $+10\mu C$  are placed  $20\text{cm}$  apart. The net electric field at the mid-point between the two charges is

- A.  $4.5 \times 10^6 \text{NC}^{-1}$  directed towards  $+5\mu C$
- B.  $4.5 \times 10^6 \text{NC}^{-1}$  directed towards  $+10\mu C$
- C.  $13.5 \times 10^6 \text{NC}^{-1}$  directed towards  $+5\mu C$
- D.  $13.5 \times 10^6 \text{NC}^{-1}$  directed towards  $+10\mu C$

**Answer: A**



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7. Two point charges  $+8q$  and  $-2q$  are located at  $x = 0$  and  $x = L$  respectively. The location of a point on the  $x$  axis at which the net electric field due to these two point charges is zero is

A.  $8L$

B.  $4L$

C.  $2L$

D.  $L/4$

**Answer: C**



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8. A cube of side  $b$  has a charge  $q$  at each of its vertices. Determine the electric field due to this charge array at the center of the cube.

A.  $q/b^2$

B.  $q/2b^2$

C.  $32q/b^2$

D. zero

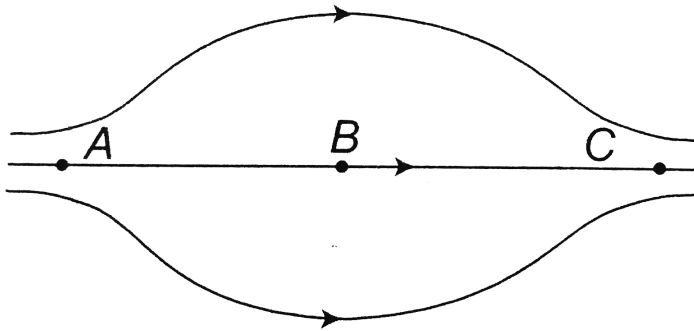
**Answer: D**



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9. The figure shows some of the electric field lines corresponding to an electric field. The figure suggests



A.  $E_A > E_B > E_C$

B.  $E_A = E_B = E_C$

C.  $E_A = E_C > E_B$

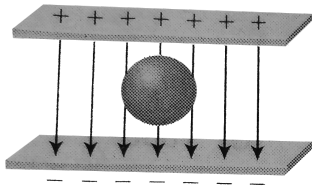
D.  $E_A = E_C < E_B$

Answer: C

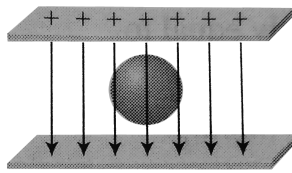


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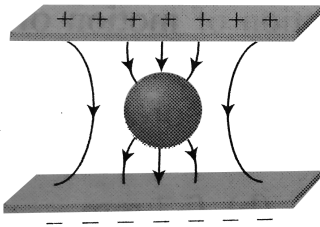
10. An uncharged sphere of metal is placed in between two charged plates as shown. The lines of force look like



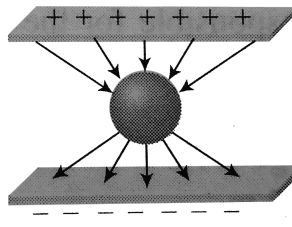
A



B



C



D

A. A

B. B

C. C

D. D

**Answer: C**



**Watch Video Solution**

**Check point 1.4**

1. The electric dipole moment of an electron and a proton 4.3 nm apart, is

A.  $6.8 \times 10^{-28} C - m$

B.  $2.56 \times 10^{-29} C^2 / m$

C.  $3.72 \times 10^{-14} C / m$

D.  $11 \times 10^{-46} C^2 / m$

**Answer: A**



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2. If  $E_a$  be the electric field strength of a short dipole at a point on its axial line and  $E_e$  that on the equatorial line at the same distance, then

A.  $E_e = 2E_a$

B.  $E_a = 2E_e$

C.  $E_a = E_e$

D. None of these

**Answer: B**



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3. Electric field on the axis of a small electric dipole at a distance  $r$  is  $E_1$  and  $E_2$  at a distance of  $2r$  on a line of perpendicular bisector. Then

A.  $\frac{E_0}{16}$

B.  $\frac{E_0}{16}$

C.  $\frac{E_0}{8}$

D.  $-\frac{E_0}{8}$

**Answer: D**



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4. The electric field due to an electric dipole at a distance  $r$  from its centre in axial position is  $E$ . If the dipole is rotated through an angle of  $90^\circ$  about its perpendicular axis, the electric field at the same point will be

A.  $E$

B.  $E/4$

C.  $E/2$

D.  $2E$

**Answer: C**



5. The torque acting on an electric dipole of moment  $p$  held at an angle  $\theta$  with an electric field  $E$  is .....

A.  $p.E$

B.  $p \times E$

C. zero

D.  $E \times p$

**Answer: B**





6. When an electric dipole  $P$  is placed in a uniform electric field  $\vec{E}$  then at what angle between  $\vec{P}$  and  $\vec{E}$  the value of torque will be maxima

A.  $90^\circ$

B.  $0^\circ$

C.  $180^\circ$

D.  $45^\circ$

**Answer: A**



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7. An electric dipole is kept in non-uniform electric field. It experiences

- A. a force and a torque
- B. a force but not a torque
- C. a torque but not a force
- D. Neither a force nor a torque

**Answer: A**



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8. An electric dipole of moment  $\vec{p}$  is placed normal to the lines of force of electric intensity  $\vec{E}$ , then the work done in deflecting it through an angle of  $180^\circ$  is

A.  $pE$

B.  $+2pE$

C.  $-2pE$

D. zero

**Answer: D**



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9. A molecule with a dipole moment  $p$  is placed in an electric field of strength  $E$ . Initially the dipole is aligned parallel to the field. If the dipole is to be rotated to be anti-parallel to the field, the work required to be done by an external agency is

A.  $-2pE$

B.  $-pE$

C.  $pE$

D.  $2pE$

**Answer: D**



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10. Two opposite and equal charges  $4 \times 10^{-8}$  coulomb when placed  $2 \times 10^{-2} \text{ cm}$  away, from a dipole. If dipole is placed in an external electric field  $4 \times 10^8$  newton/coulomb, the value of maximum torque and the work done in rotating it through  $180^\circ$  will be

A.  $64 \times 10^{-4} \text{ N} - \text{m}$  and  $64 \times 10^{-4} \text{ J}$

B.  $32 \times 10^{-4} \text{ N} - \text{m}$  and  $32 \times 10^{-4} \text{ J}$

C.  $64 \times 10^{-4} \text{ N} - \text{m}$  and  $32 \times 10^{-4} \text{ J}$

D.  $32 \times 10^{-4} \text{ N} - \text{m}$  and  $64 \times 10^{-4} \text{ J}$

**Answer: D**



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## Check point 1.5

1. The law governing electrostatics is Coulomb's law. In principle, Coulomb's law can be used to compute the electric field due to any charge configuration. In practice, however, it is a formidable task to compute the electric field due to uniform charge distributions. For such cases, Gauss proposed a theorem which states that

$$\oint \vec{E} \cdot \vec{ds} = \frac{q}{\epsilon_0}$$

where  $ds$  is an element of area directed across the outward normal for the surface at every point. The integral is called electric flux. Any convenient surface that we choose to evaluate the surface integral is called the Gaussian surface.

The *SI* unit of electric flux is

A. weber

B. newton coulomb<sup>-1</sup>

C. Volt × metre

D. joule coulomb<sup>-1</sup>

**Answer: C**



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2. A surface element  $\vec{ds} = 5\hat{i}$  is placed in an electric field  $\vec{E} = 4\hat{i} + 4\hat{j} + 4\hat{k}$ . What is the electric flux emanating from the surface ?

A. 40 unit

B. 50 unit

C. 30 unit

D. 20 unit



**Answer: A**



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3. A cube of side  $a$  is placed in a uniform electric field  $E = E_0\hat{i} + E_0\hat{j} + E_0\hat{k}$ . Total electric flux passing through the cube would be

A.  $E_0a^2$

B.  $2E_0a^2$

C.  $6E_0a^2$

D. None of these

**Answer: D**



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**4.** Flux coming out from a positive unit charge placed in air, is

A.  $\epsilon_0$

B.  $\epsilon_0^{-1}$

C.  $(4\pi\epsilon_0)^{-1}$

D.  $4\pi\epsilon_0$

**Answer: B**



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5. If the electric flux entering and leaving an enclosed surface respectively is  $\phi_1$  and  $\phi_2$ , the electric charge inside the surface will be

A.  $(\phi_1 + \phi_2)\epsilon_0$

B.  $(\phi_2 - \phi_1)\epsilon_0$

C.  $(\phi_1 + \phi_2) / \epsilon_0$

D.  $(\phi_2 - \phi_1) / \epsilon_0$

**Answer: B**

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6. Charge of 2 C is placed at the centre of a cube.

What is the electric flux passing through one face ?

A.  $\frac{1}{(3\epsilon_0)}$

B.  $\left(\frac{1}{4}\right)\epsilon_0$

C.  $\frac{2}{\epsilon_0}$

D.  $\frac{3}{\epsilon_0}$

**Answer: A**

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7. For a given surface the Gauss's law is stated as

$\oint \vec{E} \cdot d\vec{A} = 0$ . From this we can conclude that

- A. E is necessarily zero on the surface
- B. E is perpendicular to the surface at every point
- C. The total flux through the surface is zero
- D. The flux is only going out to the surface

**Answer: C**



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8. The total electric flux emanating from a closed surface enclosing an alpha particale ( $e$  = electronic chage) is

A.  $\frac{2e}{\epsilon_0}$

B.  $\frac{e}{\epsilon_0}$

C.  $e\epsilon_0$

D.  $\frac{\epsilon_0 e}{4}$

**Answer: A**



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9. The inward and outward electric flux for a closed surface unit of  $N - m^2 / C$  are respectively  $8 \times 10^3$  and  $4 \times 10^3$ . Then the total charge inside the surface is [where  $\epsilon_0 =$  permittivity constant]

A.  $4 \times 10^3 C$

B.  $-4 \times 10^3 C$

C.  $\frac{(-4 \times 10^3)}{\epsilon} C$

D.  $-4 \times 10^3 \epsilon_0 C$

**Answer: D**



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**10.** If the flux of the electric field through a closed surface is zero,

- A. (i), (ii)
- B. (ii), (iii)
- C. (ii), (iv)
- D. (i), (iii)

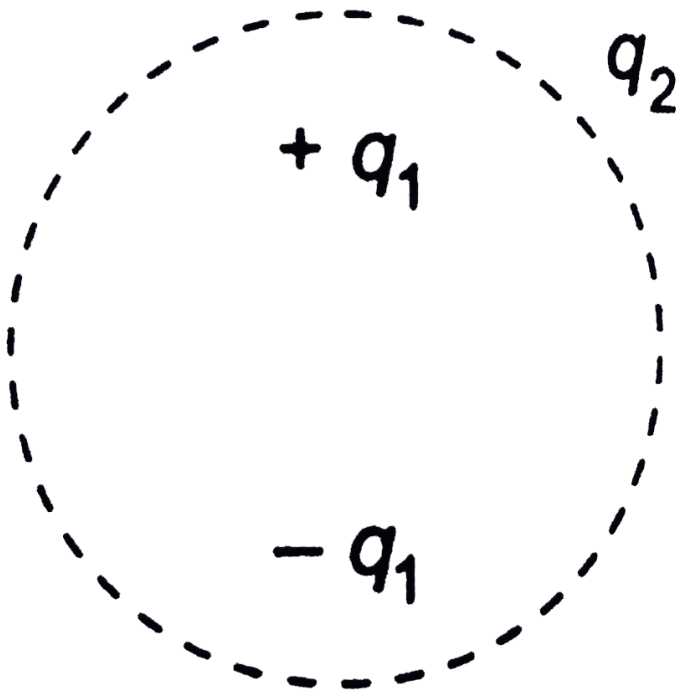
**Answer: B**



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11. Consider the charge configuration and a spherical Gaussian surface as shown in the figure. When calculating the flux of the electric field over the spherical surface, the electric field will be due to.



A.  $q_2$

B. only the positive charge

C. all the charges

D.  $+q_1$  and  $-q_1$

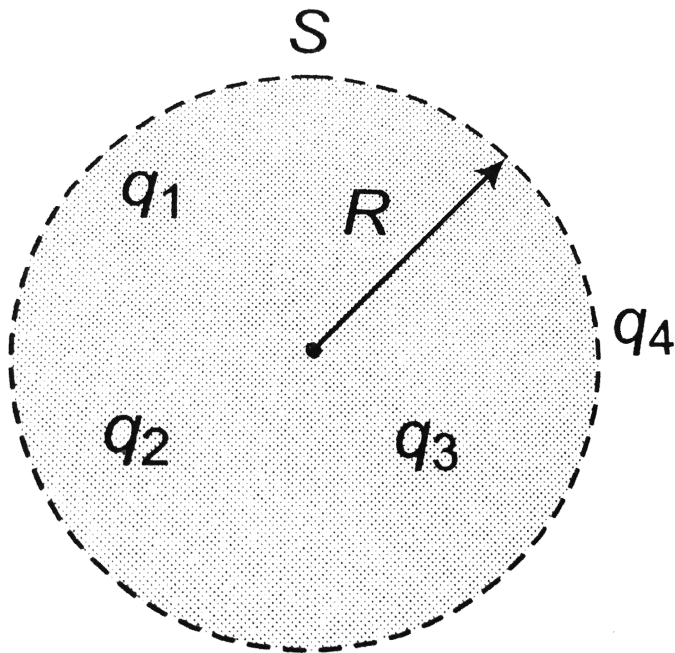
**Answer: C**



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**12.**  $q_1, q_2, q_3$  and  $q_4$  are point charges located at point as shown in the figure and  $s$  is a spherical Gaussian surface of radius  $R$ . Which of the

following is true according to the Gauss's law



A.  $\oint_s (E_1 + E_2 + E_3) \cdot dA = \frac{q_1 + q_2 + q_3}{2\epsilon_0}$

B.  $\oint_S (E_1 + E_2 + E_3) \cdot dA = \frac{(q_1 + q_2 + q_3)}{\epsilon_0}$

C.

$$\oint_S (E_1 + E_2 + E_3) \cdot dA = \frac{(q_1 + q_2 + q_3 + q_4)}{\epsilon_0}$$

D. None of the above

**Answer: D**



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**13.** The Gaussian surface for calculating the electric field due to a charge distribution is

- A. (a) any surface near the charge distribution
- B. (b) always a spherical surface
- C. (c) a symmetrical closed surface containing  
the charge distribution, at every point of

which electric field has a single fixed value

D. (d) None of the given options

**Answer: C**



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**14.** If Coulomb's law involved  $\frac{1}{r^3}$  instead of  $\frac{1}{r^2}$ ,  
would Gauss's law still be true?

A. there were magnetic monopoles

B. the inverse square law were not exactly true

C. the velocity of light were not a universal constant

D. None of the above

**Answer: B**



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**15.** Two parallel infinite line charges with linear charge densities  $+\lambda \text{ C/m}$  and  $-\lambda \text{ C/m}$  are placed at a distance of  $2R$  in free space. What is the electric field mid-way between the two line charges?

A. zero

B.  $\frac{2\lambda}{\pi\epsilon_0 R}$

C.  $\frac{\lambda}{\pi\epsilon_0 R}$

D.  $\frac{1}{2\pi\epsilon_0 R}$

**Answer: B**



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**16.** An infinite line charge produces a field of  $9 \times 10^4 \frac{N}{C}$  at a distance of 2cm. Calculate the linear charge density.

A.  $2 \times 10^{-7} C / m$

B.  $10^{-8} C / m$

C.  $10^7 C / m$

D.  $10^{-4} C / m$

**Answer: A**



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**17.** A charge of  $17.7 \times 10^{-4} C$  is distributed uniformly over a large sheet of area  $200 m^2$ . The



electric field intensity at a distance 20 cm from it  
in air will be

A.  $5 \times 10^5 N/C$

B.  $6 \times 10^5 N/C$

C.  $7 \times 10^5 N/C$

D.  $8 \times 10^5 N/C$

**Answer: A**



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**18.** From what distance should a 100 eV electron be fired towards a large metal plate having a surface charge of  $-2.0 \times 10^{-6} \text{ C m}^{-2}$ , so that it just fails to strike the plate ?

A. 0.50 mm

B. 0.44 mm

C. 0.60 mm

D. 0.77 mm

**Answer: B**



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19. If the field near the earth's surface is  $300 \text{ V m}^{-1}$  directed downwards, what is the surface density of charge on the surface of the earth?

A.  $3.0 \times 10^{-9} \text{ C/m}^2$

B.  $5.0 \times 10^{-9} \text{ C/m}^2$

C.  $2.6 \times 10^{-9} \text{ C/m}^2$

D.  $7.0 \times 10^{-9} \text{ C/m}^2$

**Answer: C**



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20. A thin spherical shell of metal has a radius of 0.25 m and carries a charge of 0.2 mC. The electric intensity at a point for outside the shell will be

A.  $2.88 \times 10^4 \text{ N/C}$

B.  $3.4 \times 10^4 \text{ N/C}$

C.  $325 \times 10^4 \text{ N/C}$

D.  $3.88 \times 10^4 \text{ N/C}$

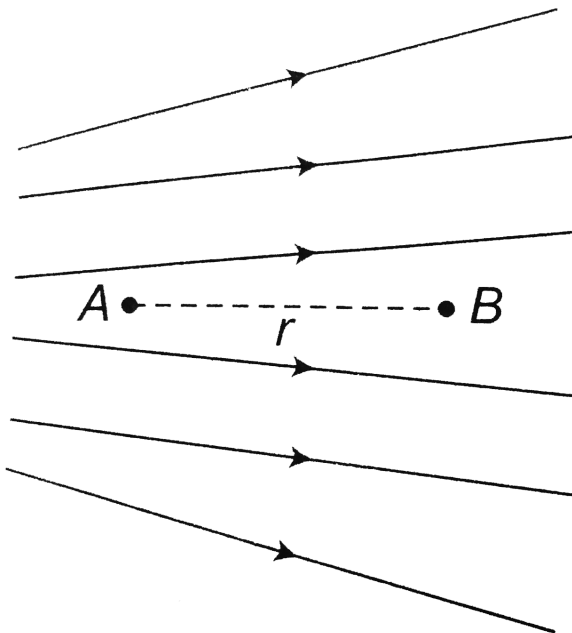
**Answer: A**



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## Taking it together

1. Figure shows the electric lines of force emerging from a charged body. If the electric field at  $A$  and  $B$  are  $E_A$  and  $E_B$  respectively and if the displacement between  $A$  and  $B$  is  $r$  then



A.  $E_A > E_B$

B.  $E_A < E_B$

C.  $E_A = \frac{E_B}{r}$

D.  $E_A = \frac{E_B}{r^2}$

**Answer: A**



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2. The unit of physical quantity obtained by the line integral of electric field is

A.  $NC^{-1}$

B.  $Vm^{-1}$

C.  $JC^{-1}$

D.  $C^2N^{-1}m^{-2}$

**Answer: C**



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3. Two point charge  $+2C$  and  $+6C$  repel each other with a force of  $12N$  . If a charge of  $-4C$  is given to each other of these charges , the force will now be

- A. 4 N (repulsive)
- B. 4 N (attractive)
- C. 12 N (attractive)
- D. 8 N (repulsive)

**Answer: B**



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4. Three equal charges are placed on the three corners of a square. If the force between  $q_1$  and  $q_2$



is  $F_{12}$  and that between  $q_1$  and  $q_3$  is  $F_{13}$ , then the ratio of magnitudes  $(F_{12} / F_{13})$  is

A.  $1/2$

B.  $2$

C.  $1/\sqrt{2}$

D.  $\sqrt{2}$

**Answer: B**



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5. The insulation property of air breaks down at  $E = 3 \times 10^6 \text{ volt/meter}$ . The maximum charge that can be given to a sphere of diameter  $5m$  is approximately (in coulombs)

A. (a)  $2 \times 10^{-2}$

B. (b)  $2 \times 10^{-3}$

C. (c)  $2 \times 10^{-4}$

D. (d)  $2 \times 10^{-5}$

**Answer: B**



**Watch Video Solution**

6. The electric field near a conducting surface having a uniform surface charge density  $\sigma$  is given by

A. (a)  $\frac{\sigma}{\epsilon_0}$  and is parallel to the surface

B. (b)  $\frac{2\sigma}{\epsilon_0}$

C. (c)  $\frac{\sigma}{\epsilon_0}$  and is normal to the surface

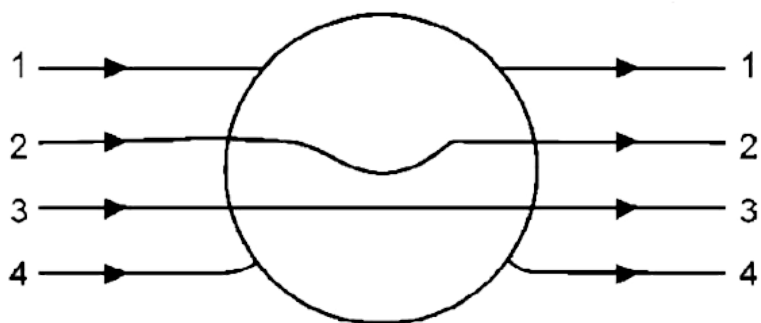
D. (d)  $\frac{2\sigma}{\epsilon_0}$  and is normal to the surface

**Answer: C**



**Watch Video Solution**

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



A. 1

B. 2

C. 3

D. 4

**Answer: D**



**Watch Video Solution**

8. A conductor has been given a charge  $-3 \times 10^{-7} C$  by transferring electron. Mass increase (in kg) of the conductor and the number of electrons added to the conductor are respectively

A.  $2 \times 10^{-16}$  and  $2 \times 10^{31}$

B.  $5 \times 10^{-31}$  and  $5 \times 10^{19}$

C.  $3 \times 10^{-19}$  and  $9 \times 10^{16}$

D.  $2 \times 10^{-18}$  and  $2 \times 10^{12}$

**Answer: D**



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9. Two point charges of  $20\mu C$  and  $80\mu C$  are 10 cm apart where will the electric field strength be zero on the line joining the charges from  $20\mu C$  charge

A. 0.1 m

B. 0.04 m

C. 0.033 m

D. 0.33 m

**Answer: C**



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**10.** For a dipole  $q = 2 \times 10^{-6}C$  and  $d = 0.01m$ .

Calculate the maximum torque for this dipole if

$$E = 5 \times 10^5 N/C$$

A.  $1 \times 10^{-3} N - m^{-1}$

B.  $10 \times 10^{-3} N - m^{-1}$

C.  $10 \times 10^{-3} N - m$

D.  $1 \times 10^2 N - m^2$

**Answer: C**



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**11.** What is the magnitude of a point charge due to which the electric field  $30cm$  away the magnitude 2?

$$\left[ \frac{1}{4\pi\epsilon_0} = 9 \times 10^9 Nm^2 / C^2 \right]$$

A.  $2 \times 10^{-11} C$

B.  $3 \times 10^{-11} C$



C.  $5 \times 10^{-11} C$

D.  $9 \times 10^{-11} C$

**Answer: A**



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**12.** A dipole of electric dipole moment  $p$  is placed in a uniform electric field of strength  $E$ . If  $\theta$  is the angle between positive direction of  $p$  and  $E$ , then the potential energy of the electric dipole is largest when  $\theta$  is

A.  $\frac{\pi}{4}$

B.  $\frac{\pi}{2}$

C.  $\pi$

D. zero

**Answer: C**



**Watch Video Solution**

**13.** The ratio of electrostatic and gravitational force acting between electron and proton separated by a distance  $5 \times 10^{-11}m$ , will be

(charge on electron  $= 1.6 \times 10^{-19} C$ , mass of  
electron  $= 9.1 \times 10^{-31} kg$ , mass of proton  
 $= 1.6 \times 10^{-27} kg$ ,  $G = 6.7 \times 10^{-11} N - m^2 / kg^2$   
)

A.  $2.36 \times 10^{39}$

B.  $2.36 \times 10^{40}$

C.  $2.34 \times 10^{41}$

D.  $2.34 \times 10^{42}$

**Answer: A**



**Watch Video Solution**

14. An electric dipole is placed in an uniform electric field with the dipole axis making an angle  $\theta$  with the direction of the electric field. The orientation of the dipole for stable equilibrium is

A.  $\frac{\pi}{6}$

B.  $\frac{\pi}{3}$

C. 0

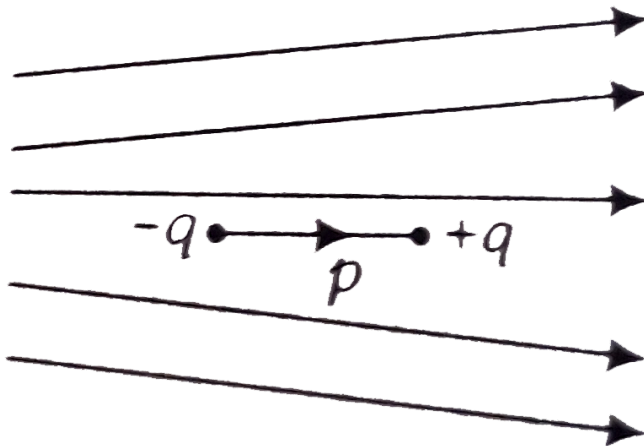
D.  $\frac{\pi}{2}$

**Answer: C**



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15. Figure shows electric field lines in which an electric dipole  $p$  is placed as shown. Which of the following statements is correct ?



- A. The dipole will not experience any force
- B. The dipole will experience a force towards right

C. The dipole will experience a force towards left

D. The dipole will experience of force upwards

**Answer: C**



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**16.** Two similar spheres having  $+q$  and  $-q$  charges are kept at a certain distance. The force acts between the two is  $F$ . If in the middle of two spheres, another similar sphere having  $+q$  charge

is kept, then it experiences a force in magnitude and direction as

A. zero having no direction

B.  $8F$  towards  $+q$  charge

C.  $8F$  towards  $-q$  charge

D.  $4F$  towards  $+q$  charge

**Answer: C**



**Watch Video Solution**

17. Two small conducting spheres of equal radius have charges  $+10\mu C$  and  $-20\mu C$  respectively and placed at a distance  $R$  from each other. They experience force  $F_1$ . If they are brought in contact and separated to the same distance, they experience force  $F_2$ . The ratio of  $F_1$  to  $F_2$  is

A. 1 : 8

B. - 8 : 1

C. 1 : 2

D. - 2 : 1

**Answer: B**





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**18.** A charges  $Q$  is placed at each of the two opposite corners of a square. A charge  $q$  is placed to each of the other two corners. If the resultant force on each charge  $q$  is zero, then

A.  $Q = \sqrt{2}q$

B.  $Q = -\sqrt{2}q$

C.  $Q = 2\sqrt{2}q$

D.  $Q = -2\sqrt{2}q$

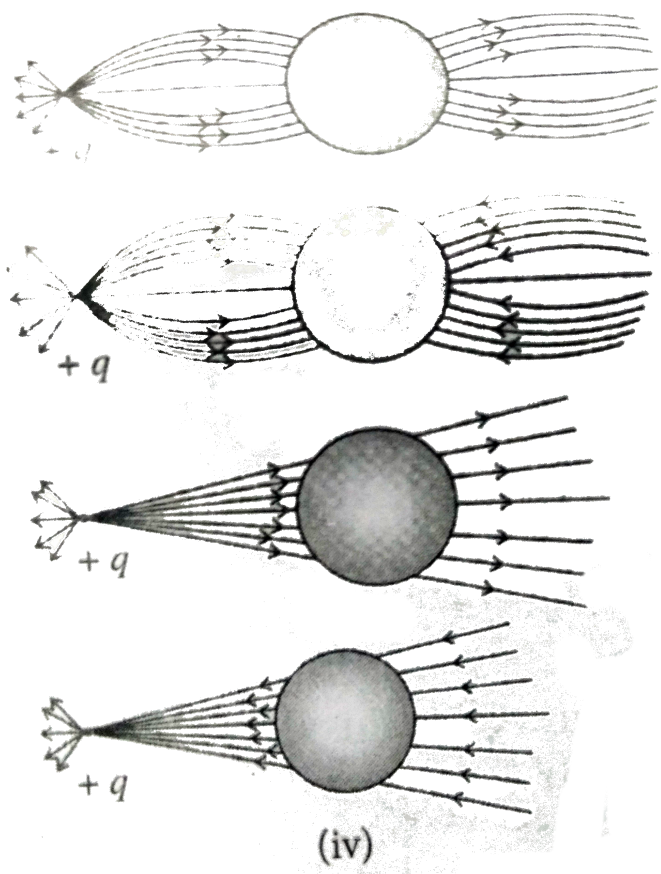
**Answer: D**

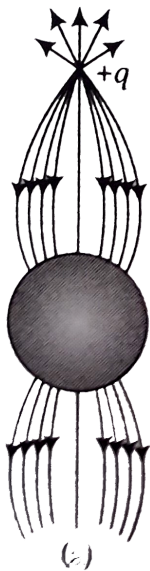


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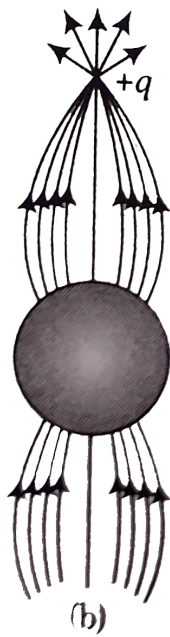
**19.** A point positive charge is brought near an isolated conducting sphere. The electric field is

best given by

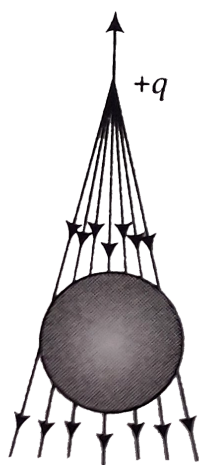




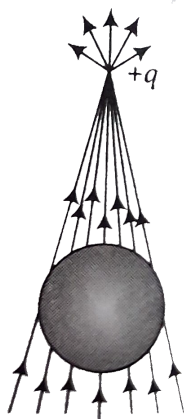
A.



B.



C. (c)



D. (d)

**Answer: A**



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

A.  $Q/2$

B.  $-Q/2$

C.  $Q/4$

D.  $-Q/4$

**Answer: D**



21. The centres of two identical small conducting spheres are 1m apart. They carry charge of opposite kind and attract each other with a force  $F$ . When they are connected by a conducting thin wire they repel each other with a force  $F/3$ . What is the ratio of magnitude of charge carried by the sphere initially ?

A. 1 : 1

B. 2 : 1

C. 3 : 1

D. 4: 1

**Answer: C**

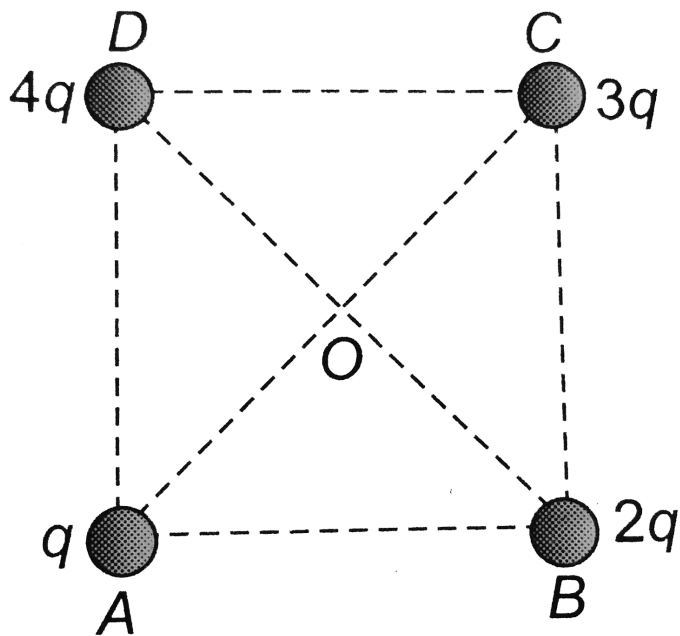


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22. Charges  $q$ ,  $2q$ ,  $3q$  and  $4q$  are placed at the corners  $A$ ,  $B$ ,  $C$  and  $D$  of a square as shown in the following figure. The direction of electric field



at the centre of the square is along



A. AB

B. CB

C. AC

D. BD

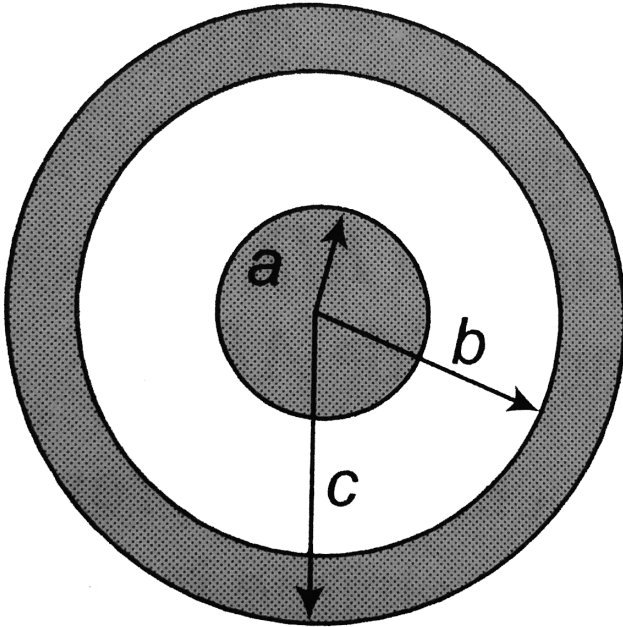
**Answer: B**



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**23.** A solid conducting sphere of radius  $a$  has a net positive charge  $2Q$ . A conducting spherical shell of inner radius  $b$  and outer radius  $c$  is concentric with the solid sphere and has a net charge  $-Q$ . The surface charge density on the inner and outer surfaces of the spherical shell will

be



A.  $-\frac{2Q}{4\pi b^2}, \frac{Q}{4\pi c^2}$

B.  $-\frac{Q}{4\pi b^2}, \frac{Q}{4\pi c^2}$

C.  $0, \frac{Q}{4\pi c^2}$

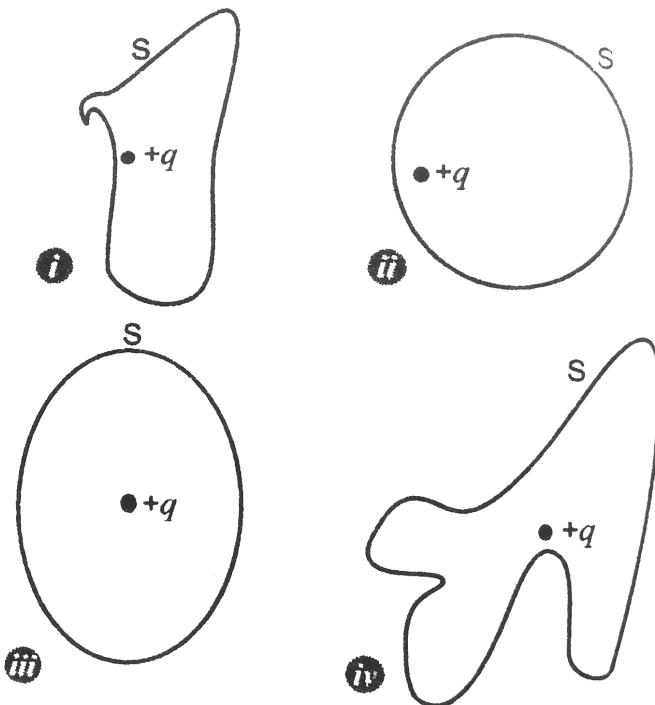
D. None of these

Answer: A



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24. The electric flux through the surface



- A. (a) in Fig. (iv) is the largest
- B. (b) in (fig. (iii) is the least
- C. (c) in fig. (ii) is same as fig.(iii) but is smaller than fig. (iv)
- D. (d) is the same for all the figure

**Answer: D**



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**25.** The point charges  $Q$  and  $-2Q$  are placed at some distance apart. If the electric field at the

location of  $Q$  is  $E$ , the electric field at the location of  $-2Q$  will be

A. (a)  $3E$

B. (b)  $E/2$

C. (c)  $E$

D. (d) None of these

**Answer: D**



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26. A ball with charge  $-50e$  is placed at the centre of a hollow spherical shell has a net charge of  $-50e$ . What is the charge on the shell's outer surface ?

A. (a)  $-50e$

B. (b) zero

C. (c)  $-100e$

D. (d)  $+100e$

**Answer: D**



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27. A mass  $m = 20g$  has a charge  $q = 3.0mC$ . It moves with a velocity of  $20 \text{ m/s}$  and enters a region of electric field of  $80 \text{ N/C}$  in the same direction as the velocity of the mass. The velocity of the mass after  $3 \text{ s}$  in this region is

A.  $80ms^{-1}$

B.  $56ms^{-1}$

C.  $44ms^{-1}$

D.  $40ms^{-1}$

**Answer: B**





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28. Two parallel metal plates having charges  $+Q$  and  $-Q$  face each other at a certain distance between them. If the plates are now dipped in kerosene oil tank, the electric field between the plates will

A. became zero

B. increase

C. decrease

D. remain same

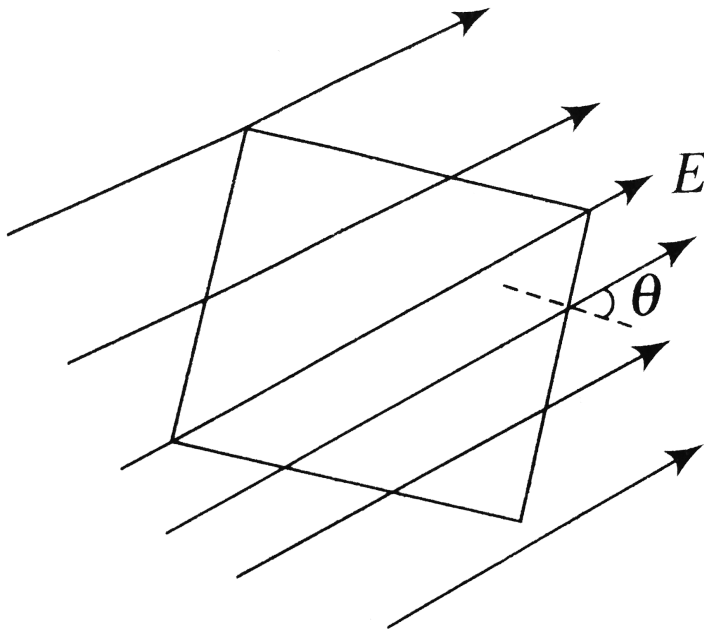
**Answer: C**



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**29.** A square surface of side  $L$  metre in the plane of the paper is placed in a uniform electric field  $E$ (volt /  $m$ ) acting along the same plane at an angle  $\theta$  with the horizontal side of the square as shown in figure. The electric flux linked to the

surface in unit of  $V - m$  is



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**30.** Three concentric metallic spherical shells of radii  $R$ ,  $2R$ ,  $3R$  are given charges  $Q_1 Q_2 Q_3$ , respectively. It is found that the surface charge

densities on the outer surface of the shells are equal. Then, the ratio of the charges given to the shells  $Q_1 : Q_2 : Q_3$  is

A.  $1 : 2 : 3$

B.  $1 : 3 : 5$

C.  $1 : 4 : 9$

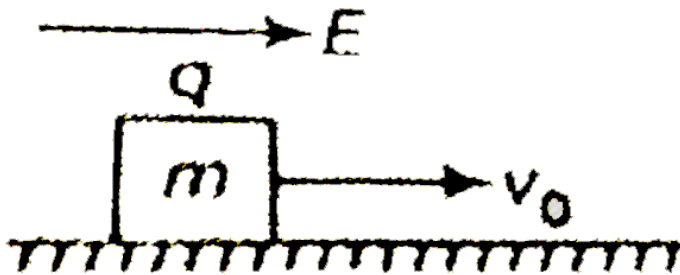
D.  $1 : 8 : 18$

**Answer: B**



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31. If a charged particle is projected on a rough horizontal surface with speed  $v_0$ . Find the value of dynamic coefficient of friction, if the kinetic energy of system is constant.



A.  $\frac{qE}{mg}$

B.  $\frac{qE}{m}$

C.  $qE$

D. None of these

**Answer: A**



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**32.** Electric charges  $q, q, -2q$  are placed at the corners of an equilateral triangle ABC of side  $l$ .

The magnitude of electric dipole moment of the system is

A.  $ql$

B.  $2ql$

C.  $\sqrt{3ql}$

D.  $4ql$

**Answer: C**



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**33.** A point charge  $+q$  is placed at a distance  $d$  from an isolated conducting plane. The field at a point  $P$  on the other side of plane is

A. directed perpendicular to the plane and away from the plane

B. directed perpendicular to the plane but towards the plane

C. directed radially away from the point charge

D. directed radially towards the point charge

**Answer: A**

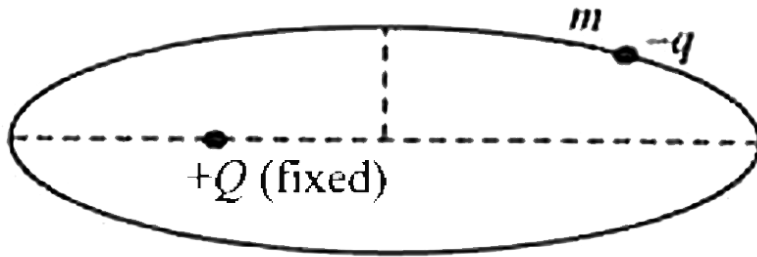


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**34.** A positive point charge  $+Q$  is fixed in space. A negative point charge  $-q$  of mass  $m$  revolves around fixed charge in elliptical orbit. The fixed



charge  $+Q$  is at one focus of the ellipse. The only force acting on negative charge is the electrostatic force due to positive charge. Then which of the following statement is true



- A. The angular momentum of the charge  $-q$  is constant
- B. The linear momentum of the charge  $-q$  is constant

C. The angular velocity of the charge  $-q$  is constant

D. The linear speed of the charge  $-q$  is constant

**Answer: A**



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**35.** Two identical conducting sphere carrying different charges attact each other with a force  $F$  when placed in air medium at a distance  $d$  apart.

The spheres are brought into contact and then taken to their original positions. Now, the two spheres repel each other with a force whose magnitude is equal to the initial attractive force. The ratio between initial charges on the spheres is

- A.  $-(3 + \sqrt{8})$  only
- B.  $-3 + \sqrt{8}$  only
- C.  $-(3 + \sqrt{8})$  or  $(-3 + \sqrt{8})$
- D.  $+\sqrt{3}$

**Answer: C**



**36.** The electric field at a distance  $3R/2$  from the centre of a charge conducting spherical shell of radius  $R$  is  $E$ . The electric field at a distance  $R/2$  from the centre of the sphere is

A. zero

B.  $E$  is perpendicular to the surface at every point

C.  $E/2$

D.  $E/3$

**Answer: A**



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**37.** Under the action of a given coulombic force the acceleration of an electron is  $2.5 \times 10^{22} ms^{-1}$ . Then, the magnitude of the acceleration of a proton under the action of same force is nearly

A.  $1.6 \times 10^{-19} ms^{-2}$

B.  $9.1 \times 10^{31} ms^{-2}$

C.  $(1.5 \times 10^{19} ms^{-2})$

D.  $1.6 \times 10^{27} ms^{-2}$

**Answer: C**



**Watch Video Solution**

**38.** A drop of  $10^{-6}$  kg water carries  $10^{-6}C$  charge. What electric field should be applied to balance its weight (assume  $g = 10ms^{-2}$ )

A. 10 V/m upward

B. 10 V/m downward

C. 0.1 V/m downward

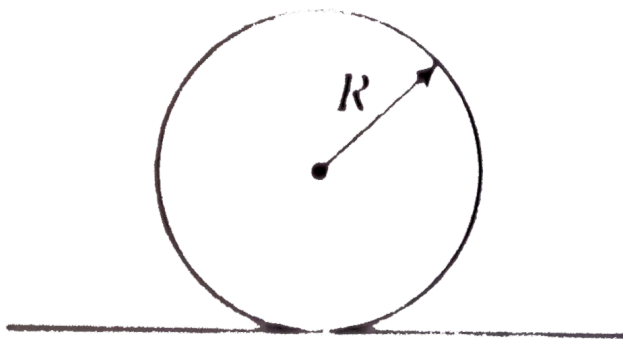
D.  $0.1 \text{ V/m}$  upward

**Answer: A**



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**39.** If linear charge density of a wire as shown in the figure is  $\lambda$



A. electric field at the centre is  $\frac{\lambda}{2\epsilon_0}$

B. electric field at the centre of the loop is

$$\frac{\lambda}{2\pi\epsilon_0 R}$$

C. electric field at the centre of the loop is

$$\frac{\lambda}{2\pi\epsilon_0 R} + \frac{\lambda}{2\epsilon_0 R}$$

D. None of the above

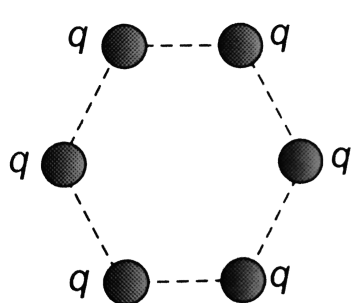
**Answer: B**



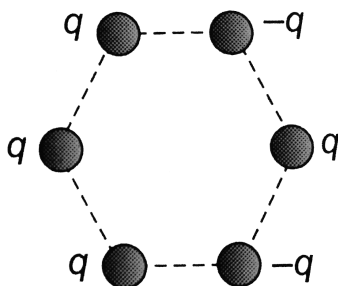
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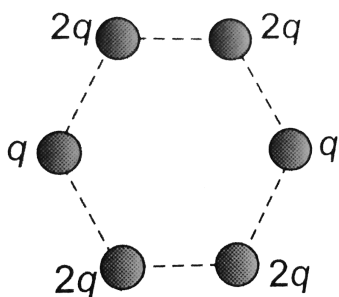
**40.** Figure below show regular hexagons with charges at the vertices. In which of the following cases the electric field at the centre is not zero



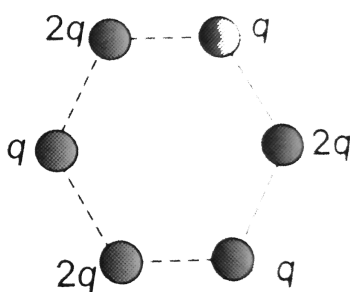
Case (1)



Case (2)



Case (3)



Case (4)

A. 1

B. 2

C. 3

D. 4

**Answer: B**



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**41.** Electric field intensity at a point in between two parallel sheets with like charges of same surface charge densities ( $\sigma$ ) is

A.  $\frac{\sigma}{2\epsilon_0}$

B.  $\frac{\sigma}{\epsilon_0}$

C. zero

D.  $\frac{2\sigma}{\epsilon_0}$

**Answer: C**



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

A. 20 Vm

B. 10 Vm

C. 40 Vm

D. 5 Vm

**Answer: A**



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**43.** Two charges of  $-4\mu C$  and  $+4\mu C$  are placed at the points  $A(1, 0, 4)$  and  $B(2, -1, 5)$

location in an electric field  $\vec{E} = 0.20\hat{i} \text{ V/cm}$ .

Calculate the torque acting on the dipole.

A.  $2.31 \times 10^{-4} \text{ N/m}$

B.  $1.13 \times 10^{-4} \text{ C/m}$

C.  $7.11 \times 10^{-4} \text{ C/m}$

D.  $7.04 \times 10^{-4} \text{ C/m}$

**Answer: B**



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**44.** An infinite line charge produces a field of  $7.182 \times 10^8 \text{ N/C}$  at distance of 2 cm. the linear charge density is

A.  $7.27 \times 10^{-4} \text{ C/m}$

B.  $7.98 \times 10^{-4} \text{ C/m}$

C.  $7.11 \times 10^{-4} \text{ C/m}$

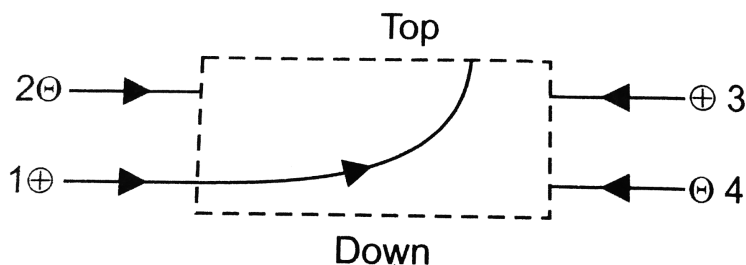
D.  $7.04 \times 10^{-4} \text{ C/m}$

**Answer: B**



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45. The figure shows the path of a positively charged particle 1 through a rectangular region of uniform electric field as shown in the figure. What is the direction of electric field and the direction of deflection of particles 2, 3 and 4 ?



- A. Top, down, top, down
- B. Top, down, down, top
- C. Down, top, top, down
- D. Down, top, down, down

**Answer: A**



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**46.** The electric intensity due to a dipole of length  $10\text{cm}$  and having a charge of  $500\mu\text{C}$ , at a point on the axis at a distance  $20\text{cm}$  from one of the charges in air is

A.  $6.25 \times 10^7 \text{ N/C}$

B.  $9.28 \times 10^7 \text{ N/C}$

C.  $13.1 \times 10^{11} \text{ N/C}$



D.  $20.5 \times 10^7 \text{ N/C}$

**Answer: A**



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**47.** Two electric dipoles of moment  $P$  and  $64P$  are placed in opposite direction on a line at a distance of  $25\text{cm}$ . The electric field will be zero at point between the dipoles whose distance from the dipole of moment  $P$  is

**A. 5 cm**

B.  $\frac{25}{9} \text{ cm}$

C. 10 cm

D.  $\frac{4}{13} \text{ cm}$

**Answer: A**



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**48.** Two spherical conductors B and C having equal radii and carrying equal charges on them repel each other with a force  $F$  when kept apart at some distance. A third spherical conductor having same radius as that B but uncharged is brought

in contact with B, then brought in contact with C and finally removed away from both. The new force of repulsion between B and C is

A.  $F / 4$

B.  $3F / 4$

C.  $F / 8$

D.  $3F / 8$

**Answer: D**



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49. A sample of HCl gas is placed in an electrical field of  $3 \times 10^4 NC^{-1}$ . The dipole moment of each HCl molecule is  $6 \times 10^{-30} C - m$ . The maximum torque that can act on a molecule is

A.  $2 \times 10^{-34} C^2 N^{-1} m$

B.  $2 \times 10^{-34} N - m$

C.  $18 \times 10^{-26} N - m$

D.  $0.5 \times 10^{34} C^{-2} N^{-1} m^{-1}$

**Answer: C**



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50. A neutral water molecule ( $H_2O$ ) in its vapor state has an electric dipole moment of magnitudes  $6.4 \times 10^{-30} C - m$ . How far apart are the molecules centers of positive and negative charge

A.  $4 \times 10^{-10}$

B.  $4 \times 10^{-11}$

C.  $4 \times 10^{-12}$

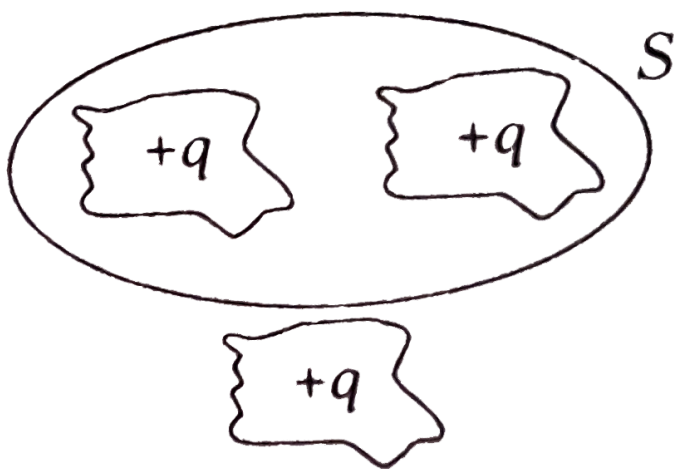
D.  $4 \times 10^{-13}$

**Answer: B**



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51. Figure shown below is a distribution of charges. The flux of electric field due to these charges through the surface  $S$  is



A.  $3q / \epsilon_0$

B.  $2q / \epsilon_0$

C.  $q / \epsilon_0$

D. zero

**Answer: B**



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**52.** There exists an electric field of  $1NC^{-1}$  along Y direction. The flux passing through the square of 1 m placed in  $xy$  – plane inside the electric field is

A.  $1.0Nm^2C^{-1}$

B.  $10.0Nm^2C^{-1}$

C.  $2.0Nm^2C^{-1}$

D. zero

**Answer: D**



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**53.** Two positive ions , each carrying a charge  $q$  , are separated by a distance  $d$ . If  $F$  is the force of repulsion between the ions , the number of



electrons missing from each ion will be ( $e$  being the charge on an electron)

A.  $\frac{4\pi\epsilon_0 F d^2}{e}$

B.  $\sqrt{\frac{4\pi\epsilon_0 F e^2}{d^2}}$

C.  $\sqrt{\frac{4\pi\epsilon_0 F d^2}{e^2}}$

D.  $\frac{4\pi\epsilon_0 F d^2}{e^2}$

**Answer: C**



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54. All charge on a conductor must reside on its outer surface.' This statement is true

A. in all case

B. for sphereical conductors only (Both solid and hollow)

C. for hollow spherical conductors only

D. for conductors which do not have any sharp points or corners

**Answer: A**



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55. Two charges  $+4e$  and  $+e$  are at a distance  $x$  apart. At what distance, a charge  $q$  must be placed from charge  $+e$  so that is in equilibrium

A.  $x / 2$

B.  $2x / 3$

C.  $x / 3$

D.  $x / 4$

**Answer: C**



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56. Among two discs A and B, first have radius 10 cm and charge  $10^{-6}\mu\text{C}$  and second have radius 30 cm and charge  $10^{-5}\mu\text{C}$ . When they are touched, charge on both  $q_A$  and  $q_B$  respectively will, be

A.  $q_A = 2.75\mu\text{C}, q_B = 3.15\mu\text{C}$

B.  $q_A = 1.09\mu\text{C}, q_B = 1.53\mu\text{C}$

C.  $q_A = q_B = 5.5\mu\text{C}$

D. None of these

**Answer: C**



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57. Two charges are at a distance  $d$  apart. If a copper plate (conducting medium) of thickness  $d/2$  is placed between them, the effective force will be

A.  $\frac{F}{2}$

B. zero

C.  $2F$

D.  $\sqrt{2F}$

**Answer: B**



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**58.** Two point charge  $-q$  and  $+q/2$  are situated at the origin and the point  $(a, 0, 0)$  respectively. The point along the  $X$ -axis where the electric field Vanishes is

A.  $x = \frac{a}{\sqrt{2}}$

B.  $x = \sqrt{2}a$

C.  $x = \frac{\sqrt{2}a}{\sqrt{2} - 1}$

$$\text{D. } x = \frac{\sqrt{2a}}{\sqrt{2} + 1}$$

**Answer: C**

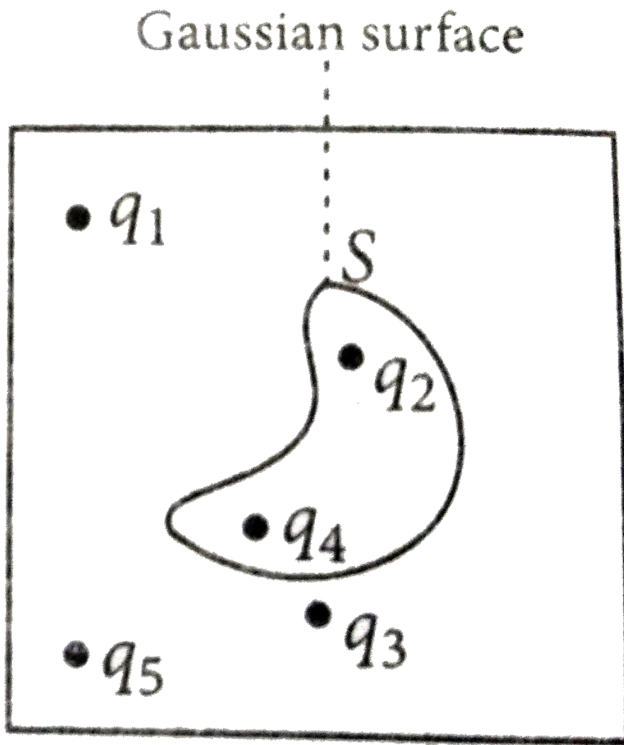


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**59.** Five charges  $q_1, q_2, q_3, q_4$  and  $q_5$  are fixed at their positions as shown in figure. S is Gaussian surface. The Gauss's law is given by

$\oint_S \vec{E} \cdot d\vec{s} = \frac{q}{\epsilon_0}$ . Which of the following

statements is correct?



A. E on the LHS of the above equation will have a contribution from  $q_1$ ,  $q_5$  and  $q_1$ ,  $q_5$  and  $q_3$  while q on the RHS will have a contribution from  $q_2$  and  $q_4$  only



B.  $E$  on the LHS of the above equation will have a contribution from all charges while  $q$  on the RHS will have a contribution from  $q_2$  and  $q_4$  only

C.  $E$  on the LHS of the above equation will have a contribution from all charges while  $q$  on the RHS will have a contribution from  $q_1$ ,  $q_3$  and  $q_5$  only

D. Both  $E$  on the LHS and  $q$  on the RHS will have contribution from  $q_2$  and  $q_4$  only

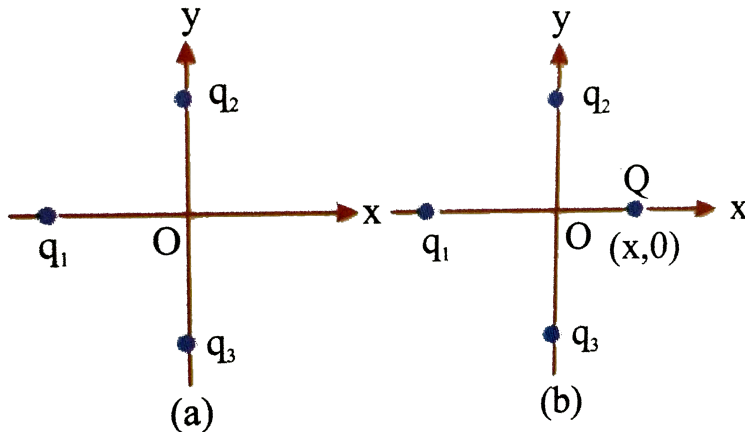
**Answer: B**



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**60.** In figure two positive charges  $q_2$  and  $q_3$  fixed along the y-axis ,exert a net electric force in the  $+x$  direction on a charge  $q_1$  fixed along the x-axis if a positive charge  $Q$  is added at  $(x, 0)$  the force

on  $q_1$



A. shall increase along the positive X-axis

B. shall decrease along the positive X-axis.

C. shall point along the negative X-axis

D. shall increase but the direction charges

because of the intersection of Q with  $q_2$  and

$q_3$

**Answer: A**



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**61.** A hemisphere is uniformly charged positively. The electric field at a point on a diameter away from the centre is directed

- A. perpendicular to the diameter
- B. parallel to the diameter
- C. at an angle tilted towards the diameter
- D. at an angle tilted away from the diameter

**Answer: A**



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**62.** A charge  $q_0$  is distributed uniformly on a ring of radius  $R$ . A sphere of equal radius  $R$  constructed with its centre on the circumference of the ring. Find the electric flux through the surface of the sphere.

A.  $\frac{2\pi R\lambda}{\epsilon_0}$

B.  $\frac{\pi R\lambda}{\epsilon_0}$

C. zero

D. None of these

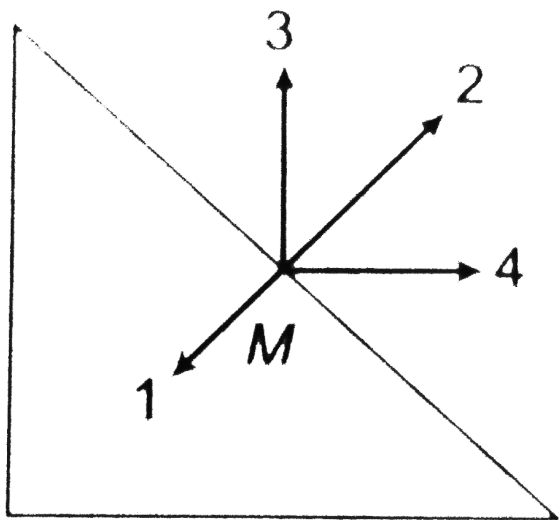
**Answer: D**



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**63.** Three identical points charges, as shown are placed at the vertices of an isosceles right angled triangle. Which of the numbered vectors coincides in direction with the electric field at the mid-point

$M$  the hypotenuse



A. 1

B. 2

C. 3

D. 4

**Answer: B**



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**64.** Two identical charged spheres of material density  $\rho$ , suspended from the same point by inextensible strings of equal length make an angle  $\theta$  between the string. When suspended in a liquid of density  $\sigma$  the angle  $\theta$  remains the same. The dielectric constant  $K$  of the liquid is

A.  $\frac{\rho}{\rho - \sigma}$

B.  $\frac{\rho - \sigma}{\rho}$

C.  $\frac{\rho}{\rho + \sigma}$



D.  $\frac{\rho + \sigma}{\rho}$

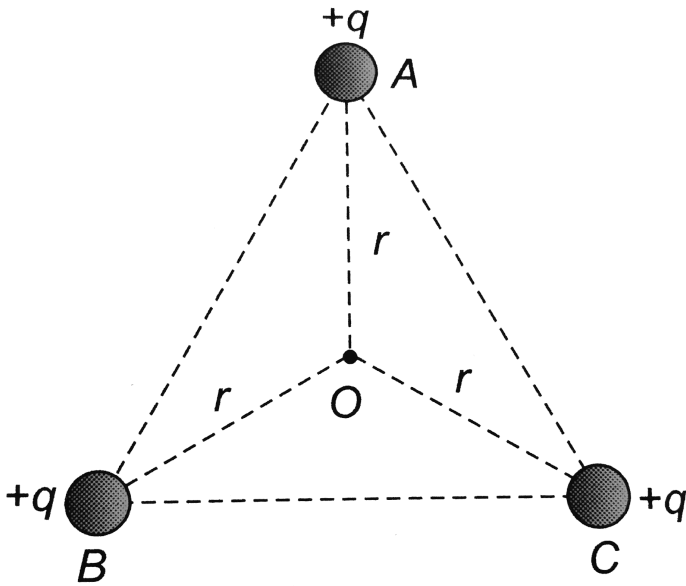
**Answer: A**



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**65.**  $ABC$  is an equilateral triangle. Charges  $+q$  are placed at each corner. The electric intensity at

$O$  will be



A.  $\frac{1}{4\pi\epsilon_0} \cdot \frac{q}{r^2}$

B.  $\frac{3}{4\pi\epsilon_0} \cdot \frac{q}{r}$

C. zero

D.  $\frac{1}{4\pi\epsilon_0} \cdot \frac{3q}{r^2}$

**Answer: C**



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**66.** A wire of linear charge density  $\lambda$  passes through a cuboid of length  $l$ , breadth  $b$  and height  $h$  ( $l > b > h$ ) in such a manner that the flux through the cuboid is maximum. The position of the wire is now changed, so that the flux through the cuboid is minimum. The ratio of maximum flux to minimum flux will be

A.  $\frac{\sqrt{l^2 + b^2 + h^2}}{h}$

B.  $\frac{\sqrt{l^2 + b^2}}{h}$

C.  $\frac{h}{\sqrt{l^2 + b^2}}$

D.  $\frac{l}{\sqrt{l^2 + b^2 + h^2}}$

**Answer: A**



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**67.** Equal charges  $Q$  are placed at the four corners A, B, C, D of a square of length  $a$ . The magnitude of the force on the charge at B will be

A.  $\frac{3q^2}{4\pi\epsilon_0 a^2}$

B.  $\frac{q^2}{4\pi\epsilon_0 a^2}$

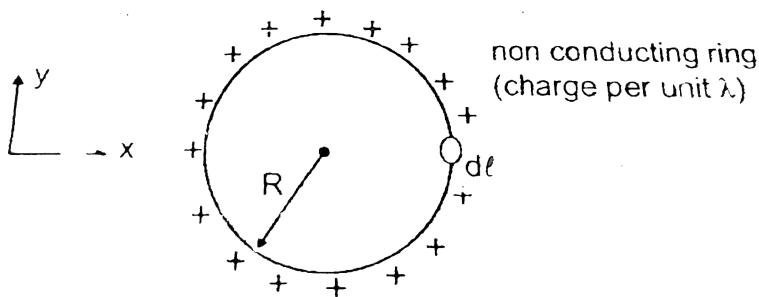
C.  $\left( \frac{1 + 2\sqrt{2}}{2} \right) \frac{q^2}{4\pi\epsilon_0 a^2}$

D.  $\left( 2 + \frac{1}{\sqrt{2}} \right) \frac{q^2}{4\pi\epsilon_0 a^2}$

**Answer: C**



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**68.**

A small part of  $dl$  length is removed from a ring

having charge per unit length  $\lambda$ . Find electric field at centre due to remaining ring.

A. zero

B.  $\frac{-\lambda dl}{4\pi\epsilon_0 a^2}$

C. infinity

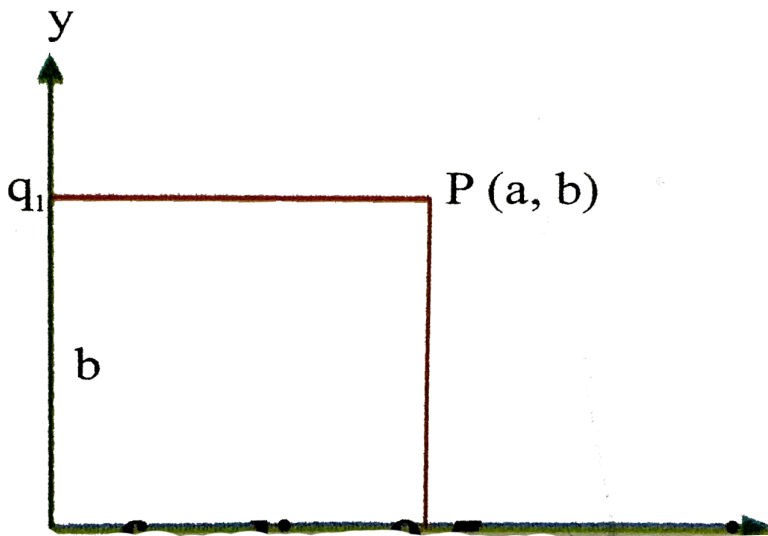
D.  $\frac{\lambda}{4\pi\epsilon_0 dl}$

**Answer: B**



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69. Two point charge  $q_1 = 2\mu C$  and  $q_2 = 1\mu C$  are placed at distance  $b = 1$  and  $a = 2cm$  from the origin on the  $y$  and  $x$  axes as shown in figure .The electric field vector at point  $(a), (b)$  will subtend on angle  $\theta$  with the "x-axis" given by



A.  $\tan \theta = 1$

B.  $\tan \theta = 2$

C.  $\tan \theta = 3$

D.  $\tan \theta = 4$

**Answer: B**



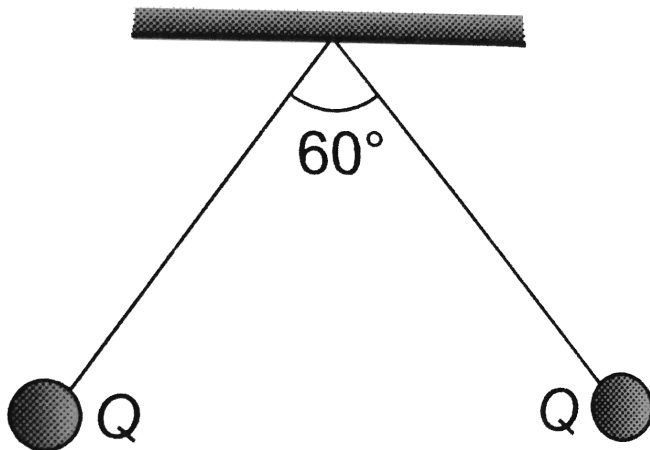
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**70.** Two small spherical balls each carrying a charge  $Q = 10\mu C$  are suspended by two insulating threads of equal lengths  $1cm$  each, from a point fixed in the ceiling. It is found that in equilibrium threads are separated by an angle  $60^\circ$  between them, as shown in figure. What is



the tension in the threads

(Given  $\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ Nm} / \text{C}^2$ )



A. 18 N

B. 1.8 N

C. 0.18 N

D. None of these

**Answer: B**



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**71.** An infinite number of charges, each of charge  $1\mu C$  are placed on the  $x$ -axis with co-ordinates  $x = 1, 2, 4, 8, \dots \infty$ . If a charge of  $1C$  is kept at the origin, then what is the net force action on  $1C$  charge

A. 9000 N

B. 12000 N

C. 24000 N

D. 36000 N

**Answer: B**



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**72.** An electron moving with the speed  $5 \times 10^6$  per sec is shot parallel to the electric field of intensity  $1 \times 10^3 N/C$ . Field is responsible for the retardation of motion of electron. Now evaluate the distance travelled by the electron before coming to rest for an instant (mass of  $e = 9 \times 10^{-31} Kg$  charge  $= 1.6 \times 10^{-19} C$ )

A. 7 m

B. 0.7 mm

C. 7 cm

D. 0.7 cm

**Answer: C**



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**73.** An electric dipole coincides on Z-axis and its mid-point is on origin of the coordinates system. The electric field at an axial point at a distance  $z$

from origin is  $E_{(z)}$  and electric field at an equatorial point at a distance  $y$  from origin is  $E_{(y)}$ . Here,  $z = y > a$ , so  $\left| \frac{E_{(z)}}{E_{(y)}} \right| = \dots$

A. 1

B. 4

C. 3

D. 2

**Answer: D**



**Watch Video Solution**

**74.** Three point charges  $+q$ ,  $-2q$  and  $+q$  are placed at points  $(x = 0, y = a, z = 0)$ ,  $(x = 0, y = 0, z = 0)$  and  $(x = a, y = 0, z = 0)$ , respectively. The magnitude and direction of the electric dipole moment vector of this charge assembly are

A.  $\sqrt{2qa}$  along  $+y$  -direction

B.  $\sqrt{2qa}$  along the line joining points

$(x = 0, y = 0, z = 0)$  and

$(x = a, y = a, z = 0)$

C.  $qa$  along the line joining point

$(x = 0, y = 0, z = 0)$  and

$(x = a, y = a, z = 0)$

D.  $\sqrt{2}qa$  along + x-direction

**Answer: B**



**Watch Video Solution**

**75.** A cylinder of radius  $R$  and length  $L$  is placed in a uniform electric field  $E$  parallel to the axis. The total flux for the surface of the cylinder is given by

A.  $2\pi R^2 E$

B.  $\pi R^2 / E$

C.  $(\pi R^2 / \pi R) / E$

D. zero

**Answer: D**

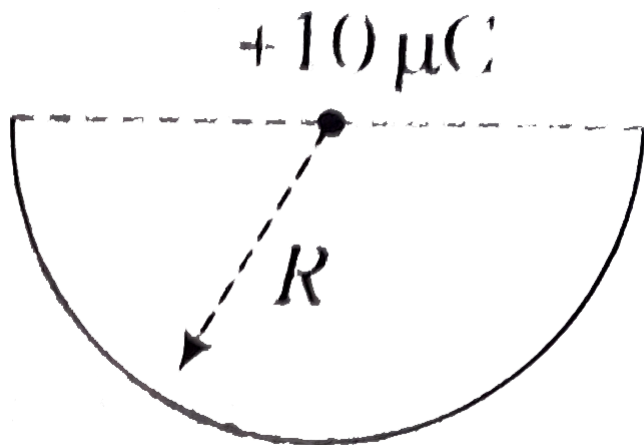


**Watch Video Solution**

**76.** A charge  $10\mu C$  is placed at the centre of a hemisphere of radius  $R = 10cm$  as shown. The electric flux through the hemisphere (in MKS



units)is



A.  $20 \times 10^5$

B.  $10 \times 10^5$

C.  $5.7 \times 10^5$

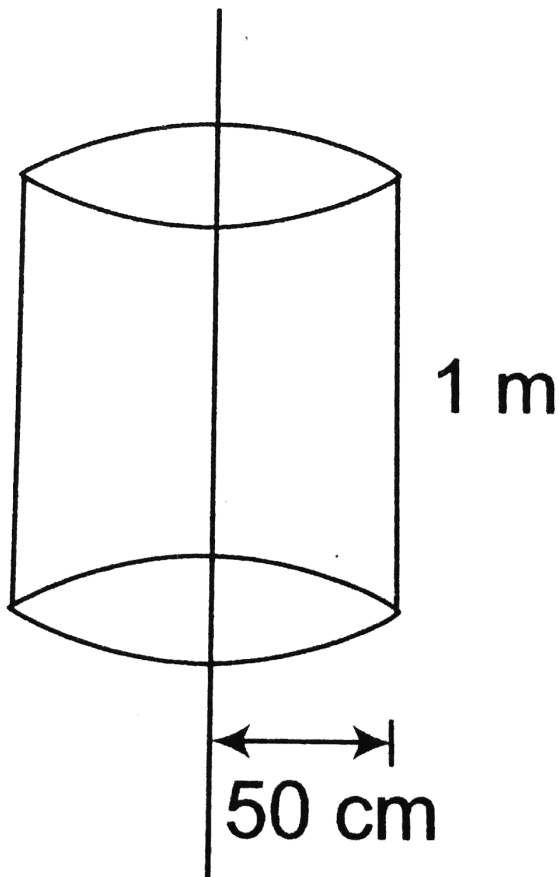
D.  $2 \times 10^5$

**Answer: C**



77. Electric charge is uniformly distributed along a straight wire of radius  $1\text{mm}$ . The charge per centimeter length of the wire is  $Q$  coulomb. Another cylindrical surface of radius  $50\text{cm}$  and length  $1\text{m}$  symmetrically enclose the wire as shown in figure. The total electric flux passing

through the cylindrical surface is



A.  $\frac{Q}{\epsilon_0}$

B.  $\frac{100Q}{\epsilon_0}$

C.  $\frac{10Q}{(\pi\epsilon_0)}$

D.  $\frac{100Q}{(\pi\epsilon_0)}$

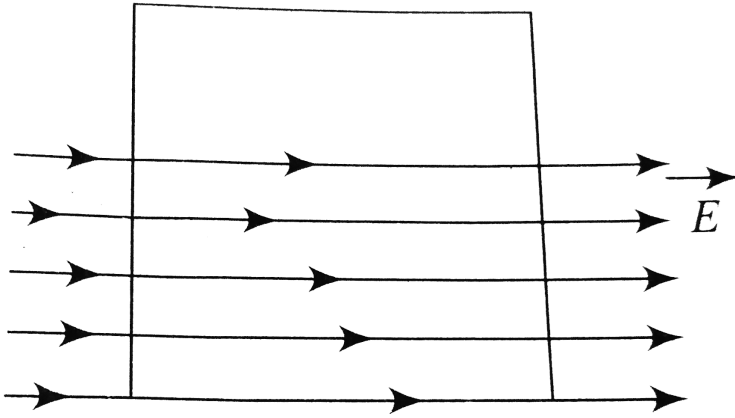
**Answer: B**



**Watch Video Solution**

**78.** A square surface of side  $Lm$  is in the plane of the paper. A uniform electric field  $\vec{E}$  ( $V/m$ ), also in the plane of the paper, is limited only to the lower half of the square surface (see figure). The electric flux in  $SI$  units associated with the

surface is:



A. zero

B.  $EL^2$

C.  $EL^2 / (2\epsilon_0)$

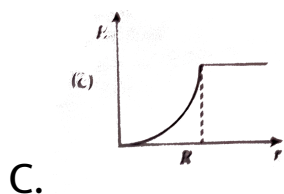
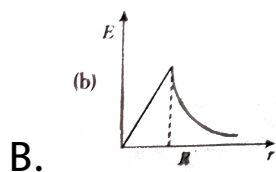
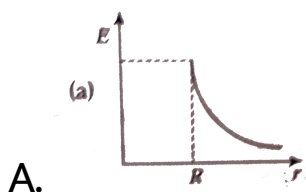
D.  $EL^2 / 2$

**Answer: A**

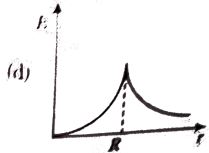


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79. Which one of the following graphs represents the variation of electric field with distance  $r$  from the centre of a charged spherical conductor of radius  $R$ ?



D.



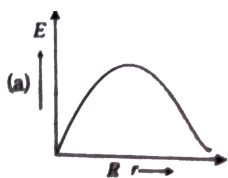
**Answer: A**



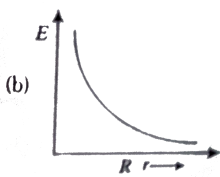
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**80.** In a uniformly charged sphere of total charge  $Q$  and radius  $R$ , the electric field  $E$  is plotted as a function of distance from the centre. The graph which would correspond to the above will be

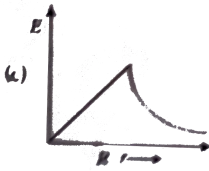
A.



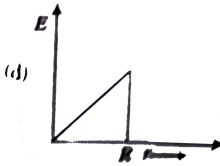
B.



C.



D.



**Answer: C**



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**81.** An electric dipole is situated in an electric field of uniform intensity  $E$  whose dipole moment is  $p$



and moment of inertia is  $I$ . If the dipole is displaced slightly from the equilibrium position, then the angular frequency of its oscillations is

A.  $\left(\frac{pE}{I}\right)^{1/2}$

B.  $\left(\frac{pE}{I}\right)^{3/2}$

C.  $\left(\frac{I}{pE}\right)^{1/2}$

D.  $\left(\frac{p}{IE}\right)^{1/2}$

**Answer: A**



**Watch Video Solution**

82. Two point charges ( $+Q$ ) and the ( $-2Q$ ) are fixed on the X-axis at positions  $a$  and  $2a$  from origin respectively. At what positions on the axis, the electric field is zero

A. only  $x = \sqrt{2}a$

B. only  $x = -\sqrt{2}a$

C. Both  $x = \pm \sqrt{2}a$

D. only  $x = \frac{3a}{2}$

**Answer: B**



**Watch Video Solution**

83. Charge  $q_2$  of mass  $m$  revolves around a stationary charge  $q_1$  in a circular orbit of radius  $r$ . The orbital periodic time of  $q_2$  would be

A.  $\left[ \frac{4\pi^2 m r^3}{k q_1 q_2} \right]^{1/2}$

B.  $\left[ \frac{k q_1 q_2}{4\pi^2 m r^3} \right]^{1/2}$

C.  $\left[ \frac{4\pi^2 m r^4}{k q_1 q_2} \right]^{1/2}$

D.  $\left[ \frac{4\pi^2 m r^2}{k q_1 q_2} \right]^{1/2}$

**Answer: A**



**Watch Video Solution**

**84.** Four charges equal to  $-Q$  are placed at the four corners of a square and a charge  $q$  is at its centre.

If the system is in equilibrium the value of  $q$  is

A.  $\frac{-Q}{4} (1 + 2\sqrt{2})$

B.  $\frac{Q}{4} (1 + 2\sqrt{2})$

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

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

**Answer: B**



**Watch Video Solution**

85. The distance between the two charges  $25\mu C$  and  $36\mu C$  is  $11\text{cm}$ . At what point on the line joining the two, the intensity will be zero

A. At a distance of 5 cm from  $25\mu C$

B. At a distance of 5 cm from  $36\mu C$

C. At a distance of 4 cm from  $25\mu C$

D. At a distance of 4 cm from  $36\mu C$

**Answer: A**



**Watch Video Solution**

**86.** The electric field at a point due to an electric dipole, on an axis inclined at an angle  $\theta$  ( $< 90^\circ$ ) to the dipole axis, is perpendicular to the dipole axis, if the angle  $\theta$  is

A.  $\tan^{-1}(2)$

B.  $\tan^{-1}\left(\frac{1}{2}\right)$

C.  $\tan^{-1}(\sqrt{2})$

D.  $\tan^{-1}\left(\frac{1}{\sqrt{2}}\right)$

**Answer: C**



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**87.** If  $10^{10}$  electrons are acquired by a body every second, the time required for the body to get a total charge of C will be

A. 2h

B. 2 days

C. 2 yr

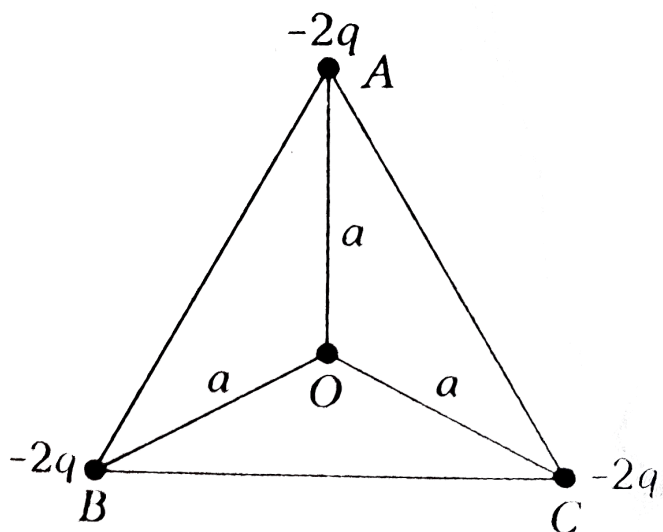
D. 20 yr

**Answer: D**



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88. ABC is an equilateral triangle. Charges  $-2q$  are placed at each corner. The electric intensity at O will be



A.  $\frac{1}{4\pi\epsilon_0} \frac{q}{r^2}$

B.  $\frac{1}{4\pi\epsilon_0} \frac{q}{r}$

C. zero



D.  $\frac{1}{4\pi\epsilon_0} \frac{3q}{r^2}$

**Answer: C**



**Watch Video Solution**

**89.** Two equally charged, indential metal spheres  $A$  and  $B$  repel each other with a force  $F$ . The spheres are kept fixed with a distance  $r$  between them. A third identical, but uncharged sphere  $C$  is brought in contact with  $A$  and removed. The magnitude of the net electric force on  $A$  is

A.  $F$

B.  $F / 4$

C.  $F / 2$

D.  $4F$

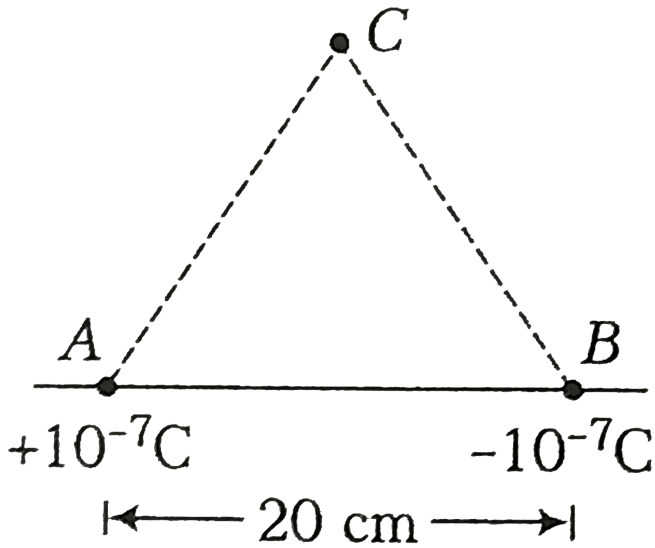
**Answer: A**



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**90.** Two point charges  $+10^{-7}C$  and  $-10^{-7}C$  are placed at A and B 20 cm apart as shown in the figure. Calculate the electric field at C, 20 cm apart

from both A and B.



A.  $1.5 \times 10^{-5} \text{NC}^{-1}$

B.  $2.2 \times 10^4 \text{NC}^{-1}$

C.  $3.5 \times 10^6 \text{NC}^{-1}$

D.  $3.0 \times 10^5 \text{NC}^{-1}$

**Answer: B**



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**91.** Infinite charges of magnitude  $q$  each are lying at  $x = 1, 2, 4, 8, \dots$  meter on  $X$ -axis. The value of intensity of electric field at point  $x = 0$  due to these charges will be

A.  $12 \times 10^9 qNC^{-1}$

B. zero

C.  $6 \times 10^9 qNC^{-1}$

D.  $4 \times 10^9 qNC^{-1}$

**Answer: A**



**Watch Video Solution**

**92.** Two copper balls, each weighing  $10g$  are kept in air  $10cm$  apart. If one electron from every  $10^6$  atoms is transferred from one ball to the other, the coulomb force between them is (atomic weight of copper is 63.5)

A.  $2.0 \times 10^{10} N$

B.  $2.0 \times 10^4 N$

C.  $2.0 \times 10^8 N$

D.  $2.0 \times 10^6 N$

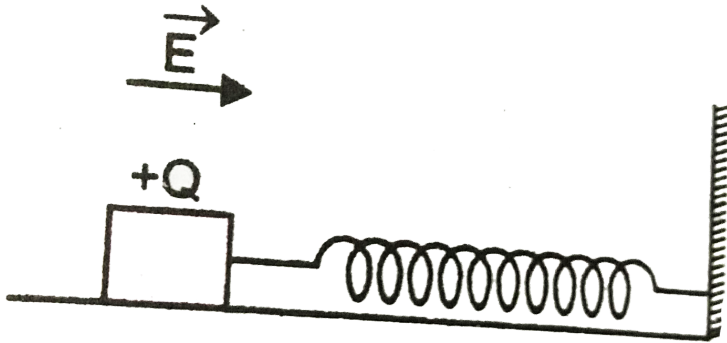
**Answer: C**



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**93.** A wooden block performs SHM on a frictionless surface with frequency,  $\nu_0$ . The block carries a charge  $+Q$  on its surface. If now a uniform electric field  $\vec{E}$  is switched on as shown

in figure., then the SHM of the block will be



- A. of the same frequency and with shifted mean position
- B. of the same frequency and with the same mean position
- C. of changed frequency and with shifted mean position

D. of changed frequency and with the same  
mean position

**Answer: A**

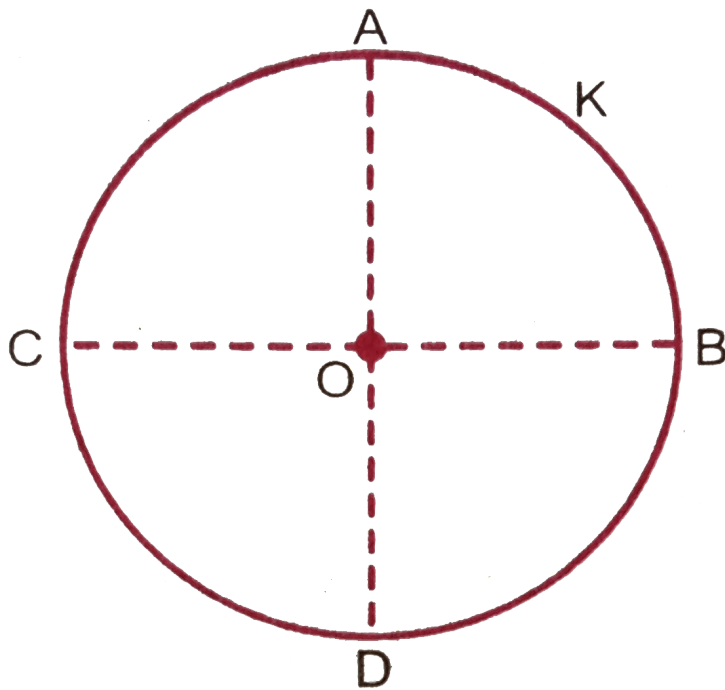


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**94.** A thin conducting ring of radius  $R$  is given a charge  $+Q$ , Fig. The electric field at the center  $O$  of the ring due to the charge on the part  $AKB$  of the ring is  $E$ . The electric field at the center due



to the charge on part  $ACDB$  of the ring is



A.  $E$  along  $KO$

B.  $3E$  along  $OK$

C.  $3E$  along  $KO$

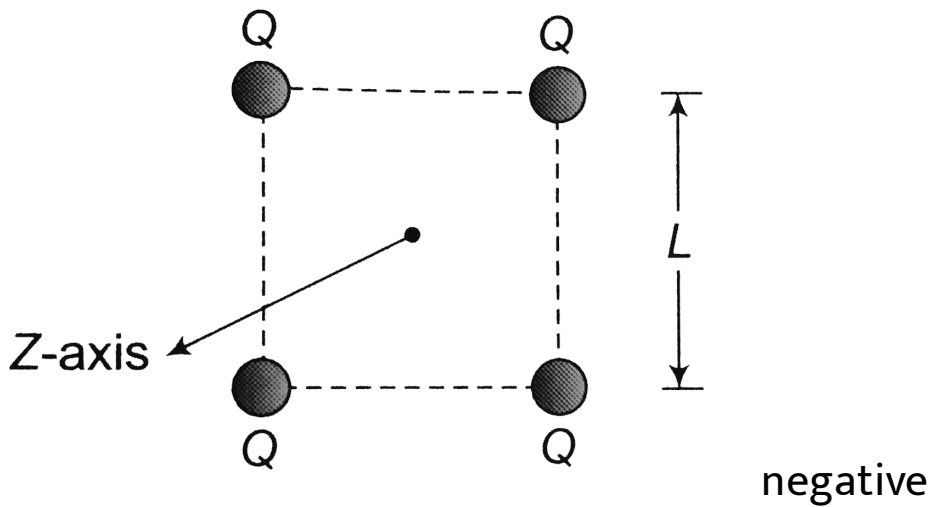
D.  $E$  along  $OK$

Answer: D



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95. Four point  $+ve$  charges of same magnitude ( $Q$ ) are placed at four corners of a rigid square frame as shown in figure. The plane of the frame is perpendicular to  $z$ -axis. If a  $-ve$  point charge is placed at a distance  $z$  away from the above frame ( $z < L$ ) then



1). charge oscillates along the Z-axis 2).it moves away from the frame 3).it moves slowly towards the frame and stays in the plane of the frame 4).it passes through the frame only once

A. negative charge oscillates along the Z-axis

B. it moves away from the frame

- C. it moves slowly towards the frame and stays in the plane of the frame
- D. it passes through the frame only once

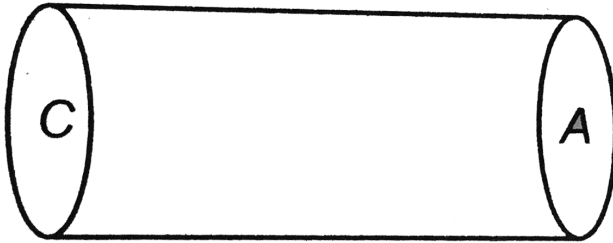
**Answer: A**



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**96.** A hollow cylinder has a charge  $qC$  within it. If  $\phi$  is the electric flux in unit of voltmeter associated with the curved surface  $B$  the flux linked with the plane surface  $A$  in unit of

voltmeter will be



A.  $\frac{1}{2} \left( \frac{q}{\epsilon_0} - \phi \right)$

B.  $\frac{q}{2\epsilon_0}$

C.  $\frac{\phi}{3}$

D.  $\frac{q}{\epsilon_0} - \phi$

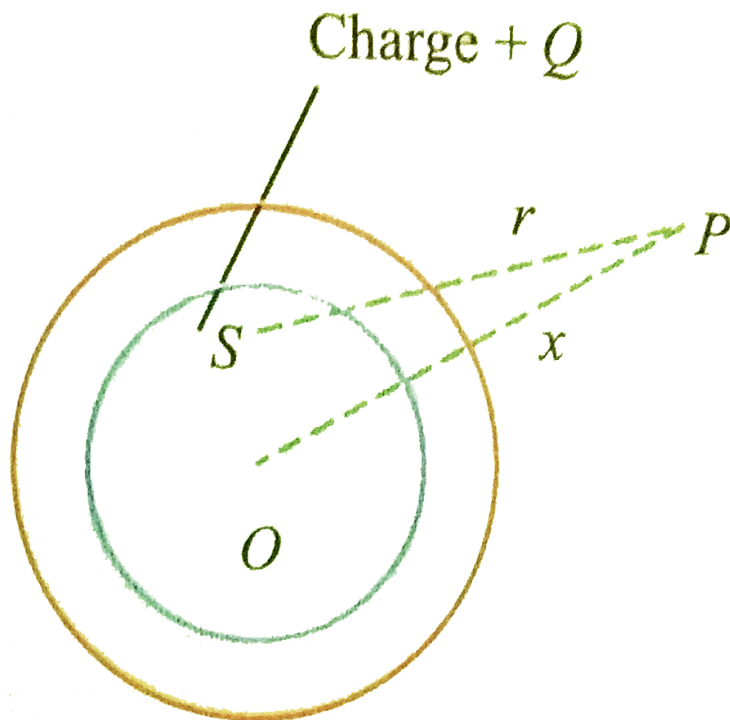
**Answer: A**



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**97.** The adjacent diagram shows a charge  $+Q$  held on an insulating support  $S$  and enclosed by a hollow spherical conductor,  $O$  represent the center of the spherical conductors and  $P$  is a point such that  $OP = x$  and  $SP = r$ . The

electric field at point  $P$  will be



A.  $\frac{Q}{4\pi\epsilon_0 x^2}$

B.  $\frac{Q}{4\pi\epsilon_0 r^2}$

C. 0

D. None of these

**Answer: A**



**Watch Video Solution**

**98.** An infinitely long thin straight wire has uniform linear charge density of  $1/3 \text{ coul} m^{-1}$ . Then the magnitude of the electric intensity at a point  $18 \text{ cm}$  away is

A.  $0.33 \times 10^{11} \text{ NC}^{-1}$

B.  $3 \times 10^{11} \text{ NC}^{-1}$

C.  $0.66 \times 10^{11} \text{ NC}^{-1}$



D.  $1.32 \times 10^{11} \text{NC}^{-1}$

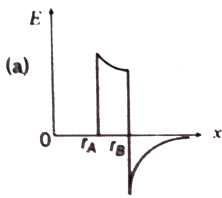
**Answer: A**



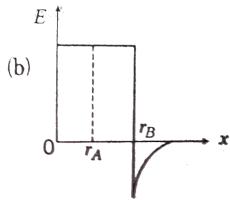
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**99.** Two concentric conducting thin spherical shells A and B having radii  $r_A$  and  $r_B$  ( $r_B > r_A$ ) are charged to  $Q_A$  and  $-Q_B$  ( $|Q_B| > |Q_A|$ ). The electric field strength along a line passing through the centre varies with the distance  $x$  as :

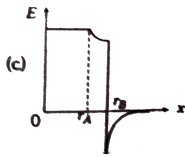
A.



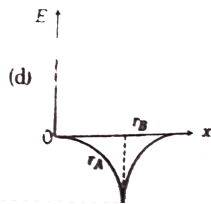
B.



C.



D.



**Answer: A**



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**100.** Two identical charged spheres suspended from a common point by two mass-less strings of length  $l$  are initially at a distance  $d$  ( $d < l$ ) apart because of their mutual repulsion. The charge begins to leak from both the spheres at a constant rate. As a result the spheres approach each other with a velocity  $v$ . Then as a function of distance  $x$  between them.

A.  $v \propto x^{-1/2}$

B.  $v \propto x^{-1}$

C.  $v \propto x^{1/2}$

D.  $v \propto x$

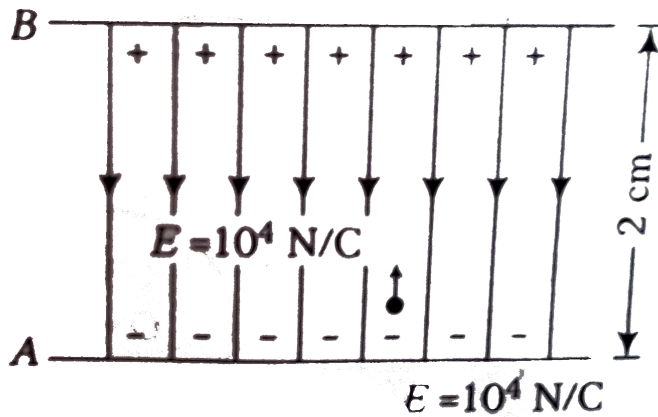
**Answer: A**



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**101.** An electron is released from the bottom plate A as shown in the figure ( $E = 10^4 \text{ N/C}$ ). The velocity of the electron when it reaches plate B

will be nearly equal to



A.  $0.85 \times 10^7 \text{ ms}^{-1}$

B.  $1.0 \times 10^7 \text{ ms}^{-1}$

C.  $1.25 \times 10^7 \text{ ms}^{-1}$

D.  $1.65 \times 10^7 \text{ ms}^{-1}$

Answer: A



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**102.** Charge  $q$  is uniformly distributed over a thin half ring of radius  $R$ . The electric field at the centre of the ring is

A.  $\frac{q}{2\pi^2\epsilon_0 R^2}$

B.  $\frac{q}{4\pi^2\epsilon_0 R^2}$

C.  $\frac{q}{4\pi r\psi_0 R^2}$

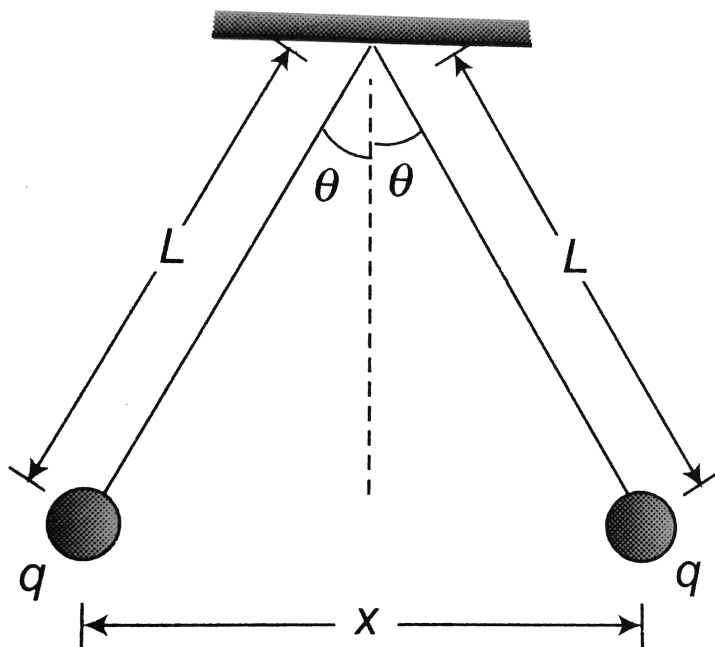
D.  $\frac{q}{2\pi\epsilon_0 R^2}$

**Answer: A**



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**103.** In the given figure two tiny conducting balls of identical mass  $m$  and identical charge  $q$  hang from non-conducting threads of equal length  $L$ . Assume that  $\theta$  is so small that  $\theta \approx \sin \theta$ , then for equilibrium  $x$  is equal to



A.  $\left( \frac{q^2 L}{2\pi\epsilon_0 m g} \right)^{1/3}$

B.  $\left( \frac{qL^2}{2\pi\epsilon_0 mg} \right)^{1/3}$

C.  $\left( \frac{q^2 L^2}{4\pi\epsilon_0 mg} \right)^{1/3}$

D.  $\left( \frac{q^2 L}{4\pi\epsilon_0 mg} \right)^{1/3}$

**Answer: A**



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**104.** Two small spheres of masses  $M_1$  and  $M_2$  are suspended by weightless insulating threads of lengths  $L_1$  and  $L_2$ . The spheres carry charges  $Q_1$  and  $Q_2$  respectively. The spheres are suspended



such that they are in level with one another and the threads are inclined to the vertical at angles  $\theta_1$  and  $\theta_2$  respectively . Which one of the following conditions is essential for  $\theta_1 = \theta_2$  ?

A.  $M_1 \neq M_2$  but  $Q_1 = Q_2$

B.  $M_1 = M_2$

C.  $Q_1 = Q_2$

D.  $L_1 = L_2$

**Answer: B**



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**105.** At which distance along the centre axis of a uniformly charged plastic disc of radius  $R$  is the magnitude of the electric field equal to one-half the magnitude of the field at the centre of the surface of the disc ?

A.  $\frac{R}{\sqrt{2}}$

B.  $\frac{R}{\sqrt{3}}$

C.  $\sqrt{2}R$

D.  $\sqrt{3}R$

**Answer: B**



**Watch Video Solution**

## Assertion and Reason

1. Assertion Mass of ion is slightly differed from its element.

Reason Ion is formed, when some electrons are removed or added, so mass changes.

A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion

- B. If both Assertion and Reason are correct  
but Reason is not the correct explanation of  
Assertion
- C. If Assertion is true but Reason is false
- D. If Assertion is false but Reason is true

**Answer: A**



**Watch Video Solution**

2. Assertion. When charges are shared between any two bodies, no charge is really lost but some

loss of energy does occur.

Reason. Some energy disappears in the form of heat, sparking etc.

A. If both Assertion and Reason are correct  
and Reason is the correct explanation of  
Assertion

B. If both Assertion and Reason are correct  
but Reason is not the correct explanation of  
Assertion

C. If Assertion is true but Reason is false

D. If Assertion is false but Reason is true

**Answer: B**



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**3. Assertion:** The coulomb force is the dominating force in the universe.

**Reason:** The coulomb force is weaker than the gravitational force.

A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion

- B. If both Assertion and Reason are correct  
but Reason is not the correct explanation of  
Assertion
- C. If Assertion is true but Reason is false
- D. If both Assertion and Reason are false



**Watch Video Solution**

**4.** Assertion Due to two charges electric field and electric potential cannot be zero at some point simultaneously.

Reason Field is a vector quantity and electric potential is a scalar quantity

- A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion
- B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion
- C. If Assertion is true but Reason is false
- D. If Assertion is false but Reason is true



**Answer: B**



**Watch Video Solution**

**5. Assertion** At the centre of the line joining two equal and opposite charges,  $E = 0$

**Reason** At the centre of the line joining two equal and similar charge,  $E \neq 0$ .

A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion

- B. If both Assertion and Reason are correct  
but Reason is not the correct explanation of  
Assertion
- C. If Assertion is true but Reason is false
- D. If both Assertion and Reason are false



**Watch Video Solution**

**6.** Assertion A point charge produces a uniform electric field.

Reason Due to a point charge, electric lines of forces are parallel and equidistant.

- A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion
- B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion
- C. If Assertion is true but Reason is false
- D. If both Assertion and Reason are false



7. Assertion: A point charge is brought in an electric field. The field at a nearby point will increase, whatever be the nature of the charge.

Reason: The electric field is independent of the nature of charge.

A. If both Assertion and Reason are correct  
and Reason is the correct explanation of  
Assertion

- B. If both Assertion and Reason are correct  
but Reason is not the correct explanation of  
Assertion
- C. If Assertion is true but Reason is false
- D. If both Assertion and Reason are false

**Answer: D**



**Watch Video Solution**

**8. Assertion:** On going away from a point charge or a small electric dipole, electric field decreases

at the same rate in both the cases

Reason: Electric field is inversely proportional to square of distance from the charge or an electric dipole.

A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion

C. If Assertion is true but Reason is false

D. If both Assertion and Reason are false

**Answer: D**



**Watch Video Solution**

9. Assertion: Electric lines of force never cross each other.

Reason: Electric field at a point superimpose to give one resultant electric field

A. If both Assertion and Reason are correct and Reason is the correct explanation of

Assertion

B. If both Assertion and Reason are correct

but Reason is not the correct explanation of

Assertion

C. If Assertion is true but Reason is false

D. If both Assertion and Reason are false

**Answer: D**



**Watch Video Solution**



**10. Assertion:** The surface charge densities of two spherical conductors of different radii are equal. Then the electric field intensities near their surface are also equal.

**Reason:** Surface charge density is equal to charge per unit area.

A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion

B. If both Assertion and Reason are correct but Reason is not the correct explanation of

## Assertion

C. If Assertion is true but Reason is false

D. If Assertion is false but Reason is true

**Answer: B**



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**11. Assertion :** Two identical balls are charged by  $q$ . They are suspended from a common point by two insulating threads  $l$  each. In equilibrium, the angle between the tension in the threads is  $180^\circ$ . (Ignore gravity).

Reason : In equilibrium tension in the spring is

$$T = \frac{1}{4\pi\epsilon_0} \frac{q \cdot q}{l^2}$$

A. If both Assertion and Reason are correct

and Reason is the correct explanation of

Assertion

B. If both Assertion and Reason are correct

but Reason is not the correct explanation of

Assertion

C. If Assertion is true but Reason is false

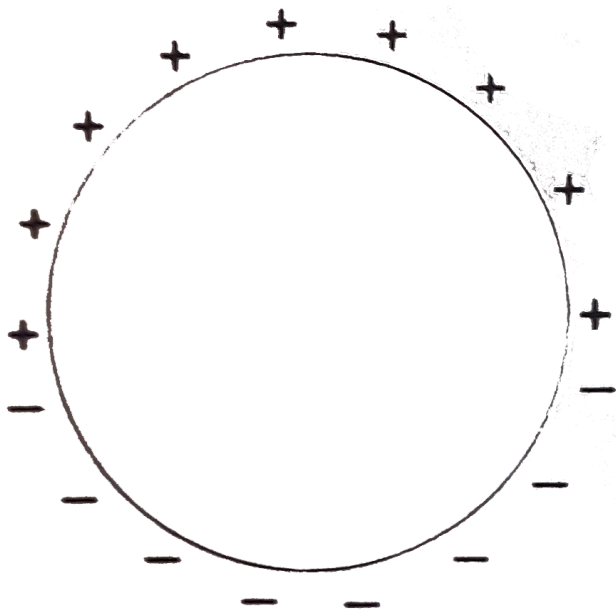
D. If Assertion is false but Reason is true

**Answer: C**



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**12.** Assertion : Half of the ring is uniformly positively charged and other half uniformly negatively charged. Then, electric field is zero at centre. Then , electric field is zero at centre.



Reason : At the centre of uniformly charged ring, electric field is zero. 1)If both Assertion and Reason are correct and Reason is the correct explanation of Assertion 2)If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion 3)If Assertion is true but

Reason is false 4) If Assertion is false but Reason is true

A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion

C. If Assertion is true but Reason is false

D. If Assertion is false but Reason is true

**Answer: D**



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**13. Assertion :** If a dipole is enclosed by a surface, then according to Gauss's law, electric flux linked with it will be zero.

**Reason :** The charge enclosed by a surface is zero.

A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion

- B. If both Assertion and Reason are correct  
but Reason is not the correct explanation of  
Assertion
- C. If Assertion is true but Reason is false
- D. If Assertion is false but Reason is true

**Answer: A**



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**14.** Assertion: In a region where uniform electric field exists, the net charge within volume of any



size is zero.

Reason: The electric flux within any closed surface in region of uniform electric field is zero.

A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion

C. If Assertion is true but Reason is false

D. If Assertion is false but Reason is true

**Answer: A**



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**15. Assertion :** With the help of Gauss's theorem we can find electric field at any point.

**Reason :** Gauss's theorem can be applied for any type of charge distribution.

A. If both Assertion and Reason are correct and Reason is the correct explanation of Assertion

- B. If both Assertion and Reason are correct  
but Reason is not the correct explanation of  
Assertion
- C. If Assertion is true but Reason is false
- D. If Assertion is false but Reason is true

**Answer: C**



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**Match the columns**

1. Match the following two columns.

Column I		Column II	
A. Electric charge	p.	$[M^{-1}L^{-3}T^4A^2]$	
B. Electric field strength	q.	$[MLT^{-3}A^{-1}]$	
C. Absolute permittivity	r.	$[MT^{-3}A^{-1}]$	
D. Electric dipole	s.	None	



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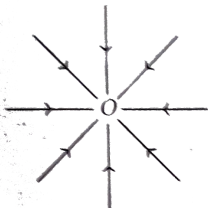
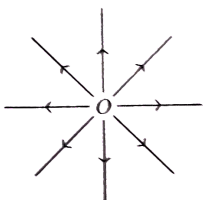
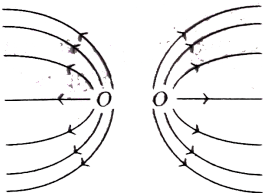
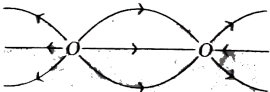
2. Two charge  $+q$  and  $-q$  are placed at distance  $r$ .

Match the following two columns when distance between them is changed to  $r'$ .



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3. Match the field lines given in Column I with charge configuration due to which field lines exist in Column II.

Column I	Column II
<p>A. </p>	<p>p. A pair of equal and opposite charges</p>
<p>B. </p>	<p>q. A pair of positive charges</p>
<p>C. </p>	<p>r. A single positive charge</p>
<p>D. </p>	<p>s. A single negative charge</p>



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4. Four metallic plates are charged as shown in figure. Now, match the following two columns.

$I \begin{array}{|c} \sigma \\ \hline \end{array} \quad II \begin{array}{|c} -2\sigma \\ \hline \end{array} \quad III \begin{array}{|c} \sigma \\ \hline \end{array} \quad IV$

$I \begin{array}{|c} \sigma \\ \hline \end{array} \quad II \begin{array}{|c} -2\sigma \\ \hline \end{array} \quad III \begin{array}{|c} \sigma \\ \hline \end{array} \quad IV$

Column I		Column II	
A.	Electric field in region-I	p.	$\frac{\sigma}{\epsilon_0}$
B.	Electric field in region-II	q.	$\frac{2\sigma}{\epsilon_0}$
C.	Electric field in region-III	r.	$\frac{\sigma}{2\epsilon_0}$
D.	Electric field in region-IV	s.	zero



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5. Match the following two columns.

Column I		Column II	
A.	Electric field outside the uniformly charged non-conducting sphere	p.	zero
B.	Electric field inside the conducting sphere	q.	$E \propto r^0$
C.	Electric field due to infinite thin plane sheet of charge	r.	$E \propto \frac{1}{r^2}$
D.	Electric field at centre of hemispherical charged body	s.	None



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Medical entrances gallery

1. An electric dipole is placed at an angle of  $30^\circ$  with an electric field intensity  $2 \times 10^5 \text{ N/C}$ . It experiences a torque equal to  $4 \text{ Nm}$ . The charge on the dipole, if the dipole is length is  $2 \text{ cm}$ , is

A.  $8 \text{ mC}$

B.  $2 \text{ mC}$

C.  $5 \text{ mC}$

D.  $7 \mu\text{C}$

**Answer: B**



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2. The electric field in a certain region is acting radially outward and is given by  $E = Ar$ . A charge contained in a sphere of radius 'a' centred at the origin of the field' will be given by

A.  $4\pi\epsilon_0 Aa^2$

B.  $A\epsilon_0 a^2$

C.  $4\pi\epsilon_0 Aa^3$

D.  $\epsilon_0 Aa^3$

**Answer: C**



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3. A Gaussian surface in the cylinder of cross-section  $\pi a^2$  and length  $L$  is immersed in a uniform electric field  $E$  with the cylinder axis parallel to the field. The flux  $\phi$  of the electric field through the closed surface is

A. (a)  $2\pi a^2 E$

B. (b)  $\pi a^2 EL$

C. (c)  $\pi a^2(2 + L)E$

D. (d) zero

**Answer: D**



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4. A total charge of  $5\mu C$  is distributed uniformly on the surface of the thin walled semispherical cup. If the electric field strength at the centre of the hemisphere is  $9 \times 10^8 NC^{-1}$ , then the radius of the cup is

$$\left( \frac{1}{4\pi\epsilon_0} = 9 \times 10^9 N - m^2 C^{-2} \right)$$

A. 5 mm

B. 10 mm

C. 5 cm

D. 10 cm

**Answer: A**



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5. Two small spherical shells A and B are given positive charges of 9 C and 4 C respectively and placed such that their centres are separated by 10 m. If P is a point in between them, where the electric field intensity is zero, then the distance of the point P from the centre of A is

A. 5 m

B. 6 m

C. 7m

D. 8 m

**Answer: B**



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**6.** A point charge  $q$  is situated at a distance  $r$  from one end of a thin conduction rod of length  $L$  having a charge  $Q$  (uniformly distributed a long

its length).find the magnitudes of electric force between the two.

A.  $\frac{Kqq}{r^2}$

B.  $\frac{2KQ}{r(r + L)}$

C.  $\frac{KQq}{r(r - L)}$

D.  $\frac{KQq}{r(r + L)}$

**Answer: D**



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7. When  $10^{19}$  electrons are removed from a neutral metal plate through some process, then the charge on it becomes

A.  $+1.6C$

B.  $-1.6C$

C.  $10^{19}C$

D.  $10^{-19}C$

**Answer: A**



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8. A charge  $Q$  is uniformly distributed over a large plastic plate. The electric field at a point  $P$  close to the centre of the plate is  $10Vm^{-1}$ . If the plastic plate is replaced by a copper plate of the same geometrical dimension and carryin the same charge  $Q$  the electric field at the point  $P$  will become

A. zero

B.  $5Vm^{-1}$

C.  $10Vm^{-1}$

D.  $20Vm^{-1}$



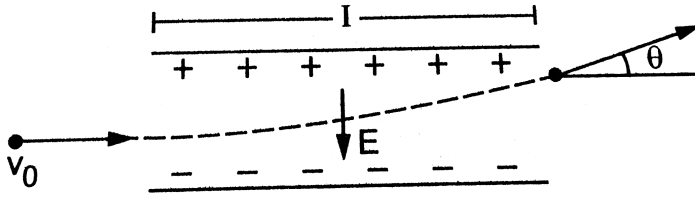
**Answer: C**



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9. A uniform electric field  $E$  is created between two parallel  
two parallel  
., charged plates as shown in figure . An electron  
. enters the field symmetrically between the  
plataes with a  
. speed  $v_0$ . The length of each plate is  $l$ . Find the  
angle of  
. deviation of the path of the electron as it comes  
out

. of the field.



$$\theta = \tan^{-1} \left( \frac{eEl}{mv_0^2} \right)$$

$$\theta = \tan^{-1} \left( \frac{eEl}{mv_0^2} \right)$$

$$\theta = \tan^{-1} \left( \frac{eEl}{mv_0^2} \right)$$

A.  $\theta = \tan^{-1} \frac{El}{mv_0^2}$

B.  $\theta = \tan^{-1} \left( \frac{eEl}{mv_0^2} \right)$

C.  $\theta = \tan^{-1} \left( \frac{eEl}{mv_0} \right)$

D.  $\theta = \tan^{-1} \left( \frac{eE}{mv_0^2} \right)$

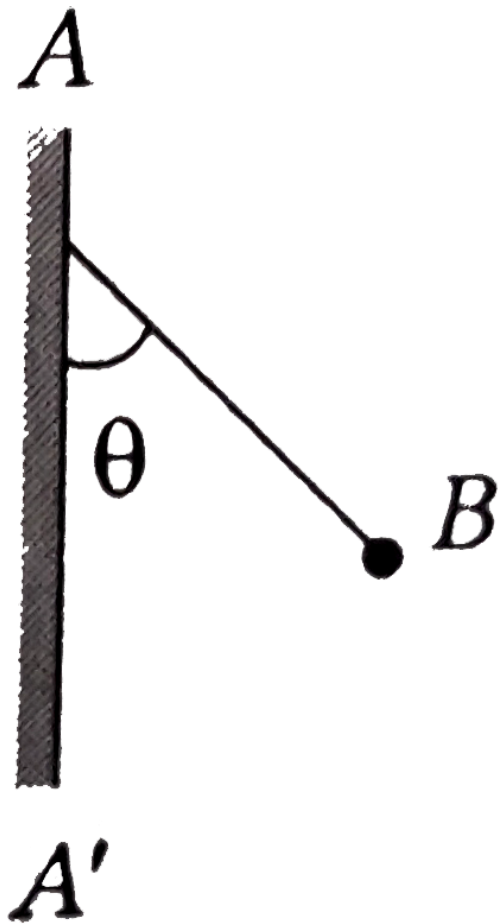
**Answer: B**





**10.** The line  $AA'$  is on charged infinite conducting plane which is perpendicular to the plane of the paper. The plane has a surface density of  $\sigma$  and bob has charge of magnitude  $q$ .  $B$  is connected by string from a point on the line  $AA'$ . The tangent of angle  $(\theta)$  formed between the line  $AA'$  and the

string is



A.  $\frac{q\sigma}{2\epsilon_0 mg}$

B.  $\frac{q\sigma}{4\pi\epsilon_0 mg}$

C.  $\frac{q\sigma}{2\pi\epsilon_0 mg}$

D.  $\frac{q\sigma}{\epsilon_0 mg}$

**Answer: A**



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**11.** The electric field at a point on equatorial of a dipole and direction of the dipole moment

A.  $180^\circ$

B.  $0^\circ$

C.  $45^\circ$

D.  $90^\circ$

**Answer: A**



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**12.** Pick out the statement which is incorrect?

- A. A negative test charge experiences a force  
opposite to the direction of the field
- B. The tangent drawn to a line of force  
represents the direction of electric field

C. Field lines never intersect

D. The electric field lines form closed loop

**Answer: D**



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**13.** An electron of mass  $m_e$  initially at rest moves through a certain distance in a uniform electric field in time  $t_1$ . A proton of mass  $m_p$  also initially at rest takes time  $t_2$  to move through an equal distance in this uniform electric field. Neglecting

the effect of gravity, the ratio of  $t_2/t_1$  is nearly equal to

A. 1

B.  $\sqrt{\frac{M_p}{M_e}}$

C.  $\sqrt{\frac{M_e}{M_p}}$

D. 1836

**Answer: B**



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**14.** Two charges  $10\mu C$  and  $-10\mu C$  are placed at points  $A$  and  $B$  separated by a distance of 10 cm. Find the electric field at a point  $P$  on the perpendicular bisector of  $AB$  at a distance of 12 cm from its middle point.

A.  $16.4 \times 10^6 NC^{-1}$

B.  $28.4 \times 10^6 NC^{-1}$

C.  $8.2 \times 10^6 NC^{-1}$

D.  $4.1 \times 10^6 NC^{-1}$

**Answer: D**



15. A uniform electric field exists in space. Find the flux of this field through a cylindrical surface with the axis parallel to the field.

A.  $\frac{\sigma}{2\pi r\epsilon_0}$

B.  $\frac{\sigma}{\epsilon_0}$

C. zero

D.  $\frac{\sigma}{2\epsilon_0}$

**Answer: C**



**16.** An inclined plane of length  $5.60\text{ m}$  making an angle of  $45^\circ$  with the horizontal is placed in a uniform electric field  $E = 100\text{Vm}^{-1}$ . A particle of mass  $1\text{kg}$  and charge  $10^{-2}\text{C}$  is allowed to slide down from rest position from maximum height of slope. If the coefficient of friction is  $0.1$ , then the time taken by the particle to reach the bottom is

1 s   1.41 s   2 s   None of these

A. 1 s

B. 1.41 s

C. 2 s

D. None of these

**Answer: B**



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**17.** Two charge spheres separated at a distance  $d$  exert a force  $F$  on each other. If they are immersed in a liquid of dielectric constant  $K=2$ , then the force (if all conditions are same) is

A.  $F / 2$

B.  $F$

C.  $2F$

D.  $4F$

**Answer: A**



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**18.** If a charge on the body is  $1nC$ , then how many electrons are present on the body?

A.  $1.6 \times 10^{19}$

B.  $6.25 \times 10^9$

C.  $6.25 \times 10^{27}$

D.  $6.25 \times 10^{28}$

**Answer: B**



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**19.** Electric field at a point of distance  $r$  from a uniformly charged wire of infinite length having linear charge density  $\lambda$  is directly proportional to

A.  $r^{-1}$

B.  $r$

C.  $r^2$

D.  $r^{-2}$

**Answer: A**



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**20.** Two equal and opposite charges of masses  $m_1$  and  $m_2$  are accelerated in a uniform electric field through the same distance. What is the ratio of their accelerations, if their ratio of masses is  $\frac{m_1}{m_2} = 0.5$ ?

A.  $\frac{a_1}{a_2} = 0.5$

B.  $\frac{a_1}{a_2} = 1$

C.  $\frac{a_1}{a_2} = 2$

D.  $\frac{a_1}{a_2} = 3$

**Answer: C**



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**21.** An electric dipole of dipole moment  $p$  is placed in a uniform external electric field  $E$ . Then, the

A. torque experienced by the dipole is  $E \times p$



B. torque is zero, if  $p$  is perpendicular to  $E$

C. torque is maximum, if  $p$  is perpendicular to  $E$

D. potential energy is maximum, if  $p$  is parallel to  $E$

**Answer: C**



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**22.** An electric dipole in a uniform electric field experiences (When it is placed at an angle  $\theta$  with

the field)

- A. Both a torque and a net force
- B. Only a force but no torque
- C. Only a torque but no net force
- D. No torque and no net force

**Answer: A**



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**23.** What is the nature of Gaussian surface involved in Gauss's law of electrostatics?

A. Scalar

B. Electrical

C. Magnetic

D. Vector

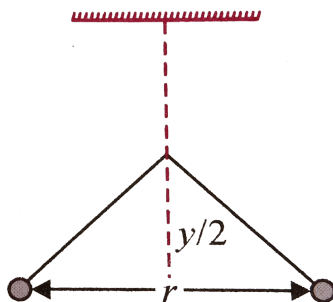
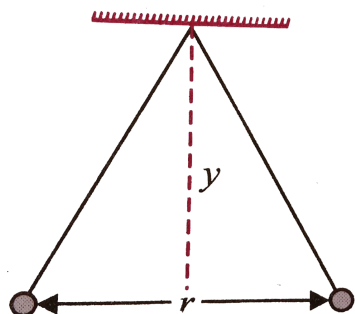
**Answer: D**



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**24.** Two path balls carrying equal charges are suspended from a common point by strings of equal length, the strings are rightly clamped at

half the height. The equilibrium separation between the balls, now becomes :



- A.  $\left(\frac{1}{\sqrt{2}}\right)^2$
- B.  $\left(\frac{r}{\sqrt[3]{2}}\right)$
- C.  $\left(\frac{2r}{\sqrt{3}}\right)$
- D.  $\left(\frac{2r}{3}\right)$

**Answer: B**



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25. An electric charge does not have which of the following properties?

- A. Total charge conservation
- B. Quantisation of charge
- C. Two types of charge
- D. Circular line of force

**Answer: D**



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**26.** The net electric force on a charge of  $+3\mu C$  at the mid-point on the line joining two charges of magnitude  $+2\mu C$  and  $+2\mu C$  separated by the distance of 6 mm, is

A. 6000 N

B. 500 N

C. 60 N

D. zero

**Answer: D**



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27. The force of repulsion between two electrons at a certain distance is  $F$ . The force between two protons separated by the same distance is  $(m_p = 1836m_e)$

A.  $2F$

B.  $F$

C.  $1836 F$

D.  $\frac{F}{1836}$

**Answer: B**



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**28.** A point charge  $q$  is placed at a distance  $a/2$  directly above the centre of a square of side  $a$ .  
The electric flux through the square is

A. (a)  $q/\epsilon_0$

B. (b)  $q/2\epsilon_0$

C. (c)  $\frac{q}{4\epsilon_0}$

D. (d)  $q/\epsilon_0$

**Answer: D**



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**29.** Electrical force is acting between two charge kept in vacuum. A copper plate is placed between the charges, the force now is

- A. (a) more
- B. (b) less but not zero
- C. (c) remains unchanged
- D. (d) zero

**Answer: B**



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30. Equal charges  $q$  are placed at the vertices  $A$  and  $B$  of an equilateral triangle  $ABC$  of side  $a$ .

The magnitude of electric field at the point  $C$  is

A.  $\frac{q}{4\pi\epsilon_0 a^2}$

B.  $\frac{\sqrt{3}q}{4\pi\epsilon_0 a^2}$

C.  $\frac{\sqrt{2}q}{4\pi\epsilon_0 a^2}$

D.  $\frac{2q}{4\pi\epsilon_0 a^2}$

**Answer: C**



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**31.** Two charges  $+4e$  and  $+e$  are at a distance  $x$  apart. At what distance, a charge  $q$  must be placed from charge  $+e$  so that is in equilibrium

A. (a)  $\frac{x}{2}$

B. (b)  $\frac{x}{3}$

C. (c)  $\frac{x}{6}$

D. (d)  $\frac{2x}{3}$

**Answer: B**



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32. A mass  $m = 20g$  has a charge  $q = 3.0mC$ . It moves with a velocity of  $20\text{ m/s}$  and enters a region of electric field of  $80\text{ N/C}$  in the same direction as the velocity of the mass. The velocity of the mass after  $3\text{ s}$  in this region is

A.  $40ms^{-1}$

B.  $44ms^{-1}$

C.  $56ms^{-1}$

D.  $80ms^{-1}$

**Answer: C**



**33.** A rod lies along the X-axis with one end at the origin and the other at  $x \rightarrow \infty$ . It carries a uniform charge  $\lambda Cm^{-1}$ . The electric field at the point  $x = -a$  on the axis will be

A.  $E = \frac{\lambda}{4\pi\epsilon_0 a} \left( -\hat{i} \right)$

B.  $E = \frac{\lambda}{4\pi\epsilon_0 a} \left( \hat{i} \right)$

C.  $E = \frac{\lambda}{2\pi\epsilon_0 a} \left( -\hat{i} \right)$

D.  $E = \frac{\lambda}{2\pi\epsilon_0 a} \left( \hat{i} \right)$

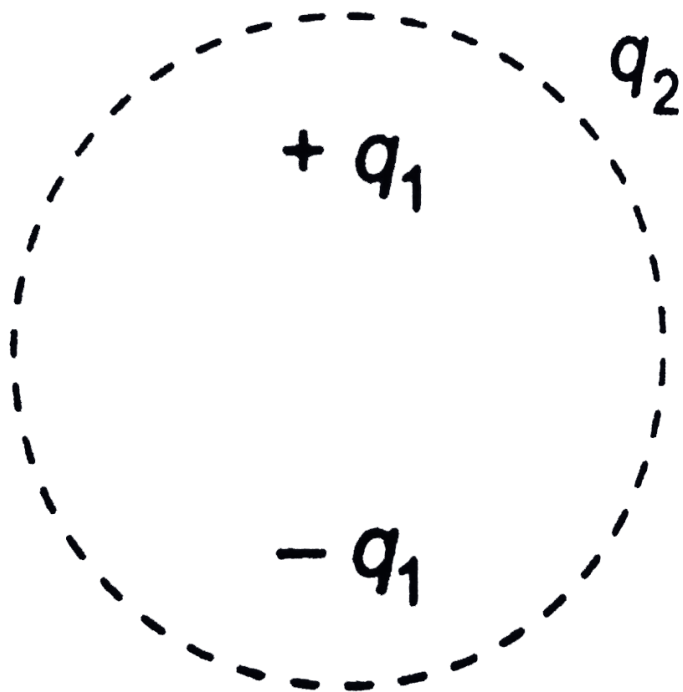
**Answer: C**



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**34.** Consider the charge configuration and a spherical Gaussian surface as shown in the figure. When calculating the flux of the electric field over the spherical surface, the electric field will be due

to.



- A.  $+q_3$  alone
- B.  $+q_1$  and  $+q_3$
- C.  $+q_1$ ,  $+q_3$  and  $-q_2$
- D.  $+q_1$  and  $-q_2$

**Answer: C**



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**35.** What is the flux through a cube of side  $a$  if a point charge of  $q$  is at one of its corner.

A.  $\frac{2q}{\epsilon_0}$

B.  $\frac{q}{8\epsilon_0}$

C.  $\frac{q}{\epsilon_0}$

D.  $\frac{q}{2\epsilon_0} 6a^2$

**Answer: B**





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**36.** If the electric field given by  $(5\hat{i} + 4\hat{j} + 9\hat{k})$ , then the electric flux through a surface of area 20 unit lying in the  $yz$ - plane will be

A. 100 unit

B. 80 unit

C. 180 unit

D. 20 unit

**Answer: A**

37. A charge  $Q$  is to be divided on two objects. What should be the values of the charges on the objects so that the force between the objects can be maximum?

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

B.  $\frac{Q}{4}$  and  $\frac{3Q}{4}$

C.  $\frac{Q}{3}$  and  $\frac{2Q}{3}$

D. None of these

**Answer: A**



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