PHYSICS

BOOKS - MODERN PUBLISHERS PHYSICS (HINGLISH)

ELECTRIC CHARGES AND FIELDS

Solved Example

1. How can we charge two metallic spheres with equal and opposite charge using the method of induction?

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2. How many electrons should be transferred in order to generate a charge of 1 C ?

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3. How much charge is carried by one mole of electrons?

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4. An object A acquires positive charge $9.6\mu C$, when rubbed against another object B. Is there any change is mass of object B ? Will this increase or decrease the mass of B and how much ?

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5. A body is continuously rubbed by running a belt of suitable material and in this process body loses 10^7 electrons per second. How much time will be needed to get a total charge of 1 C from the body ?

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6. Two point charges of +1C each are placed at a separation of 1m from each other . The force between them is used to lift a group of people . How many people can be lifted with the force ? Asssume 100 kg to be the mass of every person. Take $g = 10m/s^2$

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7. Find the ratio of the electric and gravitational forces between two protons.

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8. Two infinitesimally small bodies are charged by rubbing against each other are found to attract each other with a force of 3.7×10^{-13} N when separated by a distance of 5×10^{-8}

m. How many electrons were transferred from one body to the other after rubbing ?

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9. A very tiny ball of mass 20 g carries a positive charge $0.04\mu C$. It is held stationary in air due to electric force by a charge fixed below it at a distance of 10 cm. What should be the magnitude and nature of charge ?

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10. A positive charge Q is fixed at a point in space. There is another charge -q, which moves in a circular path of radius r around the given fixed charge . Assume that the electrostatic force between them is the only force acting on them. Calculate time period of revolution of charge .

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11. Two small identical blocks of mass 10 g carrying the same charge of magnitude 0.2 μC

are kept at a separation of 0.1 m on a rough table . If both the blocks stay in equilibrium using limiting friction from the surface then calculate the coefficient of friction between the block and the table.

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12. A charge +2 μC is placed at a point A (2,1,0). Another charge $-3\mu C$ is placed at a point B (4,2,-1). Calculate net force on a charge $+5\mu C$ placed at a point C (-1,3,2).

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13. Four identical charges +Q are kept at the corners of a square ABCD. The edge length of square is a . Find net force on the charge kept at C due to the other three charges.

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14. Two identical point charges Q are kept at a distance r from each other. A third point charge is placed on the line joining the above two charges such that all the three charges are in equilibrium. The third charge

(a) should be of magnitude q=...........

(b) should be of sign ....

(c) should be placed ....

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15. Two identical particles are charged and held at a distance of 1m form each other. They are found to be attraction each other with a force of 0.027N . Now they are connected by a conducting wire so that charge flows between them. When the charge flow stop, they are found to be repelling each other with a force of 0.009N. Find the initial charge on each particle.

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16. Two identical spheres of mass m and charge q are suspended from a common point by two threads of the same length l and it is found that threads make an angle θ with the vertical

when the spheres are in equilibrium . Calculate the value of q.

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17. Point charges of magnitude $9\mu C$ each are placed along the X-axis at x =1m , x=2m , x=4 m , x=8 m and so on till infinity . Calculate the net force experienced by a charge of 0.1 C placed at the origin.

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18. Two charges A and B of $-5\mu C$ each are placed at a separation of 20 cm . Another charge C of +3 μC is placed at a separation of 20 cm from both the charges A and B . What should be the nature and magnitude of the charge to be placed at the midpoint between A and B so that net force on charge C is zero ?

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19. A small water droplet of mass 1g carries a charge of 8×10^{-19}C. What electric field strength is required to suspend the droplet against gravity ?

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20. A uniform electric field of 3×10^4 N/C is applied iin a horizontal direction . A pendulum bob of mass 90 mg and carrying a charge of 1.5×10^{-8} C is suspended through a string of length 1m. Calculate tension developed in the string and the angle made by the string with the vertical .

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21. An electron and a proton are released from rest in a uniform electric field E and are found to take time t_e and t_p respectively to cover a distance x. Calculate the ratio of time taken by them. If both the particles are allowed to fall under gravity in vacuum, then calculate the ratio of time taken by them to cover a distance x starting from rest.

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22. How much deflection would the electron beam suffer when it travels a distance of 10 cm in a uniform electric field of 20 N/C . The initial velocity of electrons is 3×10^7 m/s directed perpendicular to the electric field .

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23. A uniform electric field E is created between two parallel

., charged plates as shown in figure . An electron

. enters the field symmetrically between the

plataes with a

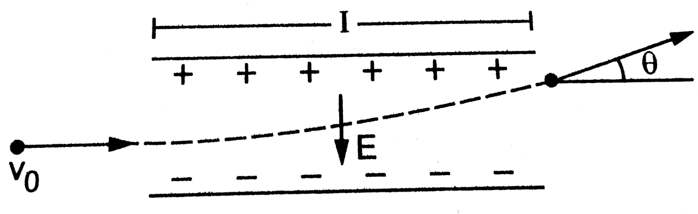
. speed `v_0. The length of each plate is l. Find

the angle of

. deviation of the path of the electron as it

comes out

. of the field.



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24. The total positive charge on a silver nucleus (atomic number :Z=47) is uniformly distributed on a sphere of radius 10^{-10} m . What will be the intensity of electric field at the surface of this sphere ?

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25. Two point objects carry positive charges of magnitude 5e and 20e . Separation between the charges is 1 cm. Find the location of points on the line joining the two charges where the electric field intensity is zero.

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26. A square PQRS has a side of 2m. Charges of +20 C, -20 C and +20 C are placed at vertices P,R and S respectively. What will be the net force experienced by a 1 C charge placed at point Q ?

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27. Two point charges +Q each are placed at adjacent corners of a square. Other two point charges -Q each are placed at the remaining two corners of the same square . The side of the square is l. Find electric field intensity at the centre of the square.

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28. Two equal and opposite charges of magnitude 10 μC each are fixed at a distance of 1 mm from each other to form an electric dipole . Calculate the electric field intensity (i) at a point on its axis at a distance 1 m from the centre of dipole and (ii)at a point on its perpendicular bisector at a distance 1 m from the centre of dipole.

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29. Electric field intensity at a point on axis of a dipole at a distance of 20 cm from the centre of dipole is 0.015 N/C. When the distance of the point from the centre is made double to its initial value then electric field intensity is reduced to 0.001 N/C . Calculate the length of the electric dipole .

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30. Locate the points around a short electric dipole , where electric field intensity is perpendicular to the axis of dipole.

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31. 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.

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32. Consider a uniformly charged ring of radius R. Find the pint on the axis where the electrie field is maximum.

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33. Calculate the electric field intensity at point P due to a charged thin rod AB as shown in the given figure. Charge is distributed uniformly over the length of the rod . The length of rod is l. The distance of point P from end B of the rod is a.Charge per unit length of the rod is λ .Also , find the electric field intensity when the length of rod is infinite .

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34. Calculate electric field intensity at point P due to a thin positive uniformly charged rod . Point P is at perpendicular distance d from the rod . The lower and upper ends of the rod make the angles α and β as shown below .

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35. Find : (i)Electric field intensity due to an infinitely long uniformly charged, straight conductor , at a perpendicular distance d from rod.

(ii)Electric field intensity at a point on perpendicular bisector of uniformly charged rod of length l and charge Q at a distance d from the centre of rod.

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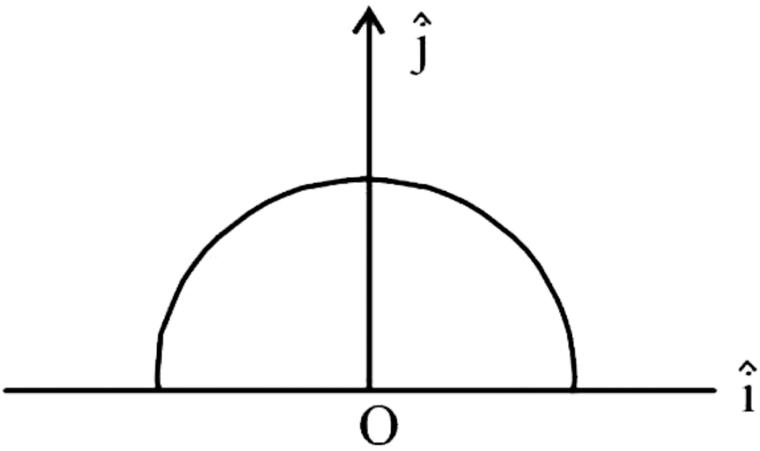
36. A thin semi-circular ring of radius r has a positive charge q distributed uniformly over it.

The net field $\vec{E}$ at the centre O is



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37. Electric field intensity in a region of space is given by $\vec{E} = 4\hat{i} + 6\hat{j} + 3\hat{k}$ N/C. Consider a plane surface of area 10 units parallel to Y-Z plane and calculate electric flux linked through this surface.

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38. A cylindrical suface is placed in uniform electric field in such a manner that axis of cylinder is parallel to the electric field intensity . Using the Gauss's law , prove that the net charge enclosed by this cylindrical surface must be zero.

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39. A point charge +Q is placed at a point. Calculate the electric flux associated with one sphere of radius r , which the given point charge at its centre.

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40. There is a cube of edge length l. The total charge on rod is Q. What maximum and minimum electric flux through surfaces of cube are possible , if one end of the rod is at the centre of cube.

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41. A charge q is placed at the centre of a cube.What is the electric flux associated with one of the faces of cube ....

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42. An electric dipole is placed inside a sphere. The centre of dipole is not at the centre of sphere, but the dipole is completely enclosed within the sphere . Calculate total flux through the spherical surface Q is one of the charges and l is distance between charges of dipole.

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43. A point charge Q is placed at the centre of circular disc of radius r . Calculate the electric flux associated with circular disc.

44. Given the components of an electric field as $E_x = \alpha x$,$E_y = 0$ and $E_z = 0$, where α is a dimensional constant. Calculate the flux through each face of the cube of side a, as shown in the figure.

45. There is one hollow sphere of radius 1 m and it contains a charge of 8.85 μC at its centre . Calculate the electric flux linked with the sphere per unit area . Electric flux per unit area is defined as flux density .

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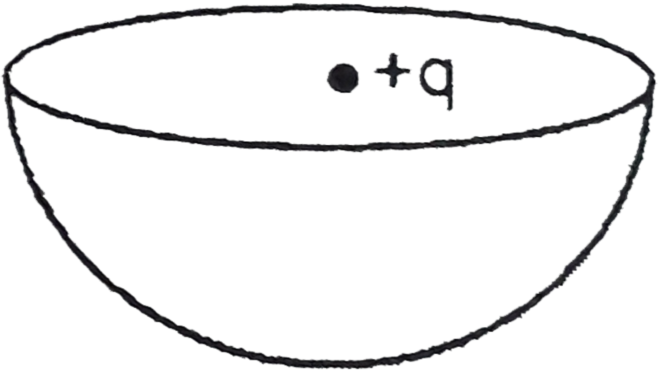
46. A point charge +q is placed at the centre of curvature of a hemisphere. Find flux through the hemispherical surface.



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47. There is one long line charge with linear charge density λ. One electron is moving in a circular path around this line charge. Plane of the circle is perpendicular to line charge and line charge passes through centre of circle. Prove that kinetic energy of electron is independent to the radius of a circle.

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48. Two infinitely long parallel wires having linear charge densities λ_1 and λ_2 respectively are placed at a distance of R metres. The force per unit length on either wire will be $\left(k = \frac{1}{4\pi\varepsilon_0}\right)$

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49. A large non-conducting surface is there with surface charge density $5\mu C/m^2$. How much force will it apply on a point charge of $2\mu C$ when placed at a distance of 2cm from the surface ?

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50. There is one horizontal non-conducting surface with surface charge density $5\mu C/m^2$. A point object of mass $100\mu g$ is placed above it

. What charge should be given to the point object so that it may stay in equilibrium against gravity ?

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Practice Problems

1. A piece of woll is rubbed against a PVC strip. What will be the charge on the strip, if approximately 2×10^{12} electrons are transferred from the wool to the PVC strip ?

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2. Find the number of electrons present in an 8-g gold pin . Given : Molar mass of gold =197 g/mol , electron per atom is gold =79 and Avogadro's number $= 6.023 \times 10^{23} g^{-1} mol^{-1}$

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3. Find the total negative or positive charge on a 2 g silver coin. The atomic number and atomic mass of silver is 47 and 107.9 u respectively, Given: Avogadro's number is $6.023 \times 10^{23} g^{-1} \text{mol}^{-1}$.

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4. Find the total negative and positive charges in 500 cc of water Given: Avogadro's number is $6.023 \times 10^{23} g^{-1} mol^{-1}$, molecular weight of water in 18.

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5. An object with a net positive charge of 2×10^{-12} C contains 1.5×10^{7} protons. Calculate the number of electrons present on it.

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6. A Spherical ball is given one million electrons per second Calculate the time required by the ball to attain a charge of-0.8 C.

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7. An object with an initial charge of 4 C is given 9×10^{19}additional electrons, Calculate the net charge on the object.

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8. A charged object having charge of-4C is given 9×10^{19} electrons. Calculate the net charge on the object

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9. Two spherical balls of the same radius carry charges -0.4 C and-0.9 C.Calculate the number of electrons to be transferred from one ball to another such that they attain the same charge

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10. Calculate the change in mass of an object if 800 electrons are given to it Given: Mass of an electron is 9.1×10^{-31} kg .

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11. The charges on three dentical ebonite spheres are +2 mC, -4 mC and +2 mC respectively. Now the first sphere is brought in contact with the second sphere and then moved apart. Then, the second sphere is brought in contact with the third sphere and moved apart. Calculate the charge acquired by each sphere, provided ench sphere is kept on an insulated stand.

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12. The identical anions are placed 7×10^{-10} m apart and experience of 4×10^{-9} N. Calculate the charge present on each anion

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13. Two electrons are placed at a distance d such that electrostatic force between both the electrons is equal to sum of weight of both the electrons Calculate the value of d.

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14. Two identical small plastic balls are rubbed against a piece of wool such that both of them received approximately 2×10^{12} and 2.5×10^{12} electrons respectively. Now both the charged balls are kept at a distance of 25 cm in air. Calculate the nature and magnitude of force between both the balls

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15. calculate the change in electrostatic force between the two balls, if charge on both the balls are increased by 10%.

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16. Two identical metallic balls with equal charges are kept 4.5 cm apart. The force between both the balls increases by 10% on giving extra charge of 0.001 μC to one of the ball. Calculate the charge on each ball.

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17. Two small objects are rubbed against each other using insulating handles and then kept at a separation of 1 m from each other in vacuum. Both objects were found to attract each other with a force of 10 N. Assume that the force between the objects is of electrical nature. Calculate the number of electrons that were transferred from one object to another during the rubbing process.

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18. A point charge Q is kept fixed on a table and another particle of charge q and mass m is to be placed in air in such a way that it remains suspended at the same location in a state of equilibrium. What should be the distance of particle from point charge fixed on table?

19. Total charge Q is divided between two point objects in such a manner that electric force of repulsion between them is maximum when placed at a separation d from each other. What is the magnitude of this maximum possible electrostatic force between them?

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20. Two point charges with charge magnitudes 2 nC and 3 nC are placed at a separation of 1 cm from each other and then released. The mass of each point charge is 1 μg. Find the magnitude of acceleration of particles at the instant they are released.

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21. Four positive point charges Q are placed at the corners of a square of side a. Calculate the charge that should be placed at the centre so that system remains in equilibrium.

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22. There is a particle A with positive charge q_1 and mass m. There is another particle B with negative charge q_2 and mass m. Particles A and B are moving along circular paths under electrostatic attraction in such a manner that separation between them is d and location of their centre of mass is centre of circular path. What will be the angular velocity of particles?

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23. Two point charges Q are kept fixed on XY-plane at points A(0, d) and B(0, -d). Another point charge -q with mass m is held at a point, on the positive side of X-axis that is at the distance 2d from both the fixed point charges. What will be the magnitude of acceleration of the negative point charge (i) just after it is released from its location? (ii) at an instant it crosses the origin?

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24. calculate the maximum possible force that the negative charge may experience if it is to be placed somewhere on X-axis, What will be the distance of negative charge from origin where it experiences the maximum electrostatic force?

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25. Assume an electron with charge e and mass m is going around in a circular path of radius r around the nucleus of an atom having atomic number Z. If we define frequency f for this electron equal to the number of revolution per second, then calculate f.

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26. The ratio of magnitude of electrostatic force and gravitational force for an electron and a proton is

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27. Two identical point charges q of mass m each are suspended through strings of equal length l from a common point of suspension. Find the charge q if angle subtended by the strings with the vertical is θ, when point charges are in a state of equilibrium.

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28. Two particles of the same mass m are suspended through strings of equal length l in such a manner that points of suspension are distance d apart. Both particles carry charges of same magnitude but of opposite polarity. Calculate the magnitude of charge if strings make an angle θ with the vertical.

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29. Two charges of 2 mC and 8 mC are kept at (2 m,0) and (7 m, 0) respectively. At what position, a third charge Q should be kept so that all the three charges are in equilibrium. Also calculate the magnitude of charge Q.

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30. Three identical charges of 2mC are kept on the vertices of an equilateral triangle of side 10 cm. A third charge of 1 mC is kept on the centroid of the triangle Calculate the force acting on the charge 1mC.

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31. Three charges of 2 mC, -4 mC and -4mC are placed on the vertices of an equilateral triangle of side 10 cm. A charge q is kept on the midpoint between both -4mC charge. Calculate the value of q such that the 2 mC charge remains at equilibrium.

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32. Two point charges $-2\mu C$ and $+3\mu C$ are kept r distance apart. The $+3\mu C$ charge is displaced such that the force of attraction between both the charges is now tripled.

Calculate the final distance between both the charges.

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33. Two identical charge of magnitude +2 μC are kept on two diagonally opposite vertices of a square of side a. Both the charges are joined using an insulated massless chord. What will be the tension in the chord? Neglect the gravitational forces involved.

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34. Two identical charges of $1\mu C$ are kept on 0,2 m) and (0,-2 m), respectively. Calculate the magnitude of the force acting on a $2\mu C$ charge placed at (-5m,0).

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35. Two charges $+0.4\mu C$ and $-0.2\mu C$ are placed on adjacent vertices of a square of side 10 cm. Another charge of $1.2\mu C$ is placed at the centre af the square Calculate the force and its direction in the charge kept in the centre .

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36. Arrange three point charges $2\mu C, 4\mu C$ and $1\mu C$ on a straight line segment of 1 m such that net force experienced by the $1\mu C$ charge is zero

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37. An electron is moving in an orbit in hydrogen atom of radius 0.5×10^{-10} m. Calculate the time period of electron about the nucleus

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38. Distributed charge of 1 C into two parts such that these part a experience the maximum force when they are kept at a distance of 1 km.

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39. Fifty charged particles of magnitudes $0.01\mu C, 0.04\mu C, 0.09\mu C$ ....and so on are placed at points (0.1 m), (0.2 m), (0.3 m) .... respectively What will be the force acting on charge of 0.1 μC placed at (0,0)

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40. Charged particles of charge 0.001 μC are placed on Y-axis at points (0,1 m) (0,2 m),(0.3

m) and so on till infinity. Find the net force on charge of 0.1μC placed at (0,0).

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41. Two small identical balls, each of mass 0.20 g, carry identical charges and are suspended by two threads of equal lengths. The balls position themselves at equilibirum such that the angle between the threads is 60°. If the distance between the balls is 0.5 m, find the charge on each ball.

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42. A glycerin drop of mass 10^{-3} g with charge equal to 2e is balanced in an external electric field. Calculate the strength of electric field, if the field is sufficient enough to hold the drop.

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43. A small metallic ball with charge 1 μC and mass 0.1 mg, when thrown in an upward direction with initial velocity u, comes to rest after covering a distance of 5 cm in a uniform external electric field of strength $2.8 \times 10^6 NC^{-1}$. Find the value of u.

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44. In Millikan's oil drop experiment, an oil drop with density $1.5 gcm^{-3}$ and a radius of 10×10^{-7} m is supported by an external electric field. Calculate the required electric field strength if charge on the drop is 15e.

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45. A small metallic sphere with charge 0.1 μC is suspended by an insulating massless string in a region of electric field of strength 500 NC^{-1}. Calculate the tension in the string if mass of the sphere is 0.8 grams and the electric field is directed in a downward direction.

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46. calculate the tension in the string and angle made by it with vertical if electric field is directed in horizontal direction.

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47. A small particle of mass 1.8×10^{-30} kg and charge -3.5×10^{-19} C is dropped in a region of electric field of strength $2.8 \times 10^{5} NC^{-1}$, directed in the upward direction. Calculate the time taken by the ball to cover a distance of 2 cm.

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48. calculate the time taken by a spherical ball if the direction of electric field is reversed and the charge on the particle is changed to $+3.5 \times 10^{-19}$ C

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49. A point charge of 0.01 μC is placed at the origin. Calculate the electric field at another point charge of 0.05 μC placed at (0 m, 5 m).

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50. Two point charges of, 1 μC and -1 μC are kept at (-2 m, 0) and (2 m, 0) respectively. Calculate the electric field at point (0, 5 m).

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51. calculate the electric field at point (5 m, 0) due to a point charge of 1 x 10(-6) C placed at

(0,5m).

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52. Two point charges of magnitude 4 μC and-4μC are kept at points (-2 cm, 0) and (2 cm, 0) respectively. Calculate the magnitude of electric field intensity at points (0, 2 cm).

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53. Electric force experienced by a charge of $1\mu C$ is 5×10^{-3} N. What should be the magnitude of electric field intensity at the position of the charge?

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54. The magnitude of electric field intensity due to a point charge is 10 N/C at a distance 1 m from it. Calculate the magnitude of charge.

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55. Two point charges q_1 and q_2 are fixed at a separation of 20 cm. Locate the point(s) on the line joining the charges where the net electric field intensity is zero.

(i)$q_1 = +2\mu C$ and $q_2 = -4\mu C$

(ii)$q_1 = +2\mu C$ and $q_2 = -2\mu C$

(iii)$q_1 = +2\mu C$ and $q_2 = +4\mu C$

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56. A particle of mass 1 mg loses 108 electrons and then stays in equilibrium against gravity inside electric field. What should be the magnitude and direction of the electric field intensity?

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57. A very small particle of mass m and charge q is given an initial speed u against uniform electric field E. How much distance will the particle cover before acquiring the same speed again?

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58. A small ball of mass m and charge q is suspended through a string in uniform electric field E applied in horizontal direction. How much tension would be developed in the string if it stays in equilibrium?

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59. A charged particle of mass m and charge q is released from rest in an electric field of constant magnitude E. The kinetic energy of the particle after time t is

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60. Mass of bob of a pendulum is m and it is suspended from the ceiling inside a uniform external electric field of magnitude E directed in horizontal direction. Initially the bob has no charge and it takes time T to complete one oscillation. Now it is given a positive charge q. How much time will the bob take to complete one oscillation now?

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61. A block of mass m is placed on a frictionless horizontal table. Consider a spring of spring constant K whose one end is connected to the block and the other end is connected to a fixed support in such a manner that spring remains horizontal. A positive charge q is given to the block. Suddenly an electric field of magnitude E is switched on in horizontal direction that is in the direction away from the fixed support. What will be the maximum possible elongation of the spring after electric field is switched on?

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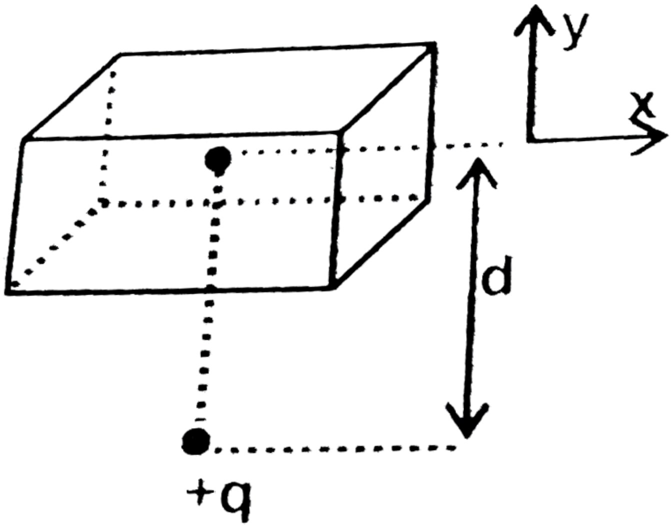
62. A charge $+q$ is placed at a distance 'd' from the centre of the uncharged metallic cube of side 'a'. The electric field at the centre of the cube due to induced charges on the cube will be



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63. There is one charged tiny spherical oil drop and the magnitude of electric field intensity at a point on its surface is E. If n such drops are combined to make a single drop then what will be the net electric field intensity at a point on the surface of the bigger spherical drop. Assume that charge is uniformly distributed over the volume of oil drop.

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

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65. An electric dipole consists of two charges of $\pm 0.5 \mu C$, kept at distance of 1.0 cm. Calculate the potential energy required to place the dipole such that it makes an angle of

30° with the external electric field of 0.8×10^4 N/C.

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66. Two charged particles of charges +0.1 μC and -0.1 μC are kept on the vertices of an equilateral triangle of side 10 cm. Calculate the electric field intensity at the centroid of the triangle.

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67. Four point charges, +0.1 μC,-0.1 μC,-0.1 μC and +0.1 μC are kept at points A(0, 2 m), B(0, -2 m), C (-$\sqrt{2}$ m, $\sqrt{2}$ m) and D ($\sqrt{2}$ m, -$\sqrt{2}$ m) respectively. Calculate the resultant dipole moment of the combination.

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68. calculate the magnitude and direction of the torque acting on the combination, if it is placed in an external electric field of $10^4 NC^{-1}$ directed along X-axis.

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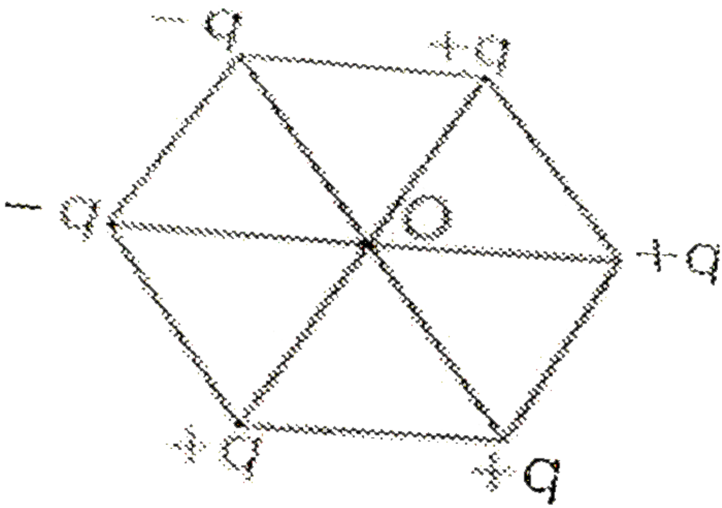
69. Six point charges are arrange at the vertices of a regular hexagon of side length a (shown in figure).



Find the magnitude of electric field at the centre of regular hexagon.

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70. Calculate the magnitude of electric field at the centre of a regular hexagon of side 2.5 cm, if each charge placed at its vertex has the same magnitude of $+0.01\ \mu C$.

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71. Calculate the electric field at the centre of a cube, if seven of its corners are given a charge of 0.02 μC and side of cube is 10 mm.

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72. A proton is placed at a distance of 3×10^{-9} m from the centre of an electric dipole along the axis of the dipole. Calculate the force on the proton due to dipole if its dipole moment is 4×10^{-30} C m. Given: Dipole length < < 3×10^{-9} m.

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73. Two point charges +4 μC and -4 μC are place(at vertices P and Q respectively of a right angled triangle. Calculate the magnitude and direction of electric field at a point R, if $\angle PQR = 90^\circ$, PQ =0.03 cm and QR = 0.04 cm.

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74. An electric dipole experiences a torque of $10\sqrt{3}$ Nm, when placed at an angle of 60° with a uniform electric field of magnitude $10^3 NC^{-1}$ Calculate the charge on the dipole if its length is 3 cm.

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75. A positive charge Q is uniformly distributed across a rod of length L. The rod is then bent in the form of a semicircle. What will be the electric field intensity at the centre of curvature of the semicircle thus formed?

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76. Find the electric field intensity at the centre of a semi circular arc of radius r, uniformaly charged with a charge q.

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77. Consider a uniformly charged ring of radius R and total charge Q. What is the magnitude of maximum possible electric field intensity on the axis of ring? What is the distance of point from the centre of ring at which the electric field is maximum?

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78. A rod of length 20 cm carries a charge of +150 μC that is uniformly distributed along its length. Find the electric field intensity at a point, which is 20 cm away from both the ends of the rod.

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79. A positive charge Q is uniformly distributed along the length L of a rod. It is bent in the shape of a square. Calculate electric field intensity at the centre of the square.

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80. Consider one design of electron gun, which has a barrel of length 1 m made of an insulating material. At one end of the barrel, a filament is electrically heated so that it emits electrons. Assume these electrons are emitted with a the sides negligible speed. What electric field should be applied parallel to the barrel so that electrons may achieve speed of light before leaving the barrel? Ignore the variation of mass of electron due to its speed.

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81. A charge q is uniformly distributed over a large plastic plate. The electric field at a point P close to the centre and just above the surface of the plate is 50 V/m. If the plastic plate is replaced by a copper plate of the same geometrical dimensions and carrying the same uniform charge q, the electric field at the point P will become :

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82. A point charge Q is kept at the centre of a square face of edge length a. Calculate the amount of flux linked with the square face due to electric field of given point charge.

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83. A sphere of radius R has a charge density σ. The electric intensity at a point at a distance r from its centre is

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84. There is one large vertical non-conducting plane surface with uniformly distributed charge. A pendulum bob is suspended through an insulating string from a point on this non-conducting surface. The length of the string is l and mass of the bob is m. The charge carried by the pendulum bob is q. It is found that in a state of equilibrium, the string of the pendulum makes 60° angle with the vertical. What will be the charge per unit area on surface? Also calculate the tension developed in the string in equilibrium state.

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85. Two large conducting plates are placed parallel to each other with a separation d. An electron $(-e, m)$ starting from rest near one of the plates reaches the other plate in time t_0. Find the surface density on the inner surface.

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86. Calculate the magnitude of electric field intensity at a point 10 cm away from a line charge of linear charge density 5 μC/m.

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87. What magnitude of force will be applied by a $2\mu C$ point charge on a large non-conducting surface having surface charge density of $6\mu C / m^2$ placed near it?

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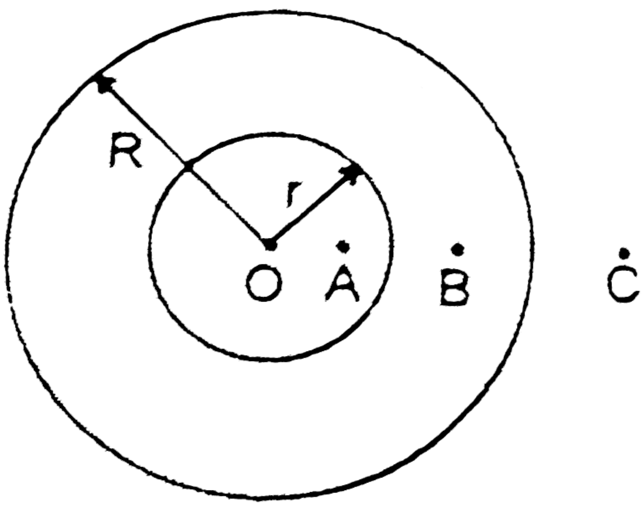
88. A Uniformly charged solid non-conducting sphere of uniform volume charge density ρ and radius R is having a concentric spherical cavity of radius r. Find out electric field intensity at following points, as shown in the figure :



(i) Point A (ii) Point B

(iii) Point C (iv) Centre of the sphere

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Conceptual Questions

1. We often say that the net charge of macroscopic bodies is basically deficiency or excess of electrons. Why not of protons ?

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2. What kind of charge is attained by a plastie rod when it is rubbed with wool ?

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3. What kind of charge is attained by a glass rod when it is rubbed with silk?

Watch Video Solution

4. If two bodies are attracting each other, then what can you say about their charge?

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5. If two bodies repel each other, then what can you say about their charges?

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6. Explain why a neutral object can be attracted to a charged objec. Why can this neutal object not be repelled by a charged object ?

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7. If a charged body is placed near a neutral conductor, will it attract the conductor or repel it ?

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8. How can we understand the phenomenon of frictional electricity?

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

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10. The amount of electric charge on one mole of electrons is ________.

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11. What is induction of charge?

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12. What name do we assign to charges due to induction?

Watch Video Solution

13. If only one charge is availabel, can it be used to obtain a charge many times greater than itself in magnitude?

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14. If you bring a charged rod near dry cork dust, the rod attracts cork dust and then on touching the rod these cork dust particles are repelled away from the rod. Explain it.

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15. A positively charged object is kept near a metallic object. If we connect the metallic object to earth, then describe how charge flows.

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16. What is the similarity between electric and gravitational forces?

Watch Video Solution

17. What is the dissimilarity in electric and gravitational forces?

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

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19. Can we use Coulomb's law to find the force between two charged conducting spheres for any distance between them?

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20. Electric lines of forces -

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21. Two lines of force in an electric field never intersect each other. Why?

Watch Video Solution

22. Two lines of force in an electric field never intersect each other. Why?

Watch Video Solution

23. Electric lines can apply lateral force on each other. Why?

Watch Video Solution

24. In electrostatic condition electric lines of force become perpendicular to metal surface. Why?

Watch Video Solution

25. The electric lines of force do not passes through

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26. What is electrostatic shielding?

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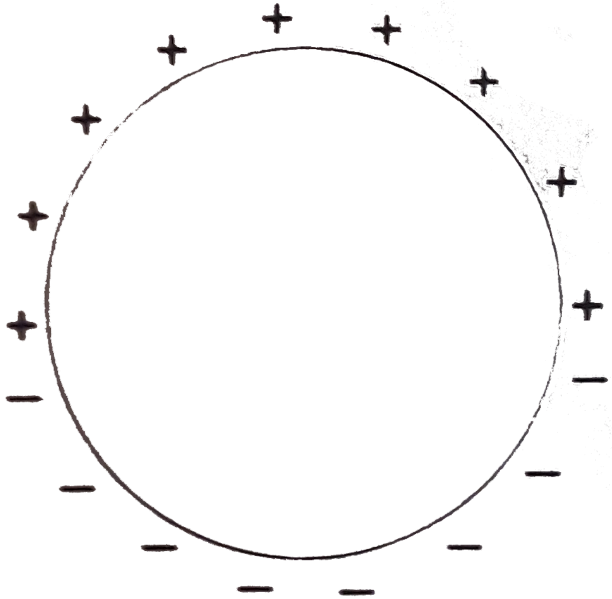
27. Assertion : Half of the ring is uniformly positively charged and other half uniformly negatively charged. Then, electric field is zero at centre. Then , electric field is zero at centre.



Reason : At the centre of uniformly charged ring, electric field is zero.

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28. What is dielectric constant for an insulating medium?

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29. Is it possible for a metal sphere of radius 1 cm to hold a charge of 1C ?

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30. It is difficult to perform electrostatic experiment on a humid day. Why?

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31. A positively charged thin metal ring of radius R is fixed in the xy plane with its centre at the origin O. A negatively charged particle P is released from rest at the point $(0, 0, z_0)$ where $z_0 > 0$. Then the motion of P is

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32. What is electric dipole?Why do we assume the electric dipole to be small in size in most of the cases?

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33. What kind of symmetry is there in electric field of electric dipole?

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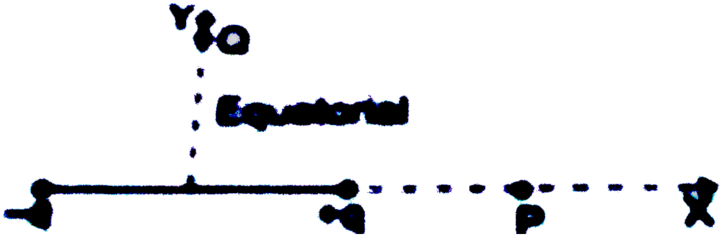
34. Due to an electric dipole shown in fig., the electric field intensity is parallel to dipole axis :



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35. How can we write electric field intensity for small dipole at a point on its perpendicular bisector in vector form?

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36. Derive an expression for potential energy of an electric dipole in a uniform electric field. In which situation, the potential energy fo dipole is (i) maximum and (ii) minimum.

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37. Derive an expression for potential energy of an electric dipole in a uniform electric field. In which situation, the potential energy fo dipole is (i) maximum and (ii) minimum.

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38. When an electric dipole is placed in a uniform electric field, a couple acts on it. The moment of couple will be maximum when the dipole is placed

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39. Based on band theory, explain why metals are good conductors of electricity, while insulators are non-conductors of electricity.

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40. Why can metals conduct electricity?

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41. What in area vector?

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42. Can electric flux be a negative number?

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43. What is the nature of Gaussian surface involved in Gauss's law of electrostatics?

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44. Can Gauss's law in electrostatics tell us exactly where the charge is located within the

Gaussian surface ?

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45. A point charge (q) is kept above the centre of 8 cm x 8 cm square metal plate at a height of 4 cm. What will be the flux associated with this surface?

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46. A sphere encloses an electric dipole withon it. The total flux across the sphere is

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47. A point charge is placed at the centre of one of the Six Surfaces of a cube. What flux will be associated with the cube?

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48. v0

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49. If a point charge q is placed at the centre of a cube, then find out flux through any one face of cube.

Watch Video Solution

50. 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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51. Why do we always get electric field intensity near a charged metallic surface of magnitude twice of the electric field intensity near a thin sheet of charge with same surface charge density as of metal plate?

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Tough & Tricky Problems

1. Two identically charged spherical objects are suspended from a common point , using two different threads of equal length. Due to repulsion between charges both strings are maintaining a constant angle with the vertical, and both the objects are in equilibrium. Use m as mass , L as length of each thread. The angle made by each thread with the vertical is θ. Calculate the charge on objects.

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2. A charge is divided into two charges q and (Q-q) .The value of q so that force between them is maximum is equal to

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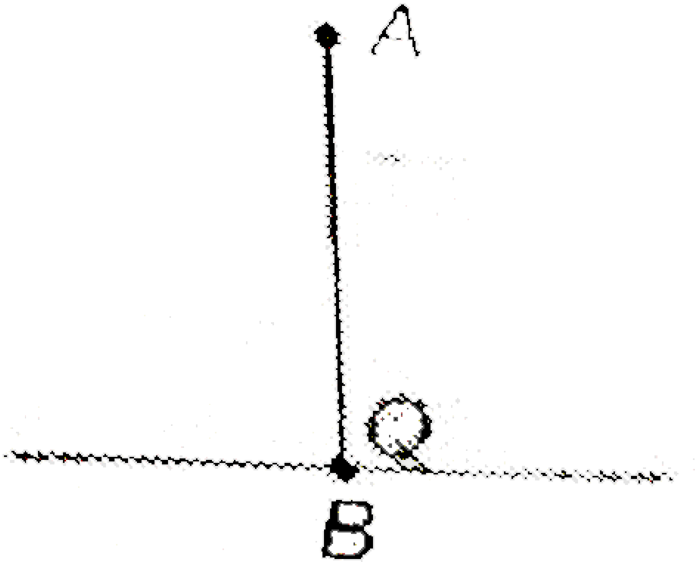
3. A point charge Q is situated at point B on the ground. A point charge q of mass m is vertically dropped along line AB from a multi storey building of height h. Find the position of the point charge q when it is in equilibrium



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4. A charged particle of mass m having charge q remains in equilibrium at height d above a fixed charge Q. Now the charged particle is slightly displaced along the line joining the charges, show that it will executes $S.H.M.$ and find the time period of oscillation.

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5. Consider three charged spheres made of some insulating material . Two of them are positively charged with charge Q and one is negatively charged with charged -q. What should be the charge ratio so that the three of them remain in equilibrium ? Assume the sizes to be very small .

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6. Each circle shwon in the figure given below is of radius R. Six identical positive point charges Q are placed at points A,B,C ,D ,E and F. What negative charge is required to be placed at the centre O so that all particles remain in equilibrium ?

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7. Two equal positive charges , Q , are fixed at points $(0, d)$ and $(0, -d)$ on the y-axis. A charged particle having charge $-q$ and mass m is released from rest at point $(d, 0)$ on the x-axis . Discuss the motion of charged particle.

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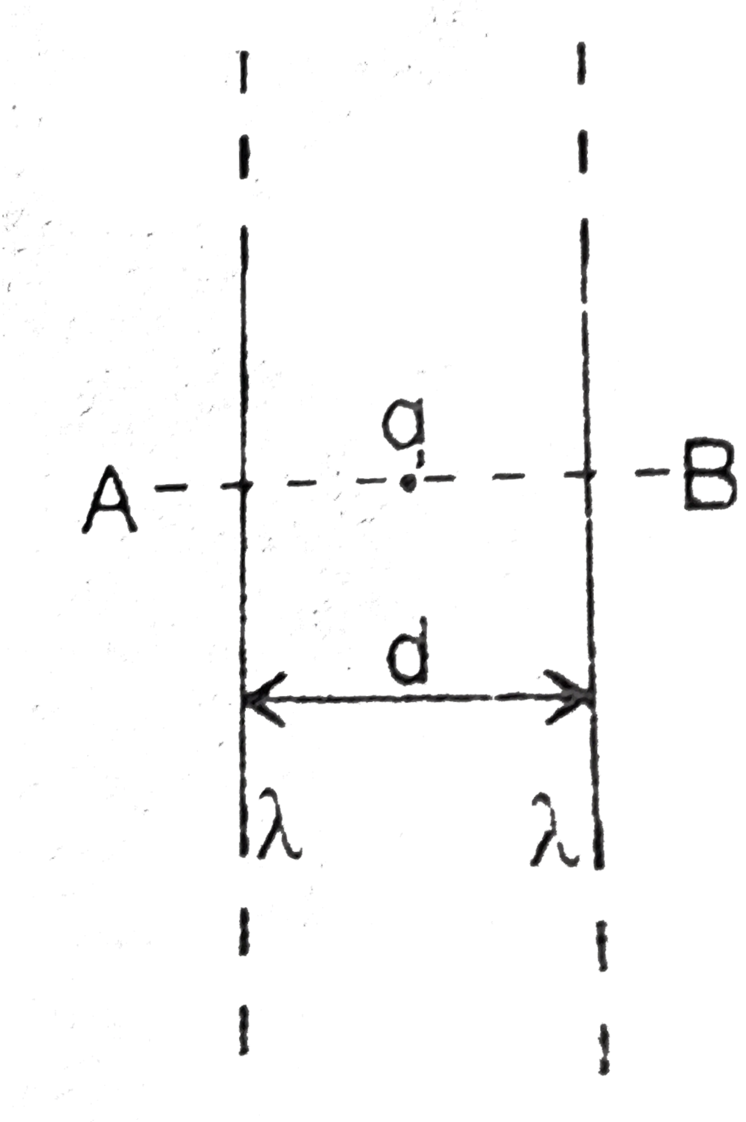
8. Two infinitely long line charges having charge density λ each are parallel to each other and separated by distance d. A charge particle of mass m and charge q is placed at mid point between them. This charge displaced slightly along a line AB which is perpendicular to the line charges and in the plane of the charges. prove that the motion of the particle will be SHM for small displacement and $\lambda q > 0$ Neglect gravity. Find the time period.



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9. A mass m carrying a charge q is suspended from a string and placed in a uniform horizontal electric field of intensity E.The angel made by the string with the vertical in the equilibrium position is

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10. A ring of radius R carries a uniformly distributed charge +Q. A point charge $-q$ is placed on the axis of the ring at a distance 2R from the centre of the ring and released from rest. The particle executes a ismple harmonic motion along the axis of the ring.

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11. A very small electric dipole with dipole moment p is placed in such in way that it is at a distance r from another point charge +q. The point charge lies on the axis of the dipole . Electric dipole moment is pointing towards the point charge. Determine electric dipole will attract the point charge or repel it ? What will be the magnitude of force between them ?

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12. There is a pentagon ABCDE, whose centre is O. Five identical charges Q are placed at the corners of pentagon.

(a)What will be the net electric field intensity at the centre of pentagon ?

(b)If charge at corner A is moved to centre O of pentagon, then what will be the net force experienced by it ?

Distance of any vertex of pentagon from its centre is d.

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13. Two point charges , $-2\mu C$ and $+6\mu C$ are fixed on a table at a distance 10 cm from each other. Where should the third charge be placed so that no net force acts on it ?

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14. A particle of mass m and charge q is released from rest in uniform electric field of intensity E. Calculate the kinetic energy it attains after moving a distance x between the plates.

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15. A uniform electric field of magnitude E exists in between two parallel metal plates , as shown in the figure given below. One particle of mass m and charge q is projected along the central line between the plates. Particle just missed to strike upper plate , while coming out of plates. Find :

(a)Time taken by the particle to come out of plates.

(b)Speed of the particle as it comes out of plates.

(c) Angle of deviation suffered by particle. The length of the plates is L and the distance between the plates is d. Ignore gravity .

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16. Four charges are kept at the corners of a square of size a. Three charges are -Q and one is 3Q. Calculate the net electric dipole moment of this system.

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17. Two large metal plates with surface charge densities $+\sigma$ and $-\sigma$ are separated from each other by a distance of d. Find the force per unit area acting between them.

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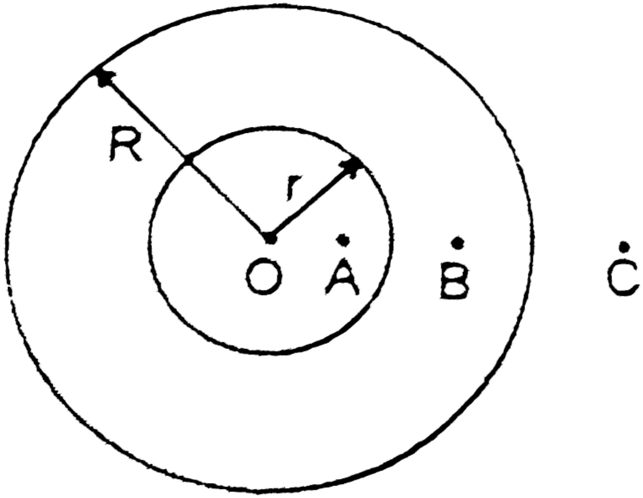
18. The kinetic energy of the electron in an orbit of radius r in hydrogen atom is ($e =$ electronic charge)

Watch Video Solution

19. A Uniformly charged solid non-conducting sphere of uniform volume charge density ρ and radius R is having a concentric spherical cavity of radius r. Find out electric field intensity at following points, as shown in the figure :



(i) Point A (ii) Point B

(iii) Point C (iv) Centre of the sphere

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20. 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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Ncert File (Textbook Exercise)

1. What is the force between two small charged soheres having charges of $2 \times 10^{-7} C$ and $3 \times 10^{-7} C$ placed 30 cm apart in air ?

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2. The electrostatic force on a small sphere of charge $0.4 \mu C$ due to anther small sphere of charge $-0.8 \mu C$ in air 0.2 N (i) What is the distance between the two spheres? (ii) What is the force on the second sphere due to the first ?

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3. Chech that the ratio $ke^2 / \mathrm{G}\,\mathrm{m}_e m_p$ is dimensionless. Look up a table of Physical Constants and setermine the value of this ratio. What does the ratio signify?

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4. (a)Explain the meaning of the statement 'electric charge of a body is quantized '

(b) Why can one ignore quantisation of electric charge when dealing with macroscopic , i.e. large scale charges ?

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5. When a glass rod is rubbed with a silk cloth, charges appear on both. A similar phenomenon is observed with many other pairs of bodies. Explain how this observation is consistent with the law of conservation of charge.

6. Four point charges $q_A = 2\mu C, q_B = -5\mu C, q_C = 2\mu C$ and $q_D = -5\mu C$ are located at the corners of square ABCD of side 10 cm. What is the force on a charge of $1\mu C$ placed at the centre of the square?

7. (a) An electrostatic field line is a continuous curve. That is, a field line cannot have sudden breaks. Why not?

(b) Explain why two field lines never cross each other at any point?

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8. Two point charges $q_A = 3\mu C$ and $q_B = -3\mu C$ are located 20 cm apart in vaccum (a) what is the electric field at the mid point O of the line AB joining the two charges

? (b) If a negative test charge of magnitude $1.5 \times 10^{-9} C$ is placed at the point, what is the force experienced by the test charge ?

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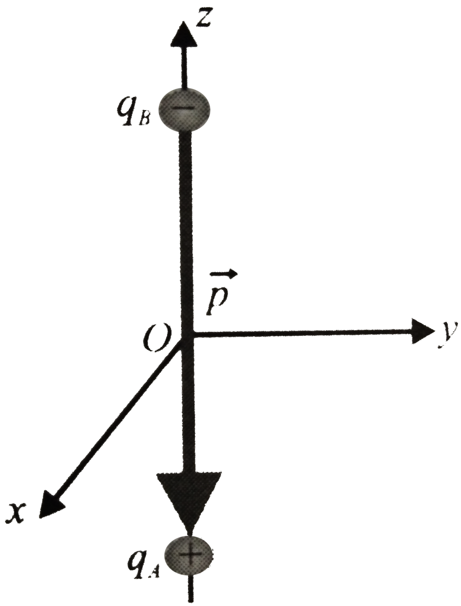
9. A system has two charges $q_A = +2.5 \times 10^{-7} C$ and $q_B = -2.5 \times 10^{-7} C$ located at point A: (0,0,-15 cm)and B: (0,0,+15 cm)`, respectively. What are the total charge and electric dipole moment of the system?



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10. An electrtic dipole with dipole moment $4 \times 10^{-9} Cm$ is aligned at 30° with the direction of a uniform electric field of magnitude $5 \times 10^4 NC^{-1}$. Calculate the magnitude of the torque acting on the dipole .

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11. A polythene piece rubbed will wool is found to have a negative charge of $3.0 \times 10^{-7} C$.

(a) Estimate the number of electrons transferred (from which to which)?

(b) Is there a transfer of mass from wool to polythene?

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12. (a) Two insulated charged copper spheres A and B have their centers speparated by a distance of 50 cm. What is the mutal force of electrostatic repulsion if the charge on each is $6.5 \times 10^{-7} C$? The radill of A and B are negalible compared to the distance of separation.

(b) What is the force of repulsion if each sphere is charged double the above amount, and the distance between them is halved ?

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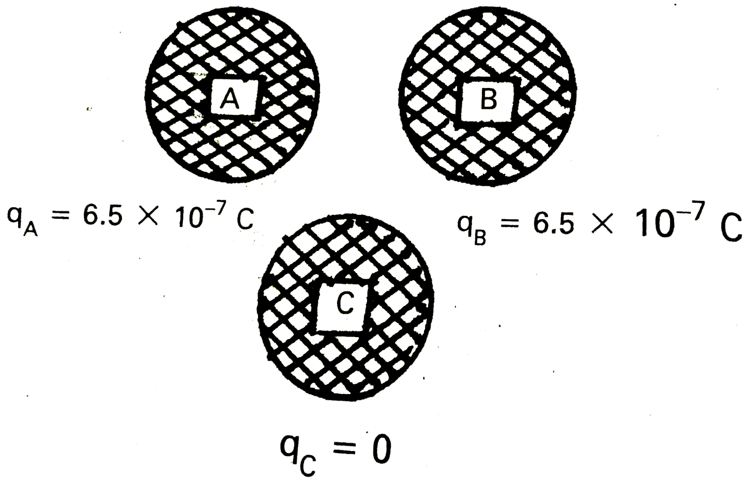
13. Suppose the spheres A and B in Exercise - 12 have identical sizes. A third sphere of the same size but uncharged is brought in contact with the first, then brought in contact with second and finally removed from both. What is the new force of repulsion between A and B if the distance between them is 50 cm?



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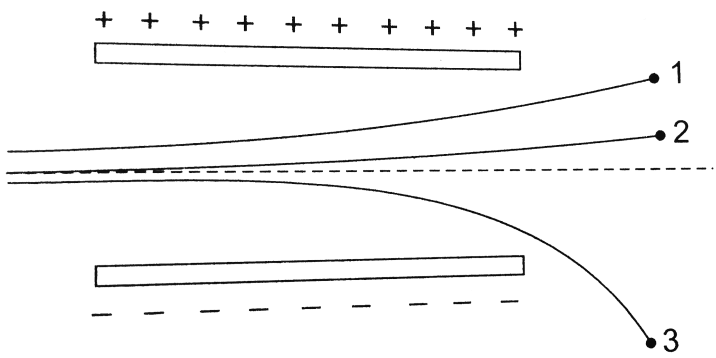
14. Figure shows tracks of three charged particles crossing a uniform electrostatic field with same velocities along horizontal. Give the

sign of the three charges. Which particle has the highest charge to mass ratio?



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15. Consider a uniform electric field $E = 3 \times 10^3 \hat{i} N / C$. (a) What is the flux of this field through a square of 10 cm on a side whose plane is parallel to the yz plane ? (b)

What is the flux through the same square if the normal to its plane makes a 60° angle with the x-axis ?

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16. What is the net flux of the uniform electric field of Exercise 1.15 through a cube of side 20 cm oriented so that its faces are parallel to the coordinate planes?

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17. Careful measurement of the electric field at the surface of a black box indicates that the net outward flux through the surface of the box is $8.0 \times 10^3 Nm^2 / C$ (a) what is the net charge inside the box ? (b) If the net outward flux through the surface of the box were zero, could you conclude that there were no charges inside the box ? Why or why not?

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18. A point charge $+10\mu C$ is a distance 5 cm directly above the centre of a square of side 10 cm, as shown in figure. What is the magnitude of the electric flux through the square?

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19. A point charge of $2.0\mu C$ is at the centre of a cubic Gaussian surface 9.0 cm on edge. What is the net electric flux through the surface?

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20. 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 is the value of the point charge ?

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21. A conducting sphere fo radius 10 cm has an unknown charge. If the electric field 20 cm from the center of the sphere is $1.5 \times 10^3 N/C$ and points radilly inwards, what is the net charge on the sphere ?

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22. 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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23. An infinite line charge produces a field of $9 \times 10^4 NC$ at a distance of 2cm. Calculate the linear charge density.

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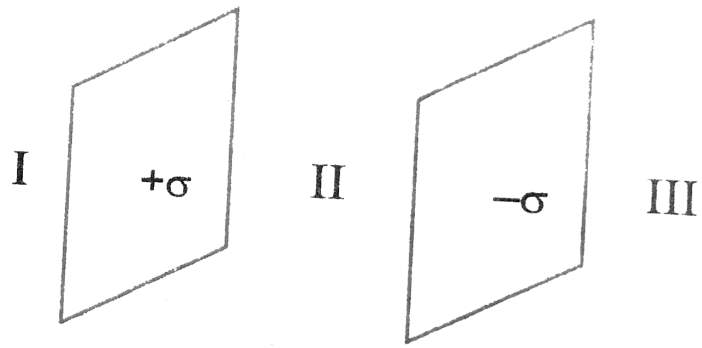
24. Two large this metal plates are parallel and close to each other. On their inner faces, the plates have surface charge densities of opposite signs and magnitude $17.0 \times 10^{-22} C/m^2$. What is $\vec{E}$: in the outer region of the first plate. (b) in the outer region of the secound plate, and (c) between the plates ? See Fig.



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25. An oil drop of 12 excess electrons is held stationaty under a constant electric field of $2.55 \times 10^{4} NC^{-1}$ in Millikan's oil drop experi,ment. The density of the oil is $1.26 gcm^{-3}$. Estimate the radius of the drop. $(g = 9.81 ms^{-2}, e = 1.60 \times 10^{19} C)$

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26. In a certain region of space, electric field is along the z-direction throughout. The magnitude of the electric field is, however, not constant but increases uniformly along the positive z-direction, at the rate of $10^5 N. C^{-1}$ per metre. What are the force and torque experienced by a system having a total dipole moment equal to 10^{-7} C. m in the negative z-direction.

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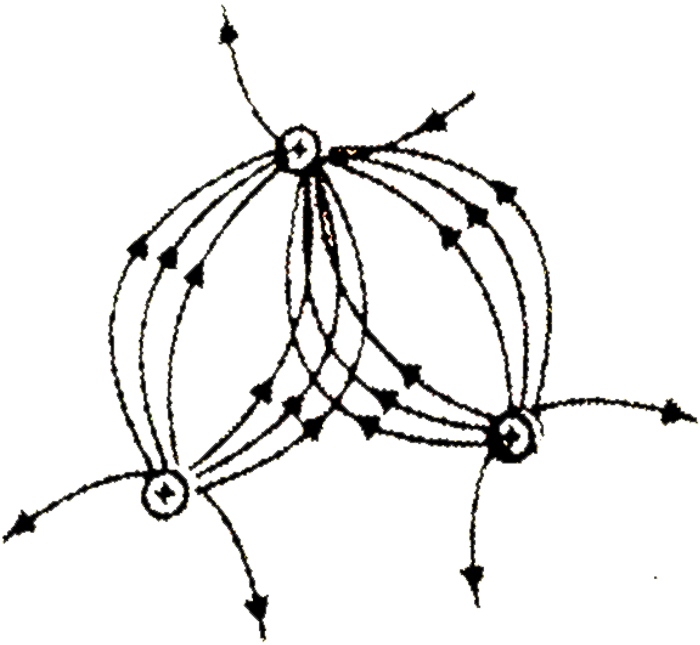
27. Which among the curves shown in Fig. cannot possibly represent electrostatic field lines?



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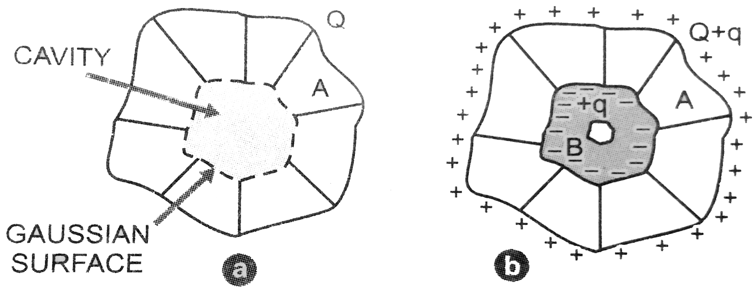
28. (a) A conductor A with a cavity as shown in Fig, is given a charge Q. Show that the entire charge must appear on the outer surface of the conductor.

(b) Another conductor B with charge q is inserted into the cavity keeping B insulated from A. Show that the total charge on the outside surface of A is $(Q + q)$ fig.

(c) A sensitive instrument is to be shielded from the strong electrostatic field in its environment. Suggest a possible way.



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29. A hollow charged conductor has a tiny hole cut into its surface. Show that the electric field in the holes is $(\sigma / 2 \in_0 \ \widehat{n}$, where $\widehat{n}$ is the unit vector in the outward normal direction, and σ is the surface charge density near ther hole.

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30. Obtain the formula for the electric field due to a long thin wire of uniform linear charge density λ without using Gauss's law. [Hint.use Coulomb's law directly and evaluate the necessary integral].

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31. It is now believed that protons and neutrons (which constitute nuclei of ordinary matter) are themselves built out of more elementary units called quarks. A proton and a neutron consist of three quarks each. Two types of quarks, the so called 'up' quark (denoted by u) of charge + (2/3)e and the 'down' quark (denoted by d) of charge (-1/3) e, together with electrons build up ordinary matter. (Quarks of other types have also been found which give rise to different unusual varieties of matter.) Suggest a possible quark composition of a proton and neutron.

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32. (a) Consider an arbitrary electrostatic field configuration. A small test charge is placed at a null point (i.e, where $\vec{E} = 0$) of the configuration. Show that the equilibrium of the test charge is necessarily unstable.

(b) Verify this result for the simple configuration of two charges of the same magnitude and sign placed a certain distance apart.

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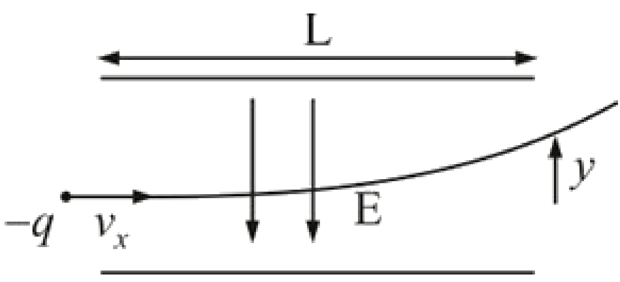
33. A particle of mass m and charge(-q) enters the region between the two charged plates intially moving along x - axis with speed V_x . The length of plate is L and a uniform electric field E is maintained between the plates . Show that the verticles deflection of the particle at the far edge of the palte is $qEL^2 / (2mv_x^2)$.



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34. Suppose that the particle is an electron projected with velocity $V_x = 2.0 \times 10^6 ms^{-1}$. If E between the plates separated by 0.5 cm is $9.1 \times 10^2 N / C$, where will the electron strike the upper plate? $(|e| = 1.6 \times 10^{-19} C, m_e = 9.1 \times 10^{-31} kg)$.

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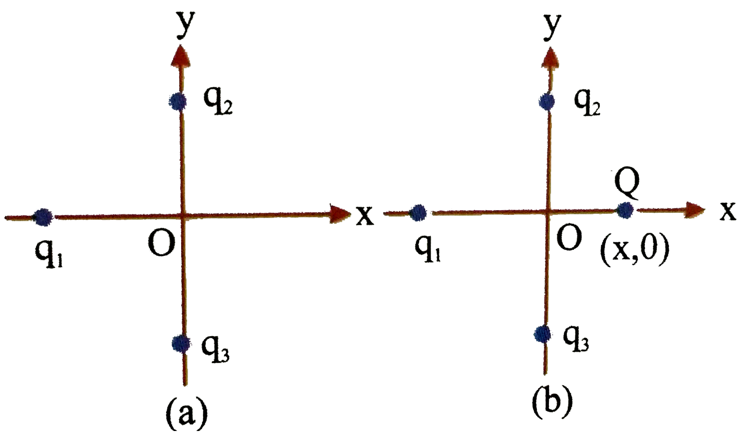
Ncert File (Ncert (Exemplar Problems))

1. 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. shell 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 changes because of the intersection of Q with q_2 and q_3

Answer: A

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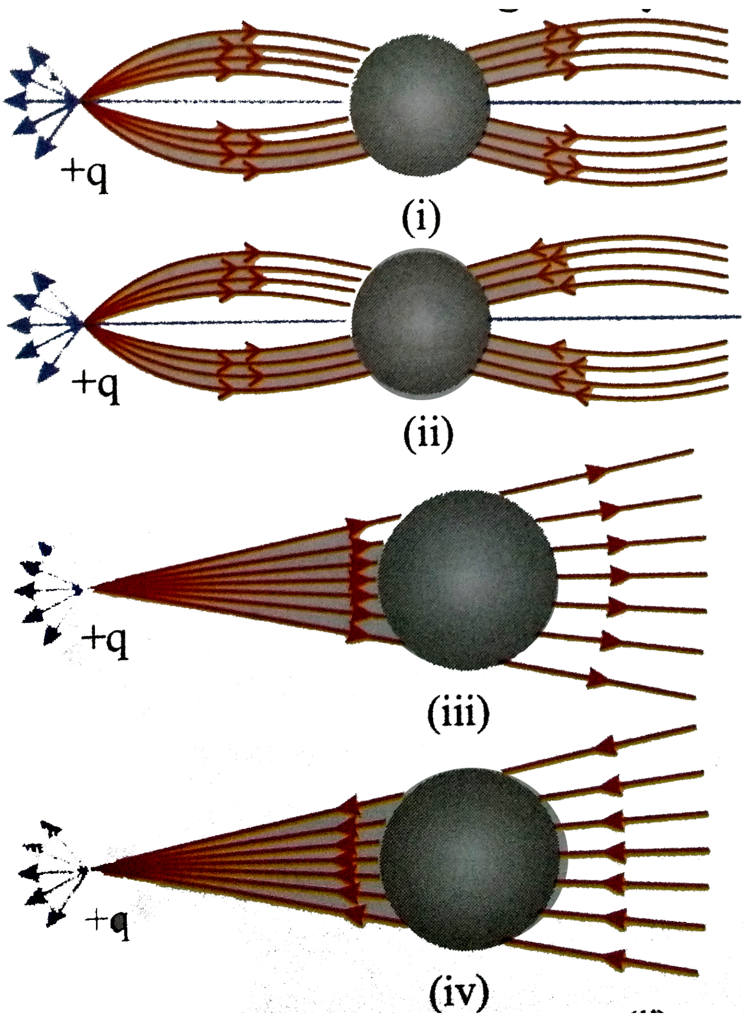
2. A point positive charge is brought near an isolated conducting sphere as shown in figure the electric field is best given by



A. Fig. (i)

B. Fig. (iii)

C. Fig. (ii)

D. Fig.(iv)

Answer: A

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3. The electric flux through the surface

A. in Fig. (iv) is the largest

B. in Fig.(iii) is the least

C. in Fig.(ii) is same as Fig.(iii) but is smaller than Fig.(iv)

D. is the same for all the figures.

Answer: D

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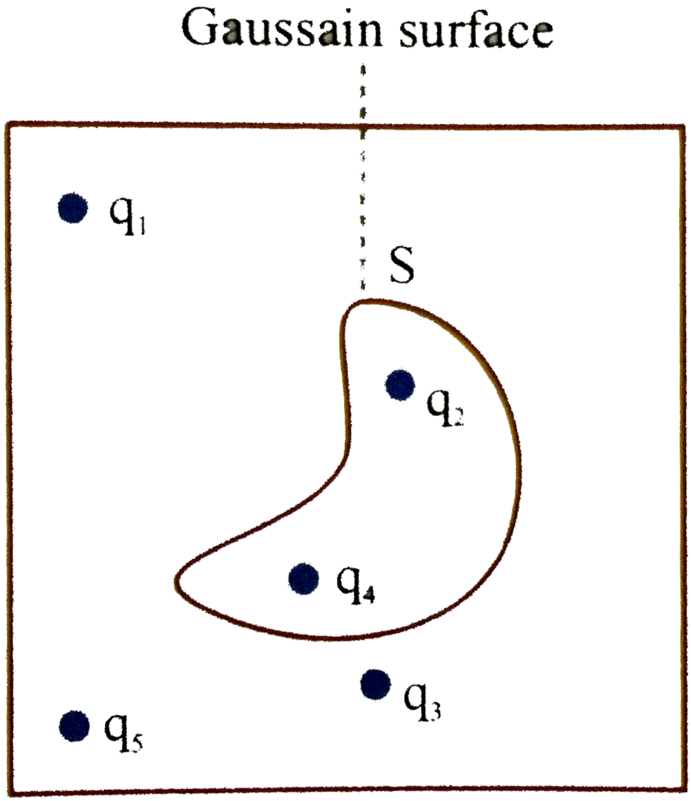
4. five charge $q_1, q_2, q_3, q_4$and q_5 are fixed at their positions as shown in figure .s is Gaussian surface .The Gauss's law is given by $\oint \vec{E} \cdot \vec{ds} = \frac{q}{\varepsilon_0}$



Which of the following statement is correct?

A. $\vec{E}$ on the LHS of the above equation will have a contribution from q_1, q_2 and q_3

while q on the RHS will have a contribution from q_2 and q_4 only.

B. $\overrightarrow{E}$ 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. $\overrightarrow{E}$ 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 $\vec{E}$ on the LHS and q on the RHS will have contributions from q_2 and q_4 only.

Answer: B

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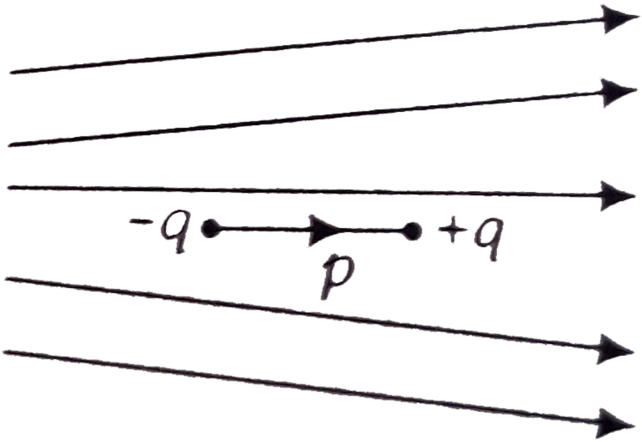
5. Figure shows electric field lines in which an electric dipole p is placed as shown. Which of the following statements is correct ?



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 a force upwards.

Answer: C

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6. 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 the 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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7. A hemispherical shell is uniformly charge positively .the electric field at 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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8. If $\oint_s E.\,ds = 0$ Over a surface, then

A. the electric field inside the surface and on it is zero.

B. the electric field inside the surface is necessarily uniform.

C. the number of flux lines entering the surface must be equal to the number of flux lines leaving it

D. all charges must necessarily be outside the surface.

Answer: C

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9. The Electric field at a point is

A. always continuous.

B. continuous if there is no charge at that point.

C. discontinuous only if there is a negative charge at that point.

D. discontinuous if there is a charge at that point.

Answer: B::D

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10. If there were only one type of charge of the universe then

A. $\oint_S \vec{E} . d\vec{S} \neq 0$ on any surface

B. $\oint_S \vec{E} . d\vec{S} = 0$ if the charge is outside the surface

C. $\oint_S \vec{E} . d\vec{S}$ could not be defined

D. $\oint_S \vec{E} . d\vec{S} = \frac{q}{\varepsilon_0}$ if charges of magnitude q were inside the surface.

Answer: B::D

Watch Video Solution

11. Consider a region inside which there are various types of charges but the total charge is zero „At points outside the region

A. the electric field is necessarily zero.

B. the electric field is due to the dipole moment of the charge distribution only.

C. the dominant electric field is $\propto \frac{1}{r^3}$, for large r, where r is the distance from a origin in this region.

D. the work done to move a charged particle along a closed path, away from the region, will be zero.

Answer: C::D

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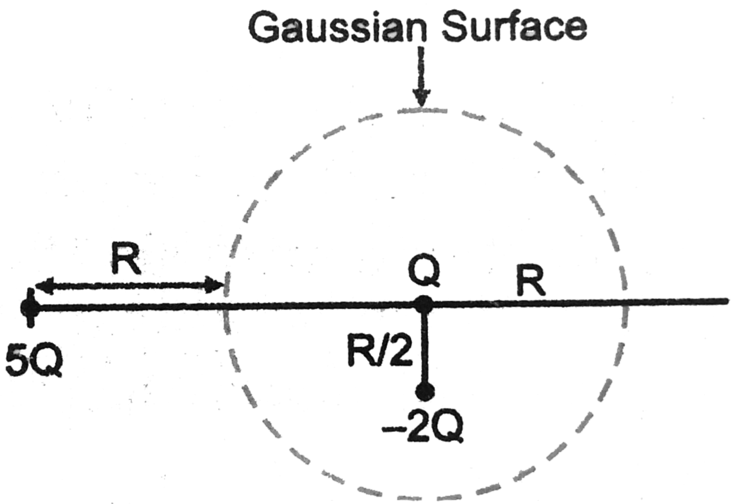
12. Refer to the arrangement of charges in Fig and a Gaussian surface of radius R with Q at the centre. Then



A. total flux through the surface of the sphere is $-\frac{Q}{\varepsilon_0}$

B. field on the surface of the sphere is $-\frac{Q}{4\pi\varepsilon_0 R^2}$

C. flux through the surface of sphere due to 5Q is zero

D. field on the surface of sphere due to -2Q is same everywhere.

Answer: A::C

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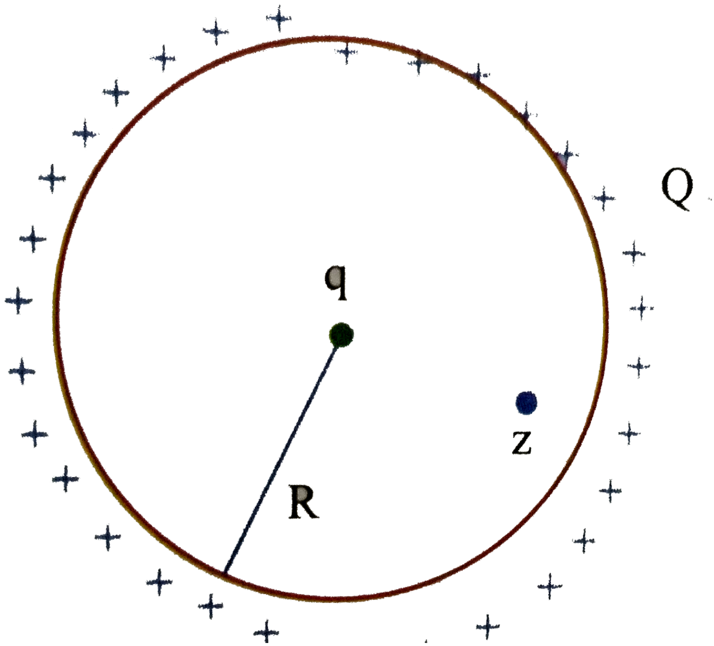
13. A positive charge Q is uniformly distributed along a circular ring of radius R.a small test charge q is placed at the centre of the ring

.The



A. If q gt 0 and is displaced away from the centre in the plane of the ring, it will be pushed back towards the centre.

B. If q lt 0 and is displaced away from the centre in the plane of the ring, it will never return to the centre and will continue moving till it hits the ring.

C. If q lt 0, it will perform S.H.M for small displacement along the axis.

D. q at the centre of the ring is in an unstable equilibrium within the plane of the ring for qgt0.

Answer: A::B::C

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14. An arbitrary surface encloses a dipole. What is the electric flux through this surface ?

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15. A metal spherical shell has an inner radius R_1 and outer radius R_2. A charge Q is placed at the center of the spherical cavity. What will be surface charge density on (i) the inner surface, and (ii) the outer surface ?

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16. The dimensions of an atom are of the order of an Angstrom. Thus there must be large electric fields between the protons and electrons. Why, then is the electronstatic field inside a conductor zero?

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17. If the total charge enclosed by a surface is zero, does it imply that the electric field everywhere on the surface is zero ? Conversely, if the electric field everywhere on a surface is zero, does it imply that net charge inside is zero.

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18. Sketch the electric field lines for a uniformly charged hollow cylinder shown in adjoining figure.

Watch Video Solution

19. What will be the total flux through the faces of the cube, with side of length a if a charge q is placed at (a) A : a corner of the cube (b) B : mid-point of an edge of the cube (c) C : center of a face of the cube (d) D : mid-point of B and C.

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20. A paisa coin is made up Al.Mg alloy and weighs 0.75 g. It has a square shape and its diagonal measures 17mm. It is electrically neutral and constants equal amounts of positive and negative charges . Treating the paisa coin made up of only Al, find the magnitude of equal number of positive and negative charges. What conclusion do you draw from this magnitude ?

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21. Consider a coin of exercise 1.20. It is electrically neutral and contains equal amounts positive and negative charge of magnitude 34.8 kC. Suppose that these equal charges were concentrated in two point charges separated by (i) 1 cm (~half the diagonal of one paisa coin) (ii) 100 m (~length of a long building), and (iii) 10^6 m (radius of the earth). Find the force on each such point charge in each of the three cases. What do you conclude from these results?

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22. The given figure represents a crystal unit of cesium chloride, CsCl. The cesium atoms, represented by one circles are situated at the corners of a cube of side 0.40 nm, whereas a Cl atom is situated at the centre of the cube. The Cs atoms are deficient in one electron while the Cl atom carries an excess electron.

(i) What is the net electric field on the Cl atom due to eight Cs atoms?

(ii) Suppose that the Cs atom at the corner A is missing. What is the net force now on the Cl atom due to seven remaining Cs atoms?

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23. Two charges q and-3q are placed fixed on X-axis separated by a distance d. Where should a third charge 2q be placed such that it will not experience any force?

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24. Fig shows the electric field lines around three points charges A,B,C.

(a) Which charges are positive ?

(b) Which charge has the largst magnitude ? Why ?

(c) In which region or regions of the picture could be the electric field be zero? Justify your answer.

(i) near A, (ii) near B, (iii) near C, (iv) nowhere.

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25. Five charges, q each are placed at the corners of a regular pentagon of side a. (Refer the adjoining figure)

(a) (i) What will be the electric field at O, if the centre of the pentagon?

(ii) What will be the electric field at O if the charge from one of the corners (say A) is removed?

(iii) What will be the electric field at O if the charge q at A is replaced by -q?

(b) How would your answer to (a) be affected if pentagon is replaced by n-sided regular polygon with charge q at each of its corners?

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Higher Order Thinking Skills & Advanced Level (Questions With Answers)

1. A positive point charge is placed in an external electric field. When we release the point charge in a state of rest then electric force acting on it starts moving it. Will the point charge always follow the electric lines of force?

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2. A point charge q is placed at the centre of a line joining two equal charges Q. The whole system is in the state of equilibrium. Can you impose some lower limit on the magnitude of the charge Q?

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3. Suppose we have one iron nucleus. We know that the entire positive charge of the atom is carried by the nucleus. In order to understand the electric field of nucleus, it is suggested that we shall assume that the entire positive charge of nucleus is uniformly distributed over the volume of the nucleus. Iron is a conductor, and we know that in any conductor charge cannot be distributed over the volume. Is it fine to assume volume distribution of charge inside the nucleus?

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4. Hydrogen atom is formod with ono proton and one electron. In ground state, the electron revolves around the proton in an orbit of radius 0.53 angstrom. Find the speed of the electron in the ground state of a hydrogen atom. Speed that we get is usually infinitely large in comparison to the usual speeds and also comparable to the speed of light to a certain extent. Is it all right to assume that the mass of the electron is equal to 9.1×10^{-31} kg? We know that mass changes with speed.

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5. Na Cl moecule is bound due to the electreic force between the sodium and the chlorine ions when one electron of sodium and the chlorine ions when one electron of sodium is transferred to chlorine. Taking the separaton between the ions to be $2.75 \times 10^{-8} cm$, find the force of attraction between them. State the assumptions (if any) that you have made.

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Revision Exercises (Very short)

1. Process of sharing the charges with the earth is called as ____

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2. There are two types of electric charges positive charges and negative charges. The property which differentiates the two types of charges is

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3. How are the SI and CGS units of charge related to each other ?

Watch Video Solution

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

Watch Video Solution

5. When a plastic rod is rubbed with wool, it acquires a negative charge because

Watch Video Solution

6. How many types of electric forces may exist in between charged bodies ?

Watch Video Solution

7. A glass rod is rubbed with silk . Will its mass increase or decrease ?

Watch Video Solution

8. When a glass rod is rubbed with silk cloth, the glass rod is found to acquire 9×10^{-15} C. Calculate the amount of charge in the silk cloth.

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9. Who introduced the concept of positive and negative charges?

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10. Mention one similarity between Coulomb force and gravitational force acting between two stationary charges.

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11. Draw the pattern of electric lines, when a point charge - Q is kept near an uncharged coducting plate.

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12. What is the name of famous experiment, which established the quantum nature of electric charge?

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13. Can a body have a charge of 1.0×10^{-19} C ?

View Text Solution

14. Write two differences between charge and mass.

View Text Solution

15. State Coulomb's law.

Watch Video Solution

16. Define 1 statcoulomb.

Watch Video Solution

17. What is the Importance of expressing coulomb's law in vector from ?

Watch Video Solution

18. Write the expression for Coulomb's law for force between two charged particles in MKS system and CGS system

Watch Video Solution

19. Two charges are at distance (d) apart in air Coulomb force between them is F. If a dielectric material of dielectric constant (K) is placed between them, the coulomb force now becomes.

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20. Define dielectric constant of a medium in terms of force between electric charges.

Watch Video Solution

21. State Coulomb's law of electric force between two charged bodies.

Watch Video Solution

22. Does Coulomb's law of electric force obey Newton's third law of motion ?

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23. What will be the electrical permittivity of medium whose dielectric constant unity?

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24. The dielectric constant of water is 80. What will be its electrical permittivity?

Watch Video Solution

25. Why does the electric field inside a dielectric decrease when it is placed in an external field ?

Watch Video Solution

26. Define linear charge density and write its SI units.

Watch Video Solution

27. Two large conduction spheres carrying charges Q_1 and Q_2 are brought close to each other. Is the magnitude of the force between them exactly given by $Q_1Q_2 / 4\pi\varepsilon_0 r^2$. Where r is the distance between their centers.

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28. Define volume charge density and write its SI unit.

Watch Video Solution

29. Why can the interior of a conductor have no excess charge in the static situation?

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30. Define electric dipole moment. Write its SI unit ?

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31. Electric dipole moment is

Watch Video Solution

32. Electric dipole moment is

Watch Video Solution

33. An electric dipole of dipole moment $\overrightarrow{p}$ is placed in an electric field $\overrightarrow{E}$ such that $\overrightarrow{p}$ and $\overrightarrow{E}$ are parallel to each other. From this orientation electric dipole is turned through 180°. What will be the work done by an external agent?

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34. When an electric dipole is subjected to a uniform electric field, what will happen?

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35. If mass of the electron = 9.1×10^{-31} Kg. Charge on the electron $= 1.6 \times 10^{-19}$ coulomb and $g = 9.8 m / s^2$. Then the intensity of the electric field required to balance the weight of an electron is-

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36. Assertion : An electrostatic field line never form closed loop.

Reason : Electrostatic field is a conservative field.

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37. S_1 and S_2 are two parallel concentric spheres enclosing charges Q and 2Q respectively as shown in the figure below. What is the ratio of electric flux through S_1

and S_2 ?

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38. Can charge lie on a Gaussian surface?

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39. State Gauss's law in the integral form and write its equation .

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40. If It is $\frac{1}{r^{2.5}}$ in place of $\frac{1}{r^2}$, would Gauss's law still hold?

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41. Can we distribute charge over the volume of conducting material ?

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42. Why is the direction of the electric field due to a charged conducting sphere at any point perpendicular to its surface?

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43. What is an electrostatic shielding? Mention its one application.

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44. A metal slab is placed in a uniform electric field $\vec{E}$. What will be the net electric field intensity inside it?

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45. A dielectric slab of material having dielectric constant 6 is kept inside the electric field of magnitude E. What will be the net electric field intensity inside it?

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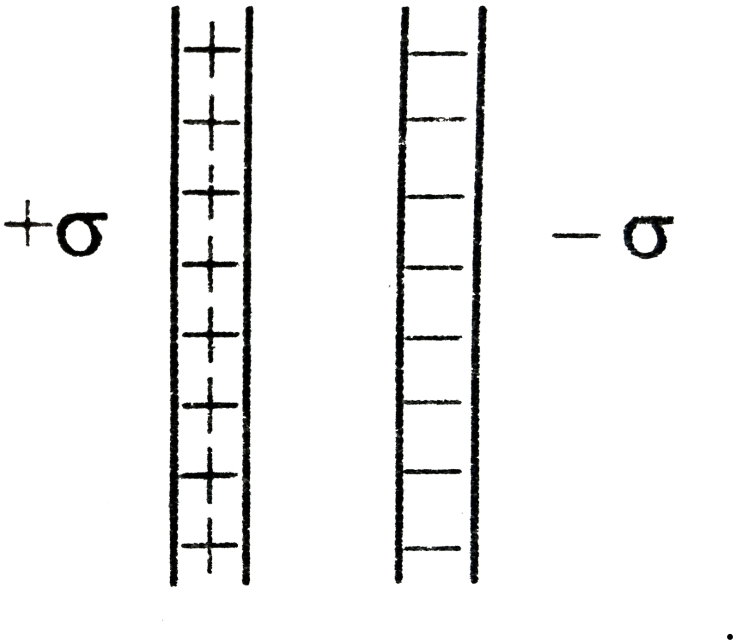
46. Two infinite sheets of uniform charge density $+\sigma$ and $-\sigma$ are parallel to each other as shown in the figure . Electric field at the



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47. Write the expression of electric field due to an infinitely long, straight, wire having linear charge density λ at a point that is at a distance r from it.

View Text Solution

48. State Gauss's law in electrostatics. Using this law derive an expression for the electric field due to a uniformly charged infinite plane sheet.

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49. Two identical balls having equal positive charge q coulomb are suspended by two in painting strings of equal length. What would be the effect on the force when a plastic sheet is inserted between the two?

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50. A surface enclosed an electric dipole, the flux through the surface is -

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51. How does the electric flux due to a point charge enclosed by a spherical Gaussian surface get a affected when its radius is increased ?

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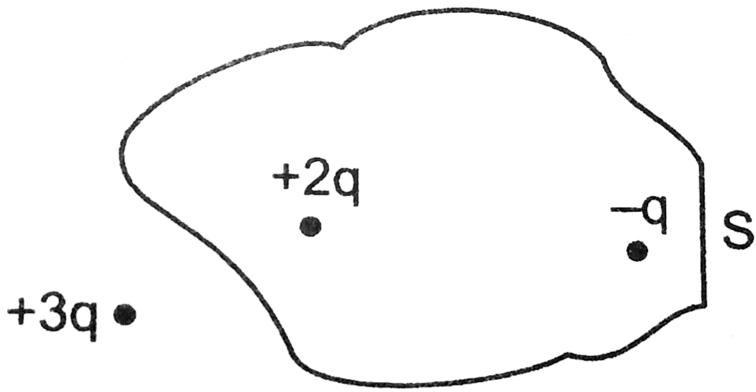
52. Fig shows three point charges $+2q, \ -q$ and $\ +3q$, What is the electric flux due to this configuration through the surface

S ?



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53. Why electrostatic field is normal to the surface at every point of a charged isolated conductor?

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54. Does the charge given to a metallic sphere depend on whether it is hollow or solid ? Give reason for your answer.

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55. A point charge of 4.427 μC is at the centre of a cube Gaussian surface 9.0 cm on the edge. Find the net electric flux through the surface. ($\varepsilon_0 = 8.854 \times 10^{-12} C^2 N^{-1} m^{-2}$)

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Revision Exercises (Additional Question)

1. A dipole of electric dipole moment p is placed in a uniform electric field of strength E. If θ is the angle between positive direction of p and E, then the potential energy of the electric dipole is largest when θ is

A. 0°

B. 90°

C. 180°

D. 45°

Answer: C

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2. A given charge is situated at a certain distance from an electric dipole in the end-on position experiences a force F If the distance of the charge is doubled, the force acting on the charge will be

A. 2F

B. F/2

C. F/4

D. F/8

Answer: D

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3. The dimensional formula of permittivity (ε_0) of free space is :

A. $M^{-1}L^{-3}T^{4}A^{2}$

B. $M^{-1}L^{-2}T^{2}A$

C. $M^{-1}L^{-2}T^{-2}A$

D. $M^{-1}L^{-2}T^{-2}A^{-2}$

Answer: A

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4. Calculate the number of electrons consituting one coulomb of charge.

A. 6.25×10^{18}

B. 6.25×10^{19}

C. 6.25×10^{21}

D. 6.25×10^{23}

Answer: C

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5. A charge Q is enclosed by a Gaussian spherical surface of radius R. If the radius is doubled, then the outward electric flux will

A. be doubled

B. increase four times

C. be reduced to half

D. remain the same

Answer: D

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6. When the distance between two charged particles is doubled, the force between them becomes

A. one-fourth

B. half

C. double

D. four times

Answer: A

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7. A body can be negatively charged by

A. giving excess of electrons to it

B. removing some electrons from it

C. giving some protons to it

D. removing some neutrons from

Answer: A

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8. A positively charged glass rod is brought near an uncharged pith ball penduium. What happens to the pith ball ?

A. attracted towards the ball

B. repelled away from the rod

C. not affected by the rod

D. attracted towards the rod, touches it and is then thrown away from it.

Answer: D

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9. How much greater in one microcoulomb compared to an electric charge?

A. 10^{13} times

B. 10^{10} times

C. 10^{11} times

D. 10^{6} times

Answer: A

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10. How many electrons constitute an electric charge of $-16\mu C$?

A. 10^{13}

B. 10^{14}

C. 10^{15}

D. 10^{12}

Answer: A

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11. If a charge q is placed at the centre of the line joining two equal charges Q such that the system is in equilibrium then the value of q is

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

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

C. $\frac{Q}{4}$

D. $-\frac{Q}{4}$

Answer: D

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12. When 10^{20} electrons are removed from the surface of a neutral metal plate, the electric charge on it (in coulomb) is

A. $+16$

B. -1.6

C. 10^{-19}

D. 10^{19}

Answer: A

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13. A charge q is placed at the centre of a cube of side l what is the electric flux passing through two opposite faces of the cube ?

A. $\frac{q}{3\varepsilon_0}$

B. $\frac{q}{4\varepsilon_0}$

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

D. $\frac{q}{8\varepsilon_0}$

Answer: A

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14. When a body becomes negatively charged, its mass

A. decreases

B. increases

C. remains the same

D. None of these

Answer: B

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Revision Exercises (Fill in the Blanks)

1. What is the effect of temperature on dielectric constant ?

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2. There are _____ points in space around an electric dipole where its electric field intensity in zero.

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3. The direction of the electric field intensity due to an electric dipole at a point on its axis is the same as the direction of _____

Watch Video Solution

4. For metals the value of dielectric constant (K) is

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5. There is force of repulsion between two like charges, because electric lines of force

Watch Video Solution

6. If a uniform electric field in existing inside a cube, then the net charge enclosed inside the cube is ___

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7. If the total charge enclosed by a surface is zero, does it imply that the electric field everywhere on the surface is zero ? Conversely, if the electric field everywhere on a surface is zero, does it imply that net charge inside is zero.

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8. A positive charge q is placed in front of conducting solid cube at a distance d from its centre. Find the electric field at the centre of the cube due to the charges appearing on its surface.

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9. Number of esu of charge in 1C is

Watch Video Solution

10. Electric field intensity _____ be added like vector with gravitational field intensity to get the total field intensity

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Revision Exercises (Short Answer)

1. 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

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2. Define conductor and insulator giving examples.

Watch Video Solution

3. What is earthing? How it is done? What is its significance?

Watch Video Solution

4. How can you charge a metal sphere negatively without touching it?

Watch Video Solution

5. State and explain the principle fo superposition as applied to electrostatic force on a charge due to a number of other charge.

Watch Video Solution

6. electric field || physical significance of electric field

Watch Video Solution

7. Two positive point charges are $3m$ apart their combined charge is $20\mu C$. If the force between them is $0.075N$, the charges are

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8. Write the expression for electric field intensity at any point outside and inside due to a charged spherical shell.

Watch Video Solution

9. Does Coulomb's law of electric force obey Newton's third law of motion ?

Watch Video Solution

10. What do you mean by area vector? What is its direction?

Watch Video Solution

11. Define electric flux. Write its SI unit. A charge q is enclosed by a spherical surface of radius R. If the radius is reduced to half, how would the electric flux through the surface change ?

Watch Video Solution

12. When an electric dipole is held at an angle in a uniform electric field, the net force F and torque τ on the dipole are

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13. Derive an expression for the intensity of the electric field at a point on the axial line of an electric dipole.

Watch Video Solution

14. (a) Derive and expression for the electric field at any point on the equatorial line of an electric dipole.

(b) Two identical point charges, q each kept 2m apart in air. A third point charge Q of unknown magnitude and sign is placed on the line joining the charges such that the system remains in equilibrium. Find the position and nature of Q.

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15. Give the expression for torque experienced by an electric dipole in an uniform electric field in a vector form. Give the meaning of the symbols used.

Watch Video Solution

16. A positive point charge (+q) is kept in the vicinity of an uncharged conducting plate. Sketch electric field lines originating from the point on to the surface of the plate.

Derive the expression for the electric field at the surface of a charged conductor.

Watch Video Solution

17. State and prove Gauss's law in electrostatics.

Watch Video Solution

18. Using Gauss's law, derive an expression for the electric field intensity at any point near a uniformly charged thin wire of $charge/length = \lambda C/m.$

Watch Video Solution

19. Calculate distance of the point from the centre of a uniformly charged ring on its axis, where it electric field intensity becomes maximum.

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20. Draw a graph of electric field E(r) with distance r from the centre of the shell for $0 \leq r \leq 0$.

Watch Video Solution

21. State Gauss's law in electrostatics. Applying Gauss's law derive the expression for electric intensity due to an infinite plane sheet of charge.

Watch Video Solution

22. Is coulomb's law in electrostatics valld in all situations ?

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23. Two positive charges which are 0.1m apart repel each other with a force of 18N. If the sum of the charges be $9\mu C$, calculate their separate values.

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24. Plot a graph showing the variation of coulomb force (F) versus $\left(\frac{1}{r^2}\right)$, where r is the distance between the two charges of each pair of charges:

$(1\mu C, 2\mu C)$ and $(2\mu C - 3\mu C)$. Interpet the graphs obtained.

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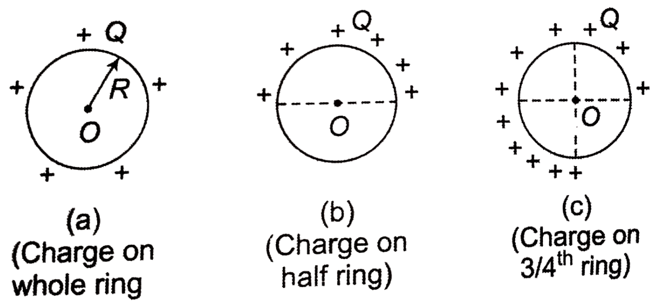
25. A charge Q is distributed uniformly on a ring of radius R as shown in the following diagrams. Find the electric potential at the center O of the ring.



(a)

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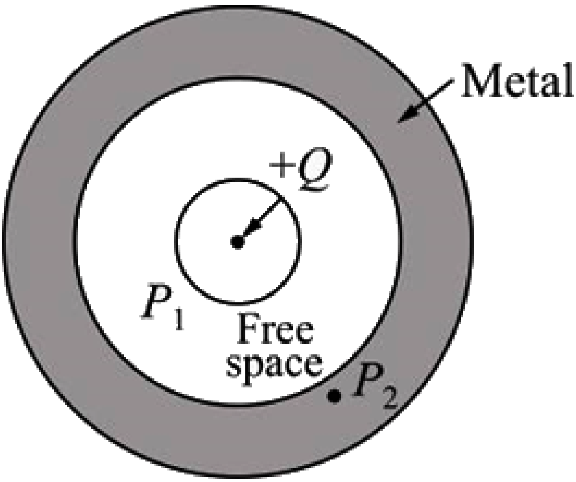
26. State Gauss's law in electrostatics. Using this law derive an expression for the electric field due to a uniformly charged infinite plane sheet.

Watch Video Solution

27. A small metal sphere carrying charge $+Q$ is located at the centre of a spherical cavity inside a large uncharged metallic spherical shell as shown in the figure. Use Gauss's law to find the expressions for the electric field at points p_1 and p_2 . Also draw the pattern of electric field lines in this arrangement.



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28. Define electric dipole moment. Is it a scalar or a vector? Derive the expression for the electric field of a dipole at a point on the equatorial plane of the dipole.

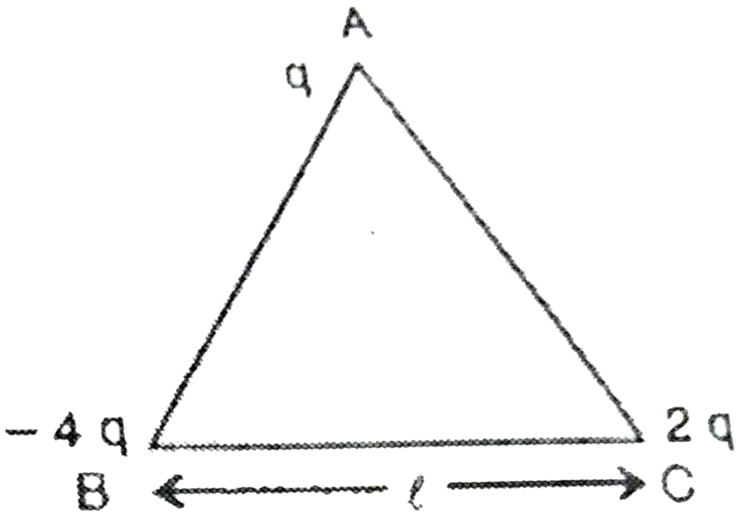
Watch Video Solution

29. A dipole of moment $\overrightarrow{p}$ is placed in a uniform electric field $\overrightarrow{E}$. The force on the dipole is $\overrightarrow{F}$ and the torque is $\overrightarrow{\tau}$

Watch Video Solution

30. (a) Three point charges q,-4q and 2q are placed at the vertices of an equilateral triangle ABC of side 'l' as shown in the figure. Obtain the expression for the magnitude of the resultant electric force acting on the charge q.

(b) Find out the amount of the work done to separate the charges at infinite distance.



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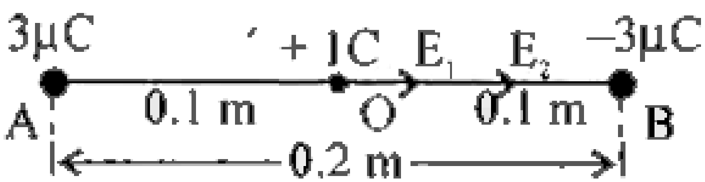
31. Two point charges $q_A = 3\mu C$ and $q_B = -3\mu C$ are located 0.2 m apart in vacuum.

a. What is the electric field at the mid point O of the line AB joining the two charges?

b. If a negative test charge of magnitude $1.5 \times 10^{-9} C$ is placed at this point, what is the force experienced by the test charge?



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32. Using Gauss's law, derive an expression for the electric field intensity at any point near a uniformly charged thin wire of $charge/length = \lambda C/m.$

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33. Two point charges $q_A = 3\mu C$ and $q_B = -3\mu C$ are located 20 cm apart in vaccum (a) what is the electric field at the mid point O of the line AB joining the two charges ? (b) If a negative test charge of magnitude $1.5 \times 10^{-9} C$ is placed at the point, what is the force experienced by the test charge ?

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34. Obtain the expression for the torque $\overrightarrow{\tau}$ experienced by an electric dipole of dipole moment $\overrightarrow{p}$ in a uniform electric field, $\overrightarrow{E}$. What will happen if the field were not uniform?

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35. Use Gauss' theorem to find the electric field due to a uniformly charged infinitely large plane thin sheet with surface charge density σ.

Watch Video Solution

36. Define dielectric constant. Two charges $\pm 20 \times 10^{-6} C$, placed 2 mm apart from an electric dipole. Determine the electric field at a point 10 cm away from the centre of the dipole on its perpendicular bisector. Given,

$$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 N.\, m^2.\, C^{-2}$$

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37. The volume charge density within a volume V is $\rho(r)$. What is the force on a small test charge q_0 placed outside the volume having position vector $\overrightarrow{r}_0$ with respect to the same origin considered to specify the position vector of the charge distribution within the volume.

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38. What is the total charge enclosed by a closed surface if the electric flux entering and leaving the surface are 20000 $NC^{-1}m^2$ and 30000 $NC^{-1}m^2$ respectively.

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Revision Exercises (Long Answer)

1. Why no two electric lines of force can interscet each other ?

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2. Define electric dipole moment. Is it a scalar or a vector? Derive the expression for the electric field of a dipole at a point on the equatorial plane of the dipole.

Watch Video Solution

3. The work in rotating electric dipole of dipole moment p in an electric field E through an angle θ from the direction of electric field, is:

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4. Use Gauss' law to derive the expression for the electric field $\left(\overrightarrow{E}\right)$ due to a straight uniformly charged infinite line of charge density $\lambda C \cdot m^{-1}$.

Watch Video Solution

5. The maximum electric field intensity on the axis of a uniformly charged ring of charge q and radius R will be

Watch Video Solution

6. Find the expression of torque acting on an electric dipole placed in a uniform electric field . Using the above obtained expression of torque find the expression for potential energy of electric dipole kept in the uniform electric field . Assume potential energy of electric dipole to be zero when its axis is perpendicular to the externally applied electric field .

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7. An isolated non-conducting solid sphere of radius R is given an electric charge. The charge is uniformly distributed in the volume of sphere. The graph which shows the correct variation of magnitude of electric field with distance from the centre of the sphere is

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8. State Gauss's law in electrostatics. Applying Gauss's law derive the expression for electric intensity due to an infinite plane sheet of charge.

Watch Video Solution

9. Applying Gauss's law derive the expression for electric intensity due to a charged conducting spherical shell at (i) a point outside the shell (ii) a point on the surface of the shell and (iii) a point inside the shell.

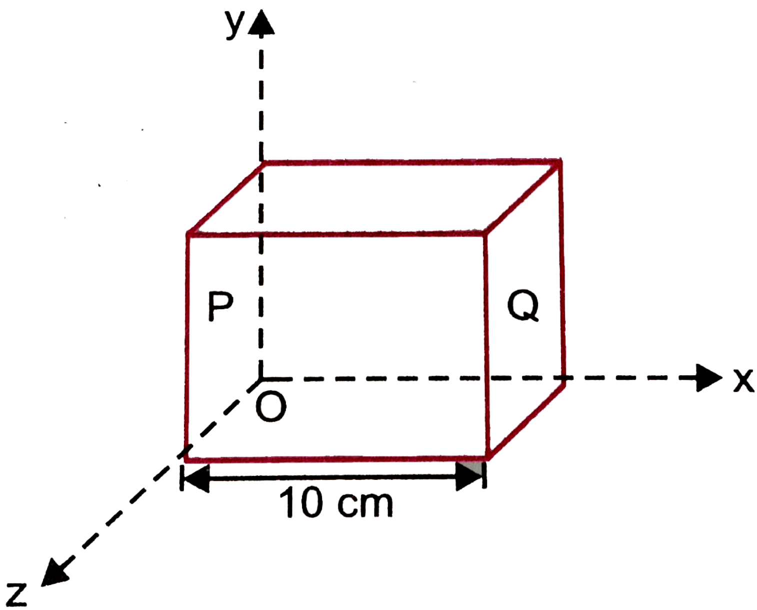
Watch Video Solution

10. A positive charge Q is situated at the centre of cube. The electric flux through any face of the cube is (in SI units)

Watch Video Solution

11. In Fig, electric field is directed along $+X$ direction and is given by $E_x = 5Ax + 2B$, where E is in NC^{-1} and x is in meter, A and B are constants having dimensions. Taking $A = 10NC^{-1}m^{-1}$ and $B = 5NC^{-1}$, calculate (i) the electric flux through the cube

and (ii) net charge enclosed within the cube.



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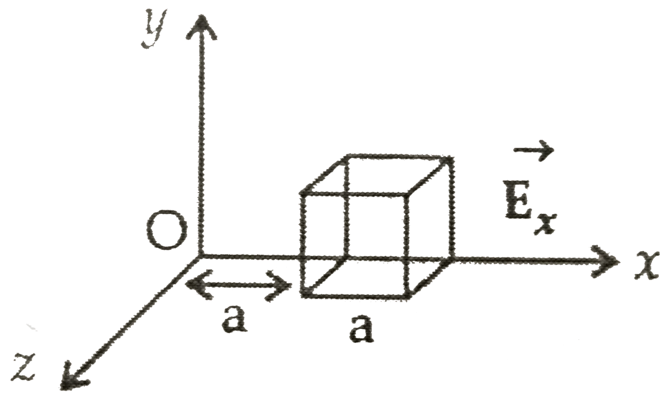
12. Define electric flux and write its SI unit . The electric field components in the figure shown are : $E_x = \alpha x, E_y = 0, E_z = 0$ where

$$\alpha = \frac{100N}{Cm}.$$

Calculate the charge within the cube , assuming a = 0.1 m .



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13. Using Gauss's law obtain the expression for the electric field due to uniformly charged thin spherical shell of radius R at a point outside the shell. Draw a graph showing the variation of electric tield with r, for r gt R and r lt R.

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14. (a)An electric dipole of dipole moment $\overrightarrow{p}$ consists of point charges +q and -q separated by a distance 2a apart. Deduce the expression for the electric field due to the dipole at a distance x from the centre of the dipole on its axial line in terms of the dipole moment Hence show that in the limit:

$r >> a, \vec{E} \to \frac{2\vec{p}}{4\pi\varepsilon_0 r^3}$

(b) Given the electric field in the region $\vec{E} = -2x\hat{i}$, find the net electric flux through the cube and the charge enclosed by it.

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15. Derive an expression for the electric field E due to a dipole of length 2a at a point at a distance r from the centre of the dipole on the axial line.

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Revision Exercises (Numerical Problems)

1. Calculate the force of attraction between a proton and an electron separated by a distance of 8×10^{-14} m

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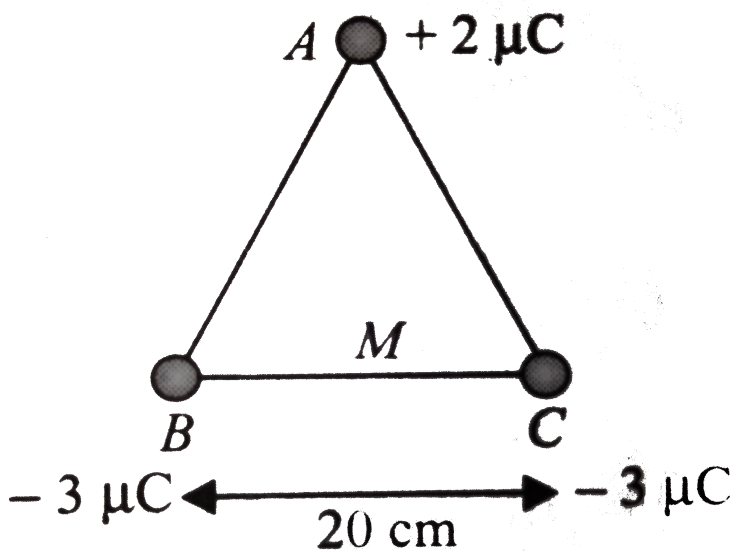
2. What is the Coulomb's force between two α-particles separated by a distance of $3.2 \times 10^{-15} m$.

Watch Video Solution

3. Calculate the electric field strength required to just support a water drop of mass 10^{-7} kg and having a charge 1.6×10^{-19} C

Watch Video Solution

4. Three point charges of $+2\mu C,\ -3\mu C$, and $-3\mu C$ are kept at the vertices A, B, and C, respectively of an equilateral triangle of side 20 cm. what should be the sign and magnitude of the charge (q) to be placed at the midpoint (M) of side BC so that the charge at A remains in equilibrium?



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5. If the electric field is given by $6\hat{i} + 3\hat{j} + 4\hat{k}$, calculate the electric flux through a surface area of 20 units lying in YZ-plane.

Watch Video Solution

6. Two charges of magnitudes -2Q and +Q are located at points $(a, 0)$ and $(4a, 0)$ respectively. What is the electric flux due to

these charges through a sphere of radius 3a with its centre at the origin?

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7. Two points having charges q_1 and q_2 are placed at the coordinates (a, 0, 0) and (0, b, 0) respectively. Find out the electric field intensity of a third point charge placed at (0, 0, c) due to those two charges.

Watch Video Solution

1. Two indentical metallic spheres A and B, each carrying a charge q repel each other with a force F. A third metallic uncharged sphere C of the same size is made to touch the spheres A and B alternately and then removed away. What is the force of repulsion between A and B ?

A. 3F/8

B. 3F/11

C. 3F/14

D. None

Answer: A

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2. Two identical conducting sphere carrying different charges attract 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 sphere repel each other with a force whole magnitude is equal to the initial attractive force. The ratio between initial charges on the spheres is

A. 2

B. 3

C. $3/2$

D. Information insufficient

Answer: B

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

A. remain in equilibrium

B. move to infinity

C. perform S.H.M about origin

D. execute oscillatory motion but not S.H.M

Answer: D

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4. A 5 g weight is fastened to two helium-filled balloons with the help of a 1m long thread. Both the balloons carry the same charge q and the distance between them in 0.6 m when the system hangs in equilibrium. The charge q is

A. $0.56\mu C$

B. $1\mu C$

C. $5.6\mu C$

D. $1nC$

Answer: A

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5. The electric field due to a small dipole of length 2l at distance $r(r > > l)$ from the centre of the dipole on the axial line is E. What is the distance of the point on the perpendicular bisector of the dipole from its centre in which the electric field intensity is E ?

A. 1

B. 2

C. 3

D. 4

Answer: D

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6. Two unequal and opposite charges are kept fixed at a distance. What is the number of points in space where electric Field intensity is zero due to this system?

A. 0

B. 1

C. 2

D. None

Answer: B

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7. Two charges of same polarity are kept fixed at a distance. What is the number of points in space where the electric field intensity due to this system is zero?

A. 1, if charges are of name magnitude

B. 2, if charges are of unequal magnitude

C. 2

D. 1

Answer: D

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8. An electric dipole is kept inside a uniform electric field. If Fis the magnitude of net force on dipole and τ is magnitude of net torque, then

A. F must be zero, τ must be zero

B. F must not be zero, τ must not be zero

C. F Must not be zero, τ must be zero

D. F must be zero, τ may be non-zero

Answer: D

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9. There is a long straight wire, uniformly charged over length. A negatively charged point mass in ceiling around the wire under its electrostatic attraction. The linear speed of point mass is

A. Inversely proportional to the radius of circle

B. Directly proportional to the radius of circle

C. Independent of the radius

D. Unpredictable due to insufficient information

Answer: C

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10. The bob of a pendulum is positively charged.Another identical charge is placed at the point of suspension of the pendulum.The time period of pendulum

A. T' gt T'

B. T' lt T'

C. T' = T'

D. Information not sufficient

Answer: C

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11. A positively charged point object is kept fixed at its location and another point mass with same charge is suspended in mid-air due to electric force of repulsion that equal to the weight of this suspended object The point mass in very slightly pushed down and then released

A. The point mass will continue to move down

B. The point mass will perform S.H.M in vertical direction

C. The point mass will fall freely under gravity

D. The point mass will move towards initial position and then comes to rest

Answer: B

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12. A uniform electric field $\vec{E}$ directed vertically upwards exists in a region of space. A point mass m carrying positive charge q is a state of equilibrium inside this electric field

A. The point mass in in stable equilibrium

B. The point mass in in unstable equilibrium

C. The point mass is in a state of neutral equilibrium

D. Equilibrium is not possible

Answer: C

View Text Solution

13. A total of 9 μC charge in distributed between two point objects. When there objects are placed at a distance of 0.1 m, they apply 18 N of force of repulsion on each other. What is the ratio of magnitude of charges on both the point object?

A. 15/12

B. 15/16

C. $10/12$

D. none

Answer: A

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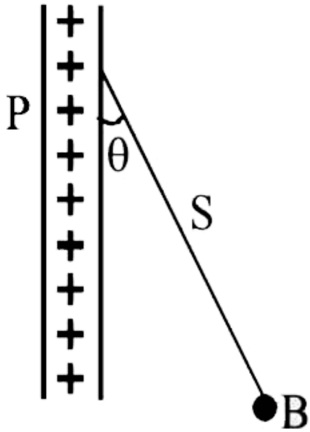
14. A charged ball B hangs from a silk thread S, which makes an angle θ with a large charged conducting sheet P, as shown in figure. The surface charge density σ of the sheet is proportional to



A. cot φ

B. tan φ

C. sec φ

D. cosec φ

Answer: B

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15. A charge Q is uniformly distributed over one large insulating surface and field intensity at a point X near its centre E. If it were a metal plate in place of an insulating surface then the electric field intensity at point X will become

A. E

B. E/2

C. 2E

D. 4E

Answer: A

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16. A point charge is brought in an electric field. The electric field at a near by point

A. will increase if charge is positive

B. will decrease if charge is negative

C. will decrease if charge is positive

D. may increase if charge is positive

Answer: D

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17. An electron and proton are placed inside a uniform electric field.

A. Electric forces acting on them are equal

B. Acceleration of both will be equal

C. The magnitude of acceleration of both will be equal

D. The magnitude of electric force on them will be equal

Answer: D

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18. A positive charge q is placed in front of a conducting solid cube at a distance d from its centre. Find the elcetric field at the centre of the cube due to the charges appearing on its surgace.

A. $\frac{q}{4\pi\varepsilon_0 d^2}$, directed away from point charge

B. $\frac{q}{4\pi\varepsilon_0 d^2}$, directed towards the point charge

C. zero

D. None

Answer: B

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19. Two identical point charges are kept at a distance d. A third point charge is placed on the perpendicular bisector of the two charges at a distance x. Show that the third charge will experience maximum force when $x = \frac{d}{2\sqrt{2}}$.

A. $\frac{d}{\sqrt{2}}$

B. $\frac{d}{2}$

C. $\frac{d}{2\sqrt{2}}$

D. $\frac{d}{4}$

Answer: C

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20. A particle of mass m and charge q is thrown at a speed u against a uniform electric field E. How much distance will it travel before coming to momentary rest?

A. $\frac{mu^2}{2qE}$

B. $\frac{mu^2}{3qE}$

C. $\frac{mu^2}{4qE}$

D. None

Answer: A

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21. v32

A. $\frac{Q}{3\varepsilon_0 L^2}$

B. $\frac{Q}{2\varepsilon_0 L^2}$

C. $\frac{Q}{5\varepsilon_0 L^2}$

D. None

Answer: B

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22. Three point charges are kept at the three corners of an equilateral triangle of edge length a, as shown in the figure. The net electric dipole moment of the system is

A. 0

B. $qa\sqrt{3}$

C. $qa\sqrt{2}$

D. qa

Answer: B

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23. A hollow insulated conducting sphere is given a positive charge of $10\mu C$. What will be the electric field at the centre of the sphere it is radius is 2 metres ?

A. Towards q_1

B. Away from q_1

C. Zero

D. None

Answer: C

Watch Video Solution

24. A point charge Q is kept at the centre of a square face of edge length a. The amount of electric flux associated with the square face in

A. $\dfrac{Q}{6\varepsilon_0}$

B. $\dfrac{Q}{24\varepsilon_0}$

C. $\dfrac{Q}{8\varepsilon_0}$

D. 0

Answer: D

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25. There is a closed three-dimensional surface and the electric flux associated with it is zero. Which of the following statements is correct?

A. Electric field intensity everywhere on surface must be zero

B. Net enclosed charge within the surface in zero

C. No charged particle must be there inside surface

D. None

Answer: B

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26. a soap bubble is given positive charge, then its radius.

A. increases

B. increases if the charge in positive

C. decreases if the charge in negative

D. is not affected

Answer: A

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27. Surface subtends a solid angle of π on a point charge +q. Electric flux due to point charge, associated with the given surface, is

A. q / ε_0

B. $q / 2\varepsilon_0$

C. $q / 4\varepsilon_0$

D. $q / 8\varepsilon_0$

Answer: C

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28. State the principle of conservation of electric charge

A. only applicable when the charge is at rest

B. only applicable when the charge moves

C. applicable in nuclear reactions

D. not applicable in nuclear reactions

Answer: C

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29. Two identical simple pendulums P and Q are susupended from a common point. The bobs of both the pendulums are positively charged but the magnitude of charge on the bob of P is double to that on Q, Both the bobs repel and reach equilibrium. If the thread of P makes an angle θ_1 with the vertical and that of Q make an angle θ_2 with the vertical, then

A. $\theta_1 > \theta_2$

B. $\theta_1 = \theta_2$

C. $\theta_1 < \theta_2$

D. Information insufficient

Answer: B

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30. An object of height 6 cm is placed perpendicular to the principal axis of a concave axis of a concave lens of focal length 5 cm. Use lens formula to determine the position, size and nature of the image if the distance of the object from the lens is 10 cm.

A. $\dfrac{2h\varepsilon_0 mu^2}{ex^2}$

B. $\dfrac{h\varepsilon_0 mu^2}{ex^2}$

C. $\dfrac{h\varepsilon_0 mu^2}{2ex^2}$

D. $\dfrac{2h\varepsilon_0 mu^2}{ex}$

Answer: A

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31. The figure given below shows one spring-mass system. Let T_1 be the time period of small oscillations when both equal masses are electrically neutral and T_2 be the time period when both masses carry aame charges. T_1 / T_2 is

A. 1

B. ≤ 1

C. ≥ 1

D. unpredictable

Answer: C

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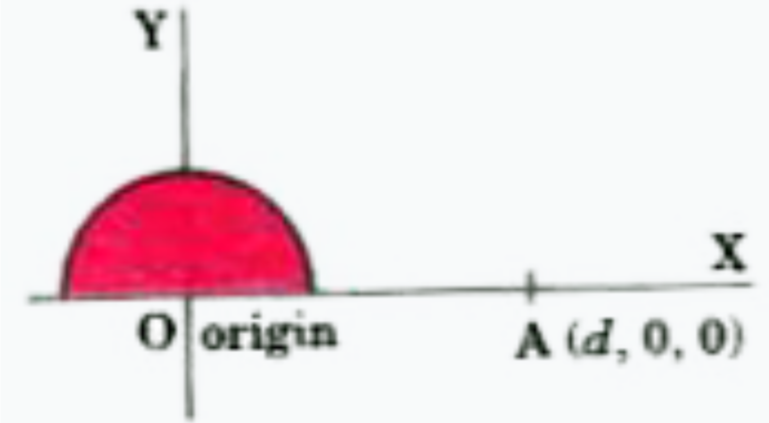
32. There is one non-conducting uniformly charged hemispherical body, which carries a total charge Q which is kept in such a manner that Y-axis divides it symmetrically.



The net electric field intensity at point A(d,0,0)

is

A. $\frac{Q}{4\pi\varepsilon_0 d^2}$

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

C. $< \frac{2Q}{4\pi\varepsilon_0 d^2}$ and $> \frac{Q}{4\pi\varepsilon_0 d^2}$

D. gt $\frac{2Q}{4\pi\varepsilon_0 d^2}$

Answer: C

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33. A small electric dipole of dipole moment P is placed at a distance r from one infinitely long uniformly charged, straight conductor. If λ is the linear charge density of straight conductor and axis of the dipole is perpendicular to the straight conductor then the force acting on the dipole is

A. $\dfrac{\lambda P}{2\pi\varepsilon_0 r^2}$

B. $\dfrac{\lambda P}{2\pi\varepsilon_0 r}$

C. $\dfrac{\lambda P}{4\pi\varepsilon_0 r^2}$

D. $\dfrac{\lambda P}{\pi\varepsilon_0 r^2}$

Answer: A

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34. There is a uniformly charged non-conducting solid sphere. A spherical cavity is made whose centre does not coincide with the centre of solid sphere. Electric field intensity inside the cavity is

A. directly proportional to distance of the point from centre of cavity

B. directly proportional to the distance of the point from centre of sphere

C. uniform

D. not predictable due to insufficient information

Answer: C

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35. There is a metal object A connected to the earth with the help of a connecting wire. A positively charged object B is brought nearer to A without touching it Which of the following statement is correct?

A. Electrons will flow from A to earth

B. Electrons will flow from earth to A

C. Charge will be induced on A but there is no transfer of charge from or towards the earth

D. None

Answer: B

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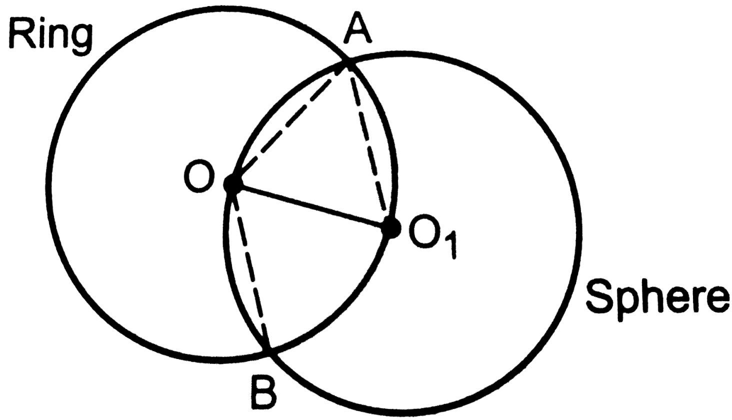
36. A Charge Q is distributed uniformly on a ring of radius r. A sphere of equal r is constructed with its centre at the periphery of the ring (figure 30.12) Find the flux of the electric field through the surface of the sphere.



A. $Q/2\varepsilon_0$

B. $Q/3\varepsilon_0$

C. $q/4\varepsilon_0$

D. $Q/5\varepsilon_0$

Answer: B

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37. A point charge -q is moving around another charge Q under the electrostatic attraction. If the path followed is elliptical, then

A. The angular momentum of charge -q remains constant

B. The linear momentum of charge -q remains constant

C. The angular speed of the charge -q remains constant

D. The linear speed of the charge -q remains constant

Answer: A

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38. A solid sphere of radius R has a charge Q distributed in its volume with a charge density $\rho = kr^{a}$, where k and a are constants and r is the distance from its centre. If the electric field at $r = \frac{R}{2}$ is $\frac{1}{8}$ times that $r = R$, find the value of a.

A. 1

B. 2

C. 3

D. 4

Answer: B

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39. An electron of mass m_e starts from rest, moves a certain distance in uniform field and takes time t_1. A proton of mass m_p also starts from rest in the same field and covers the same distande in time t_2 ,then t_1 / t_2 is equal to

A. $\sqrt{\dfrac{m_e}{m_p}}$

B. $\sqrt{\dfrac{m_p}{m_e}}$

C. 1

D. 1836

Answer: A

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40. A point charge Q is placed at one of the vertices of a cubical block. The electric flux flowing through this cube is

A. q/ε_0

B. $q/2\varepsilon_0$

C. $q/8\varepsilon_0$

D. $q/4\varepsilon_0$

Answer: B

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41. A point charge Q is placed at the corner of a cube. How much electric flux will be associated with the cube?

A. q/ε_0

B. $q/2\varepsilon_0$

C. $q/8\varepsilon_0$

D. $q/4\varepsilon_0$

Answer: C

Watch Video Solution

42. A point charge is placed at the midpoint of an edge of cube. How much electric flux will be associated with the cube?

A. q/ε_0

B. $q/2\varepsilon_0$

C. $q/8\varepsilon_0$

D. $q/4\varepsilon_0$

Answer: D

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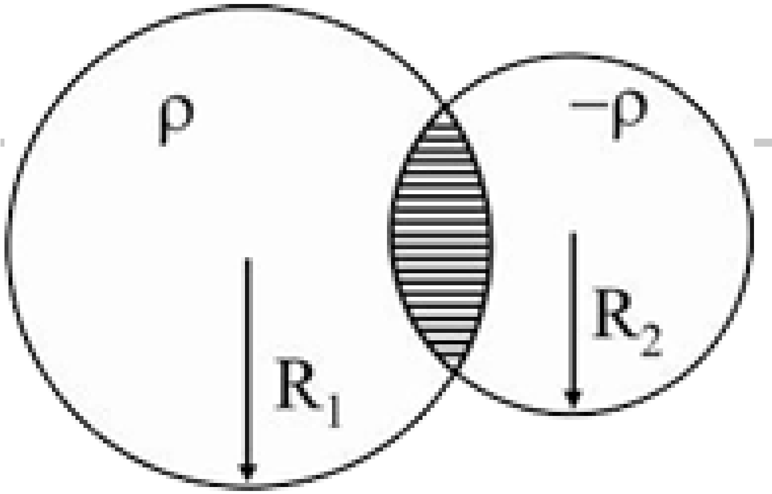
43. Two non-conducting spheres of radii R_1 and R_2 and carrying uniform volume charge densities $+\rho$ and $-\rho$ respectively are placed such that they partially overlapping region.



A. Electric field intensity is zero

B. The magnitude and direction of electric field intensity are uniform

C. The magnitude of electric field intensity is uniform but the direction is changing from point to point

D. None

Answer: B

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44. Five identical point charges +Q are placed at the five corners of a regular hexagon of edge length a. One corner is empty. Electric field intensity at the centre of the hexagon is

A. Zero

B. $\dfrac{Q}{4\pi\varepsilon_0 d^2}$, towards the empty corner

C. $\dfrac{Q}{4\pi\varepsilon_0 d^2}$, away from the empty corner

D. $\dfrac{5Q}{4\pi\varepsilon_0 a^2}$ towards the empty corner

Answer: B

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45. A positively charged rod lies along X-axis in such a manner that one end of the rod is at the origin and the other end at $x = -\infty$.

The linear charge density for the rod is λ.

Electric field intensity at x =a is

A. $\frac{\lambda}{4\pi\varepsilon_0 a}\hat{i}$

B. $-\frac{\lambda}{4\pi\varepsilon_0 a}\hat{i}$

C. $\frac{\lambda}{4\pi\varepsilon_0 a^2}\hat{i}$

D. $-\frac{\lambda}{4\pi\varepsilon_0 a^2}\hat{i}$

Answer: A

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46. Conisder a neutral conducting sphere. A poistive point charge is placed outisde the sphere. The net charge on the sphere is then

A. negative and it is uniformly distributed over the surface of the sphere if the sphere is not connected to earth.

B. negative and it is concentrated at points on the sphere closest to point charge

C. zero if the sphere is not connected to earth

D. positive if the sphere is connected to earth

Answer: C

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47. A thin metallic ring of radius R and area of cross section A carries an electric charge q that is uniformly distributed. A point charge Q is placed at the centre. The signs of charges on the ring and that of Q are same. Young's modulus for the material of the ring is Y. What is the tension developed in the ring?

A. $\dfrac{qQ}{4\pi\varepsilon_0 R^2}$

B. $\dfrac{qQ}{8\pi^2\varepsilon_0 R^2}$

C. $\dfrac{3qQ}{20\pi^2\varepsilon_0 R^2}$

D. None

Answer: B

View Text Solution

48. What is the change in radius of ring ?

A. $\dfrac{qQ}{8\pi^2\varepsilon_0 RAY}$

B. $\dfrac{qQ}{8\pi\varepsilon_0 RAY}$

C. $\dfrac{qQ}{4\pi^2\varepsilon_0 RAY}$

D. None

Answer: A

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49. There is one long non-conducting solid cylinder of radius R. The volume charge density is given by $\rho = kx^2$ where k is a constant and x is the distance of the point from centre of cylinder. Electric field intensity inside the cylinder at a distance x from the centre is

A. $\dfrac{kx^2}{3\varepsilon_0}$

B. $\dfrac{kx^3}{4\varepsilon_0}$

C. $\dfrac{kx^3}{2\varepsilon_0}$

D. $\dfrac{kx^3}{\varepsilon_0}$

Answer: B

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50. Two uniform sheets of charge with surface charge densities $+\sigma$ and $-\sigma$ are intersecting at right angles to each other. Electric field intensity due to this system is

A. $\frac{\sigma}{2\varepsilon_0}$

B. $\frac{\sigma}{2\sqrt{2}\varepsilon_0}$

C. $\frac{\sigma}{\varepsilon_0\sqrt{2}}$

D. None

Answer: C

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51. A solid conducting object with a non-uniform curvature is given a charge Q. Select the correct option.

A. Charge will be uniformly distributed on its outer surface

B. Charge will be uniformly distributed over its volume

C. Charge will be non-uniformly distributed over its outer surface with more concentration of charge where the radius of curvature is small

D. Charge will be non-uniformly distributed over its outer surface with more concentration of charge where the radius of curvature is large

Answer: C

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52. An electric dipole placed in a non uniform electric field may experience

A. only a force

B. only a torque

C. both force and torque

D. neither force nor torque

Answer: C

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53. Two electric dipoles are placed in such a manner that their electric dipole moments are directed towards each other. The force between them will be

A. attractive

B. inversely proportional to the cube of distance between charges

C. nversely proportional to the fourth power of the distance between charges

D. zero

Answer: C

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54. Select the incorrect statement.

A. In electrostatics, electric field intensity close to the surface of a metal is always along the normal

B. Net electric field intensity inside a conductor is always zero

C. Electric field lines do not pass through the conductor in an electrostatic condition

D. Net charge of an isolated system remains conserved

Answer: B

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55. Select the correct statement.

A. Electric field intensity is zero at the centre of an electric dipole

B. Net electric field intensity inside a conductor is always zero in electrostatic condition

C. Dielectric constant of a medium may be less than one

D. Dielectric materials are not affected by electric field

Answer: B

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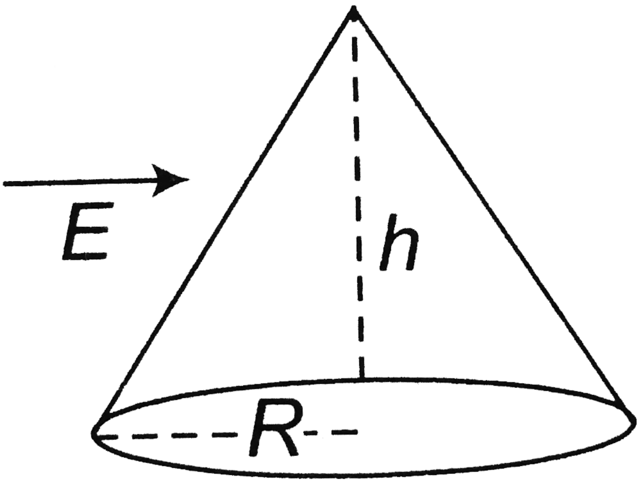
56. A cone lies in a uniform electric field E as shown in figure. The electric flux entering the cone is



A. ER h

B. ER h/3

C. ER h/4

D. 2ER h

Answer: A

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COMPETITION FILE (Objective Question (BA.MCQ))

1. Two small spheres, each carrying a charge q are placed r m apart and they interact with force F. If one of the sphere is taken around the other once in a circular path, the work done will be equal to

A. $2\pi r^2$

B. $2\pi r$

C. πr

D. zero

Answer: D

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2. The electric intensity due to a dipole of length $10cm$ and having a charge of $500\mu C$, at a point on the axis at a distance $20cm$ from one of the charges in air is

A. 6.25×10^7 N/C

B. 9.28×10^7 N/C

C. 13.1×10^{11} N/C

D. 20.5×10^7 N/C

Answer: A

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3. An electron falls from rest through a vertical distance h in a uniform and vertically upward directed electric field E. The direction of electric field is now reversed, keeping its magnitude the same. A proton is allowed to fall from rest in it through the same vertical distance h. The time of fall of the electron, in comparison to the time of fall of the proton is

A. 10 times greater

B. 5 times greater

C. smaller

D. Equal

Answer: C

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4. The point charges Q and $-2Q$ are placed at some distance apart. If the electirc field at the location of Q is E, the electric field at the location of $-2Q$ will be

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

B. $-\frac{3E}{2}$

C. $-E$

D. $-2E$

Answer: A

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5. A point Q lies on the perpendicular bisector of an electrical dipole of dipole moment p, If the distance of Q from the dipole is r (much larger than the size of the dipole), then electric field at Q is proportional to

A. p^{-1} and r^{-2}

B. p and r^{-2}

C. p^2 and r^{-3}

D. p and r^{-3}

Answer: D

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6. The number of electrons to be put on a spherical conductor of radius $0.1m$ to produce an electric field of $0.036N/C$ just above its surface is

A. 3.4×10^5

B. 2.5×10^5

C. 3.7×10^5

D. 4.7×10^5

Answer: B

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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

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8. A proton is nearly 1,836 times more massive than the electron. The Coulomb force of repulsion between two protons separated by a finite distance is F. The electrostatic force between two electrons separated by the same distance is:

A. F

B. $\dfrac{F}{1,837}$

C. 1,837 F

D. $\dfrac{1,837}{F}$

Answer: A

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9. An electron is moving round the nucleus of a hydrogen atom in a circular orbit of radius r. The coulomb force $\overrightarrow{F}$ between the two is (where $k = \dfrac{1}{4\pi\varepsilon_0}$)

A. $-k\dfrac{e^2}{r^3}\hat{r}$

B. $k\dfrac{e^2}{r^3}\overrightarrow{r}$

C. $-k\dfrac{e^2}{r^3}\overrightarrow{r}$

D. $k\frac{e^2}{r^2}\hat{r}$

Answer: C

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10. A hallow metal sphere of radius R is uniformly charged. The electric field due to the sphere at a distance r from the centre:

A. decreases as r increases for rltR and rgtR

B. increases as r increases for r lt R and r gt R

C. zero as r increases for r lt R, decreases as r increases for r gt R

D. zero as r increases for r lt R, increases as r increases for r gt R

Answer: C

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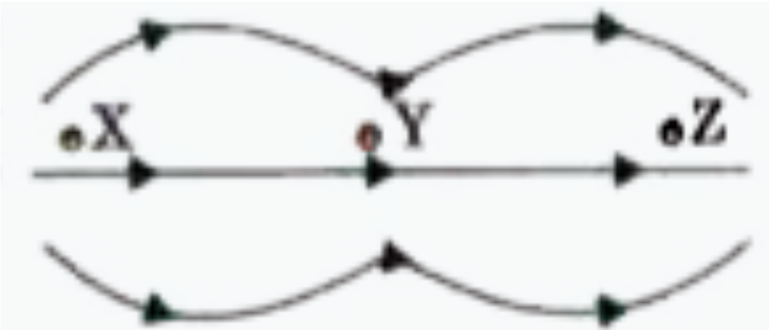
11. In the figure , electric field lines in a certain region are shown. The figure suggests that :



A. $E_x = E_y = E_z$

B. $E_x < E_y < E_z$

C. $E_x > E_y > E_z$

D. $E_x = E_z < E_y$

Answer: D

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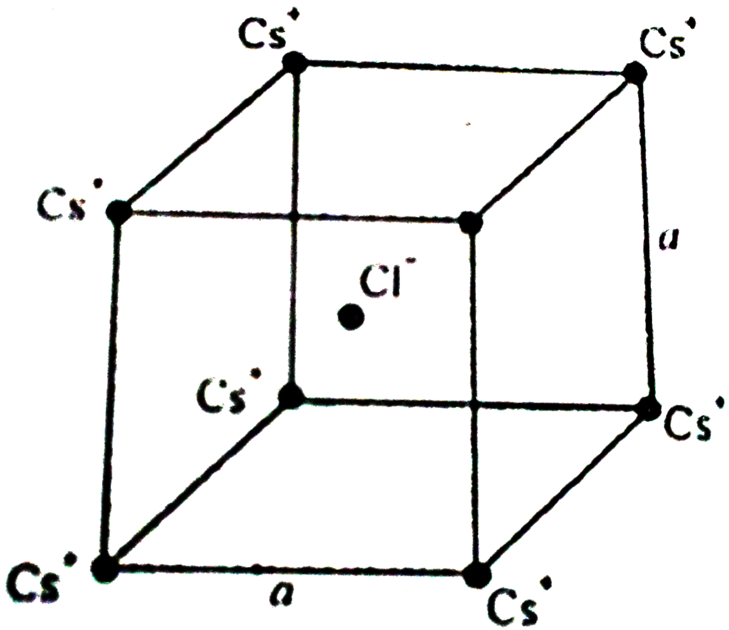
12. In the basic CsCI crystal structure,Cs^+ and CI^- ions are arrnged in a bcc configuration as shown in the figure.The net electrostatic force exerted by the eights Cs^+ ion9s on the

Cl^- ions is



A. Zero

B. $\frac{1}{4\pi\varepsilon_0}\frac{4e^2}{3a^2}$

C. $\frac{1}{4\pi\varepsilon_0}\frac{16e^2}{3a^2}$

D. $\frac{1}{4\pi\varepsilon_0}\frac{32e^2}{3a^2}$

Answer: A

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13. The electric field due to uniformly charged sphere of radius R as a function of the distance from its centre is represented graphically by

A.

B.

C.

D.

Answer: B

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14. An electric dipole has the magnitude of its charge as q and its dipole moment is p. It is placed in a uniform electric field E. If its dipole moment is along the direction of the field, the force on it and its potential energy are respectively

A. q.E and p.E

B. q.E and maximum

C. 2q.E and minimum

D. zero and minimum

Answer: D

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15. A simple pendulum has time period T The bob is given negative charge and surface below it is given positive change new time period will be

A. less than T

B. greater than T

C. equal to T

D. infinite

Answer: A

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16. Two infinitely long parallel conducting plates having surface charge densities $+\sigma$ and $-\sigma$ respectively, are seperated by a small distance. The medium between the plates is vacuum. If ε_0 is the dielectric permittivity of vacumm, then the electric field in the region between the plates is

A. $0Vm^{-1}$

B. $\frac{\sigma}{\varepsilon_0}Vm^{-1}$

C. $\frac{\sigma}{2\varepsilon_0}Vm^{-1}$

D. $\frac{2\sigma}{\varepsilon_0}Vm^{-1}$

Answer: B

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17. A toy car with charge q moves on a frictionless horizontal plane surface under the influence of a uniform electric field $\overrightarrow{E}$. Due to the force $q\overrightarrow{E}$, its velocity increases from 0 to $6m/s$ in one second duration. At that instant the direction of field is reversed.

The car continues to move for two more seconds under the influence of this field. The average velocity and the average speed of the toy car between 0 to 3 seconds are respectively.

A. 1 m/s, 3.5 m/s

B. 1 m/s, 3 m/s

C. 2 m/s , 4 m/s

D. 1.5 m/s , 3 m/s

Answer: B

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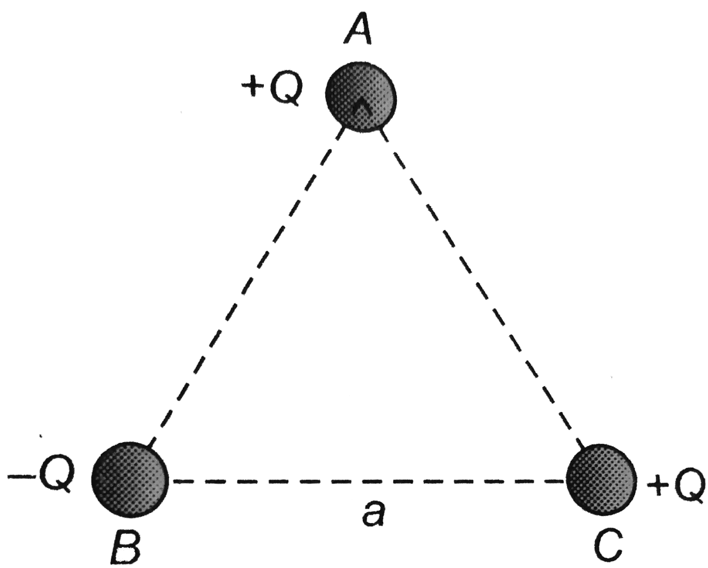
18. Three charges are placed at the vertices of an equilateral trianlge of side a as shown in the following figure. The force experienced by the charge placed at the vertex A in a direction normal to BC is



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

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

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

D. Zero

Answer: D

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19. Two point charges A and B, having charges +Q and -Q respectively, are placed at certain distance apart and force acting between them is F, if 25% charge of A is transferred to B, then force between the charges becomes:

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

B. F

C. $\frac{9F}{16}$

D. $\frac{16F}{9}$

Answer: C

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20. 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. $\sqrt{2}$qa along the line joining points (x=0,y=0,z=0) and (x=a, y=a,z=0)

B. qa along the line joining points (x=0,y=0, z=0) and (x=a, y=a, z=0)

C. $\sqrt{2}qa$ along + X direction

D. $\sqrt{2}qa$ along +Y direction

Answer: A

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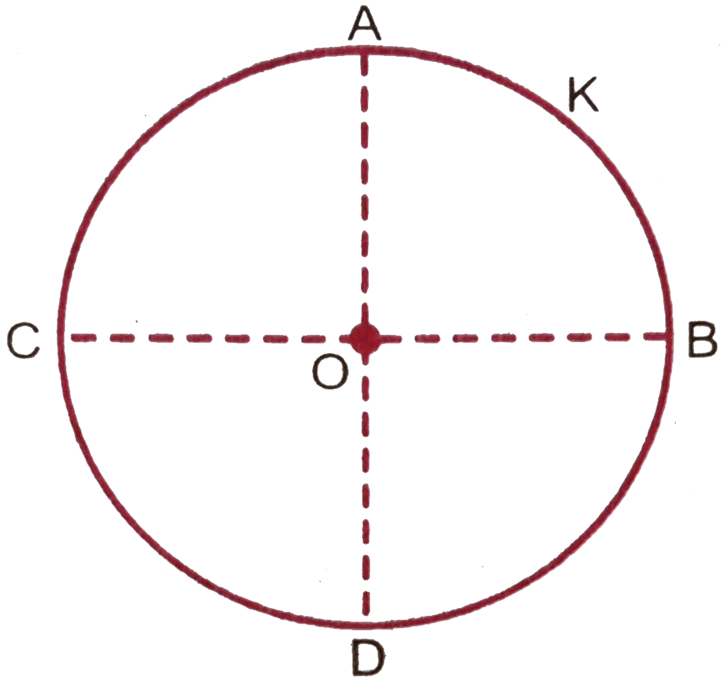
21. A thin conducting ring of radius R is given a charge $+Q$, Fig. The electric field at the center O of the ring due to the charge on the part AKB of the ring is E. The electric field at the center due to the charge on part $ACDB$

of the ring is



A. E along OK

B. E along KO

C. 3E along OK

D. 3E along KO

Answer: A

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22. 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. $\sqrt{\frac{4\pi\varepsilon_0 Fe^2}{d^2}}$

B. $\sqrt{\frac{4\pi\varepsilon_0 Fd^2}{e^2}}$

C. $\dfrac{4\pi\varepsilon_0 F e^2}{d^2}$

D. $\dfrac{4\pi\varepsilon_0 F d^2}{e^2}$

Answer: B

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23. A charge Q is enclosed by a Gaussian spherical surface of radius R. If the radius is doubled, then the outward electric flux will

A. increase four times

B. be reduced to half

C. remain the same

D. be doubled

Answer: C

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24. An electric dipole moment p is placed in an electric field of intensity $'E'$. The dipole acquires a position such that the axis of the dipole makes an angle θ with the direction of the field. Assuming that the potential energy of the dipole to be zero when $\theta = 90^\circ$, the torque and the potential energy of the dipole will respectively be

A. $pE\cos\theta, \ -pE\sin\theta$

B. $pE\sin\theta, \ -pE\cos\theta$

C. $pE\sin\theta, \ -2pE\cos\theta$

D. $pE\sin\theta, 2pE\cos\theta$

Answer: B

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25. What is the flux through a cube of side 'a' if a point charge of q is at one of its corner?

A. $\frac{q}{2\varepsilon_0}$

B. $\frac{2q}{\varepsilon_0}$

C. $\frac{Q}{8\varepsilon_0}$

D. $\frac{q}{\varepsilon_0}$

Answer: C

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26. The electric field in a certain region is acting radially outwards and is given by $E = Ar$. A charge contained in a sphere of radius $'a'$ centred at the origin of the field, will given by

A. $4\pi\varepsilon_0 Aa^3$

B. $\varepsilon_0 Aa^3$

C. $4\pi\varepsilon_0 Aa^2$

D. $A\varepsilon_0 a^2$

Answer: A

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COMPETITION FILE (Objective Question (BA.MCQ))

1. Two identical charged spheres suspended form a common point by two massless strings of lengths l, are initially at a distance $d(d >> l)$ apart because of their mutual repulsion. The charges brgin to leak from both the spheres at a constant rate. As a result, the spheres approach each other with a velocity v.

Then v varies as a function of the distance x between the spheres, as

A. $v \propto x$

B. $v \propto x^{-\frac{1}{2}}$

C. $v \propto x^{-1}$

D. $v \propto x^{\frac{1}{2}}$

Answer: B

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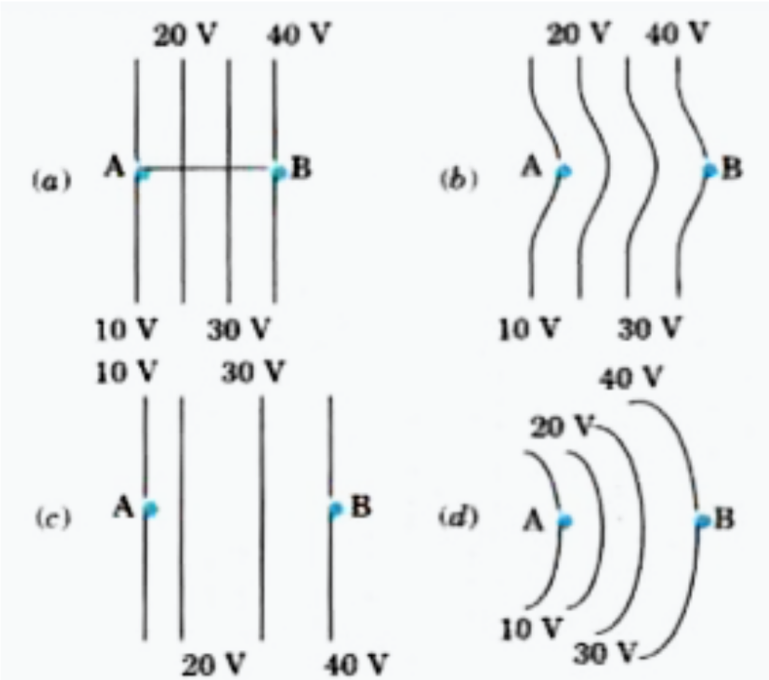
2. The diagrams below show regions of equipotential .



A positive charge is moved from A to B in each diagram.

A. Maximum work is required to move q in figure c

B. In all the four cases the work done is the same

C. Minimum work is required to move q in figure (a)

D. Maximum work is required to move q in figure (b)

Answer: B

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3. Suppose the charge of a proton and an electron differ slightely. One of them is $-e$, the other is $(e+\Delta e)$. If the net of electrostatic force and gravitational force between two hydrogen atoms placed at a distance d (much greater than atomic size) apart is zero. Then Δe is of the order of [Given mass of hydrogen $m_h = 1.67 \times 10^{-27} kg$]

A. 10^{-20} C

B. 10^{-23} C

C. 10^{-47} C

D. 10^{-37} C

Answer: D

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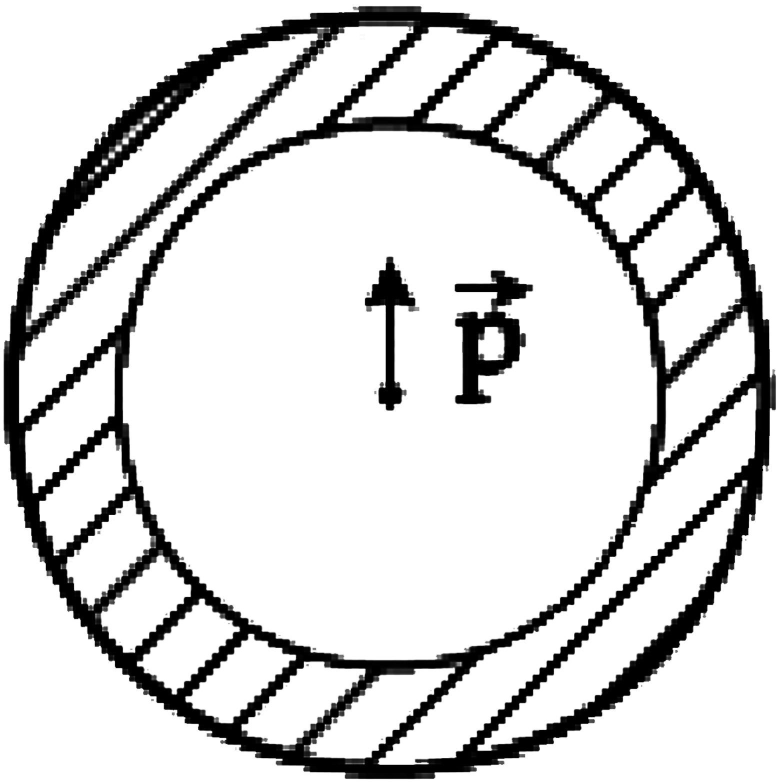
COMPETITION FILE (Objective Question (BB.MCQ))



1.

Shown in the figure is a shell made of a conductor. It has inner radius a and outer radius b, and carries charge. Q at its centre is a dipole $\overrightarrow{p}$ shown in this case:

A. Surface charge density on the inner surface of the shell is zero everywhere.

B. Electric field outside the shell is the same as that of a point charge at the centre of the shell.

C. Surface charge density on the inner surface is uniform and equal to $\frac{(Q/2)}{4\pi a^2}$

D. Surface charge density on the outer surface depends on $\left|\vec{P}\right|$

Answer: B

2. A thin spherical shell of radius R has charge Q spread uniformly over its surface. Which of the following graphs most closely represents the electric field E(r) produced by the shell in the range $0 \leq r < \infty$, where r is the distance from the centre of the shell?

A.

B.

C.

D.

Answer: A

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3. Two identical charged spheres are suspended by strings of equal lengths. The strings make an angle of 30° with each other. When suspended in a liquid of density $0.8gcm^{-3}$, the angle remains the same. If density of the material of the sphere is

$1.6 g cm^{-3}$, the dielectric constant of the liquid is

A. 1

B. 4

C. 3

D. 2

Answer: D

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4. Let $P(r)=\frac{Q}{\pi R^4}r$ be the charge density distribution for a solid sphere of radius R and total charge Q. For a point 'p' inside the sphere at distance r_1 from the centre of the sphere, the magnitude of electric field is:

A. $\frac{Qr_1^2}{4\pi\varepsilon_0 R^4}$

B. $\frac{Qr_1^2}{3\pi\varepsilon_0 R^4}$

C. 0

D. $\frac{Q}{4\pi\varepsilon_0 r_1^2}$

Answer: A

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5. 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 charge approach each other with a velocity v. Then as a function of distance x between them .

A. $v \propto x^{-1}$

B. $v \propto x^{1/2}$

C. $v \propto x$

D. $v \propto x^{-1/2}$

Answer: D

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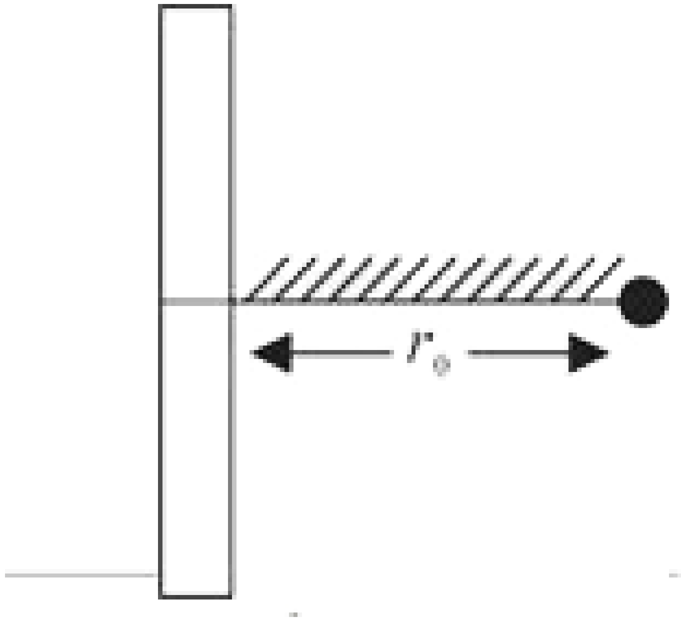
6. A positive point charge is released from rest at a distance r_0 from a positive line charge with uniform density. The speed (v) of the point charge, as a function of instantaneous distance r from line charge, is proportional to:



A. $v \propto e^{\pi / r_0}$

B. $v \propto \ln\left(\frac{r}{r_0}\right)$

C. $v \propto \sqrt{\ln\left(\frac{r}{r_0}\right)}$

D. $v \propto \left(\frac{r}{r_0}\right)$

Answer: C

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7. Two positively charged spheres of masses m_1, and m_2 are suspended from a common point at the ceiling by identical insulating massless strings of length l. Charged on the two spheres are q_1 and q_2, respectively. At equilibrium both strings make the same angle θ with the vertical. Then

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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8. Two identical charged spheres of material density ρ, suspended from the same point by inextensible strings of equal length make an angle θ between the string. When suspended in a liquid of density σ the angle θ remains the same. The dielectric constant K of the liquid is

A. $\dfrac{\rho}{\rho - \sigma}$

B. $\dfrac{\rho - \sigma}{\rho}$

C. $\dfrac{\rho}{\rho + \sigma}$

D. $\dfrac{\rho + \sigma}{\rho}$

Answer: A

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9. 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 θ 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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10. A charge Q is placed at a distance $\frac{\alpha}{2}$ above the centre of a horizontal, square surface of edge a as shown in figure (30-E1). Find the flux of the electric field through the square surface.

A. $\frac{Q}{6\varepsilon_0}$

B. $\frac{Q}{2\varepsilon_0}$

C. $\frac{Q}{3\varepsilon_0}$

D. $\frac{q}{\varepsilon_0}$

Answer: A

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11. A body of mass M and charge q is connected to a spring of spring constant k. It is oscillating along x-direction about its equilibrium position, taken to be at x = 0 with an amplitude A. An electric field E is applied along the x-direction. Which of the following statement is correct ?

A. The total energy of the system is $\frac{1}{2}m\omega^2A^2+\frac{1}{2}\frac{q^2E^2}{k}$

B. The new equilibrium position is at a distance $\frac{2qE}{k}$ from x=0

C. The new equilibrium position is at a distance $\frac{qE}{2k}$ from x=0

D. The total energy of the system is $\frac{1}{2}m\omega^2A^2 - \frac{1}{2}\frac{q^2E^2}{k}$

Answer: A

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12. Electric charge is uniformly distributed along a long straight wire of radius 1 mm. The charge per cm length of the wire Q coulomb. Another cylindrical surface of radius 50 cm and length 1 m symmetrical encloses the wire as shown in the figure. The total electric flux passing through the cylindrical surface is

A. $\frac{Q}{\varepsilon_0}$

B. $\frac{100Q}{\varepsilon_0}$

C. $\frac{10Q}{\pi\varepsilon_0}$

D. $\frac{100Q}{\pi\varepsilon_0}$

Answer: B

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13. An electric dipole is formed by two equal and opposite charges q with separation d. The charges have same mass m. It is kept in a uniform electric field E. If it is slightly rotated from its equilibrium orientation, then its angular frequency ω is:

A. $\sqrt{\frac{qE}{2md}}$

B. $\sqrt{\frac{2qE}{md}}$

C. $\sqrt{\frac{qE}{md}}$

D. $2\sqrt{\frac{qE}{md}}$

Answer: B

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14. Two identical conducting spheres A and B, carry equal charge. They are separated by a distance much larger than their diameters, and the force between them is F. A third identical conducting spheres, C,is uncharged. Sphere C is first touched to A, then to B, and then removed. As a result, the force between A and B would be equal to :

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

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

C. $\frac{3F}{8}$

D. F

Answer: C

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15. If the electric flux entering and leaving a closed surface are 6×10^6 and 9×10^6 SI units respectively, then the net charge inside the surface of permittivity of free space ε_0 is

A. $\varepsilon_0 \times 10^6$

B. $-\varepsilon_0 \times 10^6$

C. $-2\varepsilon_0 \times 10^6$

D. $3\varepsilon_0 \times 10^6$

Answer: D

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16. The bob of a simple pendulum has mass $2g$ and a charge of $5.0\mu C$. It is at rest in a uniform horizontal electric field of intensity $200V/m$. At equilibrium, the angle that the pendulum makes with the vertical is:

(take $g = 10m/s^2$)

A. $\tan^{-1}(2.0)$

B. $\tan^{-1}(0.2)$

C. $\tan^{-1}(5.0)$

D. $\tan^{-1}(0.5)$

Answer: D

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17. The time period of revolution of a charge q_1 and of mass m moving in a circular path of radius r due to Coulomb force of attraction due to another charge q_2 at its centre is

A. $\sqrt{\dfrac{16\pi\varepsilon_0 mr^3}{q_1 q_2}}$

B. $\sqrt{\dfrac{8\pi^2\varepsilon_0 mr^3}{q_1 q_2}}$

C. $\sqrt{\dfrac{\varepsilon_0 m r^3}{16 q_1 q_2}}$

D. $\sqrt{\dfrac{16\pi^3 \varepsilon_0 m r^3}{q_1 q_2}}$

Answer: B

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18. Shown in the figure are two point charges +Q and -Q inside the cavity of a spherical shell. The charges are kept near the surface of the cavity on opposite sides of the centre of the shell. If σ_1, is the surface charge on the inner surface and Q_1, net charge on it and σ_2 the surface charge on the outer surface and Q_2 net charge on it then:

A. $\sigma_1 \neq 0, Q_1 = 0$

$\sigma_2 = 0, Q_2 = 0$

B. $\sigma_1 \neq 0, Q_1 = 0$

$\sigma_2 \neq 0, Q_2 = 0$

C. $\sigma_1 = 0, Q_1 = 0$

$\sigma_2 = 0, Q_2 = 0$

D. $\sigma_1 \neq 0, Q_1 \neq 0$

$\sigma_2 \neq 0, Q_2 \neq 0$

Answer: C

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19. A long cylindrical shell carries positive surface charge σ in the upper half and negative surface charge $-\sigma$ in the lower half. The electric field lines around the cylinder will look like figure given in:(figures are schematic and not drawn to scale)

A.

B.

C.

D.

Answer: A

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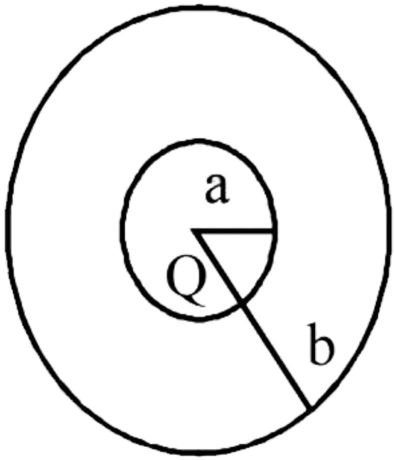
20. The region between two concentric spheres of radii 'a' and 'b', respectively (see figure), have volume charge density $\rho = \frac{A}{r}$, where A is a constant and r is the distance from the centre. At the centre of the spheres is a point charge Q. The value of A such that the electric field in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



A. $\dfrac{Q}{2\pi a^2}$

B. $\dfrac{Q}{2\pi(b^2 - a^2)}$

C. $\dfrac{2Q}{\pi(a^2 - b^2)}$

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

Answer: A

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21. An electric dipole has a fixed dipole moment $\overrightarrow{p}$, which makes angle θ with respect to x-aixs. When subjected to an electric field $\overrightarrow{E}_1 = E\hat{i}$, it experiences a torque $\overrightarrow{T}_1 = \tau\hat{k}$. When subjected to another electric field $\overrightarrow{E}_2 = \sqrt{3}E\hat{j}$ it experiences a torque $\overrightarrow{T}_2 = -\overrightarrow{T}_1$. The angle θ is

A. 30°

B. 45°

C. 60°

D. 90°

Answer: C

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22. Four closed surfaces and corresponding charge distributions are shown below.

Let the respective electric fluxes through the surface be ϕ_1, ϕ_2, ϕ_3 and ϕ_4.Then:

A. $\phi_1 < \phi_2 = \phi_3 > \phi_4$

B. $\phi_1 > \phi_2 > \phi_3 > \phi_4$

C. $\phi_1 = \phi_2 = \phi_3 = \phi_4$

D. $\phi_1 > \phi_3, \phi_2 < \phi_4$

Answer: C

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COMPETITION FILE (Objective Question (BC.MCQ))

1. Let $E_1(r)$, $E_2(r)$ and $E_3(r)$ be the respectively electric field at a distance r from a point charge Q, an infinitely long wire with constant linear charge density λ, and an infinite plane with uniform surface charge density σ. If $E_1(r_0) = E_2(r_0) = E_3(r_0)$ at a given distance r_0, then

A. $Q = 4\sigma\pi r_0^2$

B. $r_0 = \dfrac{\lambda}{2\pi\sigma}$

C. $E_1(r_0/2) = 2E_2(r_0/2)$

D. $E_2(r_0/2) = 4E_3(r_0/2)$

Answer: C

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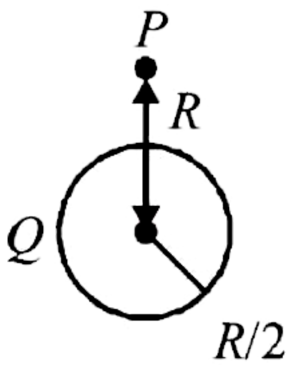
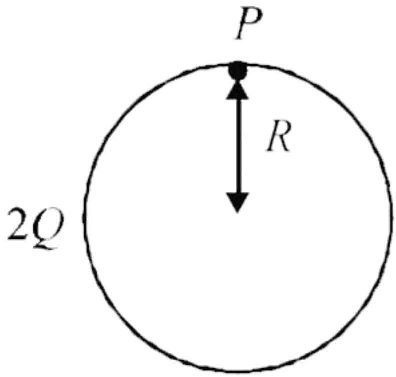
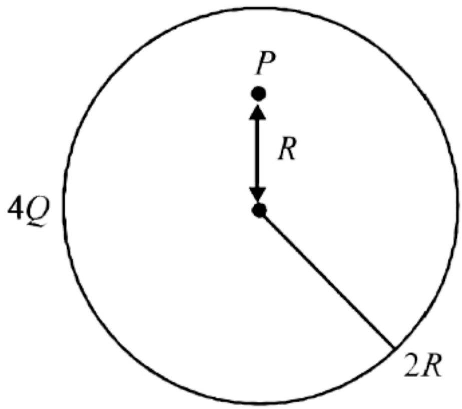
2. Charges Q, 2Q and 4Q are uniformly distributed in three dielectric solid spheres 1, 2 and 3 of radii $R/2$, R and 2R respectively, as shown in figure. If magnitude of the electric fields at point P at a distance R from the centre of sphere 1,2 and 3 are E_1, E_2 and E_3 respectively, then



Sphere 1



Sphere 2



Sphere 3

A. $E_1 > E_2 > E_3$

B. $E_3 > E_1 > E_2$

C. $E_2 > E_1 > E_3$

D. $E_3 > E_2 > E_1$

Answer: C

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3. Three positive charges of equal value q are placed vertices of an equilarteral triangle. The resulting lines of should be sketched as in :-

A.

B.

C.

D.

Answer: C

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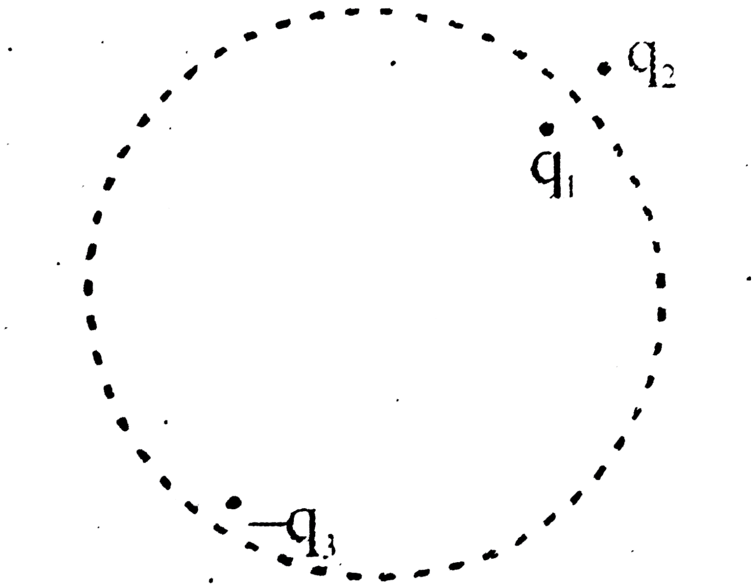
4. A Gaussian surface in the fig. is shown by dotted line. The electric field on the surface will be :-



A. due to q_1 and q_2 only

B. due to q_2 only

C. zero

D. due to all

Answer: D

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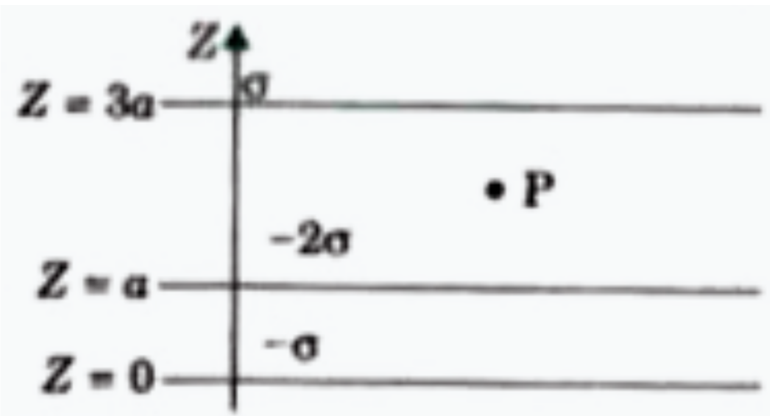
5. Three large plates having uniform surface charge densities are shown in figure. Electric field at point 'P' will be :



A. $\frac{2\sigma}{\varepsilon_0}\hat{k}$

B. $-\frac{2\sigma}{\varepsilon_0}\hat{k}$

C. $\frac{4\sigma}{\varepsilon}\hat{k}$

D. $-\frac{4\sigma}{\varepsilon_0}\hat{k}$

Answer: B

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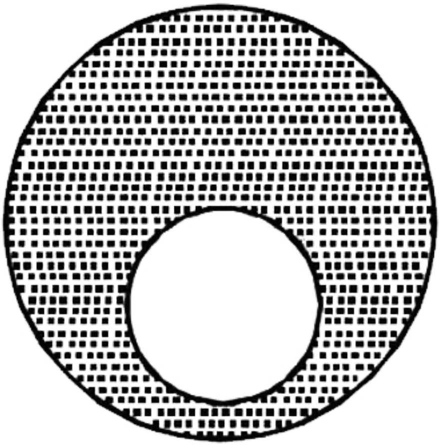
6. A spherical portion has been removed from a solid sphere having a charge distributed uniformly in its volume as shown in the figure.

The electric field inisde the emptied space is



A. zero everywhere

B. non zero and uniform

C. non-uniform

D. zero only at its centre

Answer: B

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7. Under the influence of the Coulomb field of charge $+Q$, a charge $-q$ is moving around it in an elliptical orbit. Find out the correct statement(s).

A. The angular momentum of the charge -q in 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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8. 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 denisties on the outer surfaces 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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9. Conisder a neutral conducting sphere. A poistive point charge is placed outisde 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 closest 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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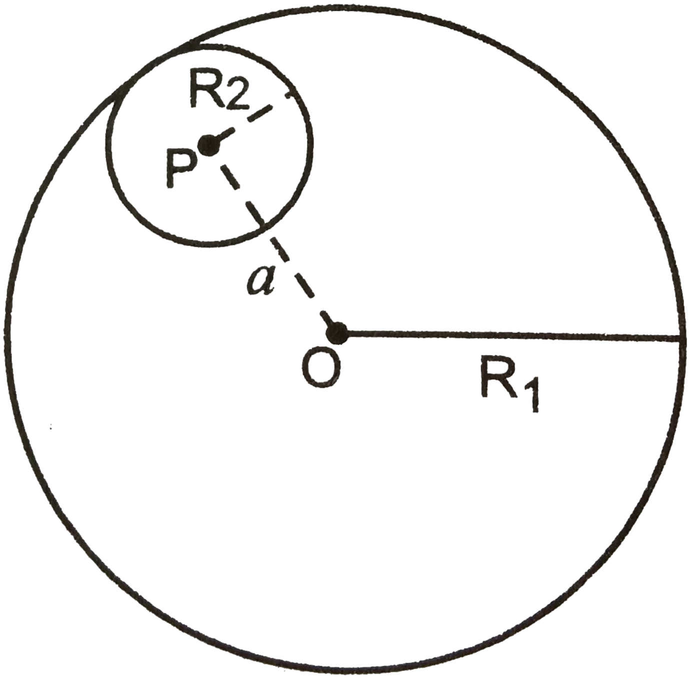
10. Consider a uniform spherical charge distribution of radius R_1 centred at the origin O. In this distribution a spherical cavity of radius R_2, centred at P with distance $OP = a = R_1 - R_2$ (fig) is made.If the electric field inside the cavity at position $\overrightarrow{r}$, then the correct statement is



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

B. $\overrightarrow{E}$ is uniform , its magnitude depends on R_2 and its direction depends on $\overrightarrow{r}$

C. $\overrightarrow{E}$ is uniform, its magnitude is independents on $\overrightarrow{a}$ but its direction depends on $\overrightarrow{a}$

D. $\overrightarrow{E}$ is uniform and both its magnitude and direction depend on $\overrightarrow{a}$

Answer: D

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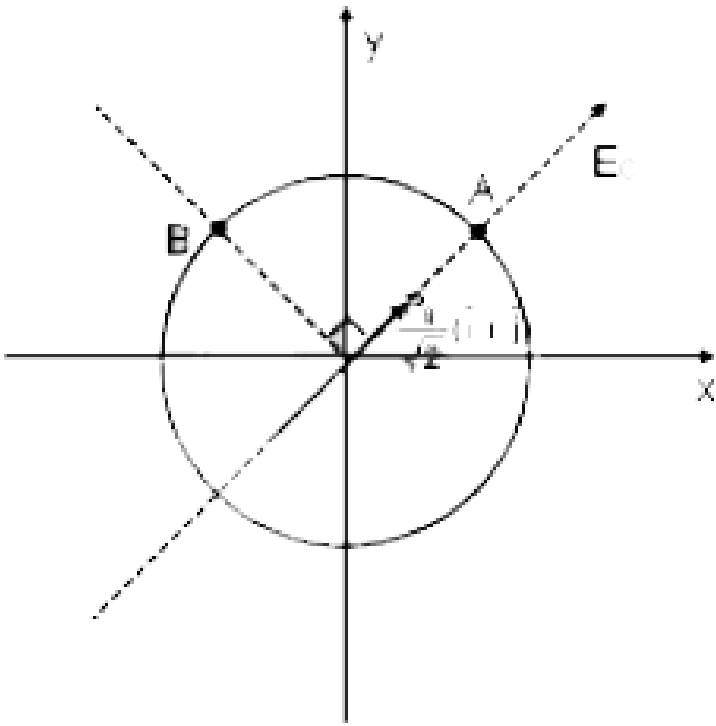
COMPETITION FILE (Objective Question (C.MCQ))

1. A dipole of Dipole moment $\overrightarrow{p} = \frac{p_0}{\sqrt{2}}\left(\hat{i} + \hat{j}\right)$. Is placed at origin. Now a uniform external electrical filed at magnitude E_0 is applied along direction of dipole. Two points A and B are lying on a equipotential surface of radius R centered at origin. A is along axial position of dipole and B is along equatorial position. There correct option are :



A. $R=\left(\frac{P_0}{4\pi\varepsilon_0 E_0}\right)^{1/3}$

B. The magnitude of total electric field on

any two points of the circle will be same

C. Total electric field at point A is

$$\overrightarrow{E}_A = \sqrt{2}E_0\left(\hat{i} + \hat{j}\right)$$

D. Total electric field at point B is $\overrightarrow{E}_B = 0$

Answer: A::D

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2. Two non-conducting solid spheres of radii R and 2R, having uniform volume charge densities ρ_1 and ρ_2 respectively, touch each other. The net electric field at a distance 2R from the centre of the smaller sphere, along the line joining the centres of the spheres, is zero. The ratio $\frac{\rho_1}{\rho_2}$ can be

A. -4

B. $-\frac{32}{25}$

C. $\frac{32}{25}$

D. 4

Answer: B::D

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3. There is a solid non-conducting sphere of radius R. Sphere is uniformly charged over the volume. Electric field due to this where in observed.

A. Electric field intensity at the centre of sphere can never be non-zero.

B. Magnitude of electric field intensity at a point inside the sphere is directly proportional to the distance of the point from centre of sphere.

C. Magnitude of electric field intensity is directly proportional to $\frac{1}{r^2}$ for points outside the sphere where r is the distance of point from the centre of sphere

D. Magnitude of electric field intensity at any point is less than its magnitude on sphere's surface.

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

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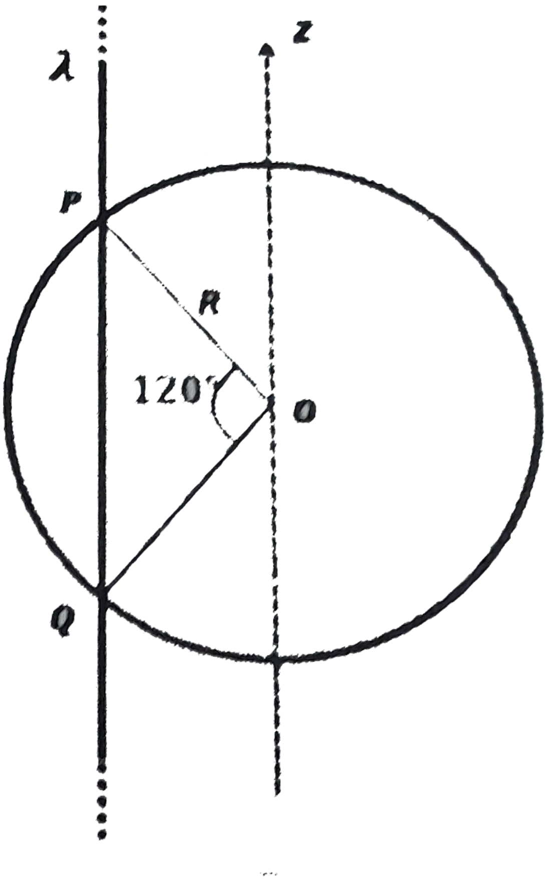
4. An infinitely long thin non-conduction wire is parallel to the z-axis and carries a uniform line charge density λ. It pierces a thin non-conducting spherical shell of radius r in such a way that that the are PQ subtends an angle 120° at the centre O of the spherical shell, as shown in the figure. The permittivity of free space is ε_0. which of the following statements is (are) true ?



A. The electric flux through the shell is

$\sqrt{3}R\lambda/\varepsilon_0$

B. The Z-component of the electric field is zero at all the points on the surface of the shell

C. The electric flux through the shell is $\sqrt{2}R\lambda / \varepsilon_0$

D. The electric field is normal to the surface of the shell at all points.

Answer: A::B

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5. An electric dipole in placed completely inside a sphere in such a manner that centre of dipole coincides with the centre of sphere.

A. Flux of electric field through the sphere may be non-zero.

B. Flux of electric field through the sphere must be zero.

C. Electric field intensity everywhere on sphere is zero.

D. Electric field intensity everywhere on sphere is non-zero

Answer: B::D

Watch Video Solution

6. An electric dipole is placed in uniform electric field. The magnitude of electric dipole moment of dipole is p and external electric field intensity is E. Asume θ is the angle between electric dipole moment and electric field intensity and U represents potential energy of electric dipole

A. If U=0 for $\theta = 0$ then for other orientations $U = pE(1 - \cos\theta)$

B. If U=0 for $\theta = 90^\circ$ then for other orientations $U = -pE\cos\theta$

C. If U=0 for $\theta = 180^\circ$ then for other orientations $U = -pE(1 + \cos\theta)$

D. All of the above

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

View Text Solution

7. Electric dipole is placed near a uniformly charged large non-conducting surface.

A. Net electric force on electric dipole is zero.

B. Net torque on electric dipole may be zero.

C. Net torque on electric dipole may be non-zero

D. Net electric force on electric dipole may be non-zero.

Answer: A::B::C

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8. Select the correct statement.

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

B. Electric field intensity calculated by Gauss's law is due to charges enclosed in the Gaussian surface only

C. Charge should not lie on a Gaussian surface.

D. Electric flux associated with a Gaussian surface is not affected by the charges outside the surface

Answer: C::D

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9. If the flux of the electric field through a closed surface is zero,

A. electric field intensity at all points on the Gaussian surface may be non-zero.

B. electric field intensity at all points on the Gaussian surface may be zero

C. electric field intensity at some points on the Gaussian surface must be zero.

D. electric field intensity at some points on the Gaussian surface may be non-zero.

Answer: A::B::D

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10. The process due to which an uncharged insulated metallic conductor gets electrically charged when held near a charged body is called _____.

A. The metal cube acquires net negative charge due to induction.

B. The metal cube acquires net positive charge due to induction

C. Interior of the metal cube remains electrically neutral but charges appear on surface.

D. Net charge on the metal cube remains zero.

Answer: C::D

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11. There is a point charge +q inside a hollow sphere and a point charge -q just outside its surface. The total flux passing through the surface of sphere is :

A. If the magnitude of charge on sphere is more than that of point charge then there will be positive charge on the outer surface and negative on the inner surface of hollow sphere.

B. If The magnitude of charge on sphere is more than that of point charge then there will be positive charge on the outer surface and inner surface of hollow sphere

C. If the magnitude of charge on sphere is less than that of point charge then there will be negative charge on the outer surface and positive charge on the inner surface of hollow sphere.

D. If the magnitude of charge on sphere is less than that of point charge then there will be negative charge on the outer surface and inner surface of hollow sphere

Answer: B::C

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12. There is a line charge of infinite length with positive charge distributed uniformly along ita length. One electron is moving in a circular path with the plane of the circle perpendicular to the line charge.

A. Kinetic energy of the electron is independent of its distance from line charge

B. Time taken by charged particle to complete one full circle around line charge is directly proportional to its distance from the line charge

C. Square of the time taken to complete one circle is proportional to the third power of its distance from the line charge.

D. Electric field intensity at a point due to line charge in inversely proportional to the length of perpendicular drawn from point on line charge.

Answer: A::B::D

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13. There is a positively charged ring of radius R whose plane in kept vertical in gravity free space. One electron is released at rest from a point on its axis at a distance x from its centre. Assume that the positive charge is uniformly distributed over ring.

A. The electron performs S.H.M about the centre if x is very small in comparison to radius of the ring.

B. The electron will attain maximum acceleration acne crossing the centre of ring if x gt R

C. Acceleration of the electron is zero at the instant it crosses the centre of ring.

D. The electron will oscillate about the centre of ring.

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

View Text Solution

14. There is a uniformly charged non-conducting solid sphere. A small spherical cavity is made inside it. Distance of the centre of cavity is x from the centre of sphere

A. Electric field intensity inside the cavity is zero if x=0

B. Electric field intensity inside cavity is non-zero if $x \neq 0$

C. Electric field inside the cavity is always uniform

D. The magnitude of electric field intensity inside the cavity is proportional to x.

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

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15. There is a long, uniformly charged, non-conducting solid cylinder.

A. The magnitude of electric field intensity at any point inside the cylinder is directly proportional to the length of perpendicular drawn from a point on the axis of cylinder.

B. The magnitude of electric field intensity at any point outside the cylinder is inversely proportional to the length of perpendicular drawn from a point on the axis of cylinder.

C. Electric field intensity in not defined for the points on the axis of cylinder

D. Electric field intensity is zero for the points on the axis of cylinder

Answer: A::B::D

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16. A point charge q is kept at a corner of a cube

A. Electric flux linked with individual faces of the cube may be zero

B. Electric flux linked with individual faces of the cube may be non-zero

C. Electric flux linked with a certain face of the cube may be $q/8\varepsilon_0$

D. Electric flux linked with a certain face of the cube may be $q/24\varepsilon_0$

Answer: A::B::D

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17. A point charge q is kept at e distance x from the centre of a neutral metallic cube.

A. Net electric field intensity at the centre is zero

B. Electric field intensity due to induced charges on cube at its centre is zero.

C. Electric field intensity due to point charge at the centre is non-zero.

D. Electric field intensity at the centre of cube due to point charge and induced charges on cube will be equal in magnitude.

Answer: A::C::D

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18. A charged shell of radius R carries a total charge Q. Given ϕ as the flux of electric field through a closed cylindrical surface of height h, radius r & with its centre same as that of the shell. Here centre of cylinder is a point on the axis of the cylinder which is equidistant from its top & bottom surfaces. which of the followintg are correct.

A. If h gt 2R and r gt R then $\phi = \frac{Q}{\varepsilon_0}$

B. If $h < \frac{8R}{5}$ and $r = \frac{3R}{5}$ then $\phi = 0$

C. If h gt 2R and r= $\frac{4R}{5}$ then $\phi = \frac{Q}{5\varepsilon_0}$

D. If h gt 2 R and r= $\frac{3R}{5}$ then $\phi = \frac{Q}{5\varepsilon_0}$

Answer: A::B::D

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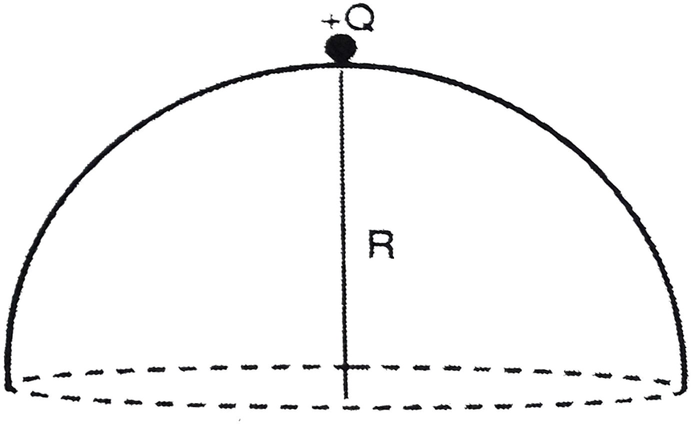
19. A point charge +Q is place just outside an imaginary hemispherical surface of radius R as shown in the figure. Which of the following statements is/are correct ?



A. Total flux through the curved and the flat surface is $\dfrac{Q}{\varepsilon_0}$

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

C. The circumference of the flat surface in an equipotential

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

Answer: C::D

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COMPETITION FILE (Objective Question (D.MCQ) Passage)

1. There is a very thin straight pipe of a large length. A transparent insulating material is used to make this pipe. The inner radius of pipe is r and the outer radius is R. Both R and are very small and the difference between them is very less. The pipe is fixed in a vertical orientation. The upper end of the pipe is open and its lower end is closed. There is a large number of small insulating spheres of radius r each carrying charge Q. These small spheres are inserted from the upper end of the pipe one after another and pushed down further so that entire pipe is filled with closely spaced insulating charged sphere. Electric field due to this system is observed for points outside the pipe and towards the midpoint of large vertical length of pipe.

If we compare the given system with a line charge then what will be the equivalent value of linear charge density.

A. Q/r

B. $Q / 2\pi r$

C. Q/2r

D. None

Answer: C

View Text Solution

2. The value of end correction for the pipe open at both the ends is a

(If the d is the inner diameter of the tube and r is the radius of the tube .)

A. n=1

B. n=2

C. n=-1

D. n=-2

Answer: C

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3. A vertical pipe open at both ends is partially submerged in water . A tuning fork is unknown frequency is placed near the top of the pipe and made to vibrate . The pipe can be moved up and down and thus length of air column the pipe can be adjusted. For definite lengths of air column in the pipe, standing waves will be set up as a result of superposition of sound waves travelling in opposite directions. Smallest value of length of air column , for which sound intensity is maximum is $10cm$[take speed of sound , $v = 344m/s$].

Answer the following questions.

The air column here is closed at one end because the surface of water acts as a wall.

Which of the following is correct ?

A. m=1

B. m=2

C. m=-1

D. m=-2

Answer: A

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4. There is a very thin straight pipe of a large length. A transparent insulating material is used to make this pipe. The inner radius of pipe is r and the outer radius is R. Both R and are very small and the difference between them is very less. The pipe is fixed in a vertical orientation. The upper end of the pipe is open and its lower end is closed. There is a large number of small insulating spheres of radius r each carrying charge Q. These small spheres are inserted from the upper end of the pipe one after another and pushed down further so that entire pipe is filled with closely spaced insulating charged sphere. Electric field due to this system is observed for points outside the pipe and towards the midpoint of large vertical length of pipe.

If there is a mall insulating sphere of same radius r and charge of magnitude Q and the polarity of charge is opposite. This small sphere is moving in a circular path around the charged system that we have described in passage. Speed of the small sphere going in a circular path is found to be proportional to the Q^n.

A. n=1

B. n=2

C. n=-1

D. n=-2

Answer: A

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5. Two identical charged spheres are suspended by strings of equal lengths. The strings make an angle of 30° with each other. When suspended in a liquid of density $0.8gcm^{-3}$, the angle remains the same. If density of the material of the sphere is

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

A. 1

B. 2

C. 3

D. 4

Answer: B

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6. Two identical charged spheres are suspended in air from a ceiling using strings of equal length. The point of suspension is common to both the spheres. Neglect the density of air. The density of material of spheres is $2\mathrm{g}/\mathrm{cm}^3$.

Both spheres repel each other and the strings are inclined at a certain angle with the vertical when the system is in equilibrium. Now both the sphere are dipped into a liquid of specific gravity 1 and dielectric constant K, but angle that the strings are making with the vertical remains unchanged. Let T_1 be the tension in both the strings when the spheres are in air and T_2, be the tension in strings when spores are dipped in liquid. Let F_1 be the electrostatic force between charges when they were kept in air and F_2, be the electrostatic force when spheres are dipped in liquid.

The magnitude of F_2 / F_1 is

A. 3

B. 2

C. $1/2$

D. $1/3$

Answer: C

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7. Two identical charged spheres are suspended in air from a ceiling using strings of equal length. The point of suspension is common to both the spheres. Neglect the density of air. The density of material of spheres is $2\mathrm{g}/\mathrm{cm}^3$.

Both spheres repel each other and the strings are inclined at a certain angle with the vertical when the system is in equilibrium. Now both the sphere are dipped into a liquid of specific gravity 1 and dielectric constant K, but angle that the strings are making with the vertical remains unchanged. Let T_1 be the tension in both the strings when the spheres are in air and T_2, be the tension in strings when spores are dipped in liquid. Let F_1 be the electrostatic force between charges when they were kept in air and F_2, be the electrostatic force when spheres are dipped in liquid.

The magnitude of T_2/T_1 is

A. 1

B. 2

C. $1/2$

D. None

Answer: C

View Text Solution

8. Two identical very small metal spheres, A and B, that are electrically neutral are fixed at a distance R On insulating handles. A third identical sphere C carrying charge Q is also connected to an insulating handle. C ia first brought into contact with A and B and then moved away from these two spheres. It is found that A and B apply F_1 force on each other.

Now C with the remaining charge is again brought into contact with A and then moved away from A and B. It is found that A and B apply F_2 force on each other. Now C is further brought into contact with B and then moved away from A and B. It is found that A and B apply F_3 force on each other Finally B is moved closer to A at a distance r, such that the force between them again becomes F_1.

The magnitude of F_1 / F_2 is

A. $3/4$

B. $4/3$

C. $4/5$

D. $5/4$

Answer: B

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9. Two identical very small metal spheres, A and B, that are electrically neutral are fixed at a distance R On insulating handles. A third identical sphere C carrying charge Q is also connected to an insulating handle. C ia first brought into contact with A and B and then moved away from these two spheres. It is found that A and B apply F_1 force on each other.

Now C with the remaining charge is again brought into contact with A and then moved away from A and B. It is found that A and B apply F_2 force on each other. Now C is further brought into contact with B and then moved away from A and B. It is found that A and B apply F_3 force on each other Finally B is moved closer to A at a distance r, such that the force between them again becomes F_1.

The magnitude of F_2 / F_3 is

A. $3 / 4$

B. $4/3$

C. $4/5$

D. $5/4$

Answer: C

View Text Solution

10. Two identical very small metal spheres, A and B, that are electrically neutral are fixed at a distance R On insulating handles. A third identical sphere C carrying charge Q is also connected to an insulating handle. C ia first brought into contact with A and B and then moved away from these two spheres. It is found that A and B apply F_1 force on each other.

Now C with the remaining charge is again brought into contact with A and then moved away from A and B. It is found that A and B apply F_2 force on each other. Now C is further brought into contact with B and then moved away from A and B. It is found that A and B apply F_3 force on each other Finally B is moved closer to A at a distance r, such that the force between them again becomes F_1.

The magnitude of r/R is

A. $\sqrt{\frac{15}{16}}$

B. $\sqrt{\frac{16}{15}}$

C. $\sqrt{\frac{20}{12}}$

D. $\sqrt{\frac{12}{20}}$

Answer: A

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COMPETITION FILE (Objective Question (Assertion Reason))

1. Assertion:A pair of closely spaced electron and proton behaves like an electrically neutral particle system and do not apply electric force on isolated proton or electron.

Reason: Two types of charges exist in nature, which are opposite to'each other in polarity. These two types of charges have a tendency to cancel the electrical effect of each other. Benjamin Franklin suggested the use of positive and negative signs to represent these two types of charges. We can calculate the net charge of any system by evaluating the algebraic sum of individual charges.

A. If both assertion and reason are correct and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is not the correct explanation of assertion

C. If assertion is correct but reason is incorrect

D. If assertion is incorrect but reason is correct.

Answer: A

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2. Assertion: Charge is invariant. It means the net charge of a system does not change even if the system is in a state of motion.

Reason: If m_0 is the mass of a particle in state of rest then the mass of the particle changes according to speed (v) of particle and can be calculated using following relation.

$$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$

A. If both assertion and reason are correct and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is not the correct explanation of assertion

C. If assertion is correct but reason is incorrect

D. If assertion is incorrect but reason is correct.

Answer: B

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3. Assertion: The net electric field intensity is zero everywhere inside a metallic volume in electrostatic condition.

Reason: In case of metals or other conducting materials, there are a plenty of free electrons, which are not bound to any particular nucleus and can move around verywhere inside the metallic volume.

A. If both assertion and reason are correct and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is not the correct explanation of assertion

C. If assertion is correct but reason is incorrect

D. If assertion is incorrect but reason is correct.

Answer: A

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4. Assertion: There is a solid metallic sphere. When some charge is given to the sphere then it is found that charge gets distributed uniformly on the outer surface of the sphere.

Reason: Electric field intensity inside the metallic volume is zero everywhere in electrostatic condition, hence for Gaussian surface of any shape inside the metallic volume, electric flux will always be zero. According to Gauss's law, the net enclosed charge is zero.

A. If both assertion and reason are correct and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is not the correct explanation of assertion

C. If assertion is correct but reason is incorrect

D. If assertion is incorrect but reason is correct.

Answer: A

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5. Assertion: If there is a system of two unequal point charges of any polarity then there is one and only one point in space around it where the electric field intensity is zero.

Reason: The direction of electric field intensity at a point is away from the positive charge and towards the negative charge, along the line joining the charge and location where electric field intensity is to be calculated.

A. If both assertion and reason are correct and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is not the correct explanation of assertion

C. If assertion is correct but reason is incorrect

D. If assertion is incorrect but reason is correct.

Answer: A

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6. Assertion: We can protect electrically sensitive instruments by keeping them inside a metallic box.

Reason: Conductors can maintain a uniform electric field inside them.

A. If both assertion and reason are correct and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is not the correct explanation of assertion

C. If assertion is correct but reason is incorrect

D. If assertion is incorrect but reason is correct.

Answer: C

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7. Assertion: Free electrons can move freely everywhere inside metallic volume and free electrons reaching near the surface escape from the metal and new electrons from surrounding enter inside the metal to compensate for these lost electrons.

Reason: In natural state, matter is electrically neutral, hence the number of protons in nucleus is always equal to the number of electrons revolving around the nucleus.

A. If both assertion and reason are correct and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is not the correct explanation of assertion

C. If assertion is correct but reason is incorrect

D. If assertion is incorrect but reason is correct.

Answer: D

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8. Assertion: When a dielectric material is kept inside some external electric field then the net electric field intensity inside the volume of dielectric is always less than external electric field intensity.

Reason: In a normal state, polar molecules of dielectric material are randomly oriented and their net electric field remains zero. If we apply electric field on a dielectric material then the polar molecules experience torque and gets aligned along its direction.

A. If both assertion and reason are correct and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is not the correct explanation of assertion

C. If assertion is correct but reason is incorrect

D. If assertion is incorrect but reason is correct.

Answer: A

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9. Assertion: No net charge can exist in the region where electric field is uniform.

Reason: For any type of Gaussian surface selected within the region of a uniform electric field, the angle between electric field intensity and area normal is 90° everywhere. Hence, electric flux linked with the selected Gaussian surface is equal to zero. If the net electric flux is zero for some Gaussian surface then according to Gauss's law the net charge enclosed within the surface must be zero.

A. If both assertion and reason are correct and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is not the correct explanation of assertion

C. If assertion is correct but reason is incorrect

D. If assertion is incorrect but reason is correct.

Answer: C

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10. Assertion: Electric field near a large conducting surface with uniform surface charge density (σ) is $E = \frac{\sigma}{\varepsilon_0}$

Reason: If there is an isolated metal plate then we cannot distribute charge only on one surface. Whatever charge is given it uniformly gets distributed on both sides. We are neglecting thickness of the plate, On the other hand, if we have two metal plates carrying equal and opposite charges and place them parallel to each other, charge on plates stays only on the inner faces.

A. If both assertion and reason are correct and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is not the correct explanation of assertion

C. If assertion is correct but reason is incorrect

D. If assertion is incorrect but reason is correct.

Answer: A

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11. Assertion: Two electrically neutral metal spheres in contact are moved closer to a charged object and then separated away from each other using insulating handles in the presence of e charged object, Both the neutral objects acquire equal and opposite charges.

Reason: When two metallic objects in contact are brought closer to a charged object then electrons are transferred from one object to the other due to induction phenomenon. If we separate the objects in presence of a charged object then electrons are unable to flow back to the original object.

A. If both assertion and reason are correct and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is not the correct explanation of assertion

C. If assertion is correct but reason is incorrect

D. If assertion is incorrect but reason is correct.

Answer: A

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12. Assertion: Metal rods connected to earth are fixed at the top of a building to protect building against lightning.

Reason: Metal has one character to repel away the approaching charge of any polarity. These metal rods repel the lightning to fall somewhere else.

A. If both assertion and reason are correct and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is not the correct explanation of assertion

C. If assertion is correct but reason is incorrect

D. If assertion is incorrect but reason is correct.

Answer: C

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13. Assertion: When two protons are brought closer to each other against their electrostatic repulsion then their combined mass becomes slightly more than their total mass.

Reason: If we bring two similar charges closer to each other from infinity then work is needed to be done against electrostatic repulsion. Mechanical work against electrostatic repulsion gets stored in the system as electric energy. We know that $E = mc^2$, hence due to an increase in energy of the system, equivalent mass of the system increases.

A. If both assertion and reason are correct and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is not the correct explanation of assertion

C. If assertion is correct but reason is incorrect

D. If both assertion and reason are incorrect.

Answer: D

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14. Assertion: Insulating materials may not provide insulation when subjected to a very high electric field condition.

Reason: When electric field is applied on a dielectric or insulating material then it aligns polar molecules of dielectric in the direction of electric field and at the same time positive and negative ends of the molecule experience force along opposite directions and molecule is stretched. Abnormally high electric field can stretch the molecule beyond permissible limits and negative ends or electrons are separated from molecules and material start conducting electricity. This phenomenon is called breakdown.

A. If both assertion and reason are correct and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is not the correct explanation of assertion

C. If assertion is correct but reason is incorrect

D. If assertion is incorrect but reason is correct.

Answer: A

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15. Assertion: Electric field intensity at a point due to a positive charge is always opposite in direction to electric field intensity due to negative charge, and it is independent to locations of charges.

Reason: The direction of electric field due to a point charge is away from the positive charge and towards the negative charge along the line joining the point charge and location where the electric field is to be calculated.

A. If both assertion and reason are correct and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is not the correct explanation of assertion

C. If assertion is correct but reason is incorrect

D. If assertion is incorrect but reason is correct.

Answer: D

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COMPETITION FILE (Objective Question (Matching))

1. Match the following

A. P-5, Q-3,4 , R-1, S-2

B. P-5, Q-3 , R-1,4 , S-2

C. P-5 , Q-3 , R-1,2 , S-4

D. P-4 ,Q-2,3 , R-1 , S-5

Answer: B

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COMPETITION FILE (Objective Question (Matrix))

1.

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2.

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COMPETITION FILE (Objective Question (Integer))

1. One short electric dipole is placed at a location in space. Locations where electric field intensity becomes zero are called a null points. How many null points exist around the dipole?

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2. Two short electric dipoles are placed in such a manner that their axis coincides and distance between their centres is r. Electric force between these two shart dipoles is found to be proportional r^{-n}. What will be the value of n?

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3. There is one short electric dipole placed on a horizontal plane. A circle is drawn assuming centre of dipole as centre of circle and plane of the circle is perpendicular to the axis of electric dipole. Thế number of points on this circle where electric field intensity due to electric dipole is perpendicular to the axis of dipole.

4. There is one short electric dipole placed on a plane. A straight line is drawn on this plane passing through the centre of electric dipole making an angle θ with the axis of dipole. A point P is selected on this line at a distance ten times the length of electric dipole from centre of electric dipole. Electric field intensity at the point P makes an angle α with the axis of electric dipole . What will be the magnitude of $\dfrac{\tan\theta}{\tan\alpha}$?

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5. Sides of a right triangular field are 25m, 24m and 7m. At the three corners of the field, a cow, a buffalo and a horse are tied separately with ropes of 3.5 m each to graze in the field. Find the area of the field that cannot be grazed by these animals.

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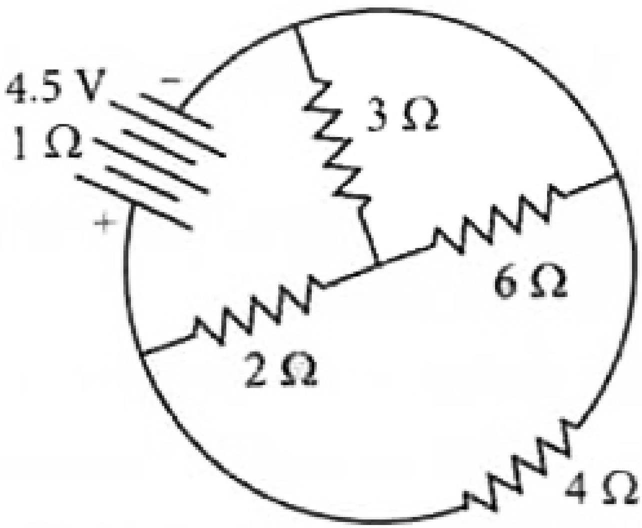
6. An electric dipole is kept fixed at a location. A positive point charge is brought near the dipole. What will be the maximum number of null points by placing point charge at appropriate location with respect to electric dipole?



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7. A particle of mass 10^{-3} kg and charge 1.0 c is initially at rest At time t=0 the paritcle comes under the influence of an electric field $\widehat{E}(t) = E_0 \sin \omega t \hat{i}$ where $E_0 = 1.0 NC^{-1}$ and $\omega = 10^3 rads^{-1}$ consider the effect of only the electrical force on the particle .Then the maximum speed in m s^{-1} attained by the paritcle at subsequent times is ____________

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8. There are two small identical metallic spheres A and B each carrying same charge. These two spheres are found to repel each other with a force P. A third identical neutral metal sphere C is first brought in contact with A and then B. The sphere C is taken away from A and B. The magnitude of electric force now is found to be 3F/x. What is x?

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9. Two positive point charges Q and one negative point charge q are arranged in a straight line in such a manner that the complete system remains in equilibrium. What can be the magnituude of Q/q ?

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10. A change in the focal length of the eye lens is brought by.

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Chapter Practice Test

1. Why electrostatic field is normal to the surface at every point of a charged isolated conductor?

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2. Define electric dipole moment. Write its SI unit ?

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3. when an electric dipole is suspended in a uniform electric field, then under what conditions the dipole is in (i) stable equilibrium and (ii) unstable equaliibrium.

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4. Two charged particles are placed at a distance r from each other. The magnitude of the electric force between the two charged particles is F. What will be the effect on F on placing the given charged particles in water? (Take dielectric constant of water 80).

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5. An electric dipole having dipole moment 2×10^{-6} C-m is enclosed by a closed surface. Determine the net electric flux coming out of the given closed surface?

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6. Two infinitely long parallel wires having linear charge density 3×10^{-9} C/m and 4×10^{-9} C/m are kept at a distance of 20 cm in air. What will be the magnitude and direction of the electric field intensity at a point that is at a distance of 10 cm from each wire?

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7. In a region of space uniform electric field $\overrightarrow{E} = 2 \times 10^3 \hat{i} NC^{-1}$ exists. Calculate the electric flux of the given field through a circular plane of radius 20 cm placed parallel to the y-z plane. Also calculate the net flux if the circular plane is tilted such that it makes an angle of 30° with the X-axis.

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8. Two charges of magnitude $-2Q$ and $+Q$ are located at points $(a, 0)$ and $(4a, 0)$

respectively .

What is the electric flux due to charges through a sphere of radius '3a' with its center at the origin.

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9. What are electric field lines? Why do two field lines never intersect each other?

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10. 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

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11. Using Gauss's law obtain the expression for the electric field due to uniformly charged thin spherical shell of radius R at a point outside the shell. Draw a graph showing the variation of electric tield with r, for r gt R and r lt R.

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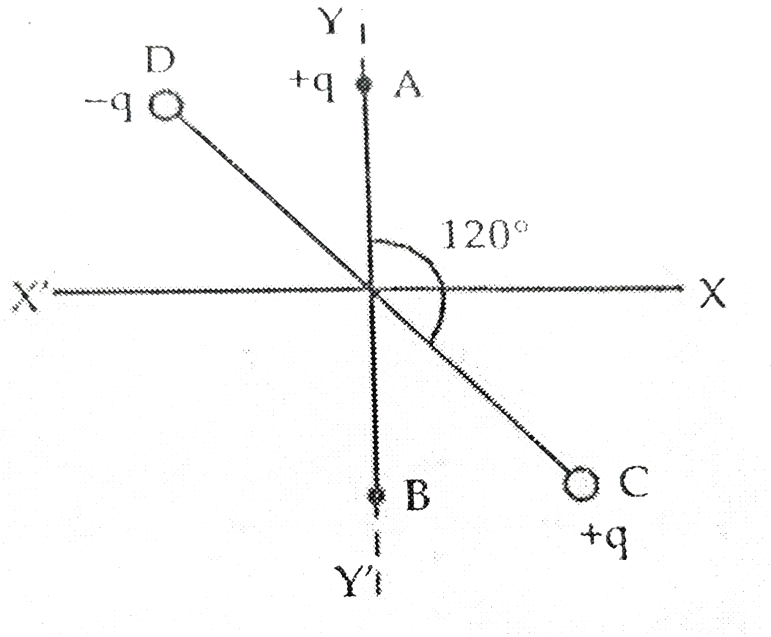
12. Two small identical electrical dipoles AB and CD, each of dipole moment 'p' are kept at an angle of 120° as shown in the figure. What is the resultant dipole moment of this combination? If this system is subjected to electric field $\vec{E}$ directed along + X direction, what will be the magnitude and direction of the torque acting on this ?



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13. A conducting ring of radius 40 cm has a charge of 5×10^{-9} C uniformly distributed over it. Calculate the electric field intensity at a

point P, 40 cm away from the centre on the axis of the ring.

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14. A thin straight infinitely long conducting wire having charge density λ enclosed by a cylindrical surface of radius rand length l_r, its axis coinciding with the length of the wire. Find the expression for the electric flux through the surface of the cylinder.

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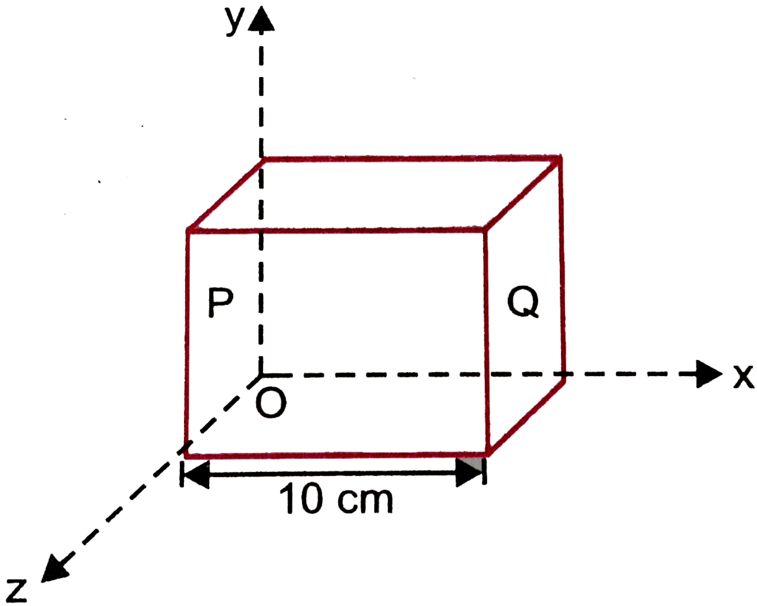
15. In Fig, electric field is directed along $+X$ direction and is given by $E_x = 5Ax + 2B$, where E is in NC^{-1} and x is in meter, A and B are constants having dimensions. Taking $A = 10NC^{-1}m^{-1}$ and $B = 5NC^{-1}$, calculate (i) the electric flux through the cube and (ii) net charge enclosed within the cube.



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