PHYSICS

BOOKS - CHHAYA PHYSICS (BENGALI ENGLISH)

ELECTRIC FIELD

Numerical Examples

1. A 196 dyne force acts between two point charges separated by a distance 6 cm. If the magnitude of one charge is 4 times that of the other, calculate the charges on each.

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2. In free space the force between two charges separated by constant distance is 9 dyn. When a charges and place in a medium of dielectric constant k, the forces between them becomes 4 dyn,. Then find the value of k

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3. A pith ball having charge -20 esu and mass 0.1 g remians suspended at rest in air 2 cm below an insulated charged sphere.What is the amount of charge on the sphere and what is the nature of that charge?

Given $g = 980cm.\ s^{-2}$

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4. The weight of each of two small metal spheres having same amount of charge is 3g. The two spheres are suspended with tow threads of length 13 cm each from a point. Due to mutual repulsion they are at rest at a distance of 10 cm. Determine the charge on each sphere and tension in the threads.

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5. Two similar balls are suspended from a point by two silk thread, each of length l. Each ball of mass m contains q amount of charge. If the angle between the two threads

is very small, show that the distance between the centres of the two balls at equilibrium is $x = \left(\frac{2q^2l}{mg}\right)^{1/3}$

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6. A+250 esu of charge P is On the line joining other two charges Q $(+50$ esu of charge) and $R($ -300 esu of charge) in between them. Distance of P from Q is 5 cm and from R it is 10 cm. What the resultant force acting on P?

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7. Three positive charge 3 esu, 4 esu and 5 esu are placed at the vertices of an equilateral triangle of side 10 cm. What is the force acting the largest charge?

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8. Two particles are placed in air seperated by a distance of 10 cm. 20 esu charge is distributed between them in such a way that the force of repulsion between them is maximum. What is the value of this maximum repulsive force in dyne?

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9. Three identical small spheres each of mass 0.1 g are suspended by three silk threads each of length 20 cm from a certain point. How much charge should be given to each sphere so that each thread will make an angle of 30° with the vertical? You may suppose that each sphere has equal charge.

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10. Three point charge are lying along the x-axis. IF two charges $q_1 = -2C$ and $q_2 = -3C$ are placed at $x_1 = 2\text{m}$ and $x_2 = -1m$, repectively and the third positive charge is so located between the first two

charges that the resultant force on it is zero, find the position of the third charge.

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11. Two negative point charges each of magnitude 2 esu and another point charge q are lying on a straight line. Each of the charges are in equilibrium. Determine the position, value and the nature of the charge q.

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12. A shower of protons from outer space deposits equal amounts of charge $+q$ on the earth and the moon. The

electrostatic repulsion then exactly counterbalances the gravitational attraction. Find the amount of charge q.

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13. The electrostatic force between two point charges and the gravitational attractive force between two point masses- both are inversely proportional to the square of the distance between the charges and the masses, respectively.

(1)(a) Compare the eletrostatic force (F_C) and the gravitational force (F_G) between an electron and a proton. (b) Compare F_C and F_G between two protons.

(ii) Find out the accelerations of an electron and of a

proton due to the electrostatic force between them when htey are placed at a distance of 1Å

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14. Three charges q,q and $-q$ are kept in the three vertices of an equilateral triangle of side l. Find out the resultant force on each of the charges.

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15. Three charges are placed at the vertices of an equilateral triangle of side l. Each of the charges is q. Find out the force on a charge Q placed at the center of mass of the triangle.

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16. Two small metal spheres of equal volume are oppositely charged and are kept 0.5 m apart in vaccum. The attractive force between them is 0.144 N. But a repulsive force of 0.081 N acts between them after they are momentarily connected with a conducting wire. Find out the initial charges on the two spheres.

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17. Two charges of equal magnitude 2×10^{-8} C separated by a silk thread of length 1 m are placed on an

insulated, smooth, horizontal surface. Calculate the tension on the string.

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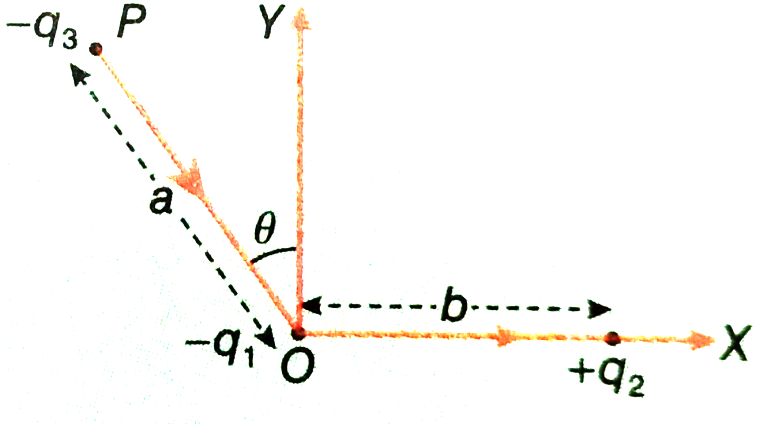
18. Three charges $-q_1$, $+q_2$ and $-q_3$ are kept in vaccum [Fig.]. Show that the horizontal component of the resultant force on the charge $-q_{10}$ would be proportional to $\frac{q_2}{b^2} + \frac{q_3}{a^2}\sin\theta$.



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19. Four charges each of $-Q$, are placed at the four corners of a square. Find out the value of a charge q placed at the centre of the square, such that all the charges would be at equilibrium.

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20. Two indentically 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 $0.8g.\ cm^{-3}$, the angle remains the same. What is the dielelectric constant of the liquid. The density of the material of the spheres is $1.6g.\ cm^{-3}$

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21. An infinite number of charges, each equal to $4\mu C$ are placed alolng x-axis at x=1m, 2m, 4m, 8 m and so on. Find the total force on a charge of 1C placed at the origin.

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

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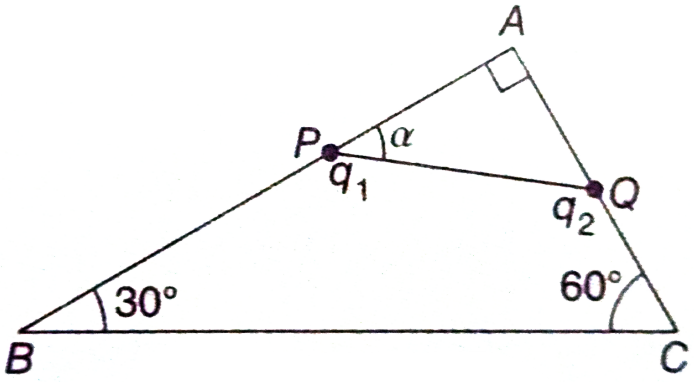
23. A rigid insulated wire frame in the form of a right angled triangle ABC is set in a vertical plane as shown in the figure. Two beads, each of mass m and carrying charges q_1 and q_2 are connected by a cord of length l and kept between the arms AB and AC of the triangle. In such a way that they can slide without friction along the arms. When the beads are stationary, determine- (i) the angle α, (ii) the tension in the cord and (iii) the normal reaction on the beads.



If the cord is now cuts what are the values of charge for which the beads continue to remain stationary?

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24. A particle A having a charge of 5.0×10^{-7}C is fixed in a vertical wall. A second particle B of mass 100g and having equal charge is suspended by a silk thread of length 30 cm from the wall. The point of suspension is located 30 cm vertically above the first particle. Find the

angle of the thread with the vertical when it stays in equilibrium.

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25. A negative charge of 20 units is placed at a distance 50 cm away from a positive charge of 80 unit. Where will the electric field be zero on the line joining the two charges?

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26. At each of the four vertices of a square of side 10 cm there is a +20 esu of charge. Find the Intensity of electric field at the point of Intersection of the two dlagonals.

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27. AB and CD are two perpendicular diameters of a circle of circumference 20π cm. There are +10 esu, +10 esu, +10 esu and -10 esu of charges at A, B, C and D respectively. What is the Intensity of electric field at the centre O of the circle? What is the direction of the field?

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28. The bob of a pendulum of weight 80 mg carries a charge of 2×10^{-8} C. The bob is at rest in a horizontal electric field of magnitude $2 \times 10^{4} V.m^{-1}$. Determine

the tension in the string and angle of the string with the vertical. Given, $g = 9.8m.\ s^{-2}$.

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29. A circular copper ring of radius r, placed in vacuum, has a charge q on it. Find out the electric fields at the centre of the ring.

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30. A circular copper ring of radius r, placed in vacuum, has a charge q on it. Find out the electric fields on the axis of the ring at a distance x from its centre. ?

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31. A circular copper ring of radius r, placed in vacuum, has a charge q on it. Find out the electric fields For what value of x would the electric field be maximum?

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32. Starting from the rest, an electron of mass m_e and a proton of mass m_p travel through a certain distance in a uniform electric field in times t_1 and t_2, respectively. Find out the ratio t_2 / t_1, neglecting the influence of gravity.

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33. Calculate the radius of a charged water drop which remains just suspended in equilibrium in the earth's electric field. Charge in the water drop is equal to that of an electron. Magnitude of the earth's electric field is $10^{-2}\text{stat}V.\,cm^{-1}$. $[e = 4.805 \times 10^{-10}$ esu of charge, $g = 980cm.\,s^{-2}]$

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34. A simple pendulum consists of a small sphere of mass m suspended by a thread of length l. The sphere carries a charge q. The pendulum Is placed in a uniform electric field of strength E directed vertically upwards.With what perlod will the pendulum oscillate if the electrostatic

force acting on the sphere is less than the gravitational force?

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35. 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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36. An electron of charge $1.6 \times 10^{-19} C$ and mass 9.1×10^{-31} kg, travelling along the X-axis with a uniform velocity of $10^6 m.\, s^{-1}$, enters in a uniform electric field of $10^3 V.\, m^{-1}$ acting perpendicular to the X-axis. If the

electric field extends over a length of 2 cm along the X-axis, what will be the deflection of the electron along the direction of the field when it emerges from it?

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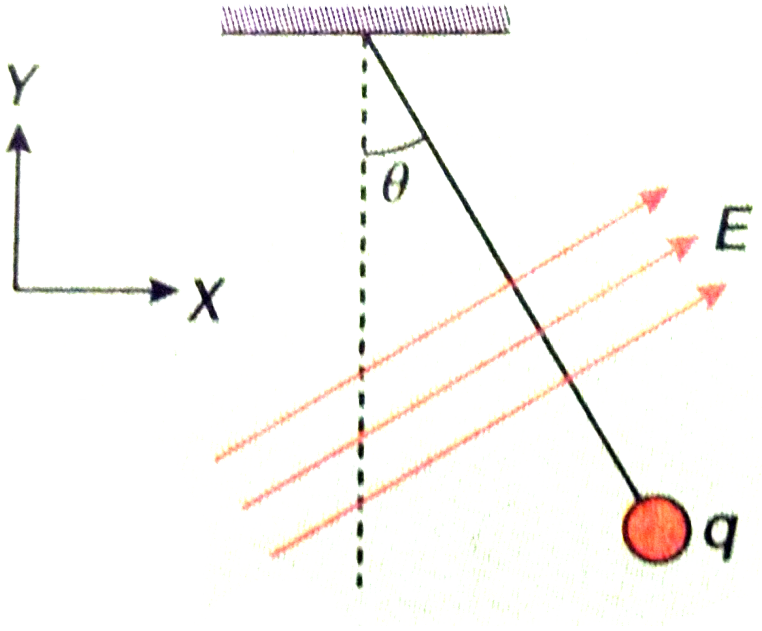
37. A charged cork ball of mass m is suspended on a light string in the adjacent figure. When $\vec{E} = \left(E_x \hat{i} + E_y \hat{j}\right) N/C$, the ball is in equilibrium at the angle θ. Find the charge of the ball and the tension in the

string.



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38. Two point charges of 10 esu and 40 esu are located at points A and B seperated by a distance 4 cm. Find the electric field intensity at a point halfway between the charges.

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39. Two negative charges each of 1 unit and a positive charge q are placed along a straight line. Find the magnitude and position of q for which all the chargews will remain at equilibrium? Is the equilibrium stable, unstable or neutral in this case?

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40. Two identical balls each of mass m are hung from a point by two silk threads of length l. Each of them has charge q. If the angle between the two threads are

negativebly small, show that equillirium distance between the centres of the balls will be ,x $= \left(\frac{2q^2 l}{mg} \right)^{1/3}$

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41. Due to cosmic shower same amount of cations +q are stored in the atmosphere of the earth and the moon. If the gravitational attraction between the earth and the moon is exactly equal to the electric repulsion between them. Then find the value of charge q stored in their atmosphere.

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42. The value of electric field at a region of space is given by, E=Ar where A=100V. m^2 and r=distance (in m) from origin inside the electric field. Find the amount of charge enclosed in a sphere of radius 20 cm centered at the origion. Given $\frac{1}{4\pi\varepsilon_0} = 9 \times \frac{101}{4\pi\varepsilon_0} = 9 \times 10^9 N.m^2.c^{-2}$

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43. How many field lines would emanate from a 1 C positive charge placed in vacuum ?

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44. A straight rod of length l placed in vacuum is charged uniformly with an amount q of charge. Calculate the electric field intensity in SI at a point on the axis of the rod at a distance x from its nearer end. Write the result in CGS system also.

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45. Two point charges are placed on the y - axis at $y = +a$ and $y = -a$ in vacuum. The magnitude of each charge is q. Determin the electric field intensity at $P(x, 0)$ on the x - axis.

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46. An electic dipole placed in vacuum is formed by two equal but opposite charges each of magnitude $1\mu C$ separated by a distance of 2 cm. calculate the electric field intensities in the following cases :

(i) at a point on the axis of the dipole situated at a distance 60 cm away from its centre.

(ii) at a point on the perpendicular bisector of the dipole situated at a distance 60 cm away from its centre.

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47. Three charges q, -2q and q are placed at three vertices of an equilateral triangle. Determine the equivalent dipole moment of the system.

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48. Electric field intensities at two axial points of an electric dipole at distances 5 cm and 10 cm from its centre are $2.5 \times 10^4 N \cdot C^{-1}$ and $2 \times 10^3 N \cdot C^{-1}$ respectively. The dipole is placed in air. determine the length of the dipole.

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49. An electric dipole is formed by two equal but opposite charges , each of magnitude $1 \mu C$, separated by a distance of 5 cm. what is the magnitude of the torque

required to place the dipole at right angles to an electric field of intensity $3 \times 10^5 N \cdot C^{-1}$?

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50. An electric dipole is formed by placing charges $\pm 20 \times 10^{-6} C$ at a distance 2 mm. Calculate the electric field at a point on the perpendicular bisector of the axis of the dipole situated at a distance 10 cm from the midpoint of the dipole.

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51. An electric field $(2hai + 3haj) N \cdot C^{-1}$ exists in a region. Calculate the electric flux linked with a square

plate of side 0.5 m held parallel to (i) yz - plane and (ii) xy - plane.

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52. In vacuum (i) find out the electric flux across an area $\vec{S} = 10\hat{j}$ placed in an electric field $\vec{E} = 2\hat{i} + 4\hat{j} + 7\hat{k}$, (ii) How many electric charges are to be placed at a point such that 4400 number of electric lines of forces with emerge from that point ? (iii) What will be the electric flux through any one of the faces of a cube of side 10 cm if a charge of 1 esu is placed at the centre of the cube ?

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53. An electric flux of $6.5 \times 10^3 N \cdot m^2 \cdot C^{-1}$ is linked with a sphere due to some charge placed in vaccum inside the sphere. Calculate the magnitude of the charge.

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54. A spherical shell of radius 20 cm has $20\mu C$ charge placed in vacuum. Calculate the electric field intensity (i) at a distance of 15 cm and (ii) at a distance of 40 cm from the centre of the spherical shell.

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55. A thin straight wire of length 40 cm placed in vacuum has $20\mu C$ charge. Calculate the electric field intensity at a distance 15 cm from the wire.

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56. A cube placed in vacuum contains a charge of $9 \times 10^{-9} C$. What will be the electric flux linked with each face of the cube ?

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57. An electric field is expressed as $\vec{E} = \left(5\hat{i} + 3\hat{j} + 2\hat{k}\right)$ unit. Find out the electric flux across an area of 200 unit

on the yz - plane in the field.

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58. The surface density of charge on a large vertical positively charged plate is $\sigma C \cdot m^{-2}$. A string attaches a metal ball of mass M and charge + q with the plate. Find out the angle between the string and the plate in equilibrium.

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59. The classical concept of atomic structure is that negative charges are uniformly distributed inside a sphere of radius R keeping the nucleus of positive charge

Ze at the centre of that sphere. An atom as a whole is electrically neutral. find out the electric field at a distance r from the nucleus, according do this atomic model.

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60. A uniform electric field along the x - axis is given as,

$$\vec{E} = \left(200\hat{i}\right) N \cdot C^{-1}, \text{for } x > 0$$

$$= \left(-200\hat{i}\right) N \cdot C^{-1}, \text{ for } x < 0$$

A cylinder of length 20 cm and radius 5 cm has its centre at the origin and axis along the x - axis is placed in vacuum. find out (i) the electric flux across each of its circular faces, (ii) the flux across its curved surface, (iii) the flux across its centre outer surface and (iv) the net charge enclosed by it.

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Section Relation Questions

1. State Coulomb's law regarding the force of interaction between two point charge. Define the unit of charge from this law.

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2. Under what conditions is Coulomb's law valid ?

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3. Define 1 esu of charge

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4. Define 1 coulomb of charge .

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5. What is the practical unit of charge? What is its relation with 1 esu of charge?

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6. What do you mean by electronic charge unit?

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7. What do you mean by dielectric constant of a medium ? What is its unit ?

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8. Show that in CGS system the magnitudes of the permitivity and the dielectric constant of a medium are numerically equal.

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9. Compare the electrostatic force acting between two charged particles and the gravitational force acting between them.

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10. Estimate the force acting on a test charge due to (i) a linear distribution ,(ii) a surface distribution and (iii) a spatial distribution of charges .

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11. Write down the vector form of Coulomb's law of electrostatics. What is its importance ?

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12. State and explain the principle of superposition for estimating the resultant force acting on a charge due to a number of other surrounding charges .

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13. Define an electric field.

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14. What do you mean by a uniform electric field?

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15. What do u mean by the intensity of an electric field? Is it a vector or a scalar quantity? What is the unit in CG system and SI?

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16. Determine the electric field at a distance r from a point charge.

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17. Determine the electric field at a point near a charged conductor. How does this value change at various points near the surface of an irregular shaped conductor?

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18. From the defination of an electric field, show that its unit in Si is $V.m^{-1}$

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19. Define electric field lines.

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20. Two field lines do not intersect each other. Explain.

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21. Indicate the magnitude of all electric field in terms of field lines.

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22. Two point charges each of magnitude +q are placed at a distance r from each other. Draw the lines of force in this case.

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23. What do you mean by neutral point in an electric field? Does any such point exist?

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24. Draw the lines of force for an isolated positive charge

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25. Draw the lines of force for an isolated negative charge

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26. Draw the lines of force for an uniform electric field.

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27. Can a field line starting from a conductor end on it? Justify your answer.

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28. State the properties of electric field lines.

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29. The electric field just outside the surface of a conductor is normal to the surface. Why?

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30. What is an electric dipole ?

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31. what do you mean by electric dipole moment ? What is its direction ?

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32. Define the term 'electric dipole moment ' with unit.

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33. Write the unit of electric dipole moment in CGS system and in SI.

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34. Express in vector form the torque acting on an electric dipole placed in a uniform electric field.

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35. An electric dipole is placed in a uniform external field $\vec{E}$. Show that the torque on the dipole is given by $\vec{\tau} = \vec{p} \times \vec{E}$, where $\vec{p}$ is the dipole moment.

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36. Determine the electric field intensity at a point on the axis of an electric dipole. If the dipole is very small, how with the field intensity be modified ?

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37. Determine the electric field intensity at a point on the perpendicular bisector of an electric dipole. If the dipole

is very small, how will the field intensity be modified ?

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38. Determine the torque acting on an electric dipole placed in a uniform electric field.

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39. When does the torque acting on an electric dipole placed in a uniform electric field become maximum and minimum ? What are the maximum and minimum values of the torque ?

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40. Show that the ratio of electric fields at equal distances on the axis and on the perpendicular bisector for a small dipole is 2 : 1.

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41. Determine the electric field intensity at any point $P(r, \theta)$ due to an electric dipole.

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42. How is an area expressed as a vector ?

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43. Define electric flux and electric flux density. Write the dimension of electric flux.

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44. What is the unit of electric flux in SI ?

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45. State Gauss' theorem in electrostatics.

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46. Show with the help of Gauss' theorem that the intensity of the electric field inside a charged thin spherical shell is zero.

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47. Determine the electric field intensities at external and internal points due to a charged thin spherical shell with the help of Guass' theorem.

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48. Calculate the electric field at a distance r from an infinitely long charged wire of linear charge density λ .

Or, Apply Gauss' theorem to find intensity at a point outside due to an infinitely long thin, uniformly charged straight wire.

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49. Determine the electric field intensity at a point near a uniformly charged infinite plane lamina.

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50. Show that the intensity of the electric field at an external point due to a uniformly charged thin spherical shell is the same as if the whole charge were situated at its centre.

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Higher Order Thinking Skill Questions

1. Two charges, $+q$ and $-q$ are separated by a distance d. At which points will the resultant electric field intensity be directed parallel to the line joining the charges ?

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2. Two point charges are separated by a certain distance. Electric field intensity is zero at a point in between the two charges. What can we conclude about the charges ?

A. If the intensity of electric field is zero at a point in between two charges, we conclude that the two charges are of the same nature. If the charges are not of the same, nature, the electric field due to the two charges will act in the same direction. Thus the resultant field will not be zero.

B.

C.

D.

Answer:

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3. 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 its centre and than released. Will the charge -q execute a simple harmonic motion along the axis of the ring ?

A. In this case, it can be shown that the force on the point charge -q is inversely proportional to the square of its distance from the centre of the ring. This is not the characteristics of a simple harmonic motion. So the particle will not execute a simple harmonic motion.

B.

C.

D.

Answer:

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4. Two small balls have equal posltive charges Q (coulomb). They are suspended by two insultating strings of equal length L (metre) from a hook fixed to a stand. The whole set up is taken to a satelllte in space where there is no gravity (state of welghtlessness). Calculate the angle between the two strings and tension in each string in newton.

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5. A charge q is placed at the mid-point of the line joining two equal charges Q. For what value of q will the system of the three charges be in equlllbrium?

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6. Two equal negative charges -q are fixed at points (0,a) and (0,-a) on the Y-axis. A positive charge Q is released from rest at the point (2a,0) on the X-axis. Will the charge Q execute simple harmonic motion?

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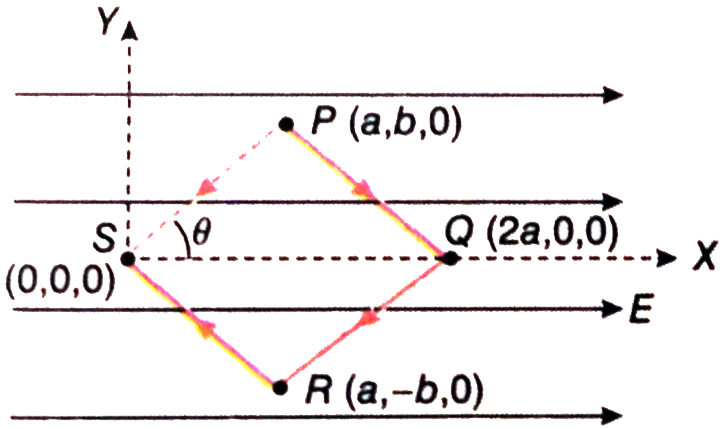
7. A piont charge q moves from point P to point S along the path PQRS [Fig.2.73] in a unlform electric field E pointing parallel to the positive X-axis. The coordinates of P, Q, R and S are (a,b,0), (2a, 0, 0), (a,-b,0) and (0,0,0) respectively. Determine the work done by the field in the above process.



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8. The presence of matter alters the net force acting between two charges. Explain.

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9. What is the difference between the electrical effects due to a point charge at rest and that in motion?

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10. What is the significance of Gauss' theorem? Is it applicable to any other fields other than electric field?

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11. Can a field line start from a charged conductor and end on it? Answer with reason.

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

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13. An electric dipole is placed in a uniform electric field in such a way that its axis lies along the electric field. Does any force or torque act on the dipole?

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14. An electric dipole is placed in a uniform electric field in with its axis inclined at a certain angle with the field. Does any force or torque act on the dipole?

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15. What should be the angle of a field line with the normal to a surface so that flux linked with the surface becomes maximum?

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16. If an electric dipole is placed in a non-uniform electric field, does any torque or force act on the dipole?

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17. Eight electric dipoles each with charge e are placed inside a cube. What should be the total electric flux linked with the cube?

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18. A cylinder is lying with axis parallel to uniform electric field $\vec{E}$. What is the total flux through the cylinder with cross-section S and length L ?

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19. An electric dipole is situated in a uniform electric field $\vec{E}$ such that its moment $\vec{p}$ is aligned in the direction of the field. Is the equilibrium of the dipole stable or unstable? If $\vec{p}$ and $\vec{E}$ are in opposite directions, what will be the nature of the equilibrium?

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20. 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 ?

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21. A particle of mass m is attached to one end of missless rigid non-conducting rod of length l. Another particle of the same mass is attached to the other end of the rod. Two particles carry charges +q and -q . This arrangement is held in the region of uniform electric field E such that the rod makes and angle $\theta(<5^{\circ})$ with the field direction. Find an expression for the minimum time that is needed for the rod to become parallel to the field after it is set free.

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22. A uniform non-conducting rod of mass m and length l has linear charge densities $+\lambda$ and $-\lambda$ on its two halves, as shown in the figure. It is hinged at its midpoint, so that it can rotate freely about the mid-point in a uniform electric field E parallel to X-axis. The rod is rotated by a small angle $\theta(<4^{\circ})$ and released. Calculate the time period of small oscillations of the rod.

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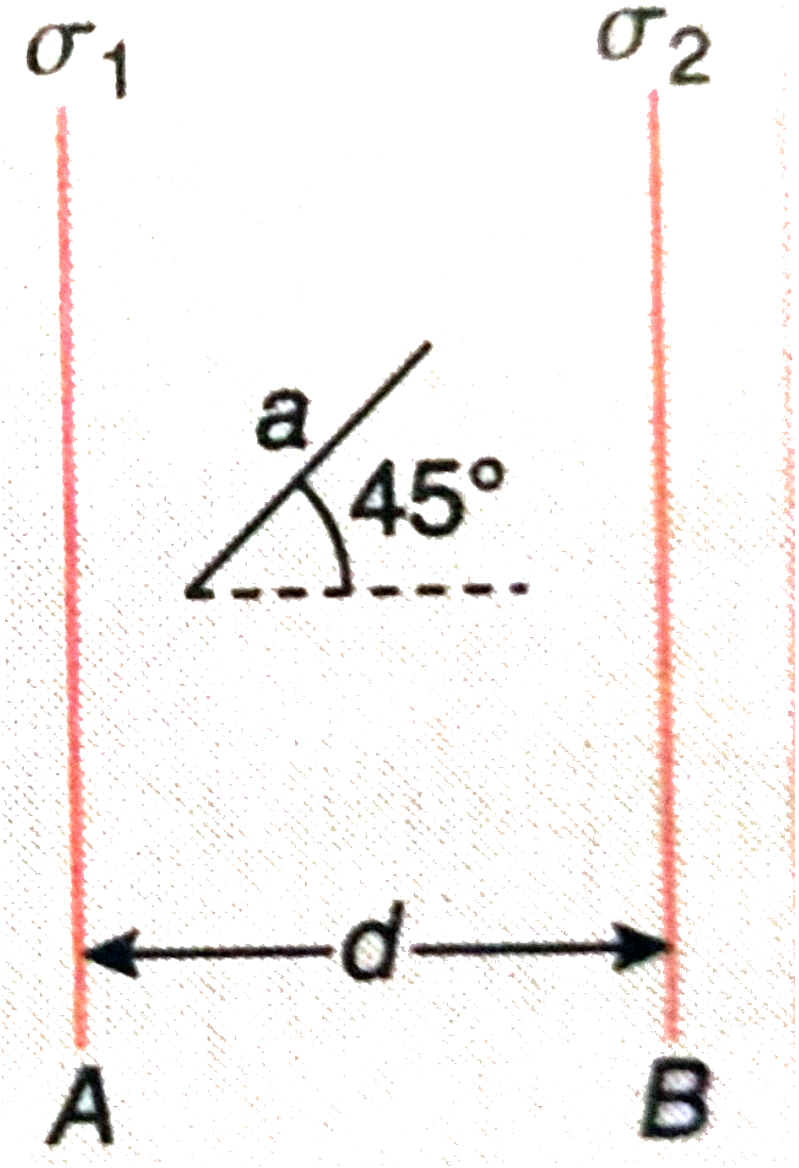
23. Two infinitely large sheets having charge densities σ_1 and σ_2 respectively $(\sigma_1 > \sigma_2)$ are placed near each other separated by distance d . A charge q is placed in between

two plates such that therefore is no effect on charge distribution on plates. Now this charge is moved at an angle of 45° with the horizontal towards plate having charge density σ_2 by distance a $(a < d)$. Find the work

done by electric field in the process.



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24. A small charge is placed at a point in a static electric field. Will the charge move along the electric line of force passing through that point?

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25. Two point charges e_1 and e_2 are separated by a distance d but the electric field is not 0 on any point joining the two points. What can be concluded from this?

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26. Force between two charges depends on the presence of the material between them - explain.

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27. Charge Q is distributed between two paraticles. What should be the value of charges on the particles so that the repulsive force acting between them is maximum?

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28. A free electron and a free proton are placed in an uniform electric field. Compare their acceleration and the force acting on them. [Rest mass of electron $= 9.1 \times 10^{-31} kg$ and rest mass of proton $= 1.67 \times 10^{-27 kg}$]

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29. Why electric fields just outside the surface of a conductor is perpendicular to the surface?

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30. In case of field outside a uniformly charged sphere, the charge can be assumed to be concentrated at the centre at the sphere . How can you prove it.

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31. How the force acting between two charges will change if the air medium betweeen them is replaced by metalic

plate?

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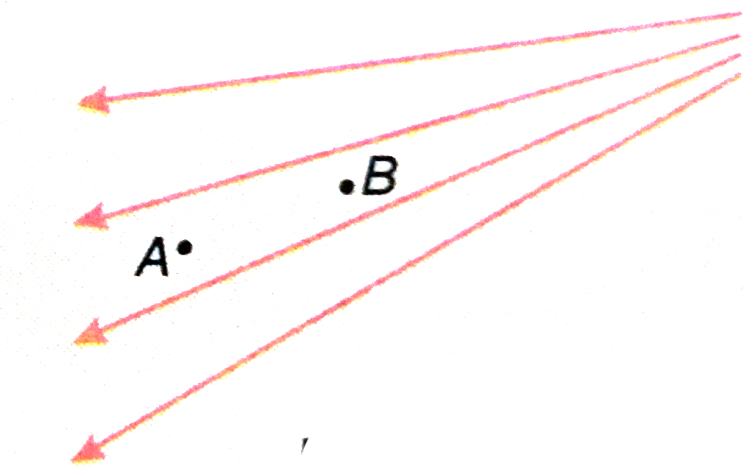
32. If a positively charged particle is kept at the points A and B in an electric field shown in Fig. , then at which point the particle will feel more force and why ?



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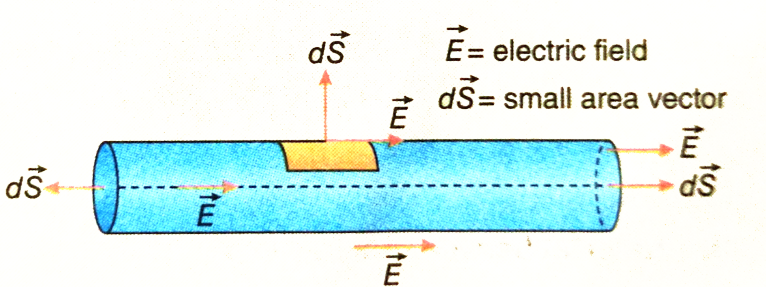
33. If the area of cross section of the cylinder is S , then what will be the electric flux through the cylinder?



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Ncert Textbook Questions With Answer Hint

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

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2. Check that the ratio ke^2/Gm_em_p is dimensionless. From the table of physical constants, determine the value of this ratio. What does the ratio signify?

Value	Dimension
$k = \frac{1}{4\pi\epsilon_0} = 9 \times 10^9\ \mathrm{N \cdot m^2 \cdot C^{-2}}$	$ML^3T^{-4}I^{-2}$
e = amount of charge of an electron or proton $= 1.6 \times 10^{-19}\mathrm{C}$	IT
G = gravitational constant $= 6.67 \times 10^{-11}\mathrm{N \cdot m^2 \cdot kg^{-2}}$	$M^{-1}L^3T^{-2}$
m_e = mass of an electron $= 9.1 \times 10^{-31}\mathrm{kg}$	M
m_p = mass of a proton $= 1.67 \times 10^{-27}\ \mathrm{kg}$	M

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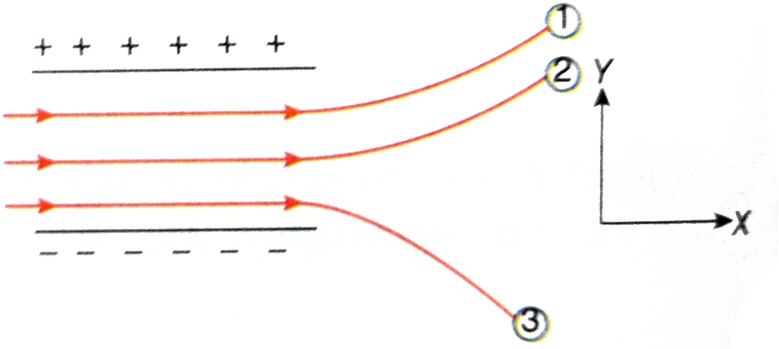
3. Fig. shows the track of three charged particles in uniform electrostatic field. Give the signs of the three

charges. Which particles has the highest charge to mass ratio.



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4. 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 $8.0 \times 10^3 N \cdot m^2 \cdot C^{-1}$.

(a) What is the net charge inside the box?

(b) If the net outward flux through the surface of the box

where zero, could you conclude that there where no charges inside the box? Why or why not ?

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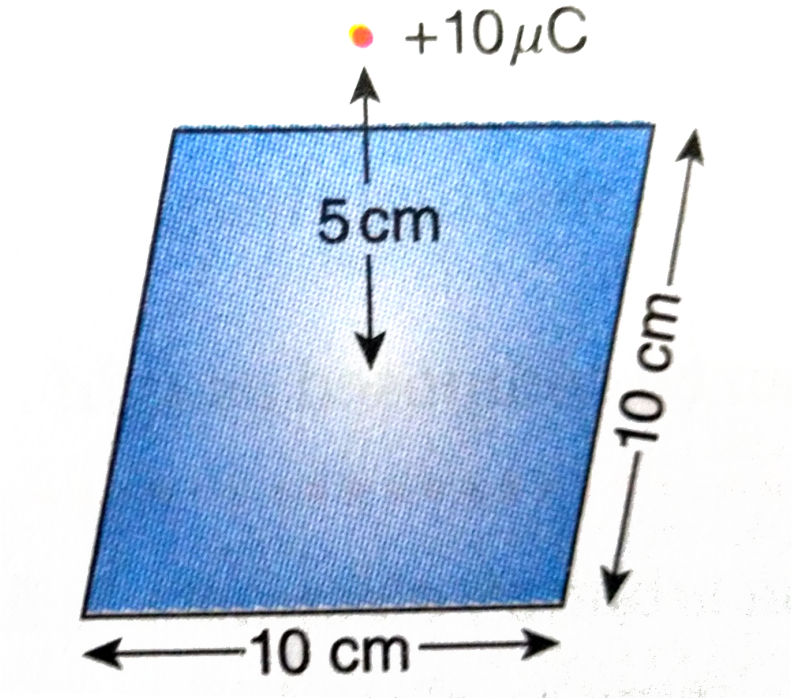
5. A point charge of $10\mu C$ is a placed at a distance 5 cm directly above the centre of a square of side 10cm, as shown in figure. What is the magnitude of the electric flux

through the square .



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6. A conducting sphere of radius 10 cm has an unknown charge. If the electric field 20cm from the centre of the

sphere is $1.5 \times 10^3 N.C^{-1}$ and points radially inward, what is the net charge on the sphere ?

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7. Two large, thin metal plates are parallel and close to each other. On their inner faces, the plates have surface charge densities of opposite signs and of magnitude $17.0 \times 10^{-22} C.m^{-2}$ .What is the electric field

In the outer region of the first plate ?

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8. Two large, thin metal plates are parallel and close to each other. On their inner faces, the plates have surface

charge densities of opposite signs and of magnitude $17.0 \times 10^{-22} C.m^{-2}$ .What is the electric field

In the outer region of the second plate ?

Watch Video Solution

9. Two large, thin metal plates are parallel and close to each other. On their inner faces, the plates have surface charge densities of opposite signs and of magnitude $17.0 \times 10^{-22} C.m^{-2}$ .What is the electric field

between the plate ?

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10. 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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11. A conductor A with a cavity as shown in Figure is given a charge Q. Show that the entire charge must appear on the outer surface of the conductor.

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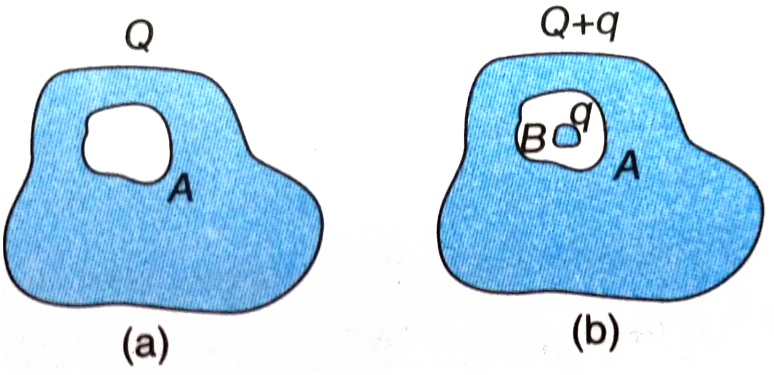
12. A hollow sphere A is taken with charge Q on it. Another conductor B with charge q is inserted into the cavity keeping B insulated from A. Show that the total charge on the outside the surface of A is $(Q+q)$.

Watch Video Solution

13. A sensitive instrument is to be shielded from the strong electrostatic fields in its environments . Suggest a

possible way.



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14. A hollow charged conductor has a tiny hole cut into its surface. Show that the electric field in the hole is $\frac{\sigma}{\in_0}\hat{n}$, where $\hat{n}$ is the unit vector in the outward direction, and σ is the surface density of charge near the hole .

View Text Solution

15. 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') and 'down' quark (denoted by 'd') of charge $\frac{2}{3}e$ and $\frac{-1}{3}e$ respectively , together with electrons build up ordinary matter. Suggest a possible quark composition of a proton and a neutron.

Watch Video Solution

16. 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.

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

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18. An infinite line charge produces a field of $9 \times 10^4 N.C^{-1}$ at a distance of 2 cm. Calculate the linear charge density.

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19. A spherical conductor of radius 12 cm has a charge of $1.6 \times 10^{-7} C$ distributed uniformly on its surface. What is the electric field

inside the sphere ?

Watch Video Solution

20. A spherical conductor of radius 12 cm has a charge of $1.6 \times 10^{-7} C$ distributed uniformly on its surface. What is the electric field

just outside the sphere ?

Watch Video Solution

21. A spherical conductor of radius 12 cm has a charge of $1.6 \times 10^{-7} C$ distributed uniformly on its surface. What is the electric field

at a point 18 cm from the centre of the sphere ?

Watch Video Solution

22. Two charge conducting spheres of radii a and b are connected to each other by a wire. What is the ratio of electric field at the surfaces of the two spheres ?

View Text Solution

23. Two large conducting sphere carrying charges Q_1 and Q_2 are brought close to each other. Is the magnitude of the electrostatic force between them exactly given by $Q_1 Q_2 / 4\pi \in_0 r^2$, where r is the distance between their centres ?

Watch Video Solution

24. A small test charge is released at rest at a point in an electrostatic field configuration . Will it travel along the field line passing through that point ?

Watch Video Solution

Ncert Exemplar Questions With Answer Hint

1. The electric flux through the surface

A. in Figure is the largest

B. In figure is the least

C. in figure is the same as figure but is similar then figure

D. is the same for all the figures

Answer: D

View Text Solution

2. Figure shows electric field lines in which an electric dipole is places as shown. Which of the following statement 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

View Text Solution

3. A hemisphere has uniform positive charge. The electric field at a point on a diameter away from the centre is directed

A. perpendicular to the diameter

B. parallel to the diameter

C. at an angle tilted towards the diameter

D. at an angle tilted away from the diameter.

Answer: A

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4. A point charge $+q$ is placed at a distance a from an isolated conducting surface. The field at a point P on the other side of the plane is directed

A. perpendicular to the plane and away from the plane

B. perpendicular to the plane but towards the plane

C. radially away from the point charge

D. radially towards the point charge

Answer: A

Watch Video Solution

5. If $\oint_S \overrightarrow{E} . \overrightarrow{dS} = 0$ over a surface then,

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

B. the electric field inside the surface is necessarity 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::D

Watch Video Solution

6. 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

7. 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 proportional to $\frac{1}{r^3}$, 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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Exercise Multiple Choice Question

1. Which of the following statements is not true for Coloumb's law in electrostatics ?

A. the law is applicable only for point charge

B. the law is applicable for any distance charge

C. according to this law force between two charges depends on the medium

D. it is an inverse square law

Answer:

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2. Select the correct statement .

A. both of electrostatic force and gravitational force are nonconservative forces

B. electrostatic force is conservative but gravitational force is nonconservative

C. electrostatic force is nonconserative but gravitational force is conservative

D. both of electrostatic force and gravitational force are conservative force

Answer:

Watch Video Solution

3. Number of esu of charge in 1C is

A. 3×10^{10}

B. 3×10^{9}

C. 3×10^{8}

D. $\frac{1}{300}$

Answer:

Watch Video Solution

4. Charge q_1 exerts force on another charge q_2 . A third chage q_3 is brought near them. The force applied by q_1 on q_2

A. will decrease

B. will increase

C. will remain the same

D. will increase if the nature of q_1 and q_2 is the same and will decrease o their nature is opposite

Answer:

Watch Video Solution

5. The number of electrons corresponding to 1 coloumb of charge is

A. 6.25×10^{17}

B. 6.25×10^{18}

C. 6.25×10^{19}

D. 1.6×10^{19}

Answer:

Watch Video Solution

6. Two point charges seperated by a distance d repel each other with a force of 9N. If the seperation between them becomes 3d, the force of repulsion will be

A. 1N

B. 3N

C. 6N

D. 27N

Answer:

Watch Video Solution

7. Charges 4Q, q and Q are placed along x-axis positions x=0, x=$\frac{l}{2}$ and x=l respectively. The value of q so that the force on charge Q is zero is

A. Q

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

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

D. $-Q$

Answer:

Watch Video Solution

8. Mutual electrostatic force F is acting on two tiny charged spheres, when they are d distance apart in air.Keeping the external conditions fixed, if the spheres are immersed in a liquid of dielectric constant 2, then the force acting on each sphere becomes

A. $4F$

B. $2F$

C. F

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

Answer:

Watch Video Solution

9. When a metal plate is introduced between two charges kept at some distance from each other , electrostatice force between the two charges will

A. decrease

B. increase

C. remain the same

D. zero

Answer:

Watch Video Solution

10. Two point charges $+4q$ and $+q$ are placed 30 cm apart. The electric field intensity at a point on the line joining the two charges is zero. The point is situated at a distance

A. 15 cm from 4q

B. 20 cm from 4q

C. 7.5 cm from q

D. 5 cm from q

Answer:

Watch Video Solution

11. If E be the intensity of the electric field at a distance $r(r > R)$ due to a uniformly charged spherical shell, then

A. $E \propto r$

B. $E \propto \frac{1}{\mathrm{r}}$

C. $E \propto r^2$

D. $E \propto \frac{1}{r^2}$

Answer:

Watch Video Solution

12. A hollow charged sphere of radius 2 m does not produce any field intensity

A. at any intertnal point of the sphere

B. at any external point of the sphere

C. at a distance greater than 2 m

D. at a distance greater than 10 m

Answer:

Watch Video Solution

13. An electron of charge -e and mas m is placed in a uniform electric field of intensity E. The value of E is such that the force on the electron due to the electric field is equal to its weight . Under this condition the value of E is

A. $\frac{mg}{e}$

B. mge

C. $\frac{e}{mg}$

D. $\frac{e^2g}{m^2}$

Answer:

Watch Video Solution

14. An electron enters normally in a uniform electric field of intensity 3200V/m with a speed of $4 \times 10^7 m/s$. The electron covers a distance of 0.10m . Deflection of the electron is

A. 1.76 mm

B. 17.6 mm

C. 176 mm

D. 0.176 mm

Answer:

Watch Video Solution

15. An electric field of intensity $9 \times 10^4 N/C$ is produced at a point 2 cm away from an infinitely long straight charged conducting wire . Electric charge per unit length becomes

A. $2 \times 10^{-7} C \cdot m^{-1}$

B. $10^{-7} C \cdot m^{-1}$

C. $9 \times 10^4 C \cdot m^{-1}$

D. none of these

Answer:

Watch Video Solution

16. Two electric charge +8q and -2q, are placed at x=0 and x=L respectively. At what point on the x-axis , net electric field intensity due to two becomes zero ?

A. $(2L, 0)$

B. $\left(\frac{L}{4}, 0\right)$

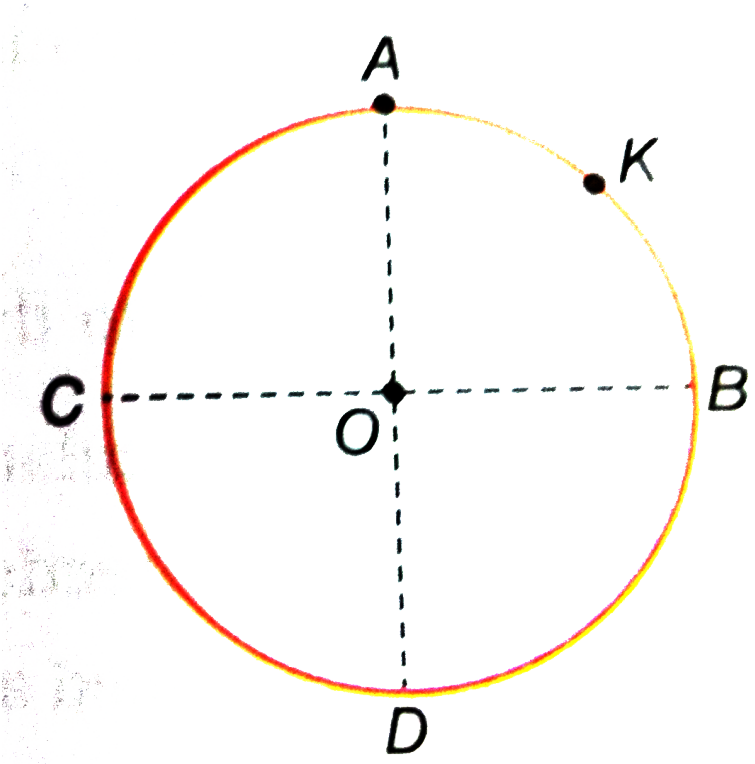
C. (8L,0)

D. (4L,0)

Answer:

Watch Video Solution

17. A thin conducting ring of radius R is given a charge +Q. The electric field at the centre O of the ring due to the charge on the part AKB of the ring is E. The electric field at the centre due to the charge on the part ACDB of the ring is



A. E along KO

B. 3E along OK

C. 3E along KO

D. E along OK

Answer:

View Text Solution

18. Due to an electric charge Q , field intensity at the position of test charge q_0 is $\vec{E}$. If the test charge is replaced by $-q_0$, then field intensity becomes

A. $-q_0\vec{E}$

B. $\frac{\vec{E}}{-q_0}$

C. 0

D. $\overrightarrow{E}$

Answer:

Watch Video Solution

19. If an electric dipole of moment $\overrightarrow{p}$ be placed in an electric field of intensity $\overrightarrow{E}$, the torque acting on the dipole is

A. $\overrightarrow{\tau} = \overrightarrow{p} \cdot \overrightarrow{E}$

B. $\overrightarrow{\tau} = \overrightarrow{p} \times \overrightarrow{E}$

C. $\overrightarrow{\tau} = \overrightarrow{p} + \overrightarrow{E}$

D. $\vec{\tau} = \vec{p} - \vec{E}$

Answer:

Watch Video Solution

20. The direction of the intensity of the electric field at a point on the perpendicular bisector of an electric dipole ($\vec{p}$ = electric dipole moment) is

A. along $\vec{p}$

B. opposite to the direction of $\vec{p}$.

C. perpendicular to $\vec{p}$

D. in any direction

Answer:

Watch Video Solution

21. A charge placed at a distance from an electric dipole on its axis experiences a force F. If the distance be doubled , the force will become

A. 2F

B. F/2

C. F/4

D. F/8

Answer:

Watch Video Solution

22. If E_1 be the electric field strength of a short dipole at a point on the axis and E_2 that on the perpendicular bisector at the same distance , then

A. $E_1 = E_2$

B. $E_1 = 2E_2$

C. $E_2 = 2E_1$

D. $E_1 = 3E_2$

Answer:

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23. An electric dipole is placed along x-axis at the origin O. A point P is at a distance of 20 cm from this origin such that OP make an angle $\frac{\pi}{3}$ with the x-axis . If electric field at P makes an angle θ with x-axis , then the value of θ is

A. $\frac{\pi}{3}$

B. $\frac{\pi}{3} + \tan^{-1}\frac{\sqrt{3}}{2}$

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

D. $\tan^{-1}\frac{\sqrt{3}}{2}$

Answer:

Watch Video Solution

24. A small electric dipole is placed at origin with its dipole moment directed along positive X-axis. The direction of electric field at point $\left(2, 2\sqrt{2}, 0\right)$ is along

A. $-$ Z-axis

B. $+$ Z-axis

C. $-Y$-axis

D. $+Y$-axis

Answer:

Watch Video Solution

25. An electric dipole is situated in an electric field of uniform intensity E whose dipole moment is P and moment of inertial is I . IF the dipole is displaced by small angle θ then the angular frequency of its oscillation is

A. $\left(\frac{PE}{I}\right)^{\frac{1}{2}}$

B. $\left(\frac{PE}{I}\right)^{\frac{3}{2}}$

C. $\left(\frac{I}{PE}\right)^{\frac{1}{2}}$

D. $\left(\frac{P}{IE}\right)^{\frac{1}{2}}$

Answer:

Watch Video Solution

26. The electric field intensity at a point near a sphere of radius r and surface density of ρ in a medium of dielectric constant K is

A. $\frac{4\pi\rho}{k}$

B. $\frac{2\pi\rho}{k}$

C. $\frac{\pi\rho}{kr}$

D. $\frac{\pi\rho}{2kr}$

Answer:

Watch Video Solution

27. The electric flux linked with a surface becomes maximum if the angle between the field lines and the surface is

A. 0°

B. 45°

C. 90°

D. 180°

Answer:

Watch Video Solution

28. A circular plate of radius r is placed parallel to a uniform electric field of intensity E . The flux linked with the circular plate is

A. zero

B. $E \times \pi r^2$

C. $E \times 2\pi r$

D. $E \times 4\pi r^2$

Answer:

Watch Video Solution

29. If the inward and the outward electric flux through a closed surface be ϕ_1 and ϕ_2 , the charge inside the closed surface is

A. $(\phi_1 - \phi_2)\ \in_0$

B. $(\phi_2 - \phi_1)\ \in_0$

C. $(\phi_1 + \phi_2)\ /\ \in_0$

D. $(\phi_2 - \phi_1)\ /\ \in_0$

Answer:

Watch Video Solution

30. A square of side 20 cm is enclosed within a sphere of radius 80 cm . Centres of the sphere and the square coincide at a common point . There are four charges of $2 \times 10^{-6} C.\ -5 \times 10^{-6}, C.\ -3 \times 10^{-6} C$ and $6 \times 10^{-6} C$ at the four corners of the square . the electric flux passing through the surface of the sphere in $N.\ m^2\ /\ C.$

A. $16\pi \times 10^{-6}$

B. zero

C. $8\pi \times 10^{-6}$

D. $36\pi \times 10^{-6}$

Answer:

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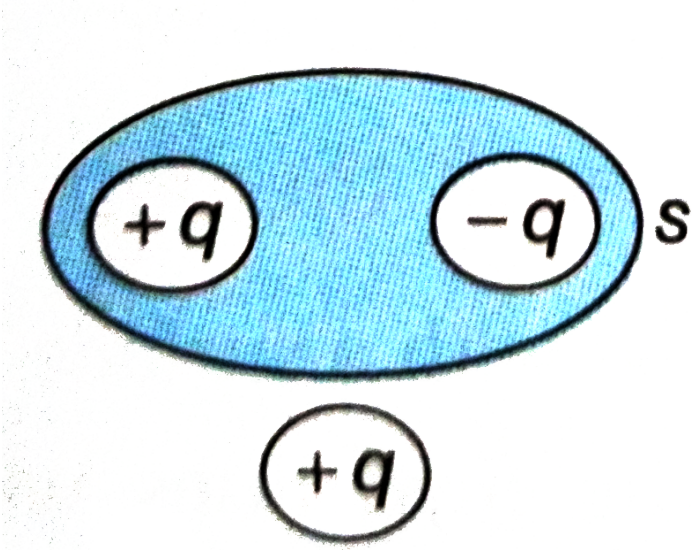
31. Distribution of charges is shown in the figure . The flux of electric field due to these charges through the surface S is



A. $\frac{3q}{\in_0}$

B. $\frac{2q}{\in_0}$

C. $\frac{q}{\in_0}$

D. zero

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

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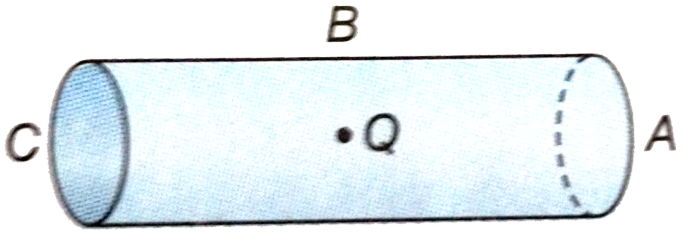
32. a hollow cylinder contains a charge Q C . If ϕ is the electric flux in unit of V . M associated with the curved surface B, the flux linked with the surface A in unit of V . M will be ($\in_0$ = permittivity)



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

B. $\frac{q}{2\in_0}$

C. $\frac{1}{2}\left(\left(\frac{q}{\in_0}-\phi\right)\right.$

D. $\frac{q}{\in_0}-\phi$

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

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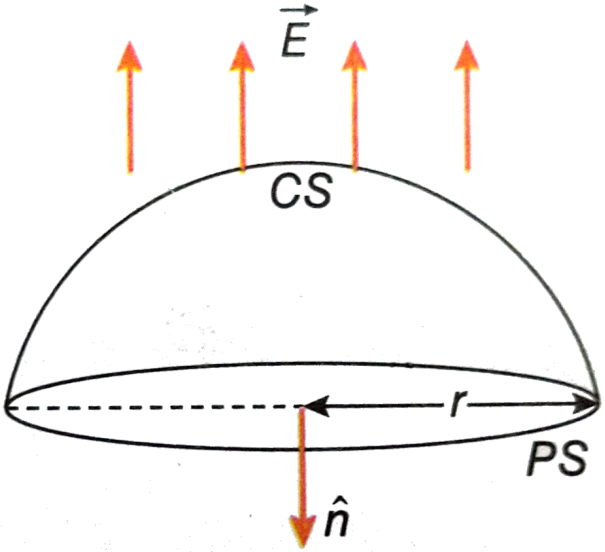
33. A hemispherical bowl of radius r is kept in an uniform electric field of intensity E . Total electric flux through the

bowl is



A. $2\pi rE$

B. $4\pi r^2 E$

C. $2\pi r^2 E$

D. $\pi r^2 E$

Answer: A::B::C

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Exercise Very Short Answer Type Questions

1. The force of interaction between two charges placed in vacuum is F . What will be the force be the force between the charges placed at the same distance in a medium of dielectric constant K ?

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2. What is the relation of esu of charge with coulomb ?

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3. If $1\mu C = x$ esu of charge , what is the value of x?

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4. Two point charges each equal to 1C exert a force _____ mutually when they are placed 1m apart in air . [fill in the blank]

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5. what is the order of the ratio of the gravitational force and the electrical force acting between two electrons?

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6. What is the electric field intensity at a distance r from a charge q placed in vacuum ?

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7. What is the unit of the intensity of electric field in SI ?

Watch Video Solution

8. Which physical quantity has the unit v m^{-1} ?

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9. Two point charges e_1 and e_2 are placed at a distance d from each other. In between them there is no point where electric field is zero. From this what conclusion can you draw ?

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10. What is the intensity of the electric field at the centre of a charged ring?

Watch Video Solution

11. The direction of electrostatic field intensity at a point on the surface of a charged conductor is along the

tangent drawn on the surface at that point . Is the statement true or false ?

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12. If a conductor is placed in an electric field, what change of the intensity of the electric field take place inside the conductor ?

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13. The electric field intensity at all points in a uniform electric field is _____ . [Fill in the blanks]

Watch Video Solution

14. The field lines in a uniform electric field are _____ lines. [Fill in the blank]

Watch Video Solution

15. Three small spheres are placed on the circumference of a circle of radius r in such a way that an equilateral triangle is formed. If the charge of each sphere is q, the electric field intensity at the centre of the circle will be _____. [fill in the blanks]

Watch Video Solution

16. A few field lines moving from left converge on the right side. The electric field intensity will be greater at the _____ . [Fill in the blank]

Watch Video Solution

17. The field lines of an isolated negative charge are radially _____. [fill in the blanks]

Watch Video Solution

18. What is the ratio of the intensity of the electric field at a particlular distance on the axis to that on the perpendicular bisector of a very small dipole ?

Watch Video Solution

19. How should an electric dipole be kept in an electric field so that no torque acts on it ?

Watch Video Solution

20. Is the dipole moment a scalar or a vector quantity ?

Watch Video Solution

21. What is the unit of dipole moment in SI ?

Watch Video Solution

22. An electric dipole is inclined with a uniform electric field. State whether a force or a torque acts on the dipole.

Watch Video Solution

23. What is the resultant electric force on an electric dipole placed in a uniform electric field ?

Watch Video Solution

24. What is the dipole moment of a non-polar molecule ?

Watch Video Solution

25. The torque acting on an electric dipole placed in a uniform electric field is maximum field. [Fill in the blank]

Watch Video Solution

26. An electric dipole of moment p is placed in equilibrium position in a uniform electric field of intensity E. to rotate the dipole through an angle θ from its initial position, the required moment of the torque is _____. [fill in the blank]

Watch Video Solution

27. If electric flux linked with a surface is maximum , what will be the angle of the field lines with the normal to the surface ?

Watch Video Solution

28. A square plate of side a is placed perpendicular to a uniform electric field of intensity E.What will be the flux linked with the plate ?

Watch Video Solution

29. If a charge exists outside a closed surface, the net electric flux linked with the closed surface will be

_____. [Fill in the blank]

Watch Video Solution

30. What is the intensity of the electric field inside a uniformly charged spherical shell ?

Watch Video Solution

31. The direction of area vector is along the _____ to the area. [Fill in the blank]

Watch Video Solution

32. The flux linked with a surface perpendicular to the field lines in an electric field will be _____ .[Fill in the blank]

Watch Video Solution

33. According to Guss's theorem in CGS system, the total electric flux linked with a closed surface is equal to _____ times the total charge lying within the surface . [Fill in the blank]

Watch Video Solution

34. Electric flux is a _____quantity . [Fill in the blank]

Watch Video Solution

Exercise Short Answer Type Questions I

1. Two charges +q and -q are placed at a distance d form each other . At which points the direction of the resultant electric field is parallel to the line joining the two charges ?

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2. An amount of charge Q is distributed between two particles. What should be the charges of the two particles so the force of interaction between them is maximum ?

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3. What is the difference between the electrical effects of point charge at rest and in motion.

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4. Two small balls having equal positive charge Q,C each are supended by two insulating strings of equal length L meter form a hook fixed to a stand . The whole set up is taken to a satellite in space where there is no gravity.Calculate the angle between the two strings and the tension in each string.

Watch Video Solution

5. A ring of radius R carries a unifrom distribution of charge +Q. A point charge -q is placed on the axis of the ring at a distance 2R form its centre and then relased form rest. Will the charged particle execute SHM along the axis of the ring ?

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6. A charge q is placed at the centre of the line joining tow equal charges Q. For what value of q will the system of the three charges be in equalilibrium ?

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7. Two equal negative charges each of -q are fixed at the points (0,a) and (0,-a) on the y - axis . A positive charge Q is released from rest at the point (2a,0) on the x-axis. Will the charge Q execute SHM about the origin ?

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8. Express Coulomb's in electrostatics in vector form . What is the importance of this vector form of the law ?

Watch Video Solution

9. State and explain the principle fo superposition as applied to electrostatic force on a charge due to a

number of other charge.

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10. Calculate the force acting on a test charge due to a continous liner charge due to continous linear charge distribution.

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11. Calculate the force acting on a test charge due to a continous linear charge distribution.

Watch Video Solution

12. Calculate the force acting on a test charge due to a continous volume charge distribution.

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Exercise Short Answer Type Questions Ii

1. Which line in the electrical field of an electric dipole can a positive charge be moved along so that no work will be done ? State the reason.

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2. A space my be electrically shielded by surrounding it with a conductor . Can a space be gravitationally shield ? Explain your answer.

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3. Why the test charge is taken to be very small in the definition of electric field intensity?

Watch Video Solution

4. A metal sphere is held fixed on a smooth horizontal insulated plane and another metal sphere is placed some

distacne away. If the fixed sphere is given a charge how will the other sphere react ?

Watch Video Solution

5. An electrostatic field line cannot be discontinsous. Why ?

Watch Video Solution

Exercise Problem Set I

1. Two equal point charges ar placed in air 10 cm aprat and the force of interaction between them is 50 mg - wt .

Determine the magnitude of the charges.

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2. The ratio of two charges is 2:3 and their distance of separation is 5 cm. If the force of attraction between them is 96 dyn, determine the magnitude the magnitude of the charges .

Watch Video Solution

3. What is the force of interaction between the proton and the electron in a hydrogen atom ? Give , charge of electron + 4.8×10^{-10} esu, averge radiius of the orbit of electron = 10^{-8} cm

Watch Video Solution

4. Charge of an electron is e and mass m. The electron is moving around a nucleus of charge Ze in a cirular path of radius r. What will be the velocity of the electron ?

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5. Two negative charges each of 1 unit and a positive charge q are placed on a straight line. Where should the charge q be placed and what should be its value for equilibrium of the charges? Is this equilibrium stable, unstable or neutral ?

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6. 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 $x = \frac{d}{2\sqrt{2}}$.

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7. Charge of an $\alpha -$ particle is $+3.2 \times 10^{-19} C$. What force will act on the α- particle in an electric field of intensity $4000\ \mathrm{N.C}^{-1}$?

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8. An electric dipole placed at an angle of 30° with a uniform electric field of intensity $10^4 N.C^{-1}$ experiences a torque of $9 \times 10^{-26} N.m$. What is the moment of the electric dipole?

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9. An electric dipole had been formed by placing two particles each of mass m at the two ends of a light rod of length l. The charges of the two particles are $+q$ and $-q$. This dipole is placed in a uniform electric field E in such a way that its axis is parallel to the direction of the field. The dipole is now deflected through a small angle. Show that for small angular displacement,

the dipole will execute angular simple harmonic motion. Calculate the time period of the simple harmonic motion.

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10. The dipole moment of an electric dipole is given by $\vec{p} = 10^{-7}\left(5\hat{i} + \hat{j} - 2\hat{k}\right)cm$. The dipole is kept in an electric field of intensity, $\vec{E} = 10^{7}\left(\hat{i} + \hat{j} + \hat{k}\right)V.m^{-1}$. Obtain the magnitude of torque acting on the dipole.

Watch Video Solution

11. An electric field of intensity $200\ \mathrm{N.C}^{-1}$ is acting along x - axis. What will be the electric flux passing through a square area in yz - plane of side 20 cm?

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12. A point charge of $12\mu C$ is placed at the centre of a cube of side 1m. What will be the electric flux passing through each face of the cube?

Watch Video Solution

13. What will be the electric flux passing through the area $\vec{S} = 10\hat{i}$ placed in an electric field of intensity $\vec{E} = 3\hat{i} + 4\hat{j} + 5\hat{k}$?

Watch Video Solution

Exercise Problem Set Ii

1. The charge of one of two small charged conductors is twice that of the other. The two conductors repel each other with a force of 50 dyn. If the distance between them is decreased by 3 cm, the force becomes 128 dyn. What are the magnitudes of the charges ? What was the initial distance ?

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2. Two point charges $+4$ esu and $+9$ esu are placed 10 cm apart. At what point on the line joining them will a

unit positive charge experience (i) an equal but opposite and (ii) an equal and unidirectional force?

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3. The mass of a metal sphere charged with $+20$ esu is 2g. Another smaller sphere with -128 esu of charge is suspended with a thread. The former sphere, just below this smaller one, is at rest. What is the distance between the centres of the two spheres? $g = 980\ \mathrm{cm}\ .\ \mathrm{s}^{-2}$

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4. Three charges are placed in vacuum on a horizontal plane. The magnitude of charge q_1 is $+8$ esu. Charge q_2 is

situated north of q_1 at a distance of 5 cm an its magnitude is $+12.5$ esu. Charge q_3 is at the east of q_1 at a distance of 8 cm and its magnitude is -24 esu. Determine the magnitude and direction of the force acting on the charge `q_(1)~

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5. Two insulated metal spheres of the same size are charged with -15 esu and $+25$ esu. The distance between their centres is 10 cm. What is the force acting between the two charges? If the two spheres are made to touch each other and then placed in their previous positions, what will be the force acting between them?

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6. Two sphere M and N, having charge q_1 and q_2 are kept at some distance from each other.q amount of charge is taken from the sphere M and transferred ot the sphere N. What is the new charge of the two spheres so that the force acting between them becomes maximum?

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7. To keep a water drop of charge $1.0 \times 10^{-7} \mu C$ and mass $10 \mu g$ in equilibrium, what should be the intensity of a static electric field?

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8. A particle of mass 4 g and charge 10 esu is placed in a uniform electric field of intensity $600V.\ cm^{-1}$. What will be the acceleration of the particle?

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9. 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

10. An electron and a proton both are allowed to fall from rest through an electric field having intensity $3 \times 10^4 N.C^{-1}$. Compare the distances covered by the electron and the proton in $3 \times 10^{-9} s$ and $1 \times 10^{-7} s$, respectively.

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11. Charge of a circular ring of radius 20 cm is $100 \mu C$. Calculate the electric field intensity at distance (i) 5 cm and (ii) 5 m away from the centre of the ring along the axis.

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12. Two charges $+q$ and $-q$ separated by a distance of $3 \times 10^{-12} m$ in air form an electric dipole. If the intensity of the electric field is $3.3 \times 10^{-32} N.C^{-1}$ at a distance 3 cm from the dipole on the perpendicular bisector, what is value of q?

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13. The charge of an electric dipole is $10 \mu C$ and length 20 mm. It is placed along an electric field of intensity $10^3 N.C^{-1}$. What is the net force acting on the dipole ? If the dipole is placed at an angle of 60° with the electric field, what amount of torque will act on it?

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14. An electric dipole is formed by the two equal and opposite charges, $6nC$ each, kept 1 mm apart. Determine the magnitude and the direction of the field intensity at a point which is 3 m away from the midpoint of the line joining the two charges and making an angle 60° with the line.

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15. Charges of an electric dipole are $8\mu C$ and $-8\mu C$. Coordinates of those charges are $(2, -1, 5)$ and $(1, 0, 4)$. If that dipole is placed in a field

of intensity $E = 0.20\hat{i}V/m$, then determine the torque acting on the dipole.

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16. In a certain place, an electric field of intensity $4\hat{j} + 3\hat{k}N.C^{-1}$ is in action. If a square plate of side 60 cm is placed parallel to (i) yz - plane and (ii) xz - plane, what amount of electric flux will pass through them?

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17. A spherical shell of radius 10 cm has $10\mu C$ charge. Calculate the electric field intensity (i) at a distance of 5

cm and (ii) at a distance of 30 cm from the centre of the spherical shell.

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18. A straight wire of length 30 cm has $15\mu C$ charge. Calculate the electric field intensity at a distance of 20 cm from the wire.

Watch Video Solution

19. Due to the presence of a charge at the centre of a sphere of radius 10 cm, the electric flux passing through the surface of the sphere is $-6 \times 10^3 N.m^2.C^{-1}$.

(i) What is the magnitude of charge inside the sphere?

(ii) If a concentric spherical Gaussian surface with a radius double that of that of the sphere is taken, what will be the amount of electric flux now passing through this surface?

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Exercise Hots Numerical Problems

1. Two spheres of the same mass, radius and charge are suspended from the same point by threads. At first, the system is placed in vacuum and then it is immersed in a liquid of density $0.8g.\ cm^{-3}$ and dielectric constant 3. In both the cases, the threads make equal angles with each

other. Determine the density of the material of the spheres.

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2. Two identical spheres, each of mass m, are suspended from a point by threads. Each sphere carries a charge q. If the angle between the threads is very small, prove that in equilibrium, the distance between the centres of the two spheres is,

$$x = \left(\frac{q^2 l}{2\pi\varepsilon_0 mg} \right)^{\frac{1}{3}}$$

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3. Two particles, each of mass m and carrying a charge q, are suspended from a point by insulated strings each of length 1 cm. In equilibrium each string makes an angle of 45° with the horizontal direction. Prove that, $q = \sqrt{2mg}$, g = acceleration due to gravity.

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4. A charge $+1 \times 10^{-5} C$ is uniformly distributed over a thin wire ring of radius 1 m. A particle of mass 0.9 g and carrying charge $-1 \times 10^{-6} C$ is placed on the axis of the ring at a distance of 1 cm from the centre of the ring. Prove that the motion of this negatively charged particle

is simple harmonic. Calculate the time period of the oscillation.

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5. Three charges, each of value q, are placed at the vartices of an equilateral triangle. A fourth charge Q is placed at the centre of the triangle. (i) If $Q = -q$, will the charge at the vertices move towards the centre of fly away from it? (ii) For what value of Q will the charges remain stationary?

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6. ABCD is a square of side 4 cm. $+16$ esu, -16 esu and $+32$ esu charges are placed at the points A, C and D respectively. Determine the resultant intensity at B.

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7. A sphere is suspended from the end A of a rod AB and the rod is balanced by placing weights on a scale pan suspended from the end B. AB = 22 cm. The flucrum of the balance is at a distance of 2 cm from the end A and 20 cm from the end B. Another sphere is placed directly below the sphere suspended from A. The distance between the centres of the two spheres is 2 cm. The two spheres are now charged with $+100$ esu. To make the rod AB

balanced again, what should be the change of weight in the scale pan?

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8. A straight conductor of length L is charged uniformly with a charge q. Calculate the electric field intensity at a distance a from the conductor on its perpendicular bisector.

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9. Two concentric thin metallic spherical shells of radii R_1 and R_2 (where $R_1 < R_2$) are charged with q_1 and q_2 coulombs, respectively. Using Gauss' theorem show that,

(i) the electric field intensity for radius $r < R_1$ is zero,

(ii) the electic field intensity for radius r, where $R_1 < r < R_2$, is $\frac{1}{4\pi\varepsilon_0}.\frac{q_1}{r^2}$ and

(iii) the electri field intensity for radius $r > R_2$ is $\frac{1}{4\pi\varepsilon_0}.\frac{q_1+q_2}{r^2}$.

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10. Two tiny spheres each having mass mkg and charge q coulomb are suspended from a point by insulating threads each l metre long but negligible θ with the vertical.

Prove that, $q^2 = \left(4mgl^2\sin^2\theta\tan\theta\right)4\pi\varepsilon_0$

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11. A particle of mass m and $+q$ is located midway between two fixed charged particles each having a charge $+q$ and at a distance $2l$ apart. Assuming that the middle charge moves along the line joining the fixed charges, show that the frequency of oscillation when it is displaced slightly is

$$\frac{q}{2\pi}\sqrt{\frac{1}{\pi\varepsilon_0 m l^3}}$$

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12. It has been experimentally proved that in a huge portion of the earth's atmosphere, electric field intensity is acting vertically downwards. Field intensity is $60\ \mathrm{V.m}^{-1}$ at an altitude of 200 m from the earth's

surface and $120\ \mathrm{V.m}^{-1}$ at an altitude of 100 m. Calculate the net electric charge enclosed by a cube of side 100 m. The cube is placed within the altitude range of 100 m to 200 m.

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13. An electron is displaced by 1.5 cm opposite to the direction of a field of intensity $2 \times 10^4 N/C$. Then a proton covers the same distance towards the direction of the previous field. Mass of a proton and an electron are $-1.73 \times 10^{-27} kg$ and $9.1 \times 10^{-31} kg$ respectively. Determine the amount of time taken by the proton and the electron.

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14. Four equal charges q are placed at the four corners of a square of length of each side a. What charge should be kept at the middle of the square so that the system is in equilibrium ?

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15. A ball having charge $4.9 \times 10^{-5} C$ and mass 100 g is allowed to fall from rest. Horizontal field intensity of the place from where the ball starts to fall is $2 \times 10^{4} N / C$. (i) Calculate the resultant force applied on the ball. (ii) What is the nature of the path followed by the ball ? (iii) What would be the position of the ball after 2 s?

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Entracnce Corner Assertion Reason Type

1. Statement I : If a proton and an electron are placed in the same uniform electron field, they experience different accelerations.

Statement II : Electric force on a test charge is independent of its mass.

A. Statement I is true, statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: B

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2. Statement I : Electric dipole moment is a vector quantity.

Statement II : The direction of electric dipole moment is from negative charge to the positive charge.

A. Statement I is true, statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: A

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3. Statement I : When an electric dipole is perpendicular to an electric field, maximum torque acts on it.

Statement II : If $\theta = 90^\circ$, then torque, $\tau = pE\sin 90^\circ = pE$.

A. Statement I is true, statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: A

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4. Statement I : A free electron suffers the same acceleration as a free proton, when placed in a uniform field.

Statement II : An electron and a proton have the same quantity of charge.

A. Statement I is true, statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: D

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5. Statement I : The electric field due to dipole on its axial line at a distance r is E. The electric field due to the same dipole on the equatorial line at the same distance will be $\frac{E}{2}$.

Statement II : Electric field due to a dipole at a point varies inversely with distance.

A. Statement I is true, statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: C

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Entracnce Corner Multiple Correct Answer Type

1. The SI unit of electric field intensity is

A. $A.m^{-1}$

B. $N.C^{-1}$

C. $J.C^{-1}.m^{-1}$

D.

Answer: A::C::D

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2. If the net electric flux through a closed surface is zero, then

A. the net charge inside the surface is zero

B. the electric field is zero everywhere on the surface

C. the number of electric field lines entering the surface equals the number leaving the surface

D.

Answer: A::B::D

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

A. $\vec{F} = \left|\vec{p}\right|\vec{E}$

B. $\left|\vec{\tau}\right| = \vec{p}.\vec{E}$

C. $\vec{\tau} = \vec{p} \times \vec{E}$

D. $\vec{F} = \vec{0}$

Answer: A::D

Watch Video Solution

4. A proton and an electron are placed in an electric field. The forces acting on them are F_1 and F_2 and their

acceleration are a_1 and a_2 respectively. Then

A. $F_1 \neq F_2$

B. $a_1 = a_2$

C. $a_1 \neq a_2$

D. F_(1)=F_(2)

Answer: 3 & 4

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5. Two identical charges $+Q$ are kept at some fixed distance. A small particle P with charge q is placed midway between them. If P is given a small displacement Δx, it will undergo simple harmonic motion if

A. q is positive and Δx is perpendicular to the line joining the charges

B. q is negative and Δx is perpendicular to the line joining the charges

C. q is negative and Δx is along the line joining the charges

D.

Answer: A::C

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6. A charge Q is divided into two equal parts $q = \frac{Q}{2}$. If the chages q and q are placed at certain distance,

A. Coulomb force is dependent on the medium in which the charges are placed

B. Coulomb force is maximum irrespective of the medium in which the charges are placed

C. none of the above

D.

Answer: A::B

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7. A ring with a uniform charge Q are radius R, is placed in the yz- plane with its centre at the origin. The field intensity at

A. the origin is $\frac{Q}{4\pi\varepsilon_0 R^2}$

B. (x, 0, 0) is $\frac{Q}{4\pi\varepsilon_0 x^2}$

C. (x, 0, 0) is $\frac{Qx}{4\pi\varepsilon_0 (R^2 + x^2)^{3/2}}$

D.

Answer: A::D

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8. A pendulum bob of mass m , carrying a charge q is at rest with its string making an angle θ with the vertical in

a uniform horizontal electric field E. the tension in the string is

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

B. $\frac{mg}{\cos\theta}$

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

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

Answer: B::C

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9. A spherical metal shell A of radius R_A and a solid metal sphere B of radius $R_B(<R_A)$ are kept far apart and

each is given charge $+Q$. Now they are connected by a thin metal wire. Then

A. $E_A^{\text{inside}} = 0$

B. $Q_A > Q_B$

C. $\frac{\sigma_A}{\sigma_B} = \frac{R_B}{R_A}$

D. $E_A^{\text{on surface}} < E_B^{\text{on surface}}$

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

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10. A non conducting solid sphere of radius R is uniformly charged. The magnitude of electric field intensity due to the sphre at a distance r from its centre

A. increases as r increases for $r < R$

B. decreases as r increases for $0 < r < \infty$

C. decreases as r increases for $R < r < \infty$

D. is discontinuous at $r = R$

Answer: A::C

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Entracnce Corner Comprehension Type

1. A circular copper ring of radius r, placed in vacuum, has charge q on it. The electric field intensity at the centre of the ring is E_1. The electric field intensity on the axis of

the ring at a distance x from its centre is E_2. The value of E_2 will be maximum when $x = x'$

What is the value of E_1?

A. 0

B. $q \times \pi r^2$

C. $q \times 2\pi r^2$

D. $\frac{q}{r^2}$

Answer: A

Watch Video Solution

2. A circular copper ring of radius r, placed in vacuum, has charge q on it. The electric field intensity at the centre of

the ring is E_1. The electric field intensity of the axis of the ring at a distance x from its centres is E_2. The value of E_2 will be maximum when $x = x'$

What is the value of E_2?

A. $\frac{q}{(x^2 + r^2)^{1/2}}$

B. $\frac{qx^2}{(x^2 + r^2)^{3/2}}$

C. $\frac{q}{(x^2 + r^2)^{3/2}}$

D. $\frac{qx}{(x^2 + r^2)^{3/2}}$

Answer: D

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3. A circular copper ring of radius r, placed in vacuum, has charge q on ti. The electric field intensity at the centre of the ring is E_1. The electric field intensity of the axis of the ring at a distance x from its centres is E_2. The value of E_2 will be maximum when $x = x'$

What is the value of x' ?

A. $\sqrt{2}r$

B. $\frac{r}{\sqrt{2}}$

C. $\frac{r}{\sqrt{3}}$

D. $\sqrt{3}r$

Answer: B

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4. An electron is released from rest in a uniform electric field of $10^6 N.\, C^{-1}$. The acceleratiion of the electron is a. The time taken by electron in attaining a speed of 0.1c (where $c = 3 \times 10^8 m.\, s^{-1}$ is t.

What is the value of a?

A. $1.76 \times 10^{17} m.\, s^{-2}$

B. $2.56 \times 10^{18} m.\, s^{-2}$

C. $1.2 \times 10^{15} m.\, s^{-2}$

D. $3.45 \times 10^{17} m.\, s^{-2}$

Answer: A

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5. An electron is released from rest in a uniform electric field of $10^6 N.\, C^{-1}$. The acceleratiion of the electron is a. The time taken by electron in attaining a speed of 0.1c (where $c = 3 \times 10^8 m.\, s^{-1}$ is t.

What is the value of t?

A. $2.8 \times 10^{-10} g)$

B. $1.7 \times 10^{-10} g$

C. $3.4x10^{-10} g$

D. $1.2 \times 10^{-8} g$

Answer: B

Watch Video Solution

6. A point mass M is attached to one end of a masslesa rigid non-conducting rod of length L. Another equal point mass is attached to the other end of the rod. The two particles carry charges $+q$ and $-q$ respectively. This arrangement is held I the region of uniform electric field E such that the rod makes a small θ (say about 5°) with field direction. Moment of inertia of the rod is I.

Now answer the question

The ratio $\frac{\theta}{\alpha}$ is

A. $\frac{I}{EL}$

B. $\frac{I}{qEL}$

C. $\frac{I}{2qEL}$

D. $\frac{2I}{3qEL}$

Answer: B

Watch Video Solution

7. A point mass M is attached to one end of a masslesa rigid non-conducting rod of length L. Another equal point mass is attached to the other end of the rod. The two particles carry charges $+q$ and $-q$ respectively. This arrangement is held I the region of uniform electric field E such that the rod makes a small θ (say about 5°) with field direction. Moment of inertia of the rod is I.

Now answer the question

Time period of SHM of the given system is

A. $2\pi\sqrt{\frac{ML}{2qE}}$

B. $2\pi\sqrt{\frac{ML}{qE}}$

C. $\pi\sqrt{\frac{ML}{qE}}$

D. $\pi\sqrt{\frac{ML}{2qE}}$

Answer: A

Watch Video Solution

8. A point mass M is attached to one end of a masslesa rigid non-conducting rod of length L. Another equal point mass is attached to the other end of the rod. The two particles carry charges $+q$ and $-q$ respectively. This arrangement is held I the region of uniform electric field E such that the rod makes a small θ (say about 5°) with

field direction. Moment of inertia of the rod is I.

Now answer the question

Time period for the rod to become parallel to E is

A. $2\pi\frac{\sqrt{ML}}{qE}\Bigg)$

B. $\frac{2\pi}{3}\sqrt{\frac{ML}{qE}}$

C. $\frac{\pi}{3}\sqrt{\frac{ML}{2qE}}$

D. $\frac{\pi}{4}\frac{\sqrt{ML}}{2qE}\Bigg)$

Answer: C

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Entracnce Corner Integer Answer Type

1. Two charges $2Q$ and $-Q$ are placed at the points $(a, 0, 0)$ and $(4a, 0, 0)$ respectively. With the two charges situated at the cenres, two spheres of radii 2a and 8a are considered. What is the ratio of electric flux through the surfaces of the two spheres?

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2. The electrostatic force of repulsion between two positively charged ions carrying equal charge is $3.7 \times 10^{-9} N$ when they are separated by a distance of $5Å$. How many electrons are missing from each ion?

Watch Video Solution

3. Two particles are placed in air seperated by a distance of 10 cm. 20 esu charge is distributed between them in such a way that the force of repulsion between them is maximum. What is the value of this maximum repulsive force in dyne?

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4. Charge of magnitude $+100$ esu and -100 esu are placed at two vertices of an equilateral triangle of side 5 cm. What is the value of resultant intensity in esu at the third vertex?

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Examination Archive Wbchse

1. Four point charges $+q,\ +q,\ +q$ and $-q$ are placed at the four comers of a square, length of each side of which is a.

Find the magnitude of the intensity of the electric field at the centre of the square.

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2. On the x-y plane to point charges $+q$ and $-q$ are placed at positiions $(0, l)$ and $(0, -l)$ respectively. Find an expression for the intensity of electric field at a point $(0, y)$ where $y > l$. Under what condition does the

charge system bechave as a dipole and hence express the electric field in terms of the dipole moment of the dipole so formed.

View Text Solution

3. A thin spherical shel of radius R is charged with $+q$ amount of charge. Use Gauss' law to find out the magnitude of the intensity of the electric field at a distance r from the centre of the shel, where (a) $r < R$ and(b) $r > R$

(ii) Show graphically how the magnitude of the intensity of the electric field changes with distance r from thke centre of the shell.

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4. An electric is expressed as $\vec{E} = 20\hat{i}V.m^{-1}$. Find the electric flux passing through a surface of area $0.25m^2$ normal to the x-axis.

Watch Video Solution

5. Define electric dipole moment. Find the torque acting on a dipole when it is placed in a uniform electric field $\vec{E}$.

Watch Video Solution

6. State Gauss's theorem in electrostatics. Find the electric flux through a surface of area $50m^2$ in x-y plane in the electric field $\vec{E} = 3\hat{i} + 2\hat{j} + \hat{k}V.m^{-1}$

Watch Video Solution

7. If an electric dipole of moment $\vec{p}$ be placed along a uniform electric field of intensity $\vec{E}$, the torque acting on the dipole is

A. $\vec{\tau} = \vec{p} \times \vec{E}$

B. $\vec{\tau} = \vec{p}.\vec{E}$

C. $\vec{\tau} = \vec{p} + \vec{E}$

D. $\vec{\tau} = 0$

Answer:

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8. Define surface density of electric charge.

Two large conducting spheres carrying charges Q_1 and Q_2 are brought close to each other. Is the magnitude of the electrostatic force between them exactly given by $\frac{Q_1 Q_2}{4\pi\varepsilon_0 r^2}$ where r is the distance betwen their centres?

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9. 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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10. Show that electric field intensity on the surface of a charged conductor is $\vec{E} = \frac{\sigma}{\varepsilon_0} n$, where σ is the surface density of charge and $\vec{n}$ is the outward pointing unit normal vector.

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11. Why are electric lines of forces not closed loop ?

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12. An electron having charge e moves with velocity $\overrightarrow{n}$ in +x direction. An electric field act on it along+y direction. The force on the electron acts along .

A. $+z$ direction

B. $-z$ direction

C. $+y$ direction

D. $-y$ direction

Answer:

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13. A charge Q is situated inside a cube placed in air. The electric flux passing through all the six faces is

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

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

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

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

Answer:

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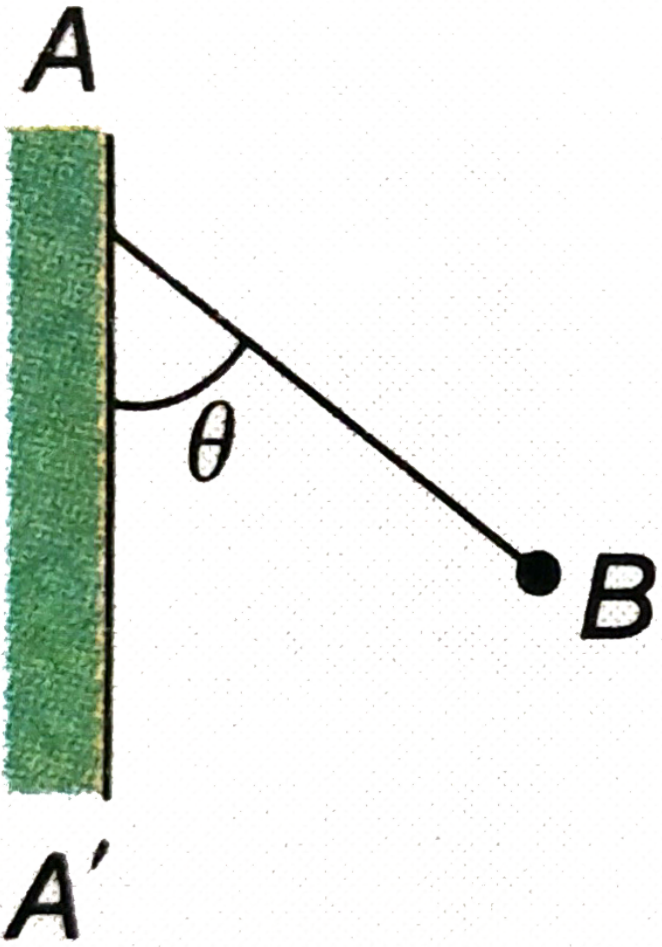
Examination Archive Wbjee

1. A line AA' is on a charged infinite conducting plane which is perpendicular to the plane of the paper. The plane has a surface density of charge σ and B is a ball of mass m with a like charge of magnitude q.B is connected by a string from a point on the line AA'. The tangent of the angle (θ) formed between the line AA' and the string

is



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

B. $\frac{q\sigma}{3\varepsilon_0 mg}$

C. $\frac{q\sigma}{2\varepsilon_0 mg}$

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

Answer:

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2. A charge q is placed at one corner of cube. The elctric flux through any of the three faces adjacent of the charge is zero.

The flux through any one of the other three faces is

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

B. $\frac{q}{6\varepsilon_0}$

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

D. $\frac{q}{24\varepsilon_0}$

Answer:

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3. Two charges $+q$ and $-q$ are placed at a distance a in a uniform electric field. The dipole moment of the combination is $2aq\left(\cos\theta\hat{i}+\sin\theta\hat{j}\right)$, where θ is the angle between the direction of the field and the line joining the two charges. which of the following statement (s) is/are correct ?

A. the torque exerted by the field on the dipole vanishes

B. the net force on the dipole vanishes

C. the torque is independent of the choice of coordinates

D. the net force is independent of a

Answer:

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4. A charged particle of mass m_1 and charge q_1 is revolving in a cricle of radius r. another charged particle of charge q_2 and mass m_2 is situated at the centre of the circle. If the velocity and time period of the revolving particle be v and T respectively, then,

A. $v = \sqrt{\frac{q_1 q_2 r}{4\pi\varepsilon_0 m_1}}$

B. $v = \frac{1}{m_1}\sqrt{\frac{q_1 q_2}{4\pi\varepsilon_0 m_1}}$

C. $T = \sqrt{\frac{16\pi^3\varepsilon_0 m_1^2 r^3}{q_1 q_2}}$

D. $T = \sqrt{\frac{16\pi^3\varepsilon_0 m_2 r^3}{q_1 q_2}}$

Answer:

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5. A Current $I = I_0 e^{-\lambda t}$ is flowing in a circuit consisiting of a parallel combination of resistance R and capacitance C.

The total charge over the entire pulse period is

A. $\frac{I_0}{\lambda}$

B. $\frac{2I_0}{\lambda}$

C. $I_0\lambda$

D. $e^{I_0\lambda}$

Answer:

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

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

B. $4\pi Q$

C. $\frac{Q}{4\pi\varepsilon_0}$

D. $\frac{Q}{6\pi\varepsilon_0}$

Answer:

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7. A charge of $0.8C$ is divided into two charges Q_1 and Q_2. These are kept at a separation of 30 cm. The force on Q_1 is maximum when

A. $Q_1 = Q_2 = 0.4C$

B. $Q_1 \approx 0.8C$ negligible

C. Q_1 negligible, $Q_2 \approx 0.8C$

D. $Q_1 = 0.2C, Q_2 = 0.8C$

Answer:

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8. A particle with charge QC, tied at the end of an inextensible string of length R metre, revolves in a vertical plane. At the centre of the circular trajectory there is a fxied charge of magnitude QC. The mass of the moving charge M is such that $Mg = \frac{Q^2}{4\pi\varepsilon_0 R^2}$. If at the highest position of the particle, the tenstion of the string just vanishes, the horizontal velocity at the lowest point has to be

A. 0

B. $2\sqrt{gR}$

C. $\sqrt{gR}$

D. $\sqrt{5gR}$

Answer:

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9. A particle with charge e and mass m, moving along the X-axis with a uniform speed u enters a region where a uniform electric field E is acting along the Y-axis. The particle starts to move in a parabola. Its focal length (neglecting any effect of gravity) is

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

B. $\frac{eE}{2mu^2}$

C. $\frac{mu}{2eE}$

D. $\frac{mu^2}{2eE}$

Answer:

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10. A unit negative charge with mass resides at the midpoint of the straight line of length 2a adjoining two fixed charges of magnitude $+Q$ each. If it is given a very small displacement $x(x << a)$ in a direction perpendicular to the straight line, it will

A. come back to its original position and stay there

B. excute oscillations with freqeuncy $\frac{1}{2\pi}\sqrt{\frac{Q}{4\pi\varepsilon_0 Ma^3}}$

C. fly to infinity

D. execute oscillations with frequency $\frac{1}{2\pi}\sqrt{\frac{Q}{2\pi\varepsilon_0 Ma^3}}$

Answer:

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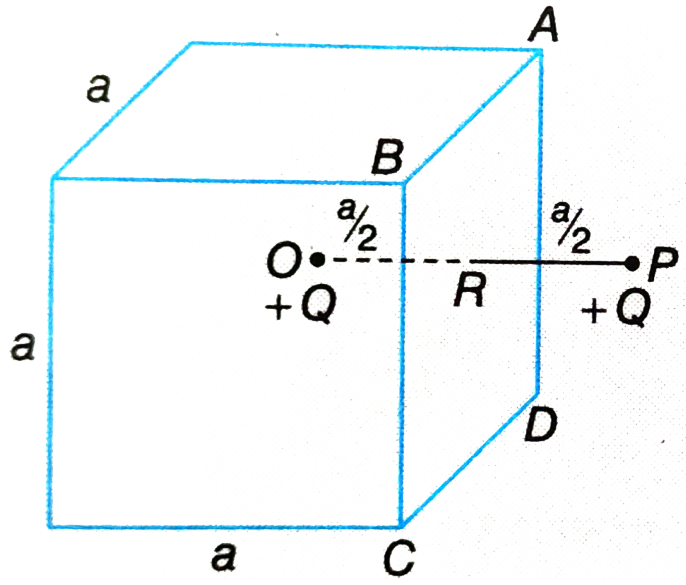
11. Consider a region in free space bounded by the surfaces of an imaginary cube having sides of length a as shown in the diagram. A charge +Q is placed at the centre O of the cube. P is such a point outside the cube that the

line OP perpendicularly intersects the surface ABCD at R and also $OR = RP = \frac{a}{2}$. A charge +Q is placed at point P also. What is the total electrie flux through the five faces of the cube other than ABCD?



A. $\frac{Q}{\in_0}$

B. $\frac{5Q}{6\ \in_0}$

C. $\frac{10Q}{6\ \in_0}$

D. zero

Answer:

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12. Four equal charges of value +Q are placed at any four vertices of a regular hexagon of side a. By suitably choosing the vertices, what can be the maximum possible magnitude of electric field at the centre of the hexagon?

(A) $\frac{Q}{4\pi \in_0 a^2}$

(B) $\frac{\sqrt{2}Q}{4\pi \in_0 a^2}$

(C) $\frac{\sqrt{3}Q}{4\pi \in_0 a^2}$

(D) $\frac{2Q}{4\pi \in_0 a^2}$

A. $\frac{Q}{4\pi \in_0 a^2}$

B. $\frac{\sqrt{2}Q}{4\pi \in_0 a^2}$

C. $\frac{\sqrt{3}Q}{4\pi \in_0 a^2}$

D. $\frac{2Q}{4\pi \in_0 a^2}$

Answer:

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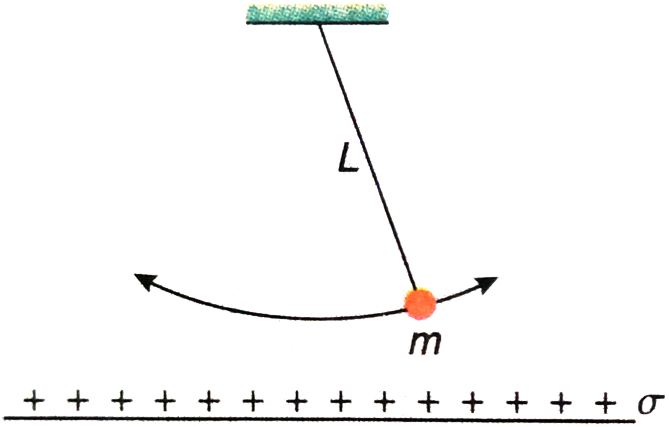
13. The bob of a pendulum of mass m, suspended by an inextensible string of length L as shown in the figure carries a small charge q. An infinite horizonatal plane conductor with uniform surface charge density σ is placed below it. What will be the time period of the

pendulum for small amplitude oscillations?



A. $2\pi\sqrt{\frac{L}{\left(g-\frac{q\sigma}{\epsilon_0 m}\right)}}$

B. $\sqrt{\frac{L}{\left(g-\frac{mq\sigma}{\epsilon_0}\right)}}$

C. $\frac{1}{2\pi}\sqrt{\frac{L}{\left(g-\frac{q\sigma}{\epsilon_0 m}\right)}}$

D. $2\pi\sqrt{\frac{L}{\left(g-\frac{q\sigma}{\epsilon_0 m}\right)}}$

Answer:

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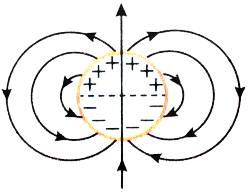
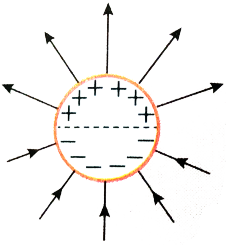
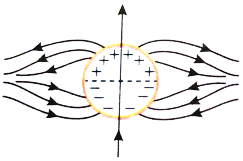
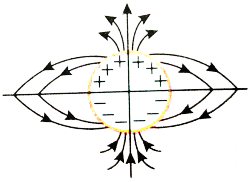
Examination Archive Jee Main

1. 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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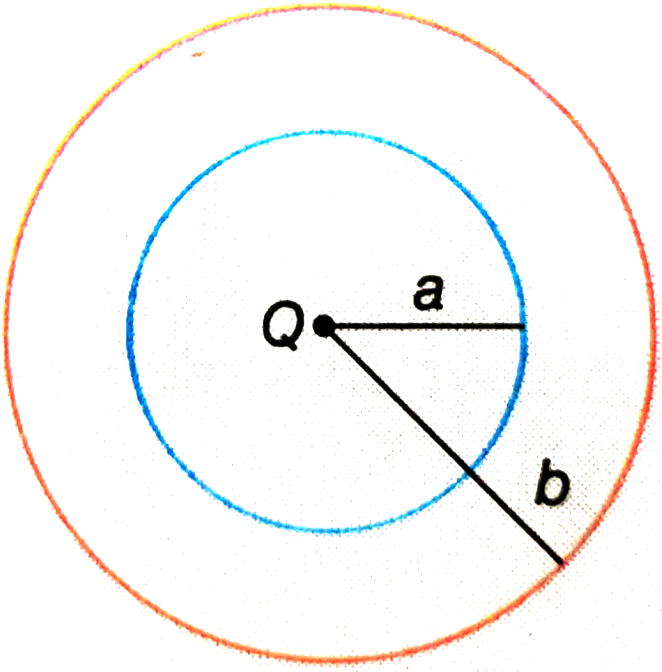
2. The region between two concentric spheres of radii a and b, respectively [Fig.2.122], has volume charge denstity $\rho = \frac{A}{r}$, where A is a constant and r is the distance from the



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. $\frac{Q}{2\pi a^2}$

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

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

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

Answer: A

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

A. 30°

B. 45°

C. 60°

D. 90°

Answer: C

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Examination Archive Aipmt

1. The eletric field in a certina region is acting radially outward and is given by E = Ar. A charge contained in 'a' centred at the origin of the field will be givne by

A. $4\pi \in_0 Aa^2$

B. $A \in_0 a^2$

C. $4\pi \in_0 Aa^3$

D. $\in_0 Aa^3$

Answer: C

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Examination Archive Neet

1. Two identical charged spheres suspended from a common point by two masses strings of length l are initially at a distance d (d lt lt 1) apart because of their mutual repulsion. The charge begins to leak from both the spheres at a constant rate. As a result the charge

approaches 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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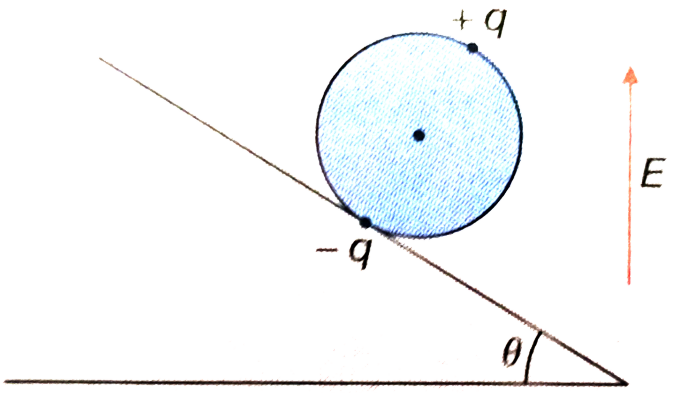
2. A wheel having mass m has charges +q and -q on diametrically opposite points. It remains in equilibrium on a rough inclined plane in the presence of a vertical

electric field E. Then value of E is



A. $\frac{mg\tan\theta}{q}$

B. $\frac{mg}{q}$

C. $\frac{mg}{2q}$

D. $\frac{m > an\theta}{2q}$

Answer: C

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3. 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 6 m/s in one second duration. At that instant the direction of the 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. $1m/s, 3.5m/s$

B. $1m/s, 3m/s$

C. $2m/s, 4m/s$

D. $1.5m/s, 3m/s$

Answer: B

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4. 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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Cbse Scanner

1. A charge q is placed at the centre of a cube of side l. What is the electric flux passing through each face of the cube?

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2. An electric dipole is held in a uniform electric field. Show that the net force acting on it zero.

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3. An electric dipole is held in a uniform electric field. The dipole is aligned parallel to the field. Find the work done in rotating it through the angle of 180°.

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4. A charge q is placed at the centre of a cube. What is the electric flux passing through two opposite faces of the cube ?

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5. A charge q is placed at the centre of a cube. What is the electric flux passing through the cube?

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6. 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.

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7. 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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8. Using Gauss' law deduce the expression for the electric field due to a uniformly charge spherical conducting shell of radius R at a point (i) outside the shell.

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9. Using Gauss' law deduce the expression for the electric field due to a uniformly charge spherical conducting shell of radius R at a point (ii) inside the shell.

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10. Why do the electrostatic field lines not form closed loops?

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11. Deduce the expression for the torque acting on a dipole of dipole moment $\vec{P}$ in the presence of a uniform electric field $\vec{E}$.

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12. Consider two hollow concentric spheres S_1 and S_2 enclosing charges 2Q and 4Q respectively as shown in figure. (i) Find out the ratio of the electric flux through them.

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13. Consider two hollow concentric spheres S_1 and S_2 enclosing charges 2Q and 4Q respectively as shown in figure. (ii) How will the electric flux through S_1 change if a medium of dielectric constant ε_r is introduced in the

space inside S_1 in place of air. Deduce the necessary expression.

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14. A point charge +Q is placed in the vicinity of a conducting surface. Trace the field lines between the charge and the conducting surface.

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15. Define electric electric flux. Write its SI unit.

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16. Using Gauss' law, obtain the electric flux due to a point charge q enclosed in a cube of side a.

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17. Show that the electric field due to a uniformly charged infinite plane sheet at any point distant x from it, is independent of x.

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18. What is the amount of work done in moving a point charge Q around a circular arc of radius 'r' at the centre of which another point charge 'q' is located?

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19. Find the electric field intensity due to a uniformly charged spherical shell at a point (i) out side the shell

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20. Find the electric field intensity due to a uniformly charged spherical shell at a point (ii) inside the shell. Plot the graph of electric field with distance from the centre of the shell.

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21. 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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22. Draw a graph of E versus r fro r gt gt a.

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23. Obtain the expression for the torque $\vec{\tau}$ experienced by an electric dipole of dipole moment $\vec{p}$ in a uniform electric field, $\vec{E}$.

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24. What will happen if the field were not uniform?

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

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27. Defined electric flux. Is it a scalar or a vector quantity?

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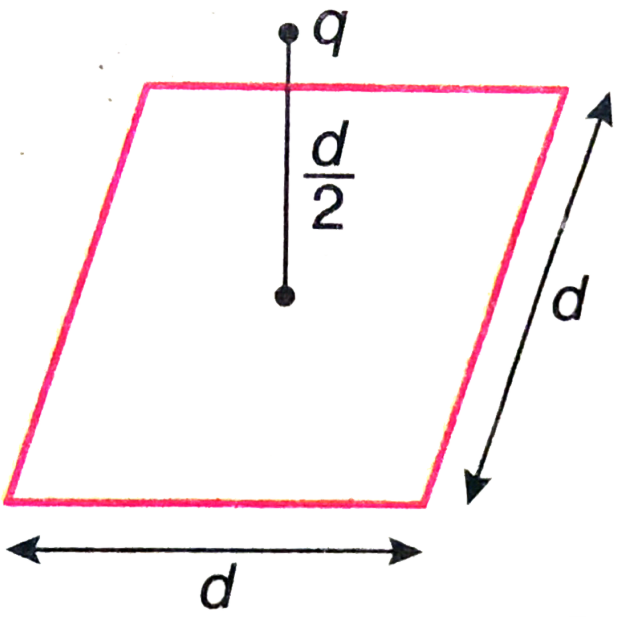
28. A point charge q is at a distance of $\frac{d}{2}$ directly above the centre of a square of side d, as shown in the figure. Use Gauss' law to obtain the expression for the electric

flux through the square.



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29. It the point charge is now moved to a distance d from the centre of the square and the side of the square is doubled, explain how the electric flux will be affected.

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

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31. Draw a graph of show the variation of E with perpendicular distance r from the line of charge.

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