PHYSICS

BOOKS - VIKRAM PUBLICATION (ANDHRA PUBLICATION)

ELECTRIC CHARGES AND FIELDS

Textual Examples

1. How can you charge a metal sphere positively without touching it?

Watch Video Solution

2. If 10^9 electrons move out of a body to another body evergy second, how much time is required to get a total charge of 1 C on the other body?

Watch Video Solution

3. How much positive and negative charge is there in a cup of water?

Watch Video Solution

4. Coulomb's law for electrostatic force between two point charges and Newton's law for gravitational force between two stationary point masses, both have inverse-square dependence on the distance between the charges/masses. Compare the strength of these forces by determining the ratio of their magnitudes (i) for an electron and a proton and (ii) for two protons

Watch Video Solution

5. Coulomb's law for electrostatic force between two point charges and Newton's law for gravitational force between two stationary point masses, both have inverse-square dependence on the distance between the charges/masses. Estimate the accelerations of electron and proton due to the electrical force of their mutual attraction when they are $1\text{Å}\left(= 10^{-10}m\right)$ apart?

$\left(m_p = 1.67 \times 10^{-27}kg, m^3 = 9.11 \times 10^{-31}kg\right)$

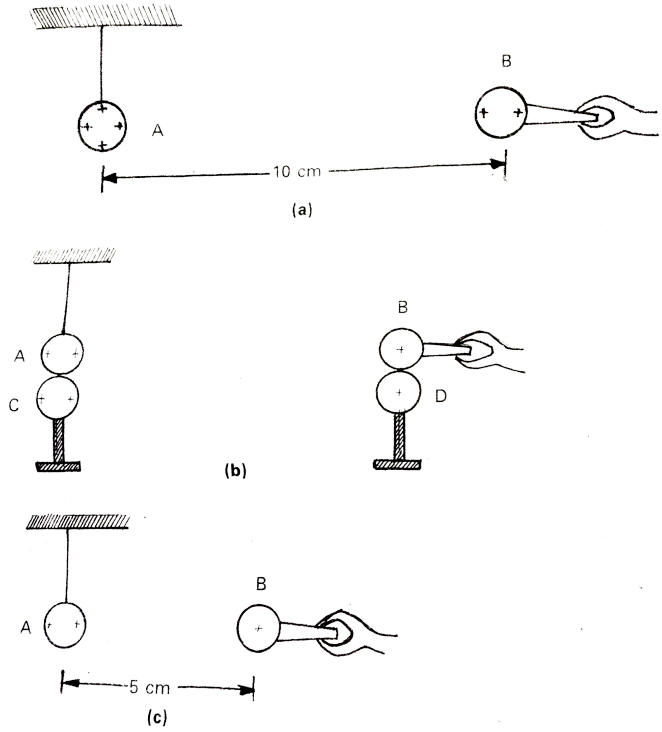
.

Watch Video Solution

6. A charged metalic sphere A is suspended by a nylon thread. Another charged metallic sphere B held by an insulating handle is brought close to A such that the distance between their centres is 10 cm, as shown in Fig. (a). The resulting repulsion of A is noted (for example, by shining a beam of light and measuring the deflection of its shadow on a screen). Spheres A and B are touched by uncharged spheres C and D respectively, as

shown in Fig. (b). C and D are then removed and B is brought closer to A to distance of 5.0 cm between their centres, as shown in Fig. (c). what is the expected repulsion of A on the basis of Coulomb's law? Spheres A and C and spheres B and D have identical sizes. Ignore the size of A and B in comparison to the

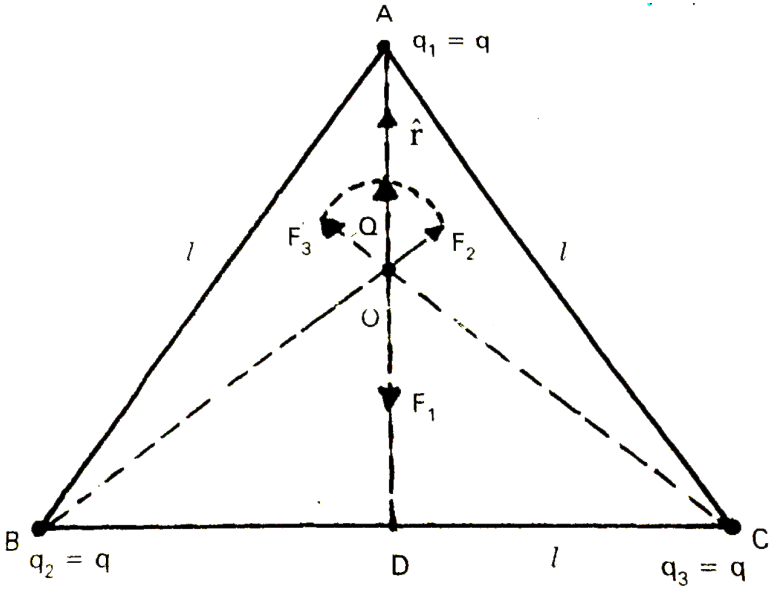
separation between their centres.



Watch Video Solution

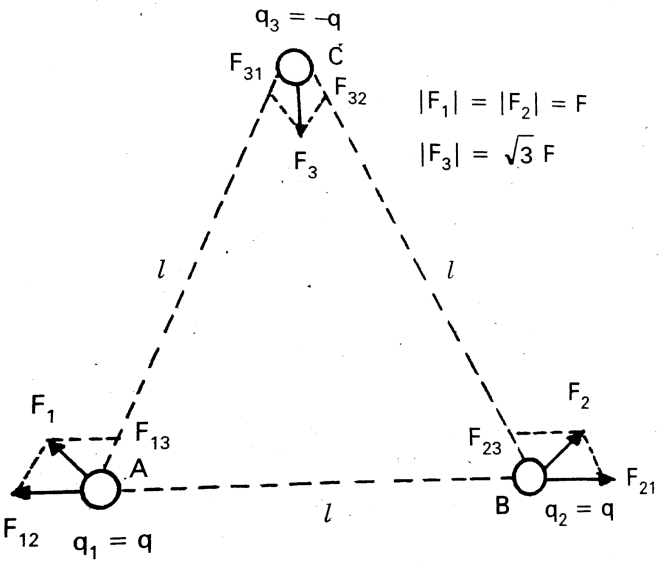
7. Consider three charges q_1, q_2, q_3 each equal to q at the vertices of an equilateral triangle

of side l. What is the force on a charge Q (with the same sign as q) placed at the centroid of the triangle, as shown in Fig. ?



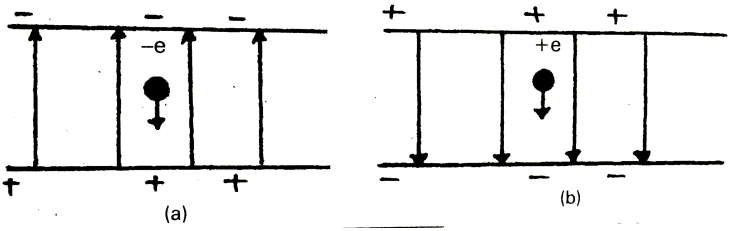
Watch Video Solution

8. Consider the charge q, q and -q placed at the vertices of an equilateral triangle, as shown in fig. What is the force on each charge?



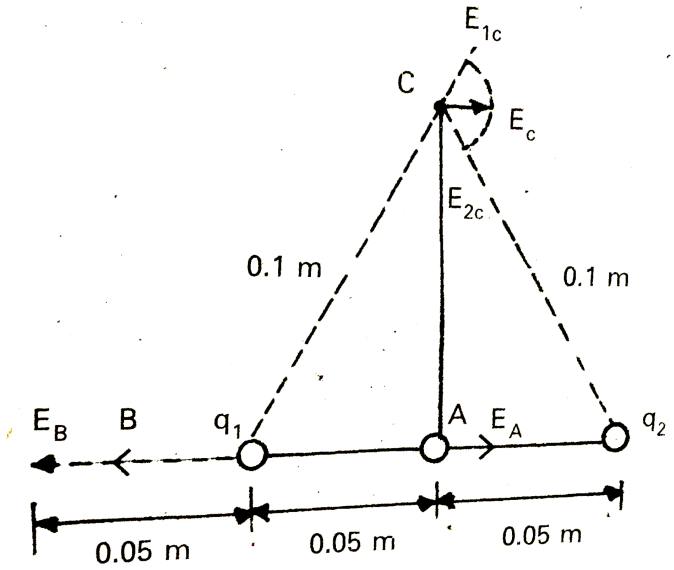
Watch Video Solution

9. An electron falls through a distance of 1.5 cm in a uniform electric field of magnitude $2.0 \times 10^4 NC^{-1}$. The direction of the field is reversed keeping its magnitude unchanged and a proton falls through the same distance. Compute the time of fall in each case. Contrast the situation with that of 'free fall under gravity'.



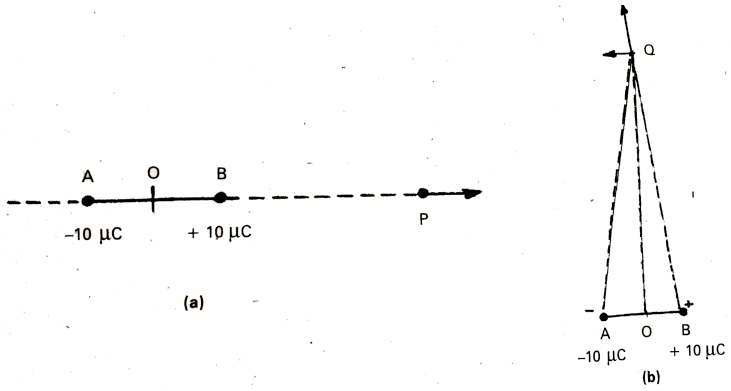
Watch Video Solution

10. Two point charges q_1 and q_2, of magnitude $+10^{-8}C$ and $-10^{-8}C$, respectively, are placed 0.1 m apart. Calculate the electric fields at points A, B and C shown in Fig.



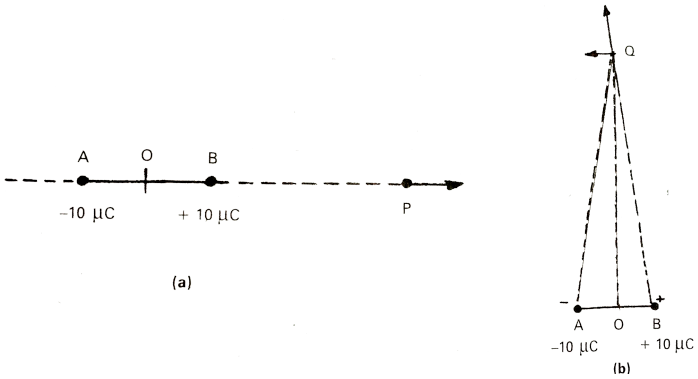
Watch Video Solution

11. Two charges $10\mu C$ are placed 5.0 mm apart. Determine the electric field at a point P on the axis of the dipole 15 cm away from its centre O on the side of the positive charge, as shown in Fig.



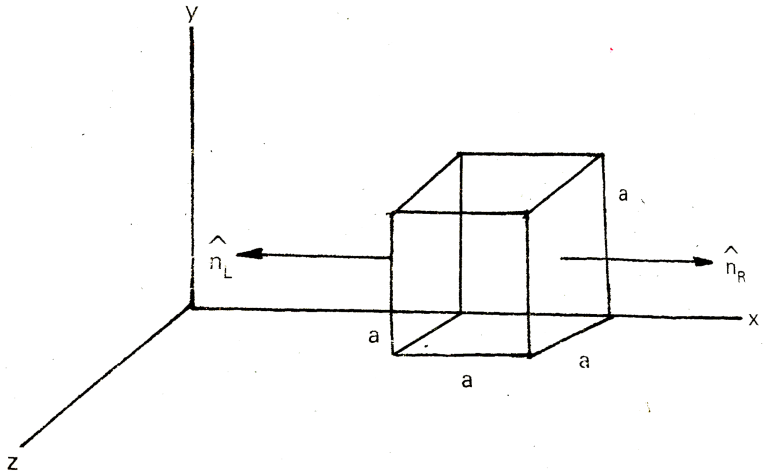
Watch Video Solution

12. Two charges $10\mu C$ are placed 5.0 mm apart. Determine the electric field at a point Q, 15 cm away from O on a line passing through O and normal to the axis of the dipole, as shown in Fig.



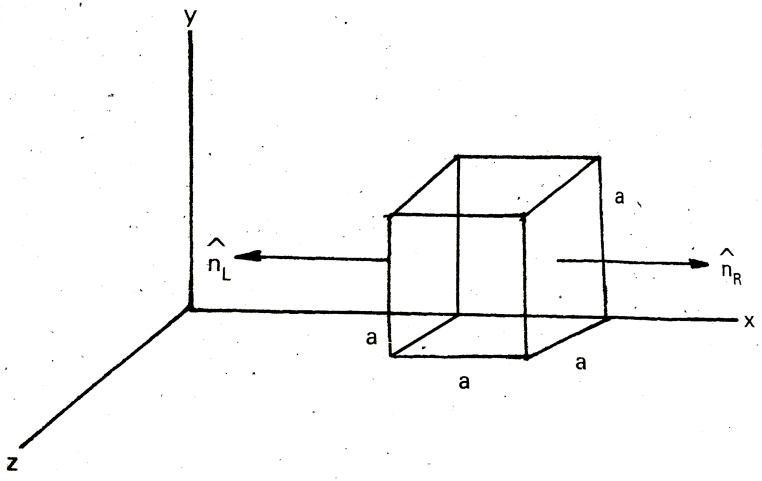
Watch Video Solution

13. The electric field components in Fig. are $E_x = ax^{1/2}, E_y = E_z = 0,$ in which $\alpha = 800 N/Cm^{1/2}$. Calculate the flux through the cube



Watch Video Solution

14. The electric field components in Fig. are $E_x = ax^{1/2}, E_y = E_z = 0,$ in which $\alpha = 800N/Cm^{1/2}.$ Calculate the charge within the cube. Assume that $a = 0.1m.$



View Text Solution

15. An electric field is uniform and in the positive x direction for positive x and uniform with the same magnitude but in the negative x direction for negative x. It is given that $E = 200\hat{i}N/C$ for $x > 0$ and $E = -200\hat{i}N/C$ for $x < 0$. A right circular cylinder of length 20 cm and radius 5 cm has its centre at the origin and its axis along the x-axis so that one face is at $x = +10$ cm and the other is at $x = -10$ cm

What is the net outward flux through each flat face?

Watch Video Solution

16. An electric field is uniform and in the positive x direction for positive x and uniform with the same magnitude but in the negative x direction for negative x. It is given that $E = 200\hat{i}N/C$ for $x > 0$ and $E = -200\hat{i}N/C$ for $x < 0$. A right circular cylinder of length 20 cm and radius 5 cm has its centre at the origin and its axis along the x-axis so that one face is at $x = +10$ cm and the other is at $x = -10$ cm

What is the flux through the side of the cylinder?

Watch Video Solution

17. An electric field is uniform and in the positive x direction for positive x and uniform with the same magnitude but in the negative x direction for negative x. It is given that $E = 200\hat{i}N/C$ for $x > 0$ and $E = -200\hat{i}N/C$ for $x < 0$. A right circular cylinder of length 20 cm and radius 5 cm has

its centre at the origin and its axis along the x-axis so that one face is at $x = +10$ cm and the other is at $x = -10$ cm

What is the net outward flux through the xylinder?

View Text Solution

18. An electric field is uniform and in the positive x direction for positive x and uniform with the same magnitude but in the negative x direction for negative x. It is given that

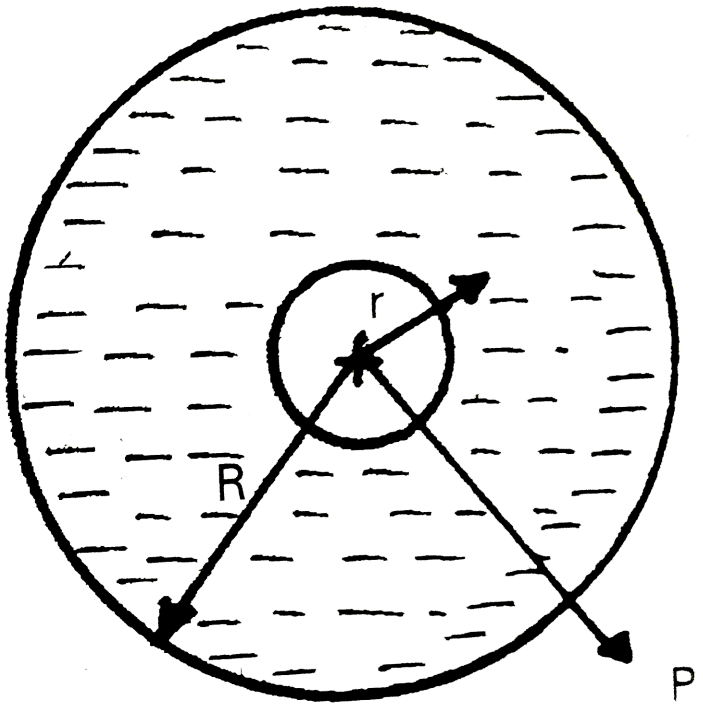
$E = 200\hat{i}N/C$ for $x > 0$ and $E = -200\hat{i}N/C$ for $x < 0$. A right circular cylinder of length 20 cm and radius 5 cm has its centre at the origin and its axis along the x-axis so that one face is at $x = +10$ cm and the other is at $x = -10$ cm

What is the net charge inside the cylinder?

View Text Solution

19. An early model for an atom considered it to have a positively charged point nucleaus of

charged Ze, surrounded by a uniform density of negative charge up to a radius R. The atom as a whole is neutral. For this model, what is the electric field at a distance r from the nucleus?



View Text Solution

Very Short Answer Questions

1. What is meant by the statement 'charge is quantized' ?

Watch Video Solution

2. Repulsion is the sure test of charging than attraction. Why?

Watch Video Solution

3. How many electrons constitute 1 C of charge?

Watch Video Solution

4. What happens to the weight of a body when it is charged positively?

Watch Video Solution

5. What happens to the force between two charges if the distance between them is (a) halved (b) doubled?

Watch Video Solution

6. The electric lines of force do not intersect. Why ?

Watch Video Solution

7. Consider two charges +q and -q placed at B and C of an equilateral triangle ABC. For this system, the total charge is zero. But the electric field (intensity) at A which is equidistant from B and C is not zero. Why?

Watch Video Solution

8. Electrostatic field lines of force do not form closed loops. If they form closed loops then the work done in moving a charge along a

closed path will be zero. From the above two statements can you guess the nature of electrostatic force?

Watch Video Solution

9. State Gauss's law in electrostatics.

Watch Video Solution

10. When is the electric flux negative and when is it positive ?

Watch Video Solution

11. Write the expresion for electric intensity due to an infinite long charged wire at a distance wire at a distance radial distance r from the wire.

View Text Solution

12. Write the expression for electric intensity due to an infinite due to an infinite plane

sheet of charge.

View Text Solution

13. Write the expresion for electric intensity due to a charged conducting spherical shel at points outside and inside the shell.

View Text Solution

Short Answer Questions

1. State and explain Coulomb's incerse square law in electricity.

Watch Video Solution

2. Define intensity of electric field at a point. Derive an expression for the intensity due to a point charge.

Watch Video Solution

3. Derive the equation for the couple acting on a electric dipole in a uniform electric field.

Watch Video Solution

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

Watch Video Solution

5. Derive an expression for the intensity of the electric field at a point on the equatorial plane of an electric dipole.

Watch Video Solution

6. Sate Gauss's law in electrostatics and explain its importance.

Watch Video Solution

Long Answer Questions

1. Define electric flux. Applying Gauss's law and serive the expression for electric intensity due to an infinite long straight charged wire. (Assume that the electric field everywhere radial and depends only on the radial distance r of the point from the wire.)

Watch Video Solution

2. State Gauss's law in electrostatics. Applying Gauss's law derive the expression for electric

intensity due to an infinite plane sheet of charge.

Watch Video Solution

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

Watch Video Solution

Textual Exercises

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

Watch Video Solution

2. An infinite number of charges each of magnitude q are placed on x-axis at distance of 1, 2, 4, 8, ... Meter from the origin respectively. Find intensity of the electric field at origin.

Watch Video Solution

3. A clock face has negative charges $-q, -2q, -3q, \ldots . -12q$ fixed at the position of the corresponding numerals on

the dial. The clocj hands do not disturb the net field due to the point charges. At what time does the hour hand point in the direction of the electric field at the centre of the dial?

View Text Solution

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

the normal to its plane makes a 60° angle with the x-axis?

Watch Video Solution

5. There are four charges, each with a magnitude Q. Two are positive and two are negative. The charges are fixed to the corners of a square of side 'L', one to each corner, in such a way that the force on any charge is directed toward the center of the sqaure. Find

the magnitude of the net electric force experienced by any charge?

Watch Video Solution

6. The electric field in a region is given by $\overline{E} = a\bar{i} + \mathbf{a}r(j)$. Here a and b are constants. Find the net flux pasing through a square area of side L parallel to y-z plane.

Watch Video Solution

7. A hollow spherical shell of radius r has a uniform charge density σ. It is kept in a cube of edge 3r such that the centre of the cube coincides with the centre of the shell. Calculate the electric flux that comes out of a face of the cube.

Watch Video Solution

8. An electric dipole consists of two equal and opposite point charge +Q and -Q, separated by

a distance 2l. P is a point collinear with the charges such that its distance from the positive charge is half of its distance from the negative charge. Calculate electric intensity at P.

Watch Video Solution

9. Two infinitely long thin straight wires having uniform linear charge densities λ and 2λ are arranged parallel to each other at a distance r

apart.The intensity of the electric field at a point midway between them is

Watch Video Solution

10. Two infinitely long thin straight wires having uniform linear charge densities λ and 2λ are arranged parallel to each other at a distance r apart. Calculate intensity of the electric field at a point midway between them.

Watch Video Solution

11. An electron of mass m and charge e is fired perpendicular to a uniform electric field of intensity E with an initial velocity u. If the electron traverses a distance x in the field in the direction of firing, find the transverse displacement y it suffers.

Watch Video Solution

Additional Exercises

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

Watch Video Solution

2. The electrostatic force on a small sphere of charge $0.4 \mu C$ due to another small sphere of charge $-0.8 \mu C$ in air is 0.2 N.

What is the distance between the two spheres?

Watch Video Solution

3. The electrostatic force on a small sphere of charge $0.4\mu C$ due to another small sphere of charge $-0.8\mu C$ in air is 0.2 N.

What is the force on the second sphere due to the first?

Watch Video Solution

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

Watch Video Solution

5. Explain the meaning of the statement 'electric charge of a body is quantized'.

Watch Video Solution

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

Watch Video Solution

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

Watch Video Solution

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

Watch Video Solution

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

Watch Video Solution

10. Explain why two field lines never cross each other at any point?

Watch Video Solution

11. The point charges $q_A = 3\mu C$ and $q_B = -3\mu C$ are located 20 cm apart in vaccum.

What is the electric field at the midpoint O of the line AB joining the two charges?

Watch Video Solution

12. The point charges $q_A = 3\mu C$ and $q_B = -3\mu C$ are located 20 cm apart in vaccum.

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

Watch Video Solution

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

Watch Video Solution

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

Watch Video Solution

15. Apolythene piece rubbled with wool is found to have a negative charge $3 \times 10^{-7} C$.

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

Watch Video Solution

16. Apolythene piece rubbled with wool is found to have a negative charge $3 \times 10^{-7} C$. Is there a transfer of mass from wool to polythene?

Watch Video Solution

17. Two insulated charged copper spheres A and B have their centres separated by a distance of 50 cm. What is the mutual force of electrostatic repulsion if the charge on each $6.5 \times 10^{-7} C$? The radii of A and B are negligible compared to the distance of separation.

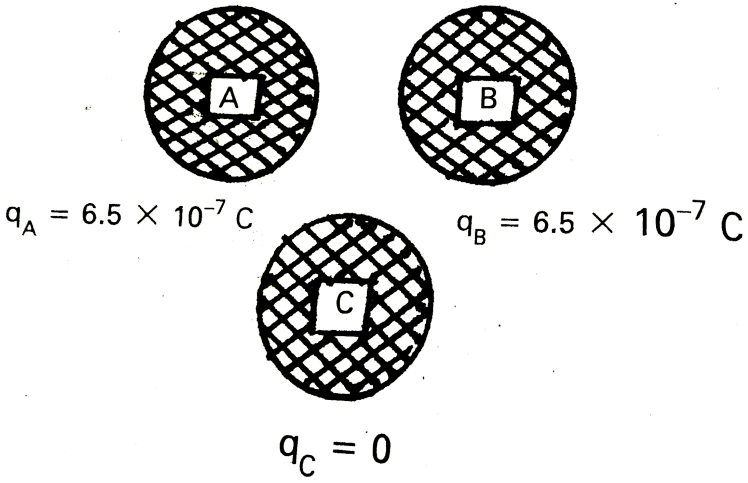
Watch Video Solution

18. What is the force of repulsion if each sphere is charged double the above amount shown in figure and the distance between them is halved?

Watch Video Solution

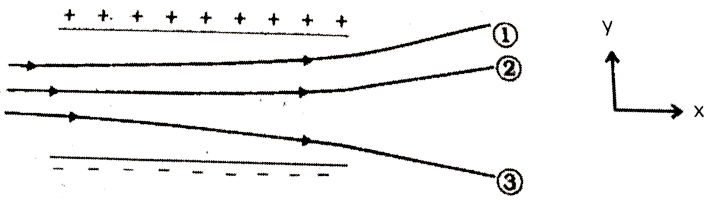
19. Suppose the spheres A and B in Exercise - 12 have identical sizes. A third sphere of the same size but uncharged is brought in contact with the first, then brought in contact with

second and finally removed from both. What is the new force of repulsion between A and B if the distance between them is 50 cm?



Watch Video Solution

20. Figure shows tracks of three charged particles in a uniform electrostatic field. Give the signs of the three charges. Which particle has the highest charge to mass ratio?



Watch Video Solution

21. Consider a uniform electric field $\overline{E} = 3 \times 10^3 NC^{-1}$. What is the flux of this

field through a square of 10 cm on a side whose plane is parallel to the YZ plane?

Watch Video Solution

22. Consider a uniform electric field $E = 3 \times 10^3 \hat{i} N/C$. A square of 10 cm on a side whose plane is parallel to the yz plane. What is the flux through the same square if the normal to its plane makes a 60° angle with the x-axis?

Watch Video Solution

23. What is the net flux of the uniform electric field of Exercise - 15 through a cube of side 20 cm oriented so that its faces are parallel to the coordinate planes?

Watch Video Solution

24. Careful measurement of the electric field at the surface of a black box indicates that the net outward flux through the surface of the

box is $8.0 \times 10^3 Nm^2/C$. What is the net charge inside the box?

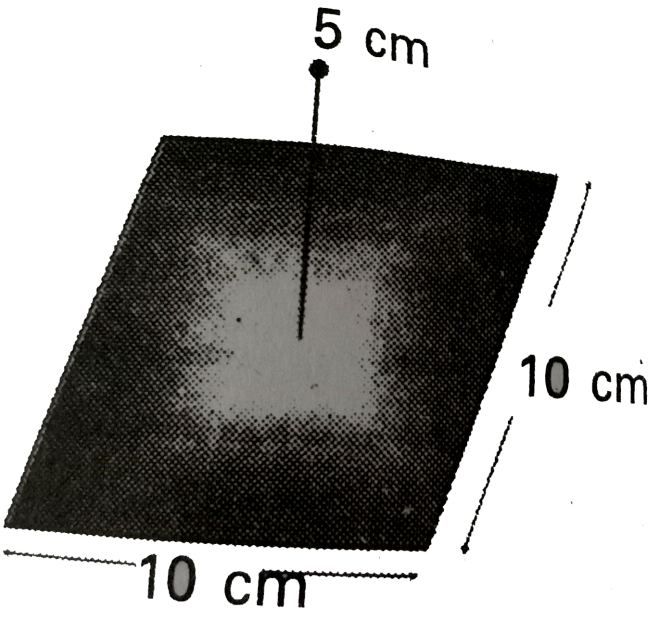
Watch Video Solution

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

Watch Video Solution

26. A point charge $+10\mu C$ is a distance 5 cm directly above the centre of a square of side 10 cm, as shown in fig. What is the magnitude of

the electric flux through the square?



Watch Video Solution

27. A point charge of $2.0\mu C$ is at the centre of a cubic Gaussian surface 9.0 cm on edge. What

is the net electric flux through the surface?

Watch Video Solution

28. A point charge causes an electric flux of $-1.0 \times 10^3 Nm^2/C$ to pass through a spherical Gaussian surface of 10.0 cm radius centred on the charge. If the radius of the Gaussian surface were doubled, how much flux would pass through the surface?

Watch Video Solution

29. A point charge causes an electric flux of $-1.0 \times 10^3 Nm^2/C$ to pass through a spherical Gaussian surface of 10.0 cm radius centred on the charge. What is the value of the point charge?

Watch Video Solution

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

$1.5 \times 10^3 N/C$ and points radially inward, what is the net charge on the sphere?

Watch Video Solution

31. A uniformly charged conducting sphere of 2.4 m dimeter has a surface charge density of $80.0 \mu C/m^2$. Find the charge on the sphere.

Watch Video Solution

32. A uniformly charged conducting sphere of 2.4 m dimeter has a surface charge density of $80.0\mu C/m^2$. What is the total electric flux leaving the surface of the sphere?

Watch Video Solution

33. An infinite line charge produces a fiels of 9×10^4 N/C at a distance of 2 cm. calculate the linear charge density.

Watch Video Solution

34. 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 E : in the outer region of the first plate,

Watch Video Solution

35. 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 E : in the outer region of the first plate,

Watch Video Solution

36. 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

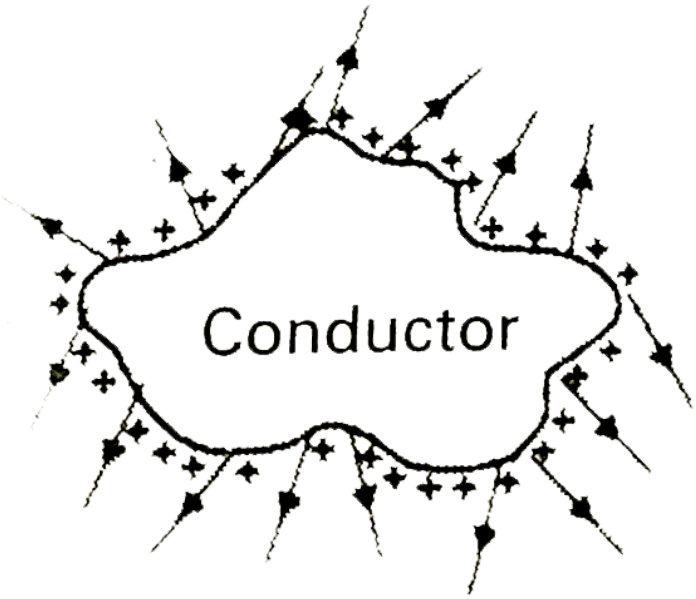
$17.0 \times 10^{-22} C/m^2$. What is E : between the plates?

Watch Video Solution

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

Watch Video Solution

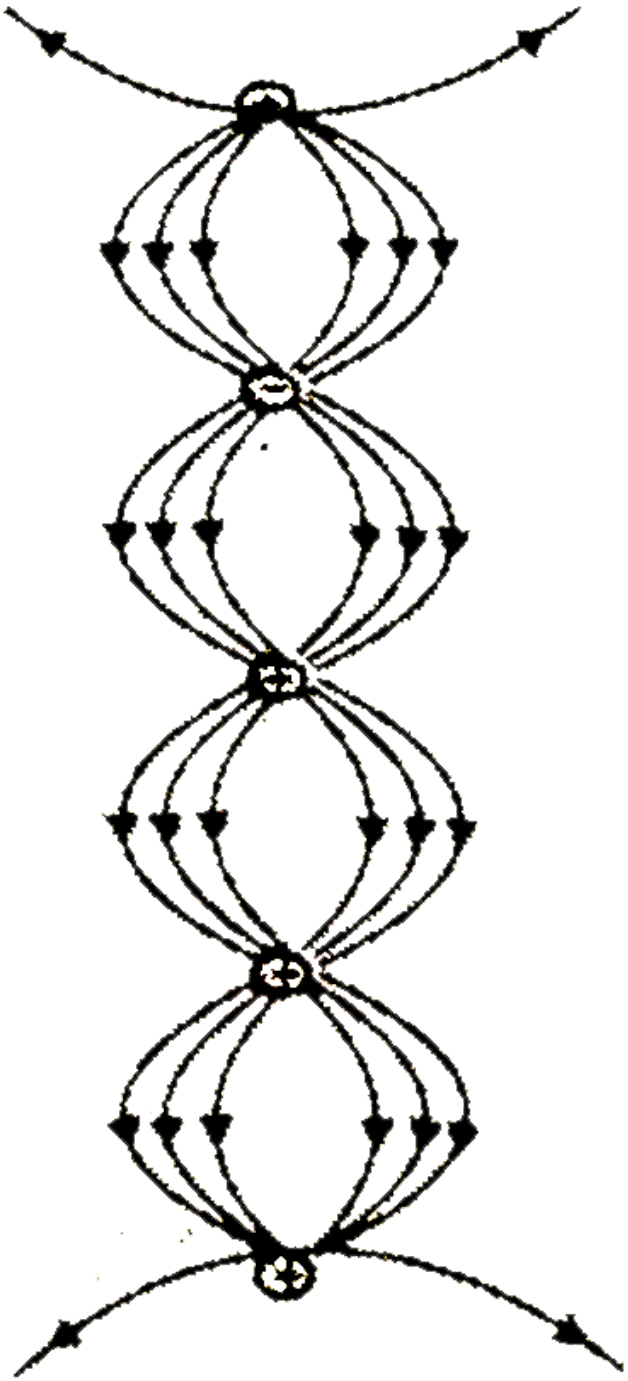
38. Which among the curves shown in Fig. cannot possibly represent electrostatic field lines?



Watch Video Solution

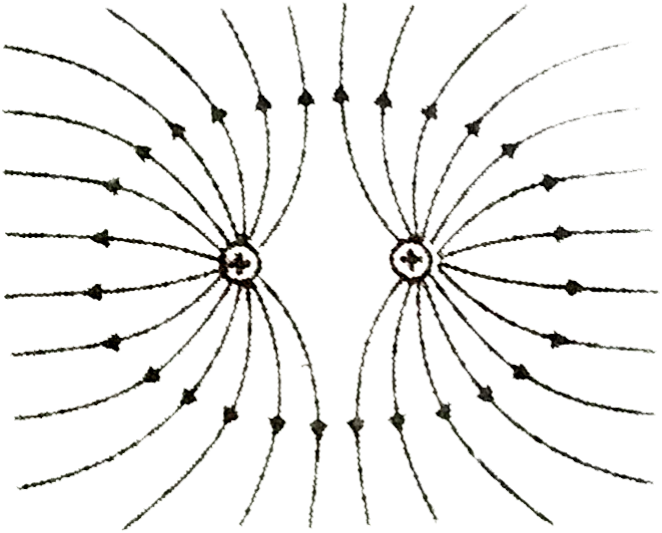
39. Which among the curves shown in Fig. cannot possibly represent electrostatic field

lines?



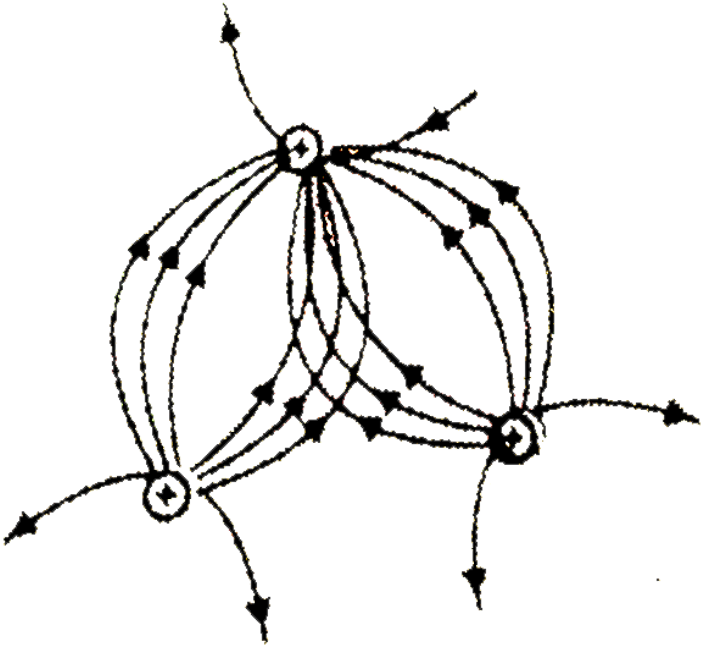
Watch Video Solution

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



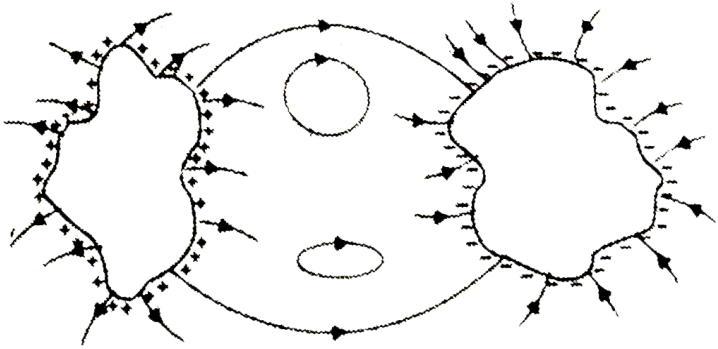
Watch Video Solution

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



Watch Video Solution

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



Watch Video Solution

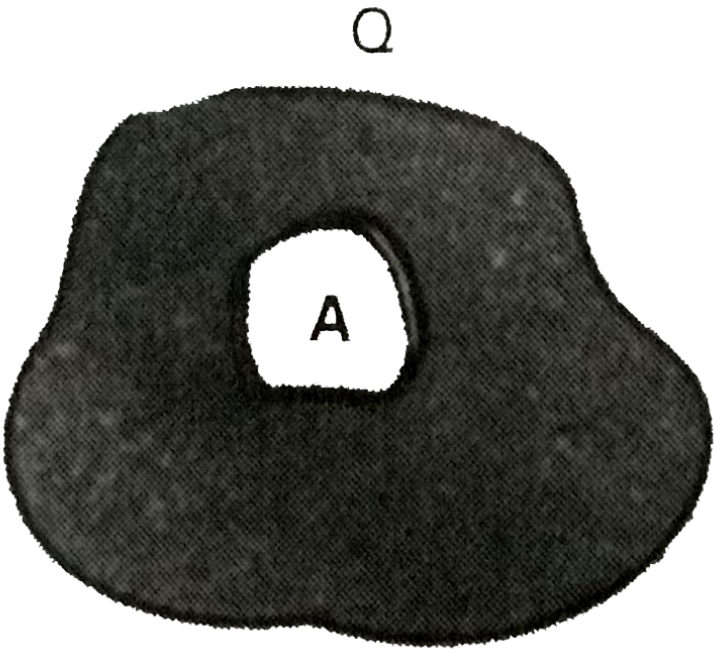
43. In a certain region of space, electric field is along the Z-direction throught. The magnitude of electric field is, however, not constant but

increases uniformly along the positive Z-direction, at the rate of $10^5 NC^{-1}$ per metre. Whay are the force and torque experienced by a system having a total dipolemoment equal to 10^7 Cm in the negative Z-direction?

Watch Video Solution

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

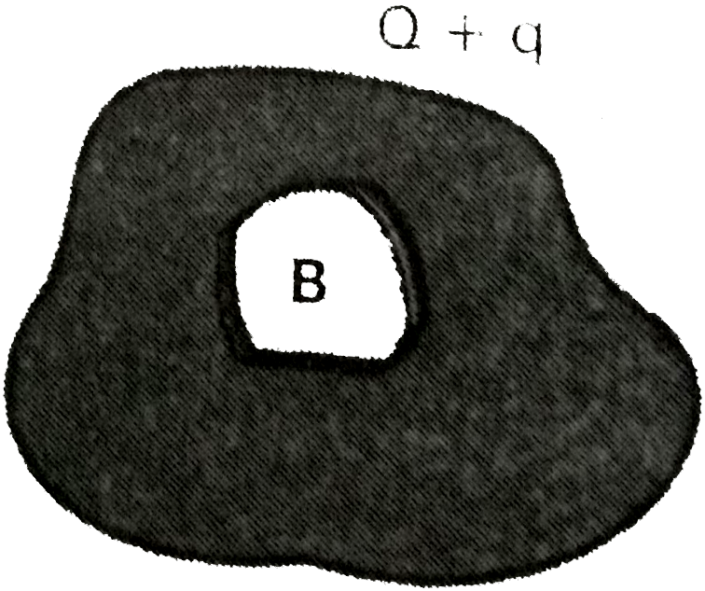
the conductor.



Watch Video Solution

45. Another conductor B with charge q is inserted into the cavity keeping B insulated

from A. Show that the total charge on the outside surface of A is $Q + q$



Watch Video Solution

46. A sensitive instrument is to be shielded from the strong electrostatic fields in its

environment. Suggest a possible way.

Watch Video Solution

47. A hollow charged conductor has a tiny hole cut into its surface. Show that the electric field in the hole is $(\sigma / \varepsilon \varepsilon_0)\hat{n}$, where $\hat{n}$ is the unit vector in the outward normal direction and σ is the surface charge density near the hole.

View Text Solution

48. Obtain the formula for the electric field due to a long thin wire of uniform linear charge density λ without using Gauss's law.

View Text Solution

49. It is now believed that protons and neutrons (which constitute nuclei of ordinary matter) are themselves built out of more elementary units called quarks. A proton and a neutron consist of three quarks each. Two

types of quarks, the so called 'up' quark (denoted by u) of charge + (2/3)e and the 'down' quark (denoted by d) of charge (-1/3) e, together with electrons build up ordinary matter. (Quarks of other types have also been found which give rise to different unusual varieties of matter.) Suggest a possible quark composition of a proton and neutron.

 Watch Video Solution

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

View Text Solution

51. Verify this result for the simple configuration of two charges of the same

magnitude and sign placed a certain distance apart.

View Text Solution

52. A particle of mass m and charge (-q) enters the region between the two charged plates initially moving along x-axis with speed V_x (as in the fig.). The length of plate is L and an uniform electric field E is maintained between the plates. Show that the vertical deflection of the particle at the far edge of the plate is

$qEL^2 / \left(2mV_x^2\right)$.

Compare this motion with motion of a projectille in gravitational field discussed in section 4.10 of 1^{st} Year Textbook of Physics.

Watch Video Solution

53. Suppose that the particle is an electron projected with velocity $V_x = 2.0 \times 10^6 ms^{-1}$. If E between the plates separated by 0.5 cm is $9.1 \times 10^2 N/C$, where will the electron strike

the upper plate?

$\left(|e| = 1.6 \times 10^{-19} C, m_e = 9.1 \times 10^{-31} kg\right).$

Watch Video Solution

Dam Sure Vsaq

1. What is meant by the statement 'charge is quantized' ?

Watch Video Solution

2. Repulsion is the sure test of charging than attraction. Why?

Watch Video Solution

3. How many electrons constitute 1 C of charge?

Watch Video Solution

4. What happens to the weight of a body when it is charged positively?

Watch Video Solution

5. What happens to the force between two charges if the distance between them is (a) halved (b) doubled?

Watch Video Solution

6. The electric lines of force do not intersect. Why ?

Watch Video Solution

7. Consider two charges +q and -q placed at B and C of an equilateral triangle ABC. For this system, the total charge is zero. But the electric field (intensity) at A which is equidistant from B and C is not zero. Why?

Watch Video Solution

8. Electrostatic field lines of force do not form closed loops. If they form closed loops then the work done in moving a charge along a closed path will be zero. From the above two statements can you guess the nature of electrostatic force?

Watch Video Solution

9. Sate Gauss's law in electrostatics and explain its importance.

Watch Video Solution

10. When is the electric flux negative and when is it positive ?

Watch Video Solution

11. Given the expression for electric field intensity at a point due to a thin infinitely long straight wire. Give the meaning the of symbols used.

Watch Video Solution

12. Give the expression for electric field intensity due to an infinite thin plane sheet. Give the meaning of the symbols used.

Watch Video Solution

13. Write the expression for electric intensity due to a charged conducting spherical shell at points outside and inside the shell.

Watch Video Solution

14. A proton and an α-particle are released in a uniform electric field. Find the ratio of (a) forces experienced by them (b) accelerations gained by each

Watch Video Solution

15. The electric field in a region is given by $\overline{E} = a\bar{i} + \mathbf{a}r(j)$. Here a and b are constants.

Find the net flux pasing through a square area of side L parallel to y-z plane.

Watch Video Solution

16. A hollow spherical shell of radius r has a uniform charge density σ. It is kept in a cube of edge 3r such that the centre of the cube coincides with the centre of the shell. Calculate the electric flux that comes out of a face of the cube.

Watch Video Solution

17. Consider a uniform electric field $\overline{E} = 3 \times 10^3 NC^{-1}$. What is the flux of this field through a square of 10 cm on a side whose plane is parallel to the YZ plane?

Watch Video Solution

Dam Sure Laq

1. State Gauss's law in electrostatics. Applying Gauss's law derive the expression for electric

intensity due to an infinite plane sheet of charge.

Watch Video Solution