PHYSICS

BOOKS - RESNICK AND HALLIDAY PHYSICS (HINGLISH)

ELECTRIC CHARGES AND FIELDS

Sample Problem

1. Two positively charged particles fixed in place on an x axis. The charges are $q_1 = 1.60 \times 10^{-19} C$ and $q_2 = 3.20 \times 10^{-19} C$, and

the particle separation is R = 0.0200m. What are teh magnitude and direction of the electrostatic force $\overrightarrow{F}_{12}$ on particle 1 from particle 2?

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2. Figure 22-8c is identical to Fig. 22-8a except that particle 3 now lies on the x axis between particles 1 and 2. Particle 3 has charge $q_2 = -3.20 \times 10^{-19} C$ and is at a distance $(3/4)$R from particle 1. What is the net electrostatic force $\overrightarrow{F}_{1.\text{net}}$ on particle 1 due to particles 2 and 3?

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3. Figure 22-8e is identical to Fig 22-8a except that particle 4 is now included. It has charge $q_4 = -3.20 \times 10^{-19} C$, is at a distance $\frac{3}{4}$ R from particle 1, and lies on a line that makes an angle $\theta = 60^\circ$ with the x axis. What is the net electrostatic electrostatic electrostatic force $\vec{F}_{1,\text{net}}$ on particle 1 due to particle 2 and 4?

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4. Two charges +8q and -2q are fixed on X-axis at origin and $x = +a$ locations. A third charge +q is to be located on X-axis (other than infinitely far

away) so that it is in equilibrium. The location of the third charge is correctly represented by

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5. Two identical, small, charged spheres, each having a mass of 4.0×10^{-2}kg hang in equilibrium as shown in Fig. 22-10a. The length of each string is 1.5m and the angle θ is 37.0°. Find the magnitude of

the charge on each sphere.

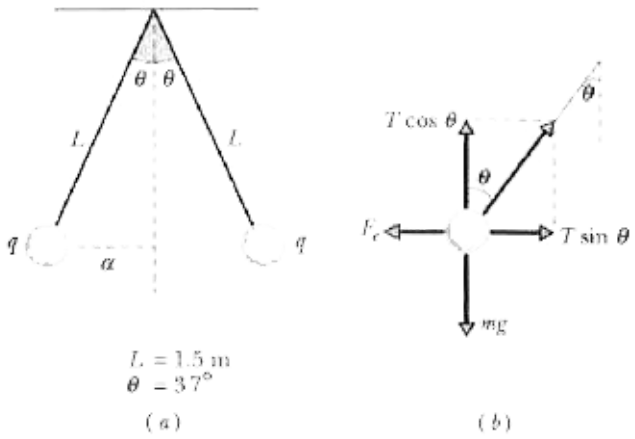

Figure 22-18 (*a*) Two small charged spheres in equilibrium. (*b*) Free body diagram of left sphere.

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6. The nucleus in an iron atom has a radius of about 4.0×10^{-15}m and contains 26 protons.

What is the magnitude of the repulsive electrostatic

force between two of the protons that are separated by $4.0 \times 10^{-15} m$?

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7. The nucleus in an iron atom has a radius of about 4.0×10^{-15}m and contains 26 protons.

What is the magnitude of the gravitational force between those same two protons?

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8. Figure 22-18a shows there particles with charges $q_1 = +2Q, q_2 = -2Q,$ and $q_3 = -2Q,$ each a distance d from the origin. What net electric field $\vec{E}$ is produced at the origin?

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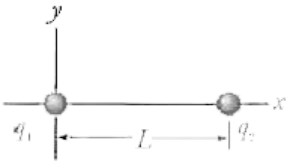
9. In Fig. 22-19, particle 1 of charge $q_1 = 5.00q$ and a particle 2 of charge $q_2 + 2.00q$ are fixed on the x-axis. As a multiple of distance L, at what coordinate on the axis is the net electric field of the particles zero?



Two particles with charges q_1 and q_2 fixed on x-axis.

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10. Sketch the net electric lines between and around the particles.

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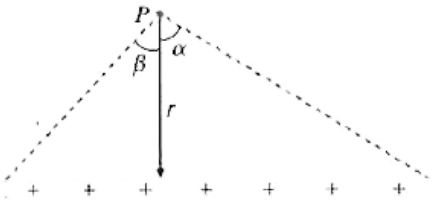
11. Figure 22-24 shows a plastic rod having a uniformly distributed charge. The charge per unit length of the rod is λ. Find the electric field due to the rod at a point P which is at a distance r from the

rod.



A uniformly charged rod is kept along x axis we need to find the electric field at P.

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12. Figure 22-26a shows a plastic rod with a uniform charge -Q. It is bent in a 120° circular arc of radius r and symmetrically paced across an x axis with the origin at the center of curvature P of the rod. In terms of Q and r, what is the electric field $\vec{E}$ due to the rod at point P?

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13. Find the electric field at the center of the sphere due to the induced charges on the surface of the sphere, as shown in Fig. 22-30.

A point charge is kept near a conducting sphere.

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14. Beams of high-speed protons can be produced in "guns" using electric fields to accelerate the protons. What acceleration would a proton experience if the gun's electric field were $2.00 \times 10^4 N/C$.

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15. Beams of high-speed protons can be produced in "guns" using electric fields to accelerate the protons. What speed would the proton attain if the field accelerated the proton through a distance of 1.00 cm?

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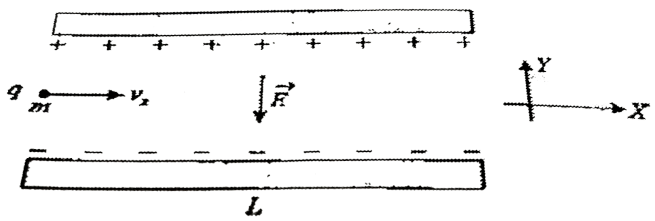
16. Figure shows an assembly of deflecting plates A and B ofan ink-jet printer which causes moving ink droplets to deflect at desired displacements by continuously varying electric field between the plates. An ink drop with a mass $m = 1.3 \times 10^{-10} kg$ and a negative charge of magnitude $q = 1.5xx10^{-13} C$ enters the region between the plates, initially moving along the x-axis with speed $v_x, = 10 m/s$. The length of plates is $L = 1.6 cm$. The plates are connected with a varying voltage and thus produce an electric field at all points between them. Assume that field $\overrightarrow{E}$ for some duration is

constant and it is acting in downward direction as shown and has a magnitude of $E = I.4 \times 10^6 N/C$, find the vertical deflection of the drop at the far edge ofthe plate? As the gravitational force on the drop is very small relative to the electrostatic force acting on the drop, it can be neglected for this analysis. $\left[6.4 \times 10^{-4} m\right]$



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17. A neutral water molecule (H_2O) in its vapor state has an electric dipole moment of magnitude $6.2 \times 10^{-30} C \cdot m$.

How far apart are the molecule's centers of positive and negative charge?

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18. A neutral water molecule (H_2O) in its vapor state has an electric dipole moment of magnitude $6.2 \times 10^{-30} C \cdot m$.

If the molecule is placed in a electric field of $1.5 \times 10^4 N/C$, what maximum torque can the field

exert on it? (Such a field can easily be set up in the laboratory.)

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19. A neutral water molecule (H_2O) in its vapor state has an electric dipole moment of magnitude $6.2 \times 10^{-30} C \cdot m$.

How much work must an external agent do to rotate this molecule by 180° in this field, starting from its fully aligned position , for which $\theta = 0$?

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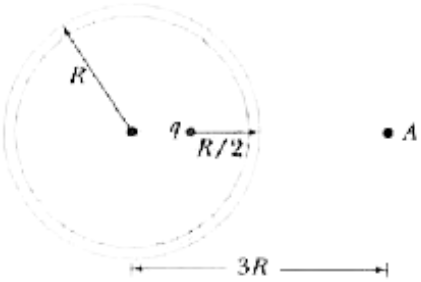
20. Find the electric field at (A) (a) due to q, (b) due to charges induced on the inner surface of the shell and (c) due to charges induced on the outer surface of the shell (Fig. 22-41).



A charge is kept inside a thin conducting shell.

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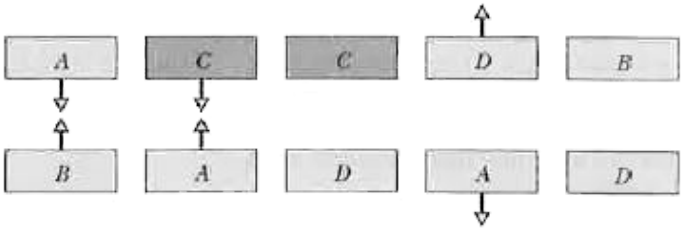
Check Points

1. The figure shows five pairs of plates : A, B and D are charged plastic plates and C is an electrically neutral copper plate. The electrostatic forces between the pairs of plates are shown for three of the pairs. For the remaining two pairs, do the plates repel or attract each other ?



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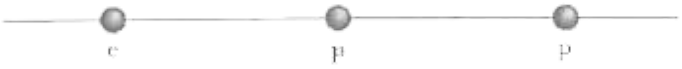
2. The figure shows two protons (symbol p) and one electron (symbol e) on an axis. On the central proton, what is the direction of (a) the force due to the electron, (b) the force due to the other proton, and (c) the net force ?



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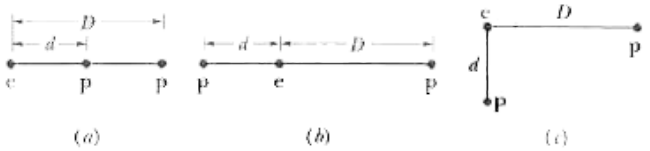
3. The figure here shows three arrangements of an electron e and two protons p. (a) Rank the arrangement according to the magnitude of the net

electrostatic force on the electron due to the protons, largest first. (b) In situation c, is the angle between the net force on the electron and the line labelled d less than or more than 45° ?



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4. Assume that charges were initially different. If the charges on them were equally distributed would the angle of divergence increase, decrease, or stay the same ?

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5. Initially, sphere A has a charge of -50 e and sphere B has a charge of +20e. The sphere are made of conducting material and are identical in size. If the spheres then touch, when is the resulting charge on sphere A?

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6. The figure here shows a proton p and an electron e on x axis. What is the direction of the electric field due to the electron at (a) point S and (b) point R ?

What is the direction of the net electric field at (c) point R and (d) point S?

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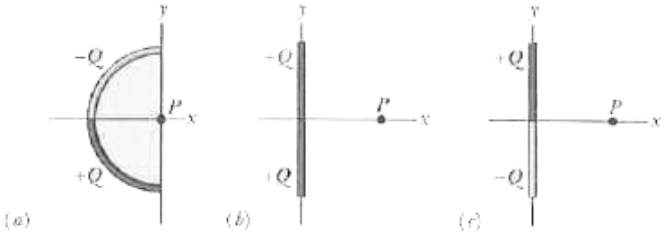
7. The figure here shows three nonconducting rods, one circular and two straight. Each has a uniform charge of magnitude Q along its top half and another along its bottom half. For each rod, what is

the direction of the net electric field at point P ?



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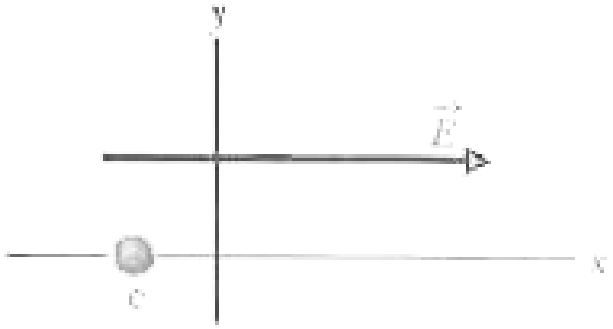
8. (a) In the figure, what is the direction of the electrostatic force on the electrone due to the external electric field shown ? (b) In which direction will the electron accelerate if it is moving parallel to the y axis before it encounters the external field ? (c) If, instead the electron is initially moving rightward,

will its speed increase, decrease, or remain constant ?



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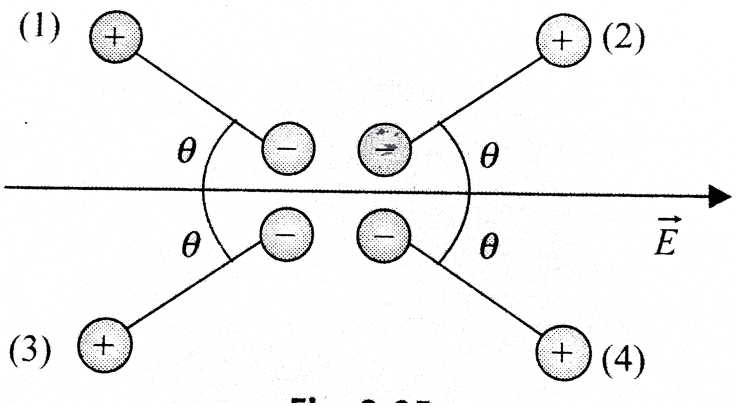
9. (Fig. 3.95) shows four orientations of an electric dipole in an external electric field. Rank the orientations acording to the

a. magnitude of the torque on the dipole, and

b. potential energy of the dipole, greatest first.



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Problems

1. In Fig. four particles form a square. The charges are $q_1 = q_4 = Q$ and $q_2 = q_3 = q$. (a) What is Q/q is the net electrostatic force on particles 2 and 3 is

zero ? (b) Is there any value of q makes the net electrostatic force on each of the four particles zero ? Explain.

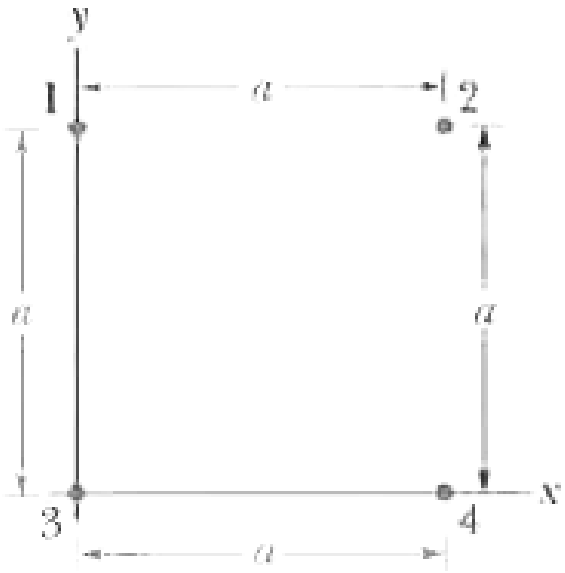

Figure 22-62 Problems 1 and 2.

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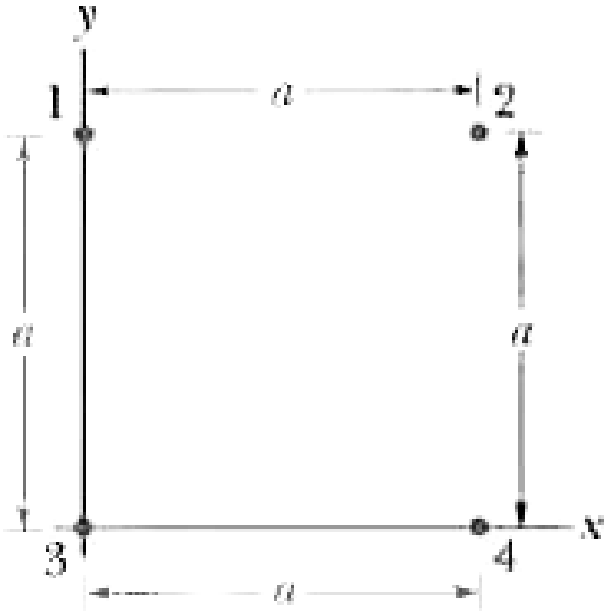
2. In Fig. , the particles have charges $q_1 = -q_2 = 300nC$ and $q_3 = -q_4 = 200nC$, and distance a = 5.0 cm. What are the (a) magnitude and (b) angle (relative to the +x direction) of the net force on particle 3 ?



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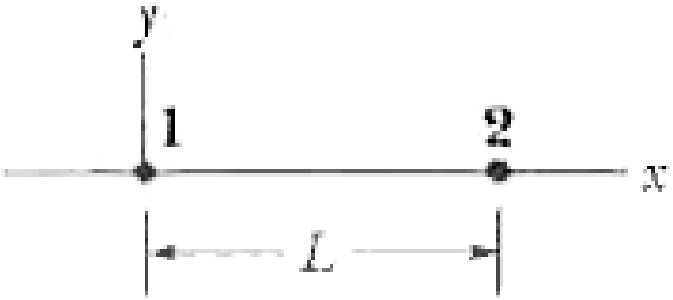
3. In Fig., particle 1 of charge $+6.0\mu C$ and particle 2 of charge $-2.0\mu C$ are held at separation $L = 10.0cm$ on an x axis. If particle 3 of unknown charge q_3 is to be located such that the net electrostatic force on it from particles 1 and 2 is zero, what must be the (a) x and (b) y coordinates of particle 3 ?



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4. Three particles are fixed on an x axis. Particle 1 of charge q_1 is at x = -a, and particle 2 charge q_2 is at x = +a. If their net electrostatic force on particle 3 of charge +Q is to be zero, what must be the ratio q_1 / q_2 when particle 3 is at (a) x = +0.750 a and (b) x = +1.50 a ?

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5. In Fig., particle 1 of charge +q and particle 2 of charge +9.00 q are held at separation L = 8.00 cm on

an x axis. If particle 3 of charge q_3 is to be located such that the three particles remain in place when released, what must be the (a) x and (b) y coordinates of particle 3, and (c) the ratio q_3 / q ?

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6. In Fig., particles 1 and 2 are fixed in place on an axis, at a separation of L = 6.00 cm. Their charges are $q_1 = +e$ and $q_2 = -27e$. Particle 3 with charge

$q_3 = +4e$ is to be placed on the line between particles 1 and 2 , so that they produce a net electrostatic force $\vec{F}_{3,\text{net}}$ on it. (a) At what coordinate should particle 3 be placed to minimize the magnitude of that force ? (b) What is that minimum magnitude ?

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7. As a cat rubs its back along a carpet, it acquires a charge of $+8.2 \times 10^{-7} C$. How many electrons did it lose to the carpet ?

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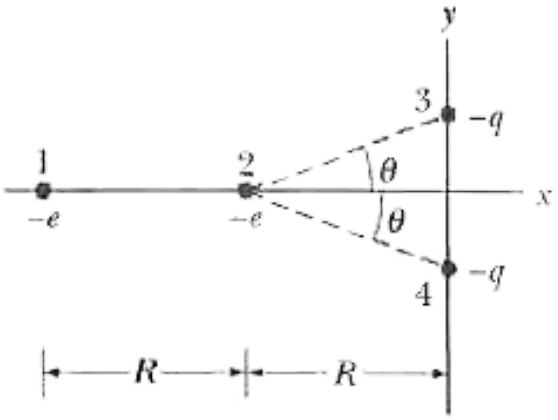
8. Figure shows electrons 1 and 2 on an x axis and charged ions 3 and 4 of identical charge -q and at identical angles θ. Electron 2 is free to move, the other three particles are fixed in place at horizontal distances R from electron 2 and are intended to hold electron 2 in place. For physically possible values of $q \leq 5e$, what are the (a) largest, (b) second largest ,

and (c) third largest values of θ for which electron 2 is held in place ?



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9. The magnitude of the electrostatic force between point charges $q_1 = 26.0\mu C$ and $q_2 = 47.0\mu C$ is initially 5.70 N. The separation is the changed such that the force magnitude is then 0.570 N. (a) What is

the ratio of the new separation to the initial separation ? (b) What is the new separation ?

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10. In the return stroke of a typical lightning bolt, a current of $2.8 \times 10^4 A$ exists for $20 \mu s$. How much charge is transferred in this event ?

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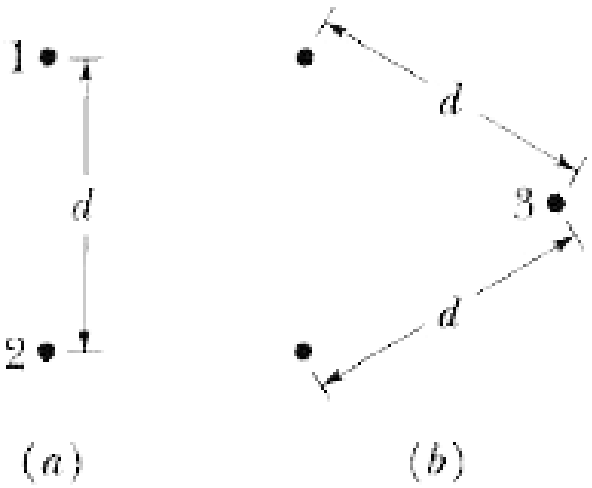
11. In Fig., particles 1 and 2 have charge $20.0 \mu C$ each and are held at separation distance d = 0.75 m. (a)

What is the magnitude of the electrostatic force on particle 1 due to particle 2? In Fig., particle 3 of charge $20.0\mu C$ is positioned so as to complete an equilateral triangle. (b) What is the magnitude of the net electrostatic force on particle 1 due to particles 2 and 3 ?



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12. Two tiny, spherical water drops, with identical charges of $-1.00 \times 10^{-16} C$, have a center-to-center separation of 1.20 cm. (a) What is the magnitude of the electrostatic force acting between them ? (b) How many excess electrons are on each drop, giving it its charge imbalance ?

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13. The magnitude of the electrostatic force between two identical ions that separated by a distance of $10.0 \times 10^{-10} m$ is $9.25 \times 10^{-10} N$. (a) What is the charge of each ion ? (b) How many electrons are

"missing" from each ion (thus giving the ion its charge imbalance) ? (c) What is the force magnitude if the separation is halved ?

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14. Two identical conducting spheres, fixed in place, attract each other with an electrostatic force of 0.108 N when their center-to-center separation is 50.0 cm. The spheres are then connected by a thin conducting wire. When the wire is removed, the spheres repel each other with an electrostatic force of 0.144 N. Of the initial charges on the spheres, with a positive net charge, what was (a) the negative

charge on one of them and (b) the positive charge on the other ?

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15. Two equally charged particles, held $3.2 \times 10^{-3} m$ apart, are released from rest. The initial acceleration of the first particle is observed to be $7.0 m / s^2$ and that of the second to be $9.0 m / s^2$. If the mass of the first particle is $6.3 \times 10^{-7} kg$, what are (a) the mass of the second particle and (b) the magnitude of the charge of each particle ?

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16. The charges and coordinates of two charged particles held fixed in an xy plane are $q_1 = +3.0\mu C, x_1 = 3.5cm, y_1 = 0.50cm,$ and $q_2 = -4.0\mu C, x_2 = -2.0cm, y_2 = 1.5cm.$ Find the (a) magnitude and (b) direction of the electrostatic force on particle 1 due to particle 2. At what (c) x and (d) y coordinates should a third particle of charge $q_3 = +6.0\mu C$ be placed such that the net electrostatic force on particle 1 due to particles 2 and 3 is zero ?

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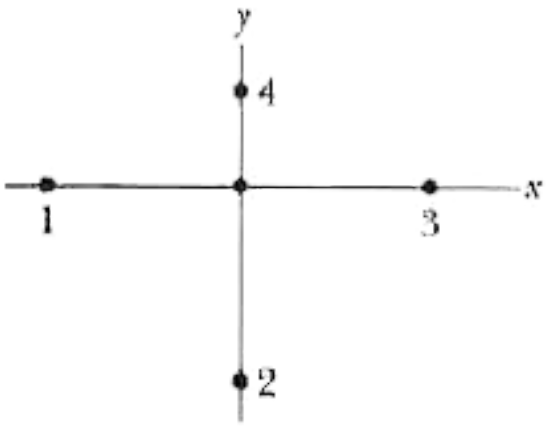
17. In Fig., particles 2 and 4, of charge -e are fixed in place on a y axis, at $y_2 = -10.0cm$ and $y_4 = 5.00cm$. Particles 1 and 3, of charge -e can be moved along the x axis. Particle 5, of charge +e, is fixed at the origin. Initially particle 1 is at $x_1 = -10.0cm$ and particle 3 is at $x_3 = 10.0cm$ (a) To what x value must particle 1 be moved to rotate the direction of the net electric force $\overrightarrow{F}_{\text{net}}$ on particle 5 by 60° counterclockwise? (b) With particle 1 fixed at its new position, to what x value must you move particle 3 to rotate $\overrightarrow{F}_{\text{net}}$ back to its original

direction ?



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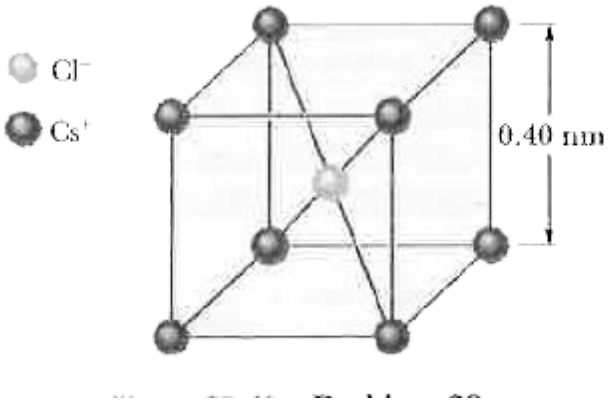
18. In crystals of the salt cesium, cesium ions Cs^+ form the eight corners of a cube and a chlorine ion Cl^- is at the cube's center Fig. The edge length of the cube is 0.40 nm. The Cs^+ ions are each deficient by one electron (and thus each has a charge of -e),

and the Cl^- ion has one excess electron (and thus has a charge of -e). (a) What is the magnitude of the net electrostatic force exerted on the Cl^- ion by the eight Cs^+ ions at the corners of the cube? (b) If one of the Cs^+ ions is missing, the crystal is said to have a defect, what is the magnitude of the net electrostatic force exerted on the Cl^- ion by the seven remaining Cl^+ ions ?



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19. Two particles are fixed on an x axis. Particle 1 of charge $50\mu C$ is located at x = - 20.0 cm, particle 2 of charge Q is located at x = 3.0 cm. Particle 3 of charge magnitude $20\mu C$ is released from rest on the y axis y = 2.0 cm. What is the value of Q if the initial acceleration of particle 3 is in the positive direction of (a) the x axis and (b) the y axis ?

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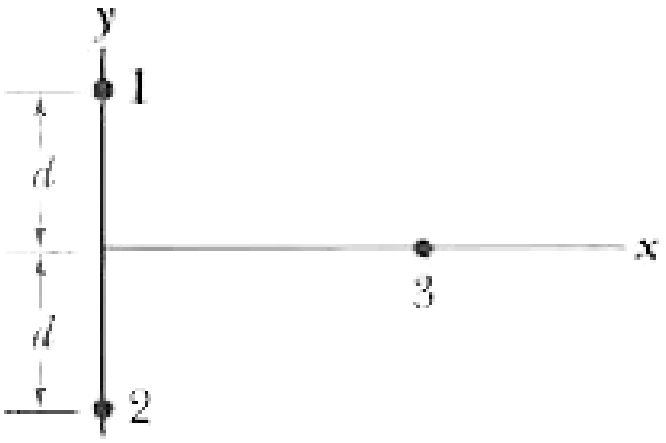
20. In Fig., particles 1 and 2 of charge $q_1 = q_2 = +4e$ are on a y axis at distance d = 1.70 m from the origin. Particle 3 of charge $q_3 = +8e$ is

moved gradually along the x axis from x = 0 to x = +5.0 m. At what values of x will the magnitude of the electrostatic force on the third particle from the other two particles be (a) minimum and (b) maximum ? What are the (c) minimum and (d) maximum magnitudes ?



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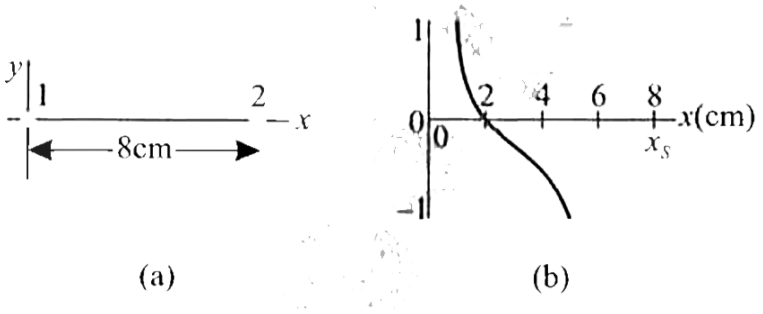
21. In Fig. a, particle 1 (of charge q_1) and particle 2 (of charge q_2) are fixed in place on an x axis, 8.00 cm apart.



(a) (b)

Particle 3 (of charge $q_3 = +8.00 \times 10^{-19} C$) is to be placed on the line between particles 1 and 2 so that they produce a net electrostatic force $F_{\text{net}} = 2F_0$ on it Figure b gives the x component of that force versus the coordinate x at which particle 3 is placed. The scale of the x-axis is set by $x_s = 8.0$cm.

What are (a) the sign of charge q_1 and (b) the ratio q_2 / q_1?

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22. A particle of charge $3.00\mu C$ is separated by 0.120 m from a particle of charge $-1.50\mu C$. (a) What is the magnitude of the electrostatic force between them ? (b) What must their separation be to reduce that force by an order of magnitude ?

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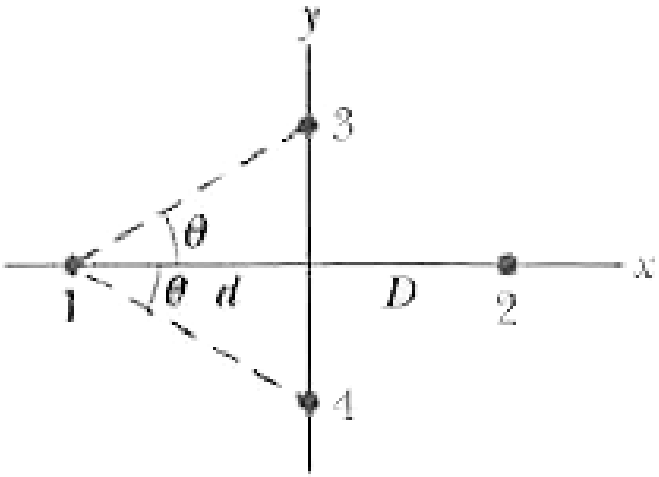
23. Figure shows an arrangement of four charged particles, with angle $\theta = 35.0^\circ$ and distance d = 2.00 cm. Particle 2 has charge $q_2 = +8.00 \times 10^{-19} C$, particle 3 and 4 have charges $q_3 = q_4 = -1.60 \times 10^{-19} C$, (a) What is distance D between the origin and particle 2 if the net electrostatic force on particle 1 due to the other particles is zero ? (b) If particles 3 and 4 were moved closer to the x axis but maintained their symmetry about that axis, would the required value of D be

greater than, less than, or the same as the part (a) ?



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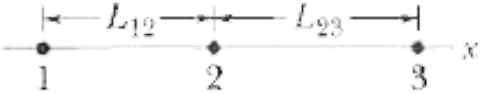
24. In Fig., three charged particles lie on an x axis. Particles 1 and 2 are fixed in place. Particle 3 is free to move, but the net electrostatic force on it from particles 1 and 2 happens to be zero. If $2.0L_{23} = L_{12}$,

what is the ratio q_1 / q_2 ?



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25. Two charged particles are fixed to an x axis : Particle 1 of charge $q_1 = 2.1 \times 10^{-8} C$ is at position x = 20 cm and particle 2 of charge $q_2 = -4.00 q_1$ is at position x = 70 cm. (a) At what coordinate on the axis (other than at infinity) is the net electric field produced by the two particles equal to zero ? (b) What is the zero-field coordinate if the particles are interchanged ?

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26. At what distance along the central perpendicular axis of a uniformly charged plastic disk of radius 0.600 m is the magnitude of the electric field equal to 25% of the magnitude of the field at the center of the surface of the disk ?

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27. Assume that a honeybee is a sphere of diameter 1.000 cm with a charge $+60.0pC$ uniformly spread over its surface . Assume also that a spherical pollen

grain of diameter $40.0\mu C$ is electrically held on the surface of the bee because the bee's charge induces a charge of $1.00pC$ on the near side of the grain and a charge of $1 + 1.00pC$ on the far side. (a) what is the magnitude of the net electrostatic force on the grain due to the bee ? Next, assume that the bee brings the grain to a distance of 1.000 mm from the tip of a flower's stigma and that the tip is a particle of charge $-60.0pC$. (b) What is magnitude of the net electrostatic force on the grain due to the stigma ? (c) Does the grain remain on the bee or move to the stigma ?

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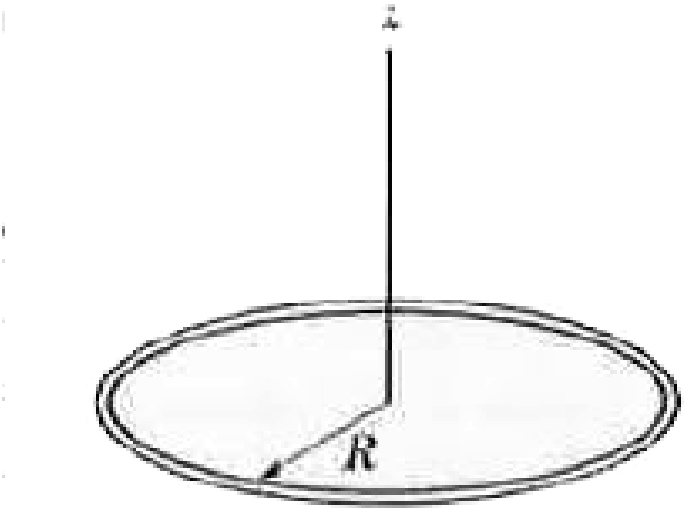
28. A thin nonconducting rod with a uniform distribution of positive charge Q is bent into a complete circle of radius R (Fig.). The central perpendicular axis through the ring is a z aaxis, with the origin at the center of the ring. What is the magnitude of the electric field due to the rod at (a) z = 0 and (b) $z = \infty$? (c) In terms of R, at what positive and $Q = 5.00\mu C$, what is the maximum

magnitude ?



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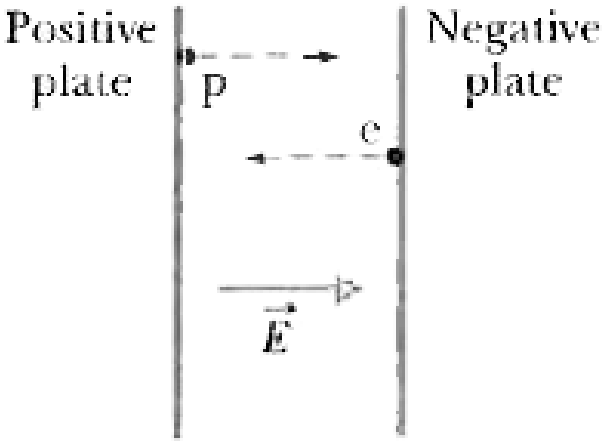
29. Two large parallel copper plates are 8.0 cm apart and have a uniform electric field between them as depicted in Fig. An electron is released from the

negatibe plate at the same time that a proton is released from the positive plate. Neglect the force of the particle on each other and find their distance from the positive plate when they pass each other.



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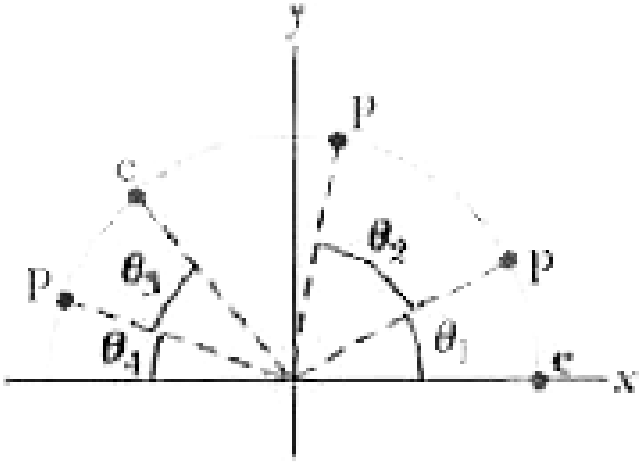
30. Figure shows an uneven arrangement of electrons (e) and protons (p) on a circular arc of

radius r = 2.50 cm, with angles $\theta_1 = 30.0^\circ, \theta_2 = 50.0^\circ, \theta_3 = 30.0^\circ,$ and $\theta_4 = 20.0^\circ$. What are the (a) magnitude and (b) direction (relative to the positive direction of the x axis) of the net electric field produced at the net electric field produced at the center of the arc ?



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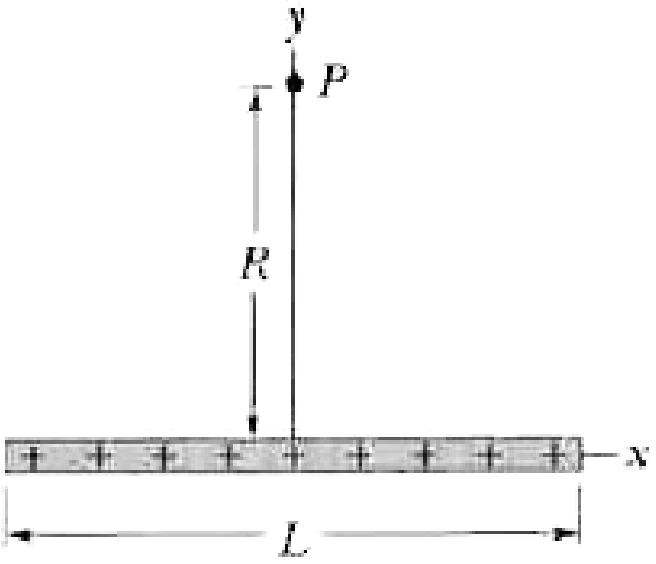
31. In Fig., positive charge q = 9.25 pC is spread uniformly along a thin nonconducting rod of length L = 16.0 cm. What are the (a) magnitude and (b) direction (relative to the positive direction of the x axis) of the electric field produced at point P, at distance R = 6.00 cm from the rod along its perpendicular bisector ?



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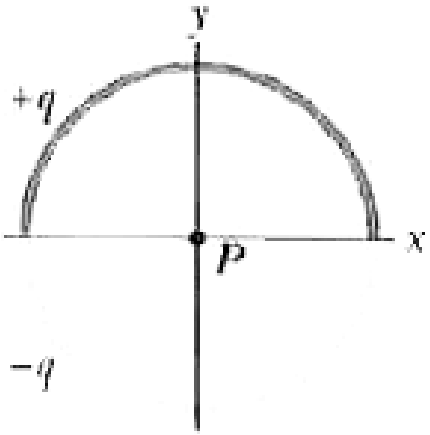
32. In Fig., two curved plastic rods, one of charge +q and the other of charge -q form a circle of radius R = 4.25 cm in an xy plane. The x axis passes through both of the connecting points and the charge is distributed uniformly on both rods. If q = 15.0 pC, what are the (a) magnitude and (b) direction (relative to the positive direction of the x axis) of the electric field $\vec{E}$ produced at P, the center of the

circle ?



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33. A charged particle creates an electric field of magnitude 300 N/C at a point 0.800 m away. What is

the difference in the field magnitude between that point and one at 0.400 m ?

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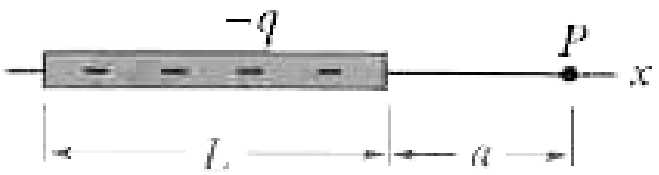
34. In Fig., a nonconducting rod of length L = 8.15 cm has a charge -q = -4.23 fC uniformly distributed along its length. (a) What is the linear charge density of the rod ? What are the (b) magnitude and (c) direction (relative to the positive direction of the x axis) of the electric field produced at point P, at distance a = 6.00 cm from the rod ? What is the electric field magnitude produced at distance a = 50 m by (d) the rod and (e) a particle of charge -q = -4.23

fC that we use to replace the rod ? (At that distance, the rod "looks" like a particle.)



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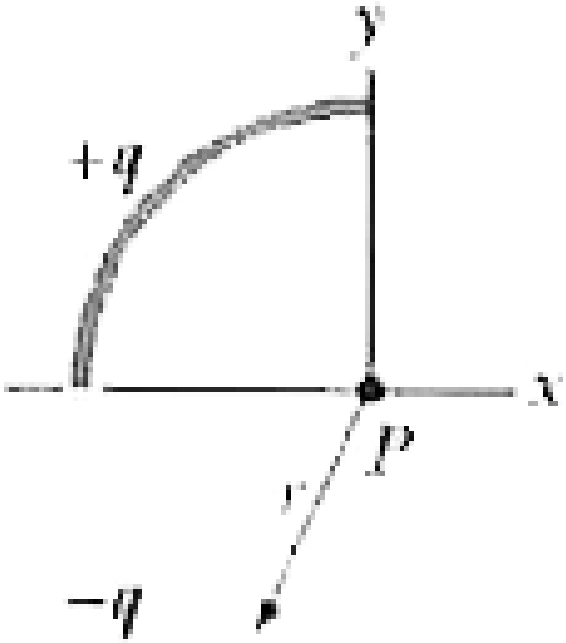
35. In Fig., a thin rod forms a semicircle of radius r = 3.00 cm. Charge is uniformly distributed along the rod, with +q = 4.50 pC in the upper half and -q = -4.50 pC in the lower half. What are the (a) magnitude and (b) direction (relative to the positive direction of the x axis) of the electric field $\vec{E}$ at P, the center of the

semicircle ?



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36. Two charged particles are attached to an x axis:

Particle 1 of charge $-4.00 \times 10^{-7} C$ is at position x =

-5.00 cm and particle 2 of charge $+4.00 \times 10^{-7} C$ is at position x = 10.cm. Midway between the particles, what is their net electric field in unit-vector notation ?

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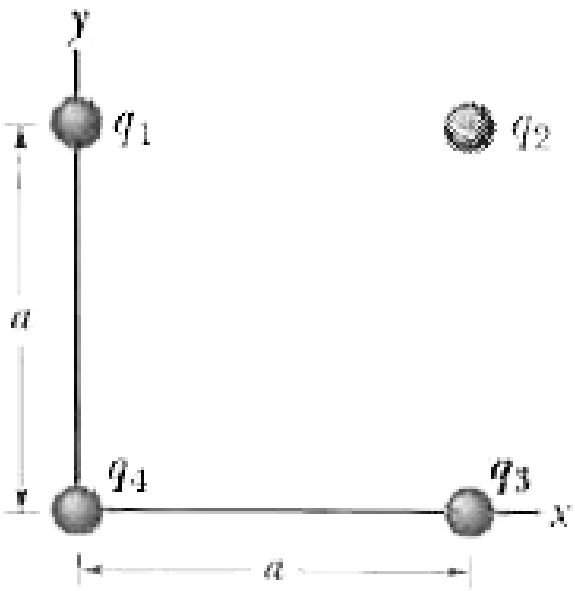
37. In Fig., the four particles form a square of edge length a = 5.00 cm and have charges $q_1 = +3nC, q_2 = -15nC, q_3 = +15nC,$ and $q_4 = -30nC$. In unit-vector notation, what net electric field do the particles produce at the square's

center ?



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38. An electron with a speed of $2.60 \times 10^8 cm/s$ enters and electric field of magnitude $1.00 \times 10^3 N/C$, travelling along a field in the

direction that retards its motion. (a) How far will the electron travel in the field before stopping momentarily, and (b) how much time will have elapsed ? (c) If the region containing the electric field is 8.00 mm long (too short for the electroc to stop within it),what fraction of the electrons initial energy will be lost in that region ?

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39. An electron is released from rest on the axis of an electric dipole is 25 nm from the center of the dipole. What is the magnitude of the electron's acceleration if the dipole moment is $3.6 \times 10^{-29} C.m$? Assume

that 25 nm is much larger than the separation of the charged particles that form the dipole ?

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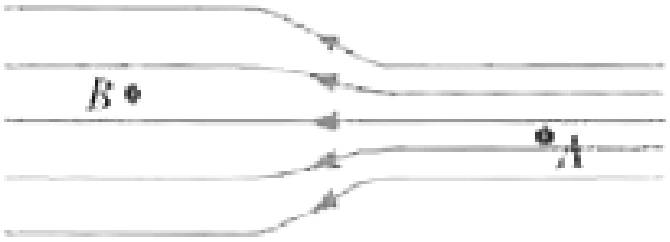
40. In Fig. the electric field lines on the left have twice the separation of those on the right. (a) If the magnitude of the field at A is 60 N/C, what is the magnitude of the force on a protorn at A? (b) What is the magnitude of the field at B?



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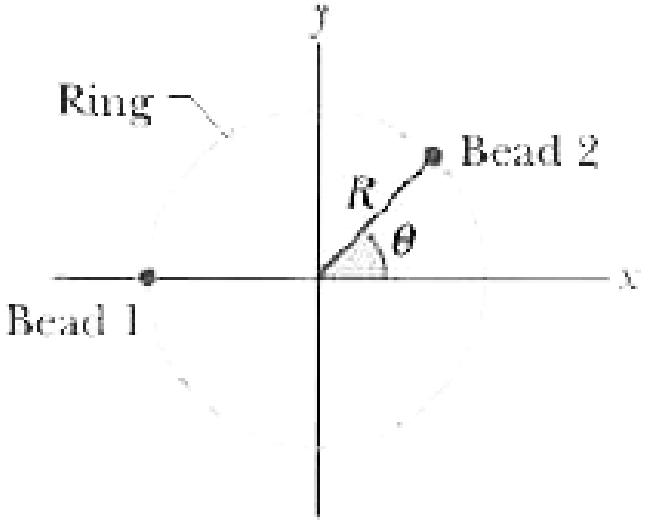
41. Figure shows a distance ring of radius R = 43.0 cm. Two small charged beads are on the ring : Bead 1 of charge $+20.0\mu C$ is fixed in place at the left side , bead 2 of charge $+6.00\mu C$ can be moved along the ring. The two beads produce a net electric field of magnitude e at the center of the ring. At what (a) positive and (b) negative value of angle θ should bead 2 be positioned such that

$E = 2.00 \times 10^5 N/C$?



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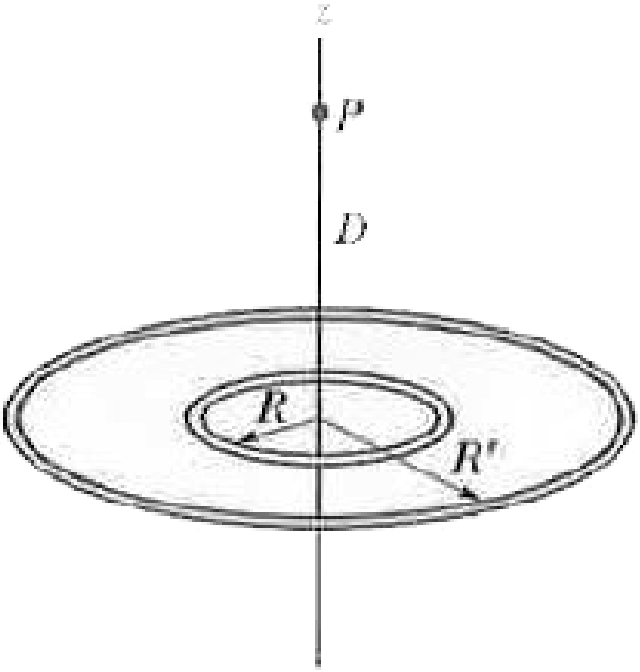
42. Figure shows two concentric rings, of radii R and R' = 4.00 R, that lie on the same plane. Point P lies on the central z axis, at distance D = 2.00 R from the

center of the rings. The smaller ring has uniformly distributed charge +Q. In terms of Q, what is the uniformly distributed charge on the larger ring if the net electriv field at P is zero ?



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43. A circular plastic disk with radius R = 2.00 cm has a uniformly distributed charge $Q = +(2.00 \times 10^6)e$ on one face. A circular ring of width $40\mu m$ is centers on that face, with the center of that width at radius r = 0.50 cm. In coulombs, what charge is contained within the width of the ring ?

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44. Charge is uniformly distributed around a ring of radius R = 4.60 cm, and the resulting electric field magnitude R is measured along the ring's central

axis (perpendicular to the plane of the ring). At what distance from the ring's center is E maximum ?

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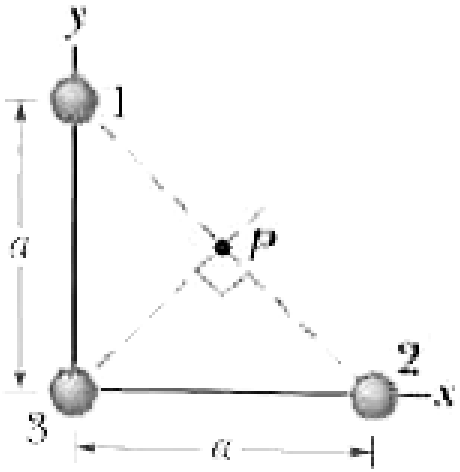
45. In Fig., the three particles are fixed in place and have charges $q_1 = q_2 = +5e$ and $q_3 = +2e$. Distance $a = 3.00\mu m$. What are the (a) magnitude and (b) direction of the net electric field at point P

due to the particles ?



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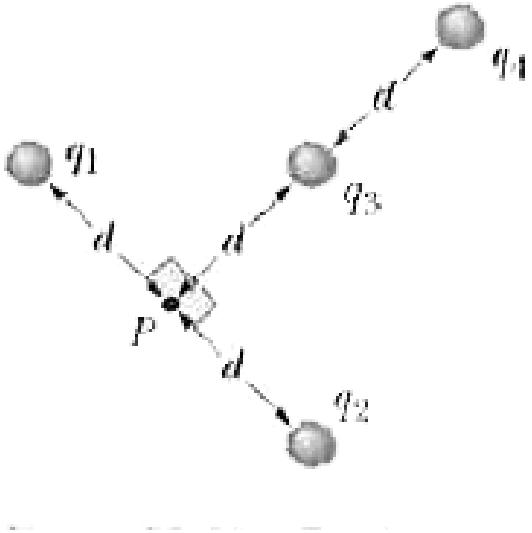
46. In Fig., the four particles fixed in palce and have charges $q_1 = q_2 = +5e, q_3 = +3e$ and $q_4 = -1e$. Distance $d = 8.0\mu m$. What is the magnitude of the net electric field at point P due to

the particles ?



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47. An electric dipole consisting of charges of magnitude $1.50nC$ separated by 6.20 μm is in an electric field of strength 300 N/C. what are (a) the magnitude of the electric dipole moment and (b) the

difference between the potential energies for dipole orientations parallel and perpendicular to $\vec{E}$?

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48. An electron is released from rest in a uniform electric field of magnitude $2.00 \times 10^4 N/C$. (a) Calculate the acceleration of the electron. (Ignore gravitational) (b) How much time does the electron take to reach 1.00 % of the speed of light ?

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49. An electron enters a region of uniform electric field with an initial velocity of 30 km/s in the same direction as the electric field, which has magnitude E = 50 N/C. (a) What is the speed of the electron 1.5 ns after entering this region? (b) How far does the electron travel during the 1.5 ns interval ?

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50. A uniform electric field exists in a region between two oppositely charged plates. An electron is released from rest at the surface of the negatively charged plate and strikes the surface of the opposite

plate, 3.0 cm away, in a time $1.5 \times 10^{-8} s$. Just as the electron strikes the second plate, what are the its (a) momentum magnitude and (b) kinetic energy ? (c) What is the magnitude of the electric field $\vec{E}$?

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51. An electric dipole consists of charges $+2e \text{ and } -2e$ separated by 0.78mm. It is an electric field of strength $3.4 \times 10^{6} N/C$. Calculate the magnitude of the torque on the dipole when the dipole moment is (a) parallel to (b) perpendicular to, and (c) anti-parallel to the electric field.

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

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

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53. A charged particles produces an electric field with a magnitude of 2.0 N/C at a point that is 50 cm away from the particle. What is the magnitude of the field at an additional distance of 2.5 cm ?

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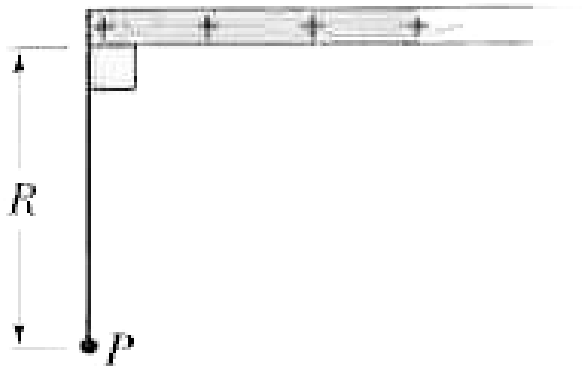
54. In Fig. a "semi-infinite" nonconducting rod (that is, infinite in one direction only) has uniform linear charge density λ. (a) show that the electric field $\vec{E}_p$ at point P makes an angle 45° with the rod and that this result is independent of the distance R. (Hint : Separetly find the component of $\vec{E}_p$ parallel to the

rod and the component perpendicular to the rod.)

(b) Find the the field magnitude for linear charge density 4.52 nC/m and R = 3.80 cm.



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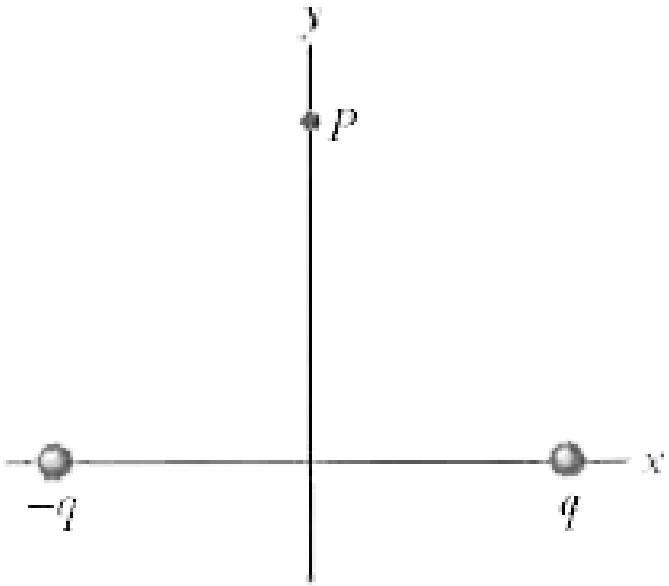
55. Figure shows two charged particles on an x axis : $-q = -3.20 \times 10^{-19} C$ at $x = -3.00m$ and $q = 3.20 \times 10^{-19} C$ at = + 3.00 m. What are (a)

magnitude and (b) direction (relative to the positive direction of the x axis) of the net electric field produced at point P at y = 4.00 m? (c) What is the magnitude of the net field if y is doubled ?



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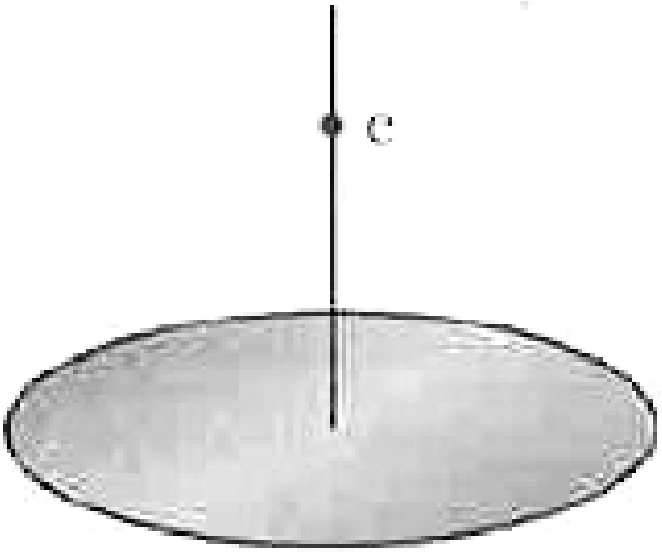
56. In Fig. an electron (e) is to be released from rest on the central axis of a uniformly charged disk of radius R. The surface charge density on the disk is $+5.00\mu C/m^2$. What is the magnitude of the electron's initial acceleration if it is released at a distance (a) R, (b) R/100, and (c) R/1000 from the center of the disk ? (d) Why does the acceleration magnitude increase only slightly as the release point

is moved closer to the disk ?



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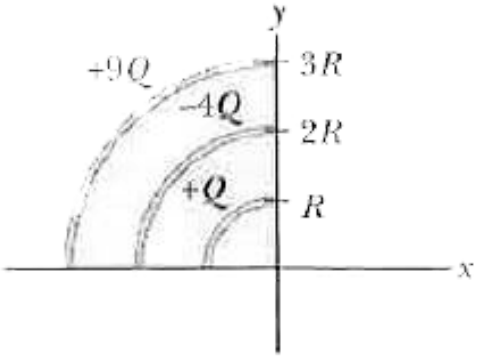
57. Figure shows the three circular arcs centered on the origin of a coordinate system. On each arc, the uniformly distributed charge is given in terms of

$Q = 4.00\mu C$. The radii are given in terms of R = 5.00 cm. What are the (a) magnitude and (b) direction (relative to the positive x direction) of the net electric field at origin due to the arc ?



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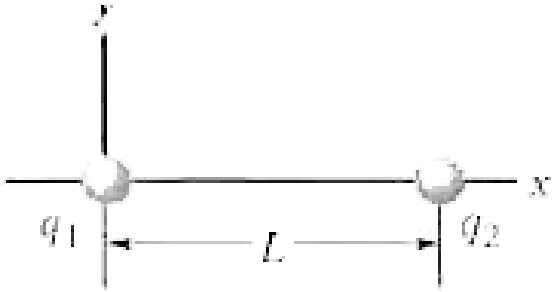
58. Two charged particles lie along x axis as shown in Fig. The particle with charge $q2 = +8\mu C$ is at x =

6.00 m, and the particle with charge $q1 = +2\mu C$ is at the origin. Locate the point where the resultant electric field is zero.



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59. In the situation described in Problem 63, find the condition that a charge kept on x = 2m may be in a stable equilibrium. If the charge is of magnitude $1\mu C$ and has a mass of 3 g, find the time period of

small oscillations of the body from its equilibrium position.

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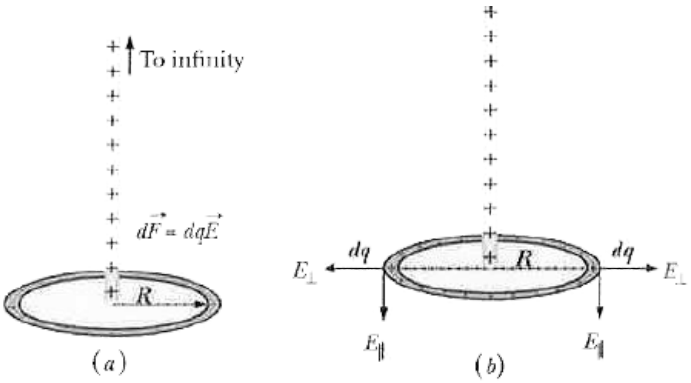
60. A semi-infinite charged rod is arranged so that its one end coincides with the center of a charged ring as shown in Fig. Both of them have a charge per unit length of λ. The radius of ring is R. The electric field of rof exert force on an element of the ring as shown in Fig. (a) What is the force on the ring due to the rod ? (b) What is the increase in the tension of the

ring due to the rod ?



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61. A positive charge q is placed in front of a conducting solid body at a distance d from its center. (a) Find the electric field at the center of the cube due to the charges appearing on its surface. (b) Does the body have to be spherical for the answer to be true ?

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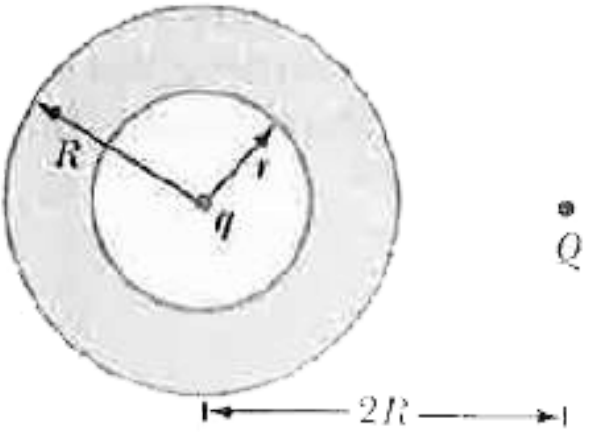
62. A conducting spherical shell of outer radius R and inner radius r = 3R/4 has no net charge on it. At its center there is a point charge q, and at a distance 2R from its center there is a point charge Q (Fig.) . (a) What is the magnitude of the electrostatic force on the charge q at the center due to the shell ? (b)

What is the magnitude of net force on it?



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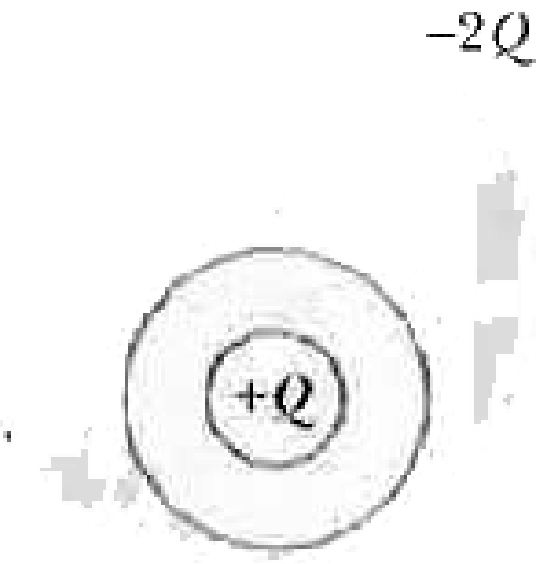
63. A pellet with charge +Q is centered inside a spherical cavity in a conducting ball. The conducting ball has a charge -2q on it. The cavity in the ball is off-center, as shown in Fig. (a) How much charge resides on the inner surface of the cavity ? (b) Is the

charge on the cavity surface distributed uniformly or nonuniformly ? Why ? (c) How much charge resides on the outer surface of the conducting ball ? (d) Is the charge on the ball's outer surface distribution uniformly or nonuniformly ?



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Practice Questions Single Correct Choice Type

1. Complete the following statement : When a glass rod is rubbed with silk cloth, the rod become positively charged as

A. Positive charges are transferred from the silk to the rod.

B. negative charges are transferred from the rod to the silk.

C. positive charge are created on the surface of the rod.

D. negative charges are transferred from the silk to the rod.

Answer: B

2. An aluminium nail has an excess charge of $+3.2\mu C$. How many electrons must be added to the nail to make it electrically neutral ?

A. 2.0×10^{13}

B. 3.2×10^{16}

C. 2.0×10^{19}

D. 3.2×10^{6}

Answer: A

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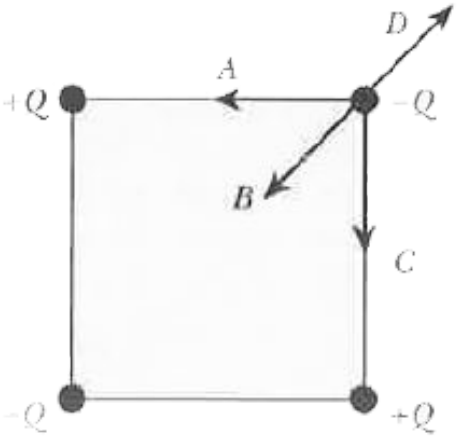
3. Four point charges, each of the same magnitude, with varying signs are arranged at the corners of square as shown in the figure below. Which of the arrows labelled A, B, C and D gives the correct direction of the net force that acts on the charge at

the upper right corner ?



A. A

B. B

C. C

D. D

Answer: B

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4. 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 a square ABCD of side 10 cm. What is the force on a charge of $1\mu C$ placed at the center of the square ?

A. $2 \times 10^3 N$

B. $4 \times 10^3 N$

C. $8 \times 10^3 N$

D. 0

Answer: D

5. Assuming only electrostatic forces are present, electric field lines in the space surrounding a charge distribution show

A. Only the directions in which static charges would accelerate when at points on those lines.

B. Only the directions in which moving charges would accelerate when at points on those

lines.

C. Tangents to the directions in which either static charges or moving charges would accelerate when passing through points on those lines.

D. The paths static or moving charges would take.

Answer: C

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6. Two uncharged conducting spheres, A and B, are suspended from insulating threads so that they

touch each other as shown in the figure. While a negatively charged rod is held near, but not touching sphere A, someone moves ball B away from A. How will the spheres be charged, if at all ?

Sphere *A*	Sphere *B*
(a) 0	+
(b) –	+
(c) 0	0
(d) +	–

A. Sphere A - 0, Sphere :- +

B. Sphere A - 0, Sphere :- +

C. Sphere A - 0, Sphere :- 0

D. Sphere A - +, Sphere :- -

Answer: D

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7. A plate carries a charge of $-3.0\mu C$, while a rod carries a charge of $+2.0\mu C$. How many electrons must be transferred from the plate to the rod, so that both objects have the same charge ?

A. 6.3×10^{12} electrons

B. 1.2×10^{13} electrons

C. 8.0×10^{12} electrons

D. 1.6×10^{13} electrons

Answer: D

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

A. $1.2 \times 10^6 N/C$

B. $5.4 \times 10^6 N/C$

C. $6.9 \times 10^6 N/C$

D. $9.9 \times 10^6 N/C$

Answer: B

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9. Which one of the following statements is true concerning the strength of the electric field between two oppositely charged parallel plates ?

A. It is zero midway between the plates

B. It is a maximum midway between the plates

C. It is maximum near the positively charged plate

D. It is constant between the plate except near the edges.

Answer: D

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10. Two tiny conducting spheres are identical any carry charges of $-20.0\mu C$ and $+50.0\mu C$. They are separated by a distance of 2.50 cm. The spheres are brought into contact and then separated to a

distance of 2.50 cm. Determine the magnitude of the force that each sphere now experiences, and state whether the force is attractive or repulsive.

A. $1.30 \times 10^2 N$, attractive

B. $3.24 \times 10^3 N$, attractive

C. $3.24 \times 10^3 N$, repulsive

D. $1.44 \times 10^4 N$, repulsive

Answer: C

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11. A $-4.0\mu C$ charge is located 0.30 m to the left of a + $+6.0\mu C$ charge. What is the magnitude and direction of the electrostatic force on the positive charge ?

A. $2.4N$ to the right

B. $2.4N$ to the left

C. $4.8N$ to the right

D. $4.8N$ to the left

Answer: B

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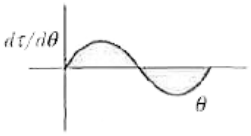
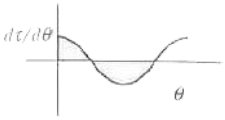
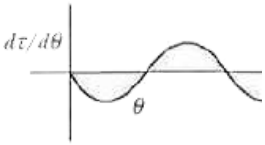
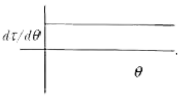
12. Correct plot of $d\tau / d\theta$. θ vs θ in case of an electric dipole placed in any uniform electric field is

A. 

B. 

C. 

D. 

Answer: B

View Text Solution

13. Consider three identical metal spheres, A, B and C. Sphere A carries of $-2.0\mu C$, spheres B carries a charge of $-6.0\mu C$, and spheres C carries a charge of $+5.0\mu C$. Sphere A and B are touched together and then separated. Sphere B and C are then touched and separated. Does sphere C end up with an excess or a deficiency of electrons and how many electrons is it ?

A. deficiency, 6×10^{13}

B. excess, 3×10^{13}

C. excess, 2×10^{13}

D. deficiency, 3×10^{12}

Answer: D

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14. An early model for an atom considered to have a positively charged point nucleus of charge 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 a distance r from the nucleus, where $r > R$?

A. $\frac{1}{4\pi\varepsilon_0}\frac{Ze}{r^2}$

B. $\frac{1}{4\pi\varepsilon_0}\frac{Ze}{R^2}$

C. $\frac{1}{4\pi\varepsilon_0}\frac{Ze}{r^2 - R^2}$

D. 0

Answer: D

Watch Video Solution

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

(i) q is positive and Δ is along the line joining the charges

(ii) q is positive and Δ is perpendicular to the line joining the charges

(iii) q is negative and Δ is perpendicular to the line joining the charges

(iv) q is positive and Δ is along the line joining the charges

A. q is positive and the given displacement is along line joining the charges.

B. q is positive and the given displacement is perpendicular to the line joining the charges.

C. q is negative and the given displacement is perpendicular to the line joining the charges.

D. q is negative and the given displacement is along line

Answer: D

 Watch Video Solution

16. A charge Q exerts a 12 N force on another charge q. If the distance between the charges is doubled, what is the magnitude of the force exerted on Q by q?

A. 3 N

B. 6 N

C. 24 N

D. 36 N

Answer: A

Watch Video Solution

17. Four identical metallic objects carry the following charges : +1.6, +6.2, -4.8 and $-9.4\mu C$. The object are brought simultaneously into contact, so that each touches the others. Then they are separated, what is the final charge on each object ?

A. $-6.4\mu C$

B. $-1.6\mu C$

C. $-5.6\mu C$

D. $-2.4\mu C$

Answer: B

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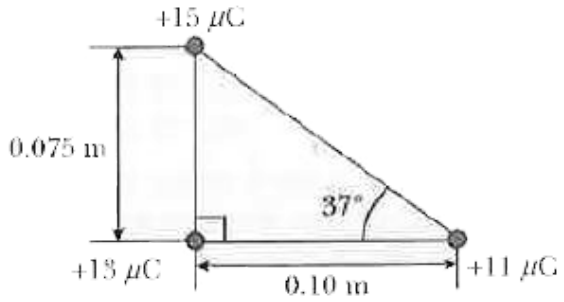
18. Three charges are positioned as indicated in the following figure. What are the horizontal and vertical components of the net force exerted on the $+15\mu C$

charge by the $+11\mu C$ and $+13\mu C$ charges ?



Horizontal	Vertical
(a) 95 N	310 N
(b) 76 N	310 N
(c) 76 N	370 N
(d) 95 N	130 N

A. Horizontal - 95 N, Vertical - 310 N

B. Horizontal - 76 N, Vertical - 310 N

C. Horizontal - 76 N, Vertical - 370 N

D. Horizontal - 95 N, Vertical - 130 N

Answer: C

View Text Solution

19. An electric dipole in a uniform electric field has potential energy U. The magnitude of the torque acting on the dipole due to the field is τ.

A. U is minimum and τ is zero when the dipole is perpendicular to the field.

B. U is zero and τ is a maximum when the dipole is perpendicular to the field.

C. U is a minimum and τ is a maximum when the dipole is perpendicular to the field.

D. U is a minimum and τ is zero when the dipole is anti-parallel to the field.

Answer: B

Watch Video Solution

20. At which point (or points) in the given figure is the electric field zero N/C for the two point charges shown on the x axis ?

A. The electric field is never zero in the vicinity of these charges.

B. The electric field is zero somewhere on the x axis to the left of the +4q charge.

C. The electric field is zero somewhere on the x axis to the right of the -2q charge.

D. The electric field is zero somewhere on the x axis between the two charges, but this point is nearer to the -2q charge.

Answer: C

Watch Video Solution

21. A small object, which has a charge $q = 7.5\mu C$ and mass $m = 9.0 \times 10^{-5} kg$, is placed in a constant electric field. Starting from rest, the object accelerates to a speed of $2.0 \times 10^{3} m/s$ in a time of 0.96 s. Determine the magnitude of the electric field.

A. $2.5 \times 10^{4} N/C$

B. $4.5 \times 10^{4} N/C$

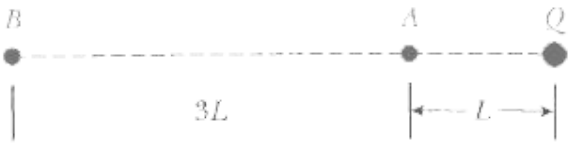
C. $3.4 \times 10^{4} N/C$

D. $1.7 \times 10^{4} N/C$

Answer: A

Watch Video Solution

22. In the following figure, point A is a distance L away from a point charge Q. point B is a distance 4L away from Q. What is the ratio of the electric field at B to that at A, E_B / E_A ?



A. $\frac{1}{16}$

B. $\frac{1}{9}$

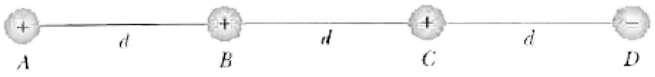
C. $\frac{1}{4}$

D. $\frac{1}{3}$

Answer: A

Watch Video Solution

23. Four point charges have equal magnitudes. Three are positive, and one is negative, as the drawing shows. They are fixed in place on the same straight line, and adjacent charges are equally separated by a distance d. Consider the net electrostatic force acting on each charge. Calculate the ratio of the largest to the smallest net force.



A. 2.3

B. 9.0

C. 1.5

D. 5.0

Answer: B

Watch Video Solution

24. What is the magnitude and direction of the electric force on a $-1.2\mu C$ charge at a point where the electric field is 2500 N/C and is directed along the +y axis.

A. 0.15 N, -y direction

B. 0.0030 N, -y direction

C. 0.15 N, +y direction

D. 0.0030 N, +y direction

Answer: B

Watch Video Solution

25. The membrane surrounding a living cell consists of an inner and an outer wall that are separated by a small space. Assume that the membrane acts like a parallel plate capacitor in which the effective charge

density on the inner and outer walls has a magnitude of $7.1 \times 10^{-6} C/m^2$. What is the magnitude of the electric field within the cell membrane ?

A. $5.9 \times 10^7 N/C$

B. $8.0 \times 10^5 N/C$

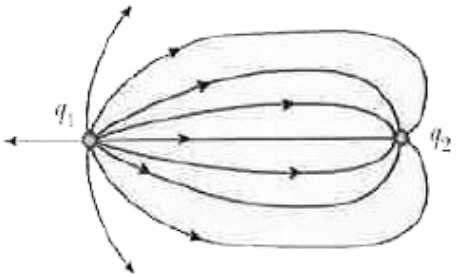
C. $2.0 \times 10^3 N/C$

D. $7.6 \times 10^{-1} N/C$

Answer: B

Watch Video Solution

26. The following figure shows the electric field lines in the vicinity of two charges. Which one of the following statements concerning this situation is true ?



A. q_1 is negative and q_2 is positive

B. The magnitude of the ratio (q_1 / q_2) is more than one.

C. Both q_1 and q_2 have the same sign of charge

D. The magnitude of the electric field is the same everywhere

Answer: B

 Watch Video Solution

27. There are four charges, each with a magnitude of $2.0\mu C$. Two are positive and two are negative. The charges are fixed to the corners of a 0.30 m square, one to a corner, in such a way that the net force on any charge is directed toward the center of the square. Find the magnitude of the net electrostatic force experienced by any charge.

A. 0.20 N

B. 0.57 N

C. 0.37 N

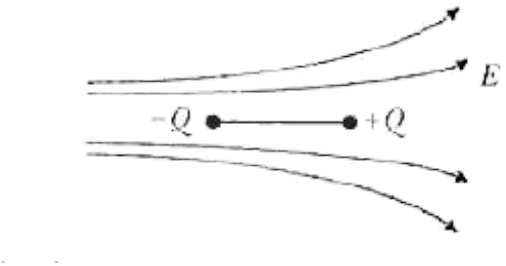
D. 0.16 N

Answer: C

Watch Video Solution

28. A rigid electric dipole is force to move in the electric field represented in the figure. Which one of the following phrases most accurately describes the initial motion of the dipole if it released from rest in

the position shown ?



A. It moves to the left

B. It moves to the right

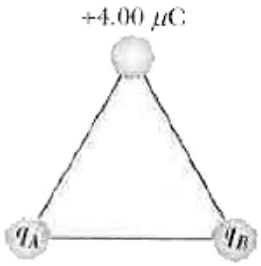
C. It does not moves at all

D. It moves toward to the top of the page

Answer: A

Watch Video Solution

29. The following figure shows an equilateral triangle, each side of which has length of 2.00 cm. Point charges are fixed to each corner, as shown. The $4.0\mu C$ charge experiences a net force due to the charges q_A and q_B. This net force points vertically downward and has a magnitude of 405 N. Determine the magnitudes and algebraic signs of the charges q_A and q_B.



q_A	q_B
(a) −2.60 μC	−2.60 μC
(b) +5.20 μC	−5.20 μC
(c) −4.50 μC	−4.50 μC
(d) −2.60 μC	−4.50 μC

A. $q_A = -2.60\mu C, q_B = -2.60\mu C$

B. $q_A = +5.20\mu C, q_B = +5.20\mu C$

C. $q_A = -4.50\mu C, q_B = -4.50\mu C$

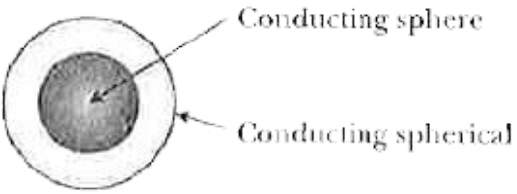
D. $q_A = 2.60\mu C, q_B = -4.50\mu C$

Answer: A

View Text Solution

30. A conducting sphere carries a net charge of $-6\mu C$. The sphere is located at the center of a conducting spherical shell that carries a net charge of $+2\mu C$ as shown in the figure. Determine the

excess charge on the outer surface of the spherical shell.



A. $-4\mu C$

B. $+4\mu C$

C. $-8\mu C$

D. $+8\mu C$

Answer: A

View Text Solution

31. Two identical conducting spheres carry charges of $+5.0\mu C$ and $-10\mu C$, respectively. The centers of the spheres are initially separated by a distance L. The two spheres are brought together so that they are in contact. The spheres are then returned to their original separation L. What is the ratio of the magnitude of the electric force on either sphere after the spheres are touched to that before they were touched ?

A. $\frac{1}{1}$

B. $\frac{9}{5}$

C. $\frac{4}{5}$

D. $\frac{5}{1}$

Answer: C

View Text Solution

32. A charge +q is located at the origin, while an identical charge is located on the x axis at x = +0.50 m. A third charge of +2 q is located on the x axis at such a place that the net electrostatic force on the charge at the origin doubles, its direction remaining unchanged. Where should the third charge be located ?

A. $+0.50m$

B. $+0.71m$

C. $-0.50m$

D. $-0.71m$

Answer: B

Watch Video Solution

33. A charge of $-3.00\mu C$ is fixed at the center of a compass. Two additional charges are fixed on the circle of the compass (radius 0.100 m). The charges on the circle are $-4.00\mu C$ at the position due north and $+5.00\mu C$ at the position due east. what is the magnitude and direction of the net electrostatic

force acting on the charge at the center ? Specify the direction relative to due east.

A. $3.60N$, 51.3° north of east

B. $34.6N$, 36.3° north of east

C. $14.4N$, 44.2° north of east

D. $17.3N$, 38.7° south of east

Answer: D

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34. Four point charges have the same magnitude of $2.4 \times 10^{-12}C$ and are fixed to the corners of a

square that is 4.0 cm on a side. Three of the charges are positive and one is negative. Determine the magnitude of the net electric field that exists at the center of the square.

A. 14N/C

B. 27 N/C

C. 42 N/C

D. 54 N/C

Answer: D

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35. At a distance r_1 from a point charge, the magnitude of the electric field created by the charge is 248 N/C. At a distance r_2 from the charge, the field has a magnitude of 132 N/C. Find the ratio r_2 / r_1 ?

A. 0.730

B. 0.939

C. 1.12

D. 1.37

Answer: D

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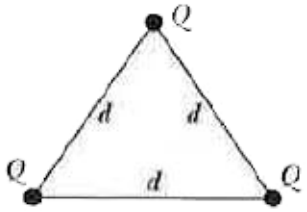
36. Three identical point charges, q, are placed at the vertices of an equilateral triangle as shown in the figure. The length of each side of the triangle is d. Determine the magnitude and direction of the total electrostatic force on the charge at the top of the triangle.



A. $\frac{Q^2\sqrt{3}}{4\pi\varepsilon_0 d^2}$, directed upward

B. $\frac{Q^2\sqrt{3}}{4\pi\varepsilon_0 d^2}$, directed downward

C. $\frac{Q^2\sqrt{3}}{2\pi\varepsilon_0 d^2}$, directed upward

D. $\frac{Q^2\sqrt{3}}{2\pi\varepsilon_0 d^2}$, directed downward

Answer: A

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37. One mole of a substance contains 6.02×10^{23} protons and an equal number of electrons. If the protons could somehow be separated from the electrons and placed in very small, individual containers separated by $1.00 \times 10^3 m$, what would be the magnitude of the electrostatic force exerted by one box on the other ?

A. $8.7 \times 10^8 N$

B. $9.5 \times 10^9 N$

C. $2.2 \times 10^{10} N$

D. $8.3 \times 10^{13} N$

Answer: D

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38. Two identical charged spheres suspended from a common point by two mass-less strings of length l are initially at a distance d ($d < < l$) apart because of their mutual repulsion . The charge begins to leak

from both the spheres at a constant rate. As a result the charge approach each other with a velocity v. Then as a function of distance x between them .

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

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

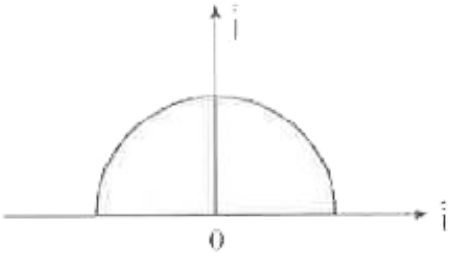
C. $v \propto x$

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

Answer: D

Watch Video Solution

39. A thin semi-circular ring of radius r has a positive charge q distributed uniformly over it as shown in the figure. The net field $\vec{E}$ at the center O is



A. $\frac{q}{2\pi^2\varepsilon_0 r^2}\hat{j}$

B. $\frac{q}{4\pi^2\varepsilon_0 r^2}\hat{j}$

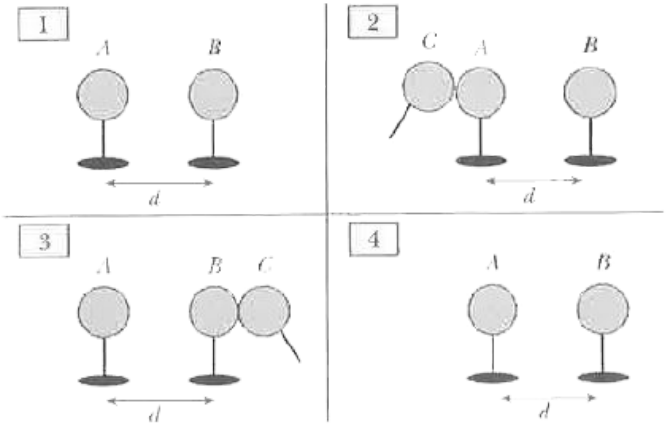
C. $-\frac{q}{2\pi^2\varepsilon_0 r^2}\hat{j}$

D. $-\frac{q}{2\pi^2\varepsilon_0 r^2}\hat{j}$

Answer: D

View Text Solution

40. In Frame 1, two identical conducting spheres, A and B, carry equal amounts of excess charge that have the same sign. The spheres are separated by a distance d, and sphere A exerts an electrostatic force on sphere B that has a magnitude F. A third sphere, C, Which is handled only by an insulating rod, is introduced in Frame 2. Sphere C is identical to A and B except that it initially uncharged. Sphere C is touched first to sphere A, in Frame 2, and then to sphere B, in Frame 3, and is finally removed in Frame 4.



Determine the magnitude of the electrostatic force that sphere A exerts on sphere B in Frame 4.

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

B. $\frac{F}{3}$

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

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

Answer: D

View Text Solution

41. A large negatively charged object was placed on an insulated table. A neutral metallic ball rolled straight toward the object but stopped before touching it. A second neutral metallic ball rolled along the same path as the first ball. Struck the first ball driving it a bit closer to the negatively charged object and stopped. After all stopped rolling, the first ball was closer to the negatively charged object than the second ball. At no time did either ball touch the charged object. which statement is correct concerning the final charge on each ball ?

A. The first ball is positive and the second negative

B. The first ball is negative and the second positive

C. Both balls remain neutral

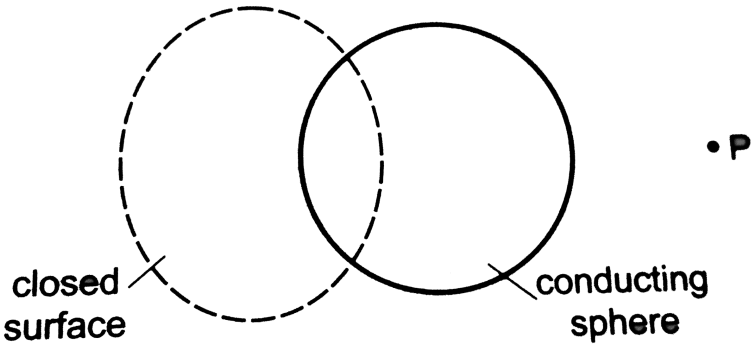
D. Both balls are positive

Answer: A

View Text Solution

42. Figure shown a closed surface which intersects a conducting sphere. If a positive charge is placed at

the point P, the flux of the electric field through the closed surface



A. will remain zero

B. will become positive

C. will become negative

D. will become undefined

Answer: B

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43. If we seal a pipe with two metal end caps around a point charge Q, the electric field outside the pipe will be

A. identical to the field of an isolated point charge

B. identically zero, because the metal shields the field

C. nonzero but dependent on where the charge is within the pipe.

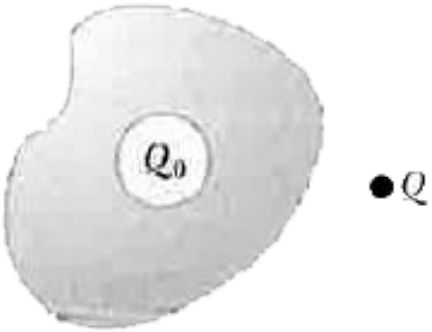
D. nonzero, but independent of where the charge is within the pipe.

Answer: D

View Text Solution

44. A charge Q_0 is placed at the center of spherical cavity of a conductor and another charge Q is placed outside the conductor as shown in the figure. The

correct statement is :



A. Force on Q_0 and Q are equal and opposite

B. Force on Q_0 is zero and force on Q is nonzero

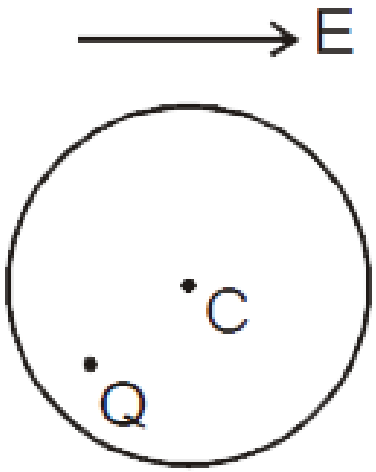
C. Force on Q and Q_0 is zero

D. Force on Q_0 is nonzero and force on Q is zero

Answer: B

View Text Solution

45. A positive point charge Q is kept (as shown in the figure) inside a neutral conducting shell whose centre is at C. An external uniform electric field E is applied. Then :



A. Force on Q due to E is zero

B. Net force on Q is zero

C. Net force acting on Q and conducting shell considered as a system is zero.

D. Net force acting on the shell due to E is toward right

Answer: D

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Practice Questions More Than One Correct Type

1. A particle of mass 2 kg chrge 1 mC is projected vertially with velocity k$10ms^{-1}$. There is as uniform

horizontal electric field of $10^4 N/C$, then

A. The horizontal range of the particle is 10 m

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

C. The maximum height reached is 5 cm

D. The horizontal range of the particle is 0 m

Answer: A::B::C

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2. Two small spheres of masses M_1 and M_2 are suspended by weightless insulating threads of lengths L_1 and L_2. The spheres carry charges Q_1

and Q_2 respectively. The spheres are suspended such that they are in level with one another and the threads are inclined to the vertical at angles θ_1 and $\theta_2$respectively . Which one of the following conditions is essential for $\theta_1 = \theta_2$?

A. $m_1 = m_2$

B. $|q_1| = |q_2|$

C. $l_1 = l_2$

D. None of these

Answer: A::C

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3. Three non-conducting infinite planes of charge A, B, and C are vertical and parallel to one another. There is a uniform electric field $\overrightarrow{E}_p$ to the right of plane C. The field $\overrightarrow{E}_p$ points to the left and the field $\overrightarrow{E}_p$ to the right of plane C. The field $\overrightarrow{E}_p$ points to the left and the field $\overrightarrow{E}_p$ points to the right. The signs of the charges on the plates A, B and C may be

A. $-, -, -$

B. $+, -, -$

C. $+, -, -$

D. $+, +, +$

Answer: B::C::D

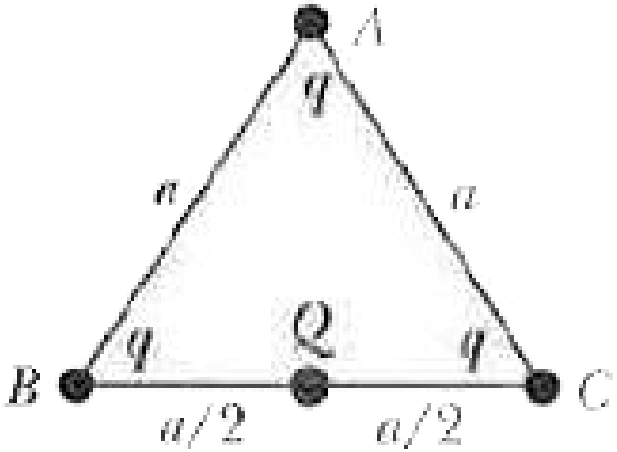
View Text Solution

Practice Questions Linked Comprehension

1. The given figure shows an equilateral triangle ABC.

A positive point charge |q is located at each of the three vertical A, B and C. each side of the triangle is of length a.

A point charge Q (that may be positive or negative) is placed at the mid-point between B and C.



Is it possible to choose the value of Q (that is non-zero) such that the force on Q is zero ? Explain why or why not.

A. Yes, because the forces on Q are vector and three vectors can add to zero

B. No, because the forces on q are vectors and three vectors can never add to zero

C. Yes, because the electric force at the mid-point between B and C is zero whether a charge is placed there or not.

D. No, because a fourth charge would be needed cancel the force on Q due to the charge at A.

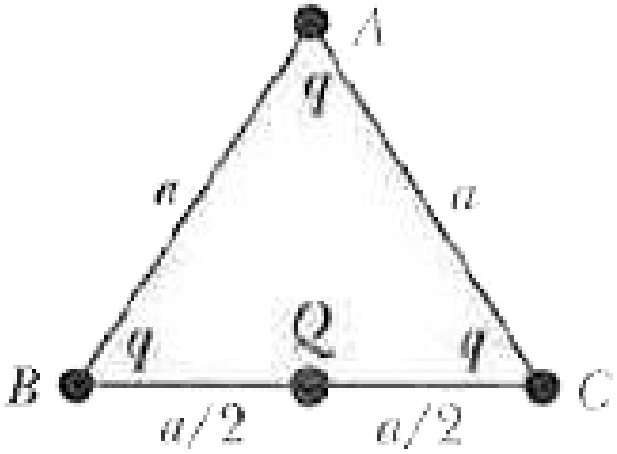
Answer: D

View Text Solution

2. The given figure shows an equilateral triangle ABC. A positive point charge |q is located at each of the three vertical A, B and C. each side of the triangle is

of length a.

A point charge Q (that may be positive or negative) is placed at the mid-point between B and C.



Determine an expression for the magnitude and sign of Q so that the net force on the charge at A is zero newtons.

A. $Q = +q\left(\frac{3\sqrt{3}}{4}\right)$

B. $Q = -q\left(\frac{3\sqrt{3}}{4}\right)$

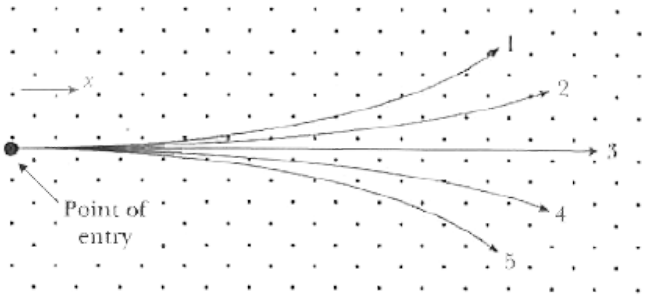
C. $Q = -q\left(\frac{4\sqrt{3}}{4}\right)$

D. $Q = +q\left(\frac{3}{4\sqrt{3}}\right)$

Answer: B

View Text Solution

3. The given figure shows five particles are shot from left into a region that contains a uniform electric field. The numbered lines shows the paths taken by the five particles. A negatively charged particle with a charge -3Q follows path 2 while it moves through this field. Do not consider any effects due to gravity.



In Which direction does the electric field point ?

A. Toward the top of the page

B. Toward the left of the page

C. Toward the right of the page

D. Toward the bottom of the page

Answer: D

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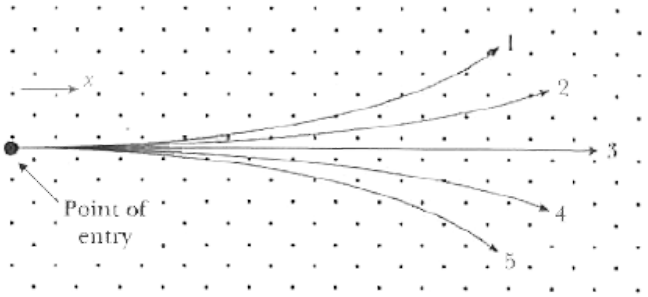
4. The given figure shows five particles are shot from left into a region that contains a uniform electric field. The numbered lines shows the paths taken by the five particles. A negatively charged particle with a charge -3Q follows path 2 while it moves through this field. Do not consider any effects due to gravity.



Which path would be followed by a helium atom (an electrically neutral particle) ?

A. path 1

B. path 2

C. path 3

D. path 4

Answer: C

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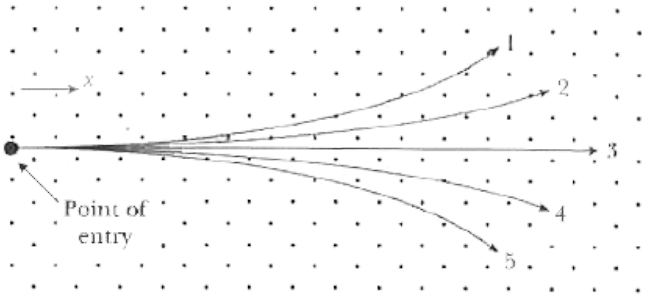
5. The given figure shows five particles are shot from left into a region that contains a uniform electric field. The numbered lines shows the paths taken by the five particles. A negatively charged particle with a charge -3Q follows path 2 while it moves through

this field. Do not consider any effects due to gravity.



Which path would be followed by a charge + 6Q ?

A. path 1

B. path 5

C. path 2

D. path 4

Answer: B

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Practice Questions Matrix Match

1. An electric dipole is placed in an electric field. Column I is the description of electric field and the angle between the dipole moment $\overrightarrow{p}$ and the electric field intensity $\overrightarrow{E}$ and Column II gives the effect of the field on the dipole. Then,

Column I	Column II
(a) Uniform electric field	**(p)** Force = 0
(b) Electric field due to a point charge	**(q)** Torque = 0
(c) Electric field between the two oppositely charged large plates	**(r)** $\vec{p} \times \vec{E} = 0$
(d) Dipole moment parallel to uniformly charged long wire	**(s)** Force $\neq 0$

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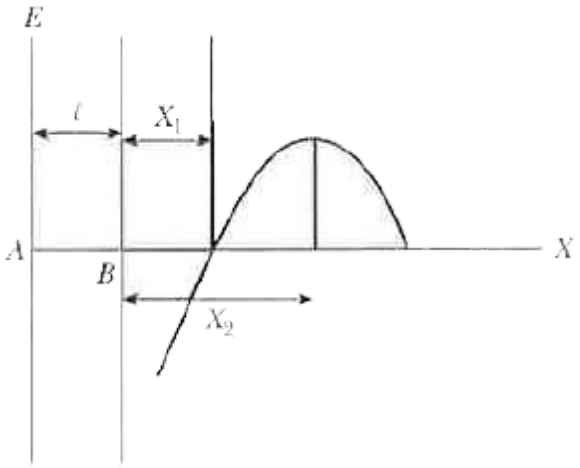
2. Two points like charges Q_A and Q_B are positioned at points a and B (see figure). The electric field strength to the right of charge Q_B on the line that passes through the two charges varies according to a law that is represented schematically in Figure below accompaanying the problem without employing a definite scale. Assume electric field to be positive if its direct ion coincides with (the positive direction on the x-axis. THe distance between the charges is l.



Column I	Column II
(a) Charge Q_A	(p) Positive
(b) Charge Q_B	(q) Negative
(c) $\lvert Q_A/Q_B \rvert$	(r) $\left(\frac{l+x_1}{x_1}\right)^2$
(d) x_2	(s) $\frac{l}{(Q_A/Q_B)^{1/3}-1}$

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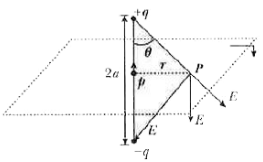
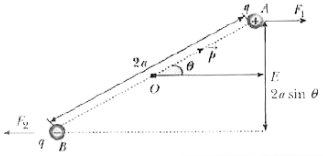
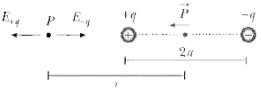
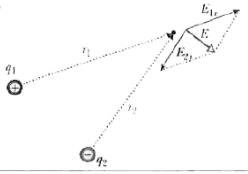
3. An electric dipole is the combination of two equal and opposite charges q and -q, respectively,

separated by distance 2a. There are different points where we can find electric field due to the electric dipole. In the given table, column 1 shows different positions of point where we have to find electric field due to dipole, column 2 shows the figure of dipole with different positions of point where we have to find the electric field and column 3 shows the value or final formula of the electric field of different positions of the point.

when point P lies on the equatorial plane of the electric dipole, electric field due to +q is ?

Column I	Column II	Column III
(I) Point P is at a distance r from the center of the dipole	(i) 	(J) $\frac{-q\hat{p}}{4\pi\varepsilon_0(r^2+a^2)}$
(II) P be the point at a distance r from the center of the dipole on side of charge $+q$	(ii) 	(K) $\frac{q\hat{p}}{4\pi\varepsilon_0(r-a)^2}$

Column I	Column II	Column III
(III) P be the point at infinity	(iii) 	(L) $\frac{-q\hat{p}}{4\pi\varepsilon_0(r+a)^2}$
(IV) P be the point at the center	(iv) 	(M) $\frac{q\hat{p}}{4\pi\varepsilon_0(r^2+a^2)}$

A. (III) (ii) (L)

B. (IV) (i) (M)

C. (III) (iii) (J)

D. (I) (i) (M)

Answer: D

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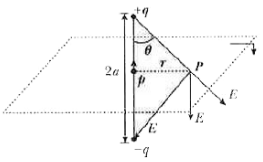
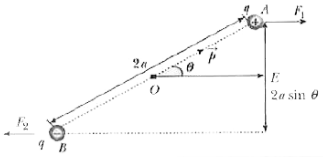
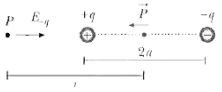
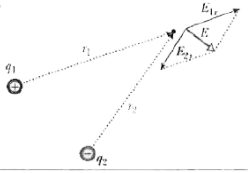
4. An electric dipole is the combination of two equal and opposite charges q and -q, respectively, separated by distance 2a. There are different points where we can find electric field due to the electric dipole. In the given table, column 1 shows different positions of point where we have to find electric field due to dipole, column 2 shows the figure of dipole with different positions of point where we have to find the electric field and column 3 shows the value

or final formula of the electric field of different positions of the point.

When point P lies on the axis of the electric dipole, electric field due to -q is ?

Column I	Column II	Column III
(I) Point P is at a distance r from the center of the dipole	(i) 	(J) $\frac{-q\hat{p}}{4\pi\varepsilon_0(r^2+a^2)}$
(II) P be the point at a distance r from the center of the dipole on side of charge $+q$	(ii) 	(K) $\frac{q\hat{p}}{4\pi\varepsilon_0(r-a)^2}$

Column I	Column II	Column III
(III) P be the point at infinity	(iii) 	(L) $\frac{-q\hat{p}}{4\pi\varepsilon_0(r+a)^2}$
(IV) P be the point at the center	(iv) 	(M) $\frac{q\hat{p}}{4\pi\varepsilon_0(r^2+a^2)}$

A. (III) (ii) (L)

B. (II) (iii) (L)

C. (II) (iii) (J)

D. (I) (i) (K)

Answer: B

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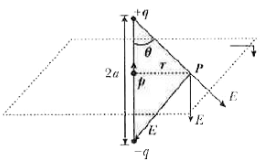
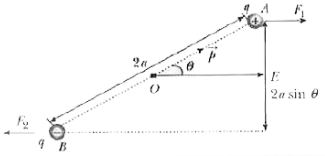
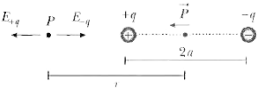
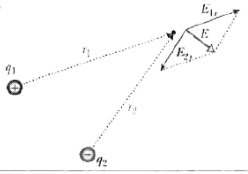
5. An electric dipole is the combination of two equal and opposite charges q and -q, respectively, separated by distance 2a. There are different points where we can find electric field due to the electric dipole. In the given table, column 1 shows different

positions of point where we have to find electric field due to dipole, column 2 shows the figure of dipole with different positions of point where we have to find the electric field and column 3 shows the value or final formula of the electric field of different positions of the point.

When point P lies on the equatorial plan of the electric dipole, electric field due to -q is ?

Column I	Column II	Column III
(I) Point P is at a distance r from the center of the dipole	(i) 	(J) $\frac{-q\hat{p}}{4\pi\varepsilon_0(r^2+a^2)}$
(II) P be the point at a distance r from the center of the dipole on side of charge $+q$	(ii) 	(K) $\frac{q\hat{p}}{4\pi\varepsilon_0(r-a)^2}$

Column I	Column II	Column III
(III) P be the point at infinity	(iii) 	(L) $\frac{-q\hat{p}}{4\pi\varepsilon_0(r+a)^2}$
(IV) P be the point at the center	(iv) 	(M) $\frac{q\hat{p}}{4\pi\varepsilon_0(r^2+a^2)}$

A. (I) (i) (J)

B. (I) (i) (M)

C. (III)(iii) (J)

D. (I) (i) (K)

Answer: A

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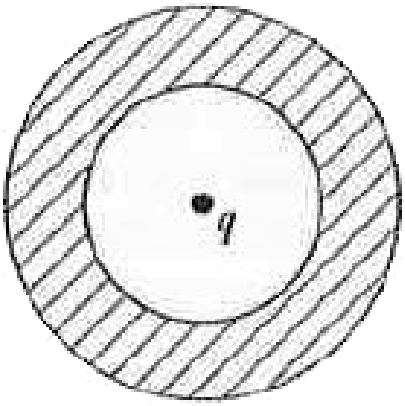
6. Consider the figure given below



A charge Q is placed inside the Spherical conductor shell. In the given table, column 1 shows different charges, column 2 shows the positions of the electric charge and column 3 shows the different types of

charge distribution.

Column I	Column II	Column III
(I) Charge q	(i) at the center of the shell	(J) Charge distribution is at the inner surface
(II) Charge Q	(ii) displaced from center	(K) Charge distribution is at the outer surface
(III) An excess charge q	(iii) not given to the shell but just displaced	(L) Charge distribution is in the center
(IV) An excess charge Q	(iv) given to the shell	(M) No Charge distribution

In which case will the charge distribution be non-uniform ?

A. (I) (i) (M)

B. (IV) (ii) (M)

C. (II) (ii) (J)

D. (I) (iv) (K)

Answer: C

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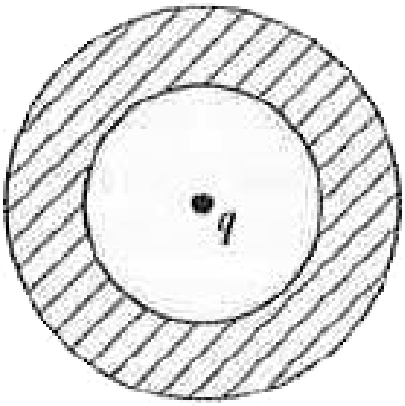
7. Consider the figure given below



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(III) An excess charge q	(iii) not given to the shell but just displaced	(L) Charge distribution is in the center
(IV) An excess charge Q	(iv) given to the shell	(M) No Charge distribution

In which case will the Charge distribution be uniform ?

A. (III) (iv)(K)

B. (IV) (i)(M)

C. (III) (ii)(L)

D. (I) (i)(M)

Answer: A

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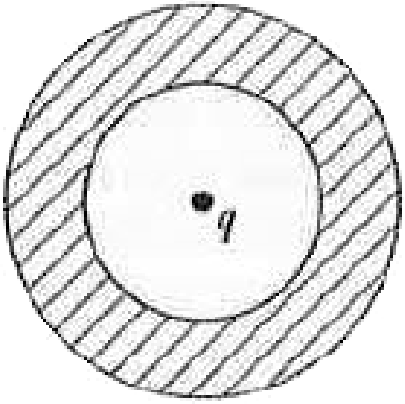
8. Consider the figure given below



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(III) An excess charge q	(iii) not given to the shell but just displaced	(L) Charge distribution is in the center
(IV) An excess charge Q	(iv) given to the shell	(M) No Charge distribution

What heppens when the charge is near the conductor shell ?

A. (III) (i) (K)

B. (IV) (i) (J)

C. (III) (iii) (M)

D. (II) (iii) (K)

Answer: D

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Practice Questions Integer Type

1. A point charge $q = 1C$ and mass $1kg$ is projected with speed $10m/s$ in the perpendicular direction of unifrom electric field $E = 100V/m$. The value of latus rectum of the path followed by charged particle (in meter) is :

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2. Two spherical objects are separated by a distance of $1.80 \times 10^{-3} m$. The objects are initially electrically neutral and are very small compared to the distance between them. Each object acquires the same negative charge due to the addition of electrons. As a result, each object experiences an electrostatic force that has a magnitude of $4.55 \times 10^{-21} N$. How many electrons did it take to produce the charge on one of the objects ?

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3. An electric dipole, made up of a positive and negative charge, each of 1 mC and placed at a distannce 2 cm apat. If the dipole is placed in an electric field of $10^5 NC^{-1}$, then calculate the maximum torque.

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