PHYSICS

BOOKS - CENGAGE PHYSICS (ENGLISH)

COULOMB LAW AND ELECTRIC FIELD

Illustration

1. A glass rod is rubbed with a silk cloth. The glass rod acquires a charge of $+19.2 \times 10^{-19} C$.

(i) find the number of electrons lost by glass rod.

(ii) Find the negative charge acquired by silk.

(iii) Is there transfer of mass from glass to silk?

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2. If an object made of substance A is rubbed with an object made of substance B, then A becomes positively charged and B becomes negatively charged. If however, an object made of substance C, then A becomes negatively charged, What will happen if an object made of substance B is rubbed against an object made of substance C?

(a) B becomes positively charged and C becomes positively

(b) B becomes positively charged and C becomes negatively charged.

(c) B becones negatively charged and C becomes positively charged.

(d) B becomes negatively charged and C becomes negatively charged.

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3. Object A, B and C, are three identical, insulated, spherical conductors. Originally, A and B have charges of +3 mC, whereas C has a charge of -6mC. Objects A and C are touched and moved apart, Objects B and C are touched before they moved apart.

(i) If objects A and B are now held near each other they will

(a) attract (b) repel (c) have no effect on each other.

(ii) If instead object A and C held near each other, they will

(a) attract (b) repel (c) have no effect on each other.

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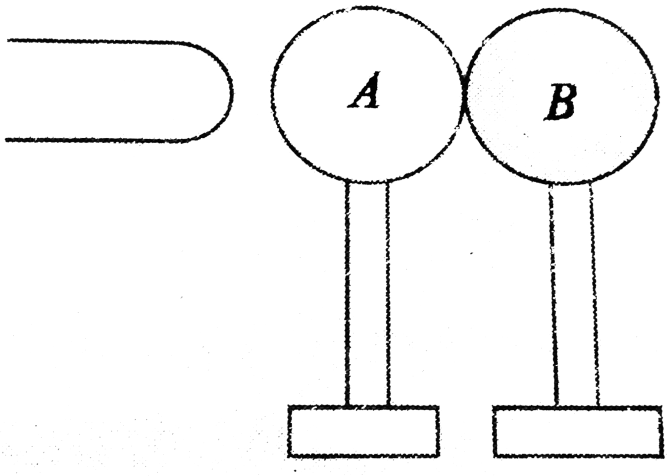
4. Figure shows that a positively charged rod is brought near two ucharged metal spheres A and B clamped on insulated stands and palced in contact with each other.



(i) What would happen if the rod is removed before the spheres are separated?

(ii) Would the induced charges be equal in magnitude even if the spheres had different sizes or different conductors?

(iii) What will happen if the spheres are separated first and then the rod is removed far away?

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5. Calculate the total positive (or negative) charge on a 3.11 g copper penny. Given Avogadro's number $= 6.023 \times 10^{23}\left(g^{-1}\right)mol^{-1},$, Given Avogadro's number and atomic mass=63.5.

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6. An electron and a proton, initiall sepatated by a distance d in air are released from rest simultaneously. The two particles are free to move. When they collide, are they (a) at the midpoint of their initial separation, (b) closer to the initial position of the proton or (c) closer to the initial position of the electron?

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

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8. Four identical point charges are placed at the corners of a square, A fifth point charge placed at the center of the square experiences zero net force . Is this a stable equilirium for the fifth charge? Explain.

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9. Two free positive charges 4q and q are a distance apart. What charge Q is needed to achieve equilibrium for the entire system and where show it be placed from charge q ?

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10. Three positive charges of equal magnitude q are placed at the vertices of and equilateral triangle of side l. How can the system of charges be placed in equilibrium?

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11. A charge Q located at a point $\vec{r}$ is in equilibrium under the combined field of three charges q_1, q_2 and q_3. If the charges q_1 and q_2 are located at point $\vec{r}_1$ and $\vec{r}_2$ respectively, find the direction of the force on Q due to q_3 in terms of q_1, (q_2), $\vec{r}_1 \vec{r}_2$, and $\vec{r}$.

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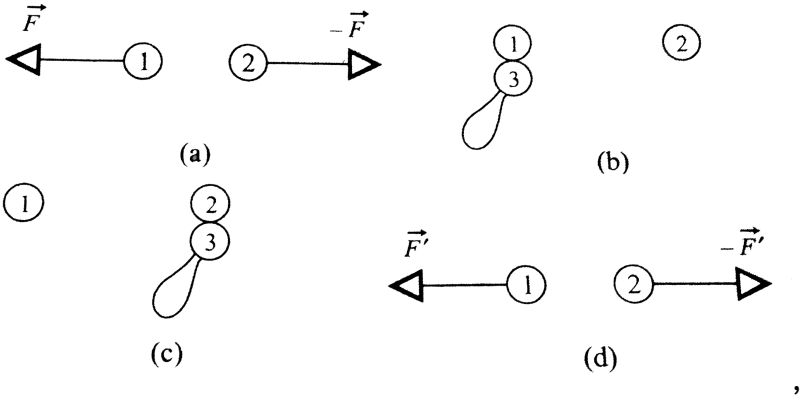
12. Two identical conducting spheres 1 and 2 carry equal amounts of charge and are ficed apart at a certain distance larger than their diameters. The spheres repel each other with an electrical force of 88mN. A thired identical sphere 3, having an insulating handle and initially uncharged, is touched first to sphere 1 and then to sphere 2 and finally

removed. Find the force between spheres 1 and 2 as shown if Figure.



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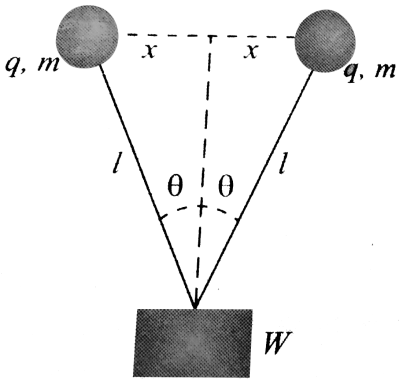
13. Two identical He-filled spherical balloons each carrying a charge q are tied to a weight W with strings and float in equlibrium, as shown in figure.

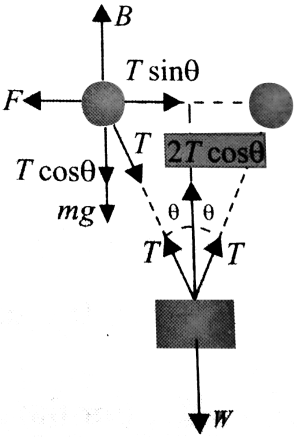
(i) Find the magnitude of q, assuming that the charge on each balloon acts as if it were concentrated at the center.

(ii) Find the volume of each balloon. Take the density of He as ρ_{He} and the

density of air as ρ_a. Ignore the weight of the unfilled balloons .



(a)



(b)

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14. Three charges of equal magnitude q is placed at the vertices of an equilateral triangle of side l. The force on a charge Q placed at the centroid of the triangle is

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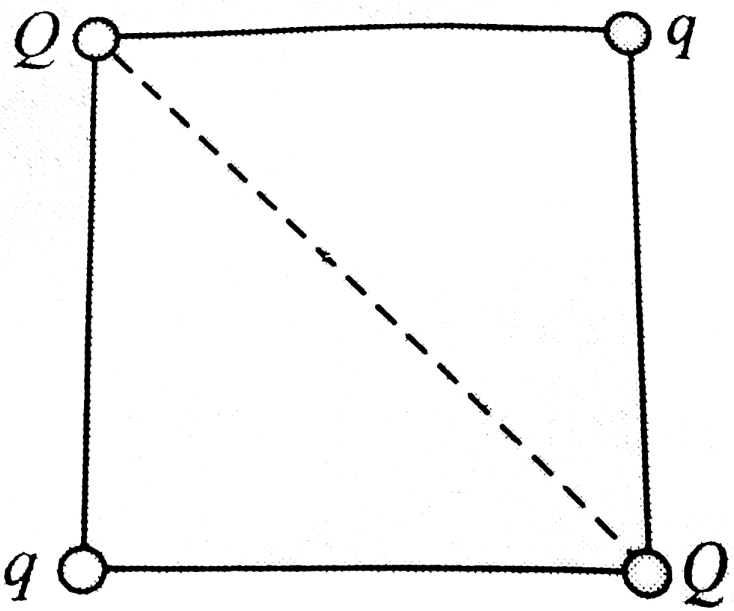
15. Point charge are placed at the verticas of a squre of side a as shown in fig. What should be the sign of charge q and magnitude of the ratio

$|q/Q|$ so that

(i) net force on each Q is zero?

(ii) net force on each q is zero?

Is it possible that the entire system could be in electrostatic equilibrium?



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16. Two identical small charged spheres, each having a mass m, hang in equilibrium the length of each string is l, and the angle made by any string with the vertical is θ. Find the magnitude of the charge on each sphere.

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17. Two identical balls each having a density ρ are suspended from a common point by two insulating string of equal length. Both the balls have equal mass and charge. In equilibrium each string makes an angle θ with vertical. Now, both the balls are immersed in a liquid. As a result the angle θ does not change. The density of the liquid is σ. find the dielectric constant of the liquid.

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18. Three paricles, each of mass m and carrying a charge q each, are suspended from a common pointby insulating massless strings each of

length L. If the particles are in equilibrium and are located at the corners of an equilateral triangle of side a, calculate the charge q on each particle. Assume $L > > a$.

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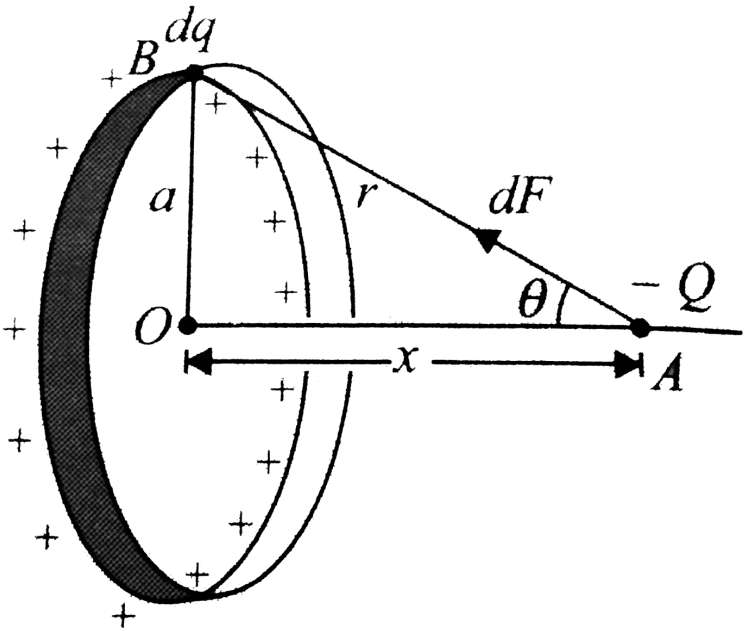
19. A thin fixed ring of radius a has a positive chage q unformly distributed over it.A particle of mass m having a megative charge Q, is placed on the axis at a distance of $x(x < < a)$ form the center of the ring. Show that the motion of the negatively chaged particle is

approximatly simple harmonic. Calculate the time period of oscillation.



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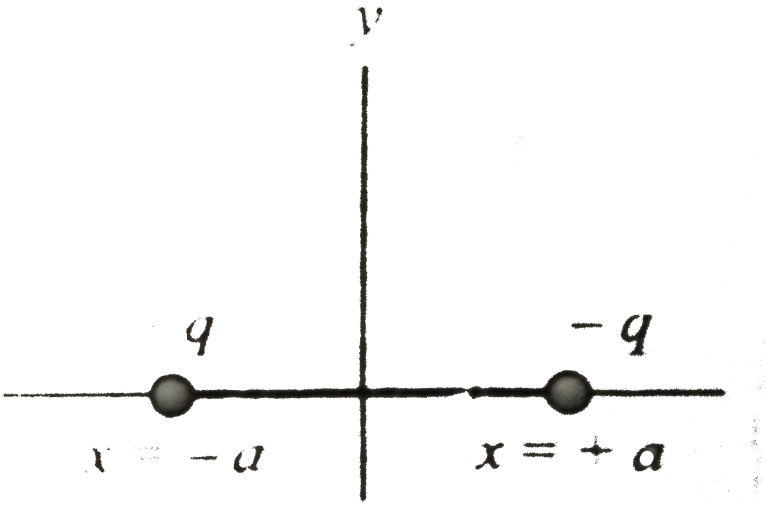
20. Two point charge $\pm q$ are placed on the axis at $x = -a$ and $x = +a$, as shown in fig.

(i) Plot the variation of E along the x-axis.

(ii) Plot the variation of E along the y-axis.



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21. Two negative charges of a unit magnitude and a positive charge q are placed along a straight line. At what position and value of q will the system be in equilibrium? (Negative charges are fixed).

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22. Two point charges $+5 \times 10^{-19} C$ and $+20 \times 10^{-19} C$ are separated by a distance of 2m. The electric field intensity will be zero at a distance d=..... From the charges of $5 \times 10^{19} C$.

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23. The positions of two point charges q_1 and q_2 are $\vec{r}_1$ and $\vec{r}_2$, respectively. Find the position of the point where the net field is zero due to thses charges.

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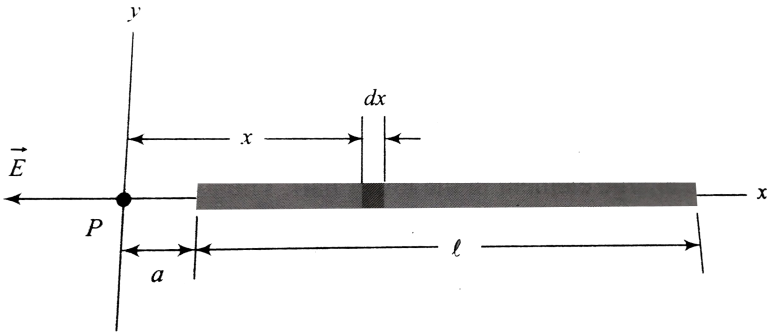
24. A rod of length l, has a uniform positive charge per unit length and a total charge Q. calculate the electric field at a point P located along the

long axis of the rod and at a distance a from one end



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25. Find the electric field at the centre of a uniformly charged semicircular ring of radius R. Linear charge density is λ

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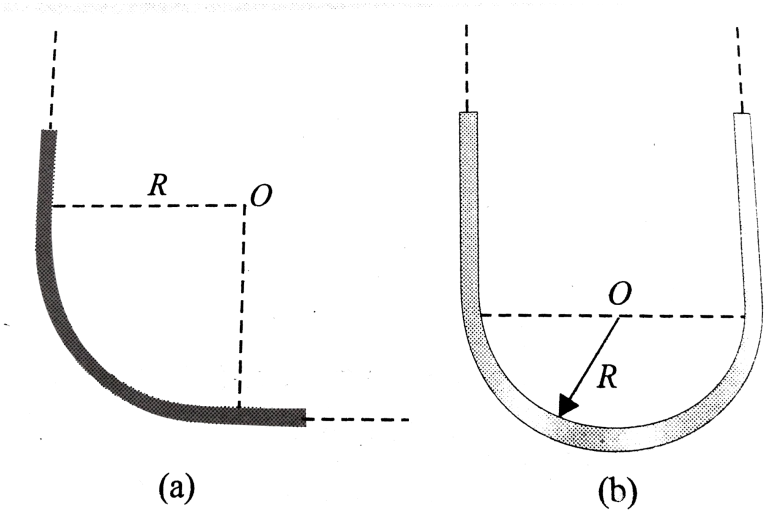
26. A long wire with a uniform charge density λ is bent in two configurations shown in fig. Determine the electric field intensity at point

O.



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27. A segment of a charged wire of length l, charge density λ_2 and an infinitely long charged wire. Charge density λ_1. Lie in a plate at right angles to each other. The separation between the wires is r_0. Determine the force of interction between the wires.

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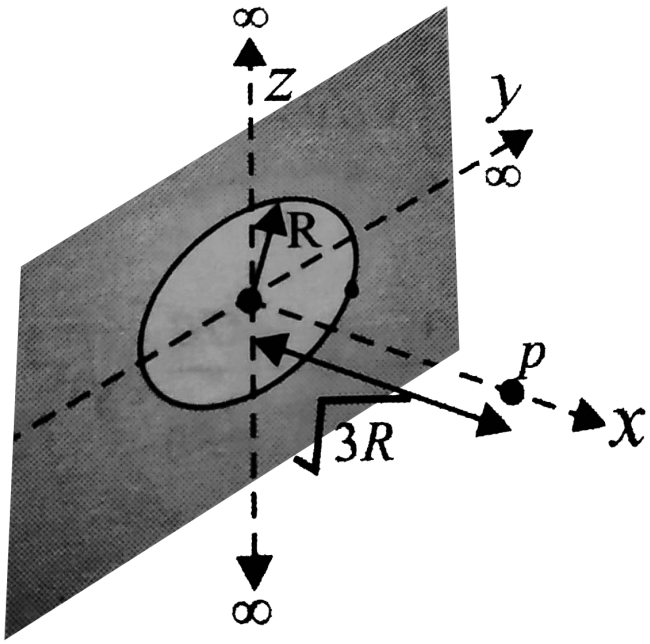
28. An infinite dielectric sheet having charge density σ has a holeof radius R in it. An electrom is released from point P on the axis of the hole at a distance $\sqrt{3}R$ from the center. Find the speed with which it crosses the plane of the sheet.



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29. Charges $+q$ and $-2q$ are fixed at distance d apart as shown in fig.

(i) sketch roughly the pattern of electric field lines, showing the positon of neutral point.

(ii) Where should a charge partical q be placed so that it experience no force ?

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30. The field lines for two point charges shown in fig.

(i) Is the field uniform?

(ii) Determine the ratio q_A / q_B.

(iii) What are the sign of q_A and q_B ?

(iv) Apart from infinity, where is the neutral point?

(v) If q_A and $q_B$are separated by a distance $10\left(\sqrt{2}-1\right)$ cm, find the position of neutral point.

(vi) where will the lines meet which are coming from A and are not

meeting at q_B?

(vii) Will a positive charge follow the line of force if free to move?

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31. A particle of mass ma and charge q is released from rest in a uniform filed of magnitude E. the uniform field is created between two parallel plates of charge densities $+\sigma$ and $-\sigma$, respectively. The particle accelerates toward the other plate a distance d apart. Determine the speed at which it stirkes the opposite plate.

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32. A uniform E exiest between two metal plates one negative and other positive. The plate length is l and the seperation of the plates is d.

(i) An electron and a proton start fron the negative plate and positive plane, respactively, and go the opposite plates. which one of them wins this race?

(ii) An electron and a proton start moving parallel to the plates towards the other end from the midpoint of the separation of plates at one end of the plates. Which of two will have greater deviation when they come out of the plates if they start with the

(a) same initial velocity

(b) same initial kinetic energy, and (c) same initial momentum.

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33. A partical having charge that of an electron and mass 1.6×10^{-30}kg is projected with an initial speed u at the angle 45° to the horizontal from the lower plate of a parallel-plate capacitor as shown in fig. The plates are suffieciely long and have a separation of 2 cm, find the maximum value of the velocity of he particle so that it does not hit the upper plate. Take the electric field between the plates as $10^{3} Vm^{-1}$ directed upward.

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

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35. Three charges +q, +q and -2q are placed at the vertices of an equilareral triagle. What is the dipole moment of the system?

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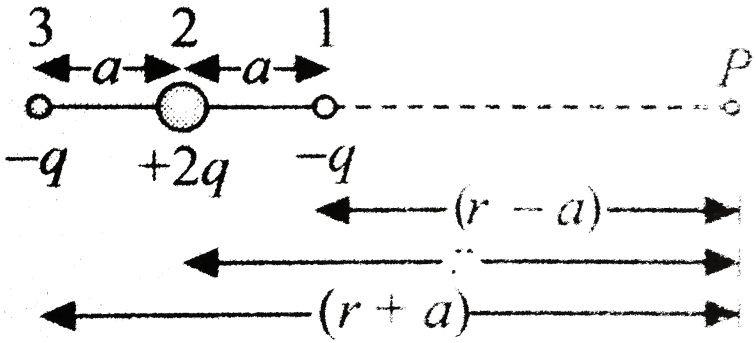
36. Three charges -q,+2q, and -q are arranged on a line as shown in fig. Calculate the field at a distance $r > > a$ on the line.



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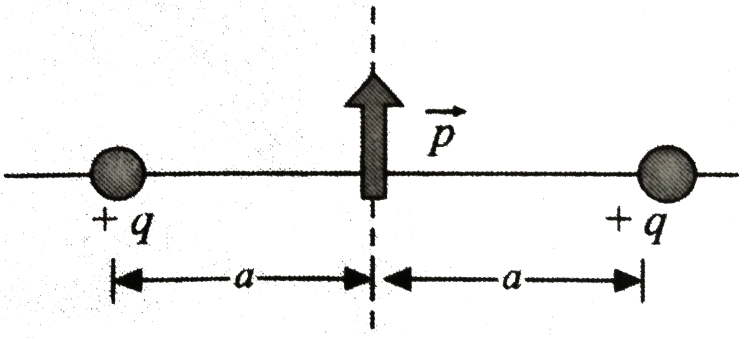
37. What is the force on a dipole of dipole moment p placed as shown in fig.



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38. An electric dipole of dipole miment $\vec{p}$ is placed in a uniform electric field $\vec{E}$. Write the expression for the torque $\vec{\tau}$ experienced by the dopole. Identify two pairs of perpendicular vectors in the expression. Show diagrammatically the orientation of hte dipole in the field for which the torque is (i) maximum and (ii) half the minimum value, and (iii) zero.

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39. An electric dipole consists of two charges of $0.1\mu C$ separated bu a distance of $2.0cm$. The dipole is placed in an external field of $10^5 NC^{-1}$. What maximum torqur does the field exert on the dipole?

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40. In a certain region of space, electric field is along the z-direction throughout. The magnitude of electric field is however not constant, but increases uniformly along the positive z-direction at the rate of

$10^5 NC^{-1}m^{-1}$. The force experienced by the system having a total dipole moment equal to 10^{-7}C m in the negative z- direction is

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Solved examples

1. Two balls of charges q_1 and q_2 initially have a velocity of the same nagnitude and direction. After a unform electric field has been applied for a certain time. The direction of the first ball changes by 60° and the velocity magnitude is reduced by half. The direction ofvelocity of the second ball changes by 90°. In whata ratio will hte velociyt of the second ball change? Determine, the magnitude of the charge to mass ratio of the ball if it is equal to α_1 for the firt ball. Ignore the electrostatic interactin between the balls.

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2. A rigid insulated wire frame in the form of a right-angled triangle ABC is set in a vertical plane as shown in fig. two beads of equal masses m each and carrying charges q_1 and q_2 are connected by a cord of length l and can slide without friction on the wires.

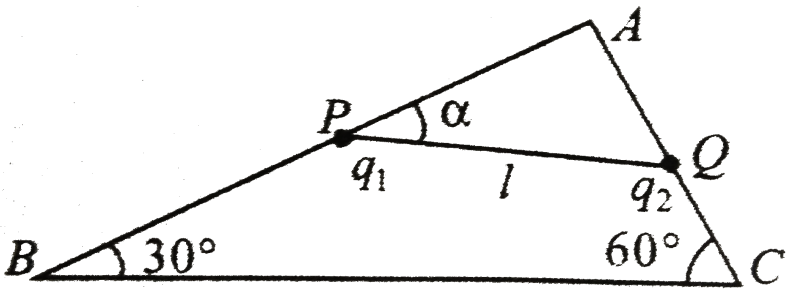
Cinsidering the case when the beads are stationary, determine

(i) the angel α

(ii) the tension in the cord, and

(iii) The normal recation on teh beads.

If the cord is now cut, what are the value of the charges for which the beads continue to remain stationary?



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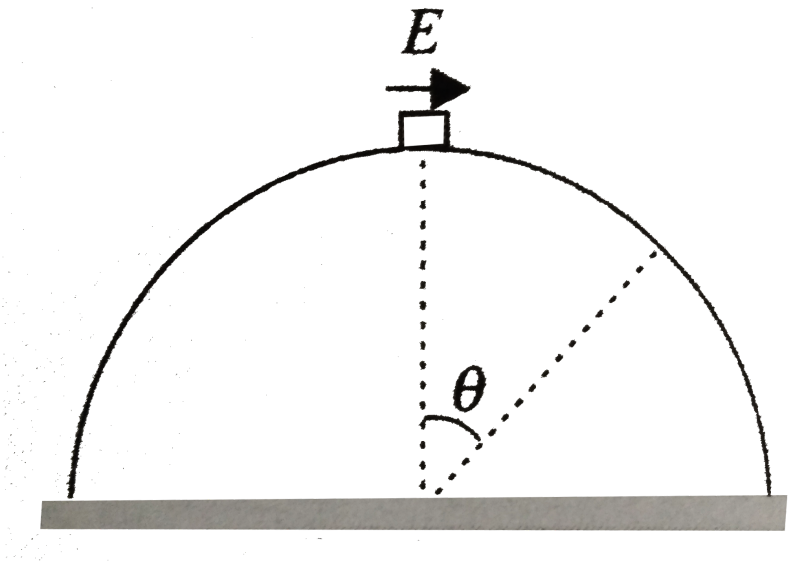
3. In a horizontal unifrom electirc field, a small charged disk is gently released on the top of a fixed sperical dome. The disk slides down the some without friction and breaks away from the surface of the dome at the angular position $\theta = \sin^{-1}(3/5)$ from vertical. Determine the ratio of the force of gravity acting on the disk to force of its interaction with the field .



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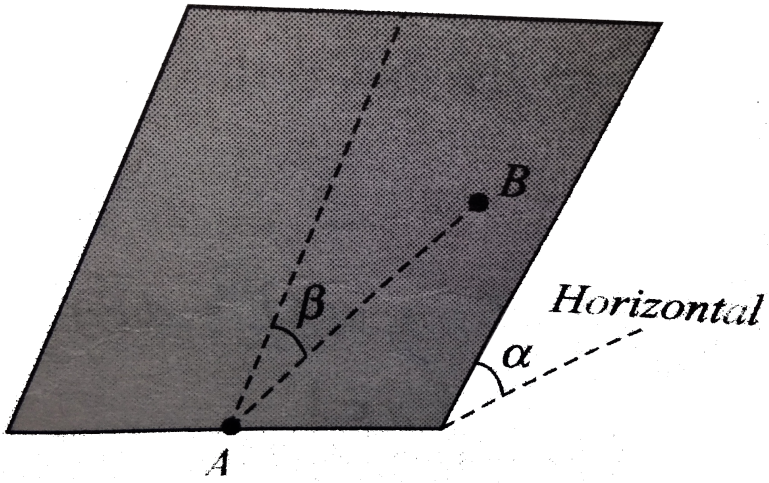
4. A charge particle A is fixed at the base of a uniform slope of inclination α. Another charge particle B is placed on the slope at an angular position β measured from the line of greatest slope passing through the position of the first particle. The coefficient of froction between the particle B and the slope is $\mu(\mu < \tan\alpha)$ .For the particle at B to stay in equilibrium what would be the maximum value of the angle β ?



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5. In a free space, a thin rod carrying uniformly distributed negative charge $-q$ is placed symmetrically along the axis of a tin ring of radius R

varrying uniformly dostributed charge Q. The mass of the rod is m and length is $l = 2R$. The ring is fixed and the rod is free to move. The rod is displaced slightly along the axis of the ring and then released. Find the period T to the small amplitude oscillations of the rod.

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6. Two charges $+q_1$ and $-q_2$ are placed at A and B respectively. A line of force emanates from q_1 at an angle α with the line AB. At what angle will it terminate at $-q_2$?

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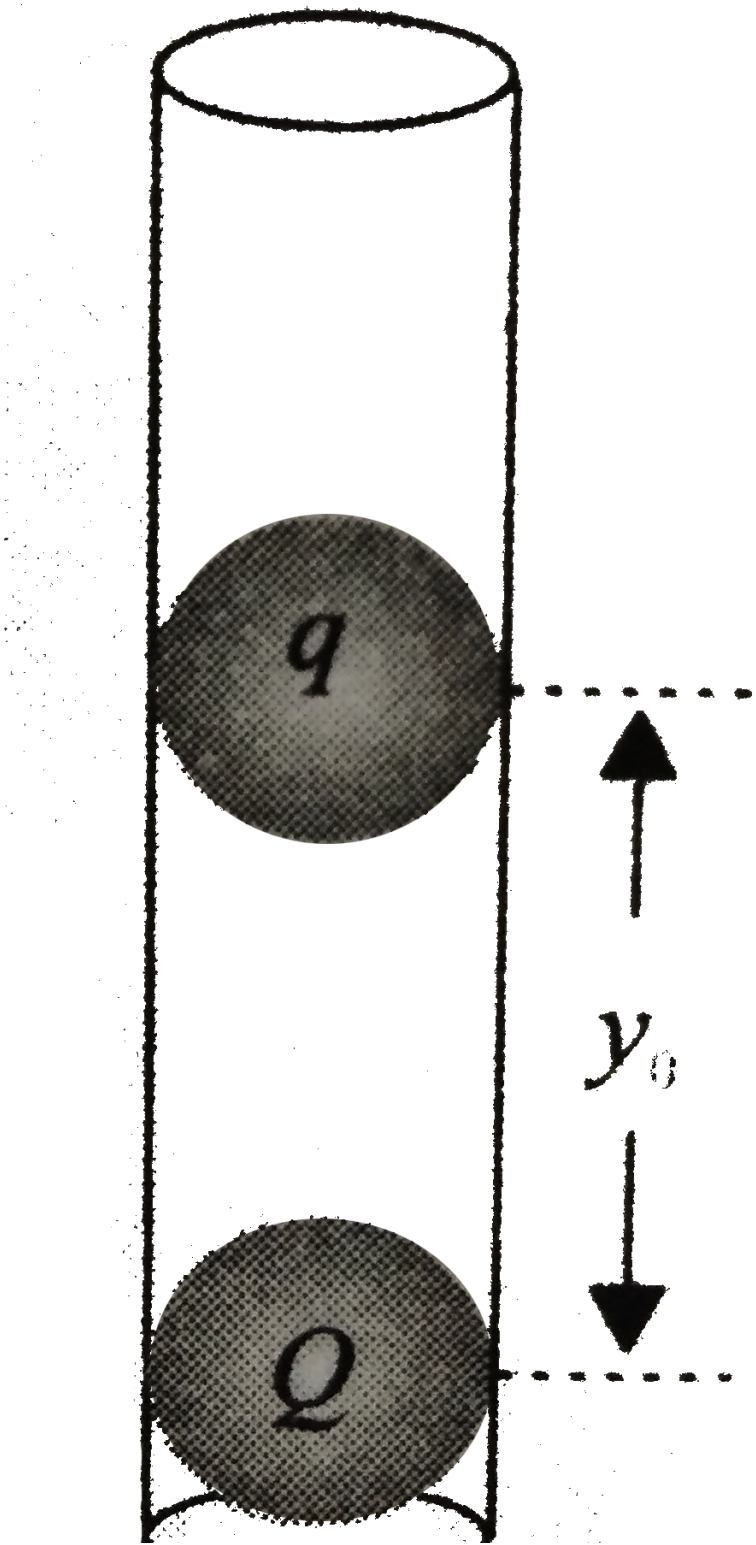
7. A small point mass m has a charge q, which is constrained to move inside a narrow frictionless cylinder, At the bae of the cylinder is point mass of charge Q having the same sign as q. If the mass m is displaced by a small amount from its equilibrium position and released. it will exhibit simple harmonic motion. Find the angular frequency of the mass?


q
y_0
Q

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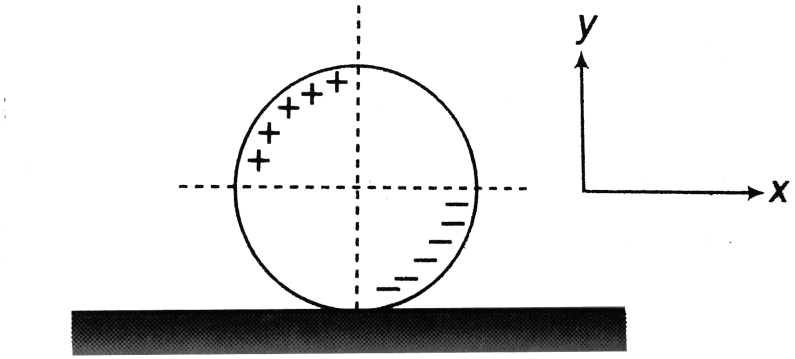
8. A non-conducting ring of mass m and radius R is charged as shown. The charge density, i.e. charge per unit length is λ. It is then placed on a rough non-conducting horizontal plane. At time $t = 0$, a uniform electric field $E = E_0\hat{i}$ is switched on and the ring starts rolling without sliding. Determine the friction force (magnitude and direction) acting on the ring when it starts moving.



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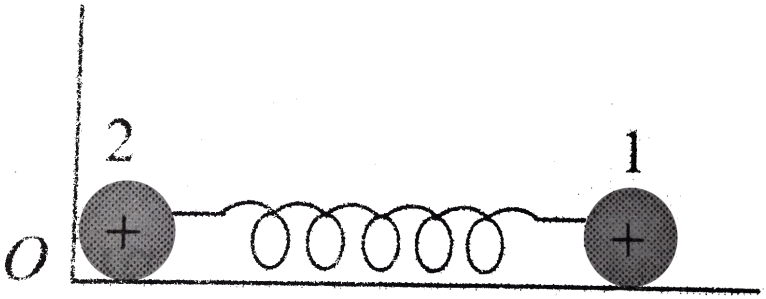
9. Two small identical balls lying on a horizontal plane are connected by a weightless spring. One ball (ball 2) is fixed at O, and the other (ball 1) is free. The balls are charged identically as a result of which the spring length increases $\eta = 2$ times. Determine the change in frequency.



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10. A non-conducting ring of mass m and radius R has a charge Q uniformly distributed over its circumference. The ring is placed on a rough horizontal surface such that plane of the ring is parallel to the surface. A vertical magnetic field $B = B_0 t^2$ tesla is switched on. After 2 a from switching on the magnetic field the ring is just about to rotate about vertical axis through its centre.

(a) Find friction coefficient μ between the ring and the surface.

(b) If magnetic field is switched off after $4s$, then find the angle rotated by the ring before coming to stop after switching off the magnetic field.

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Exercises

1. (a) How many electorns are in 1C of negative charge?

(b) Which is the true test of electrification: attraction or repulsion?

(c) Can a body have a charge of $0.8 \times 10^{-19} C$?

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

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3. (a) Can two bodies having like charge attract each other (yes/No)

(b) Can a charged body attract an unchanged body? (yes/No)

(c) Two identical metallic spheres of exactly equal masses are taken, one is given a positive charge q and the other an equal negative charge. Their masses after charging are different. Co„ent on the statement.

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4. A particle has a charge of $+10^{-12}C$.

(a) Does it contain more or less number of electrons as compared to the netual state?

(b) Calculate the number of electrons transferred to provide this charge.

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5. An ebonite rod is rubbed with fur and is found to have a charge of $-3.2 \times 10^{-8}C$ on it

(a) Calculate the number of electrons transferred,

(b) What is the charge of rubbing?

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6. The electric charge of macroscopic bodies is actually a surplus or defieciency of electrons. Why not protons?

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7. When a comb is run in dry hair, it starts attracting small pieces of paper, which after touching the comb, often jump violently away from it, Why ?

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8. A person standing on an ainsulating stool touches a charged insulatd conductor. Will the conductor get completely discharged?

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9. Define the following statement: " if there were only one electrically charged paticle in th entire universe, the concept of electric charge would be meaningless".

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10. How many megacoulombs of positive(or negative) Charge are present in 2.0 mol of neutral hydrogen gas.

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11. A polythene piece rubbed with wool is found to have a negative charge of $3 \times 10^{-7} C$. (a) Estimate the number of electrons transferred (from which to which? (b) Is there a transfer of mass from wool to polythene?

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12. Two identical conduction spheres, one having an initial charge +Q and the other initially uncharged, are brought into contact.

(a) What is the new charge on each sphere?

(b) While the spheres are in contact, a positively chaged rod is moved close to one sphere, causing a redistribution of hte charges on the two spheres so the charge on hte sphere closest to the rod has a charge-Q. What is the charge to the other sphere?

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13. Two identical conducting spheres are charged by induction and then separated by a large distance, sphere 1 has charge +Q and sphere 2 has charge -Q. A third sphere is initially uncharged. If sphere 3 is touched to sphere 1 and separated and then touched to sphere 2 and separated what is the final charge on each of the three spheres?

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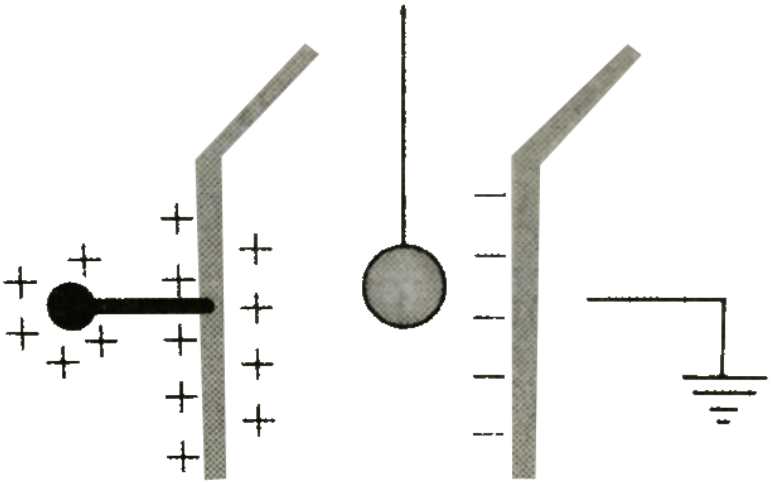
14. A table tennis ball covered with a conducting paint is suspended by a silk thread so that it hangs between tow metal plates. One plate is earthed, when the other plate is connected to a high voltage generator, what will happen to the ball.



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15. In 1 g of a solid, there are 5×10^{21} atoms. If one electrons is removed fron each of 0.01% atoms of the solid, find the charge gained by the solid (given that electronic charge is $1.6 \times 10^{19} C$).

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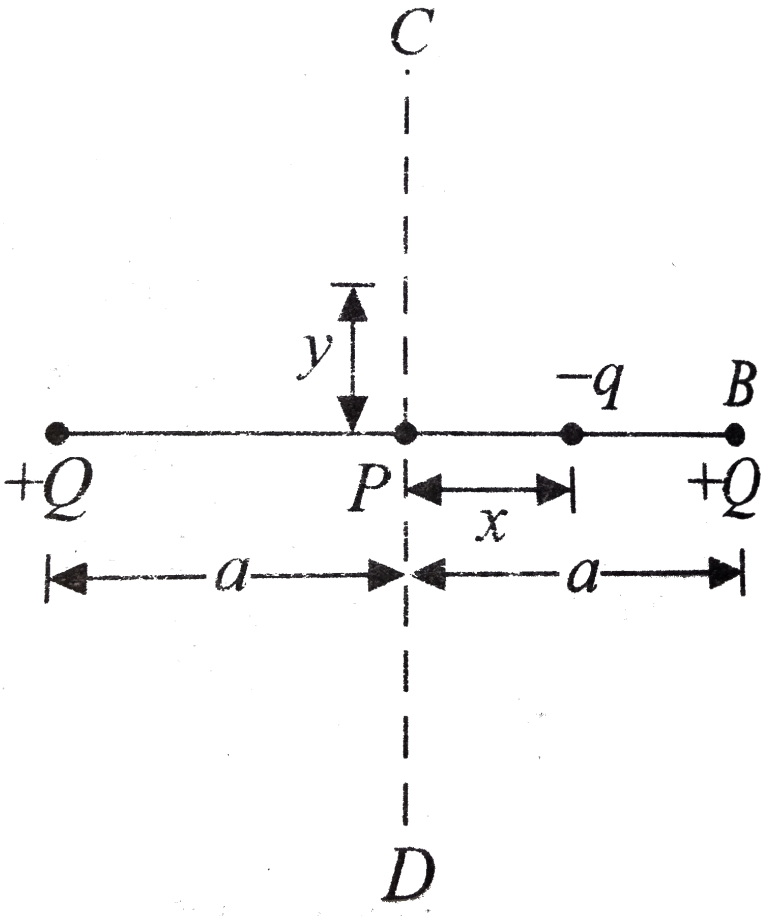
16. In the arrangement shown in fig. two positive charges, $+Q$ each,are fixed. Mark the correct statement(s) regarding a third charged particle $-q$ place at the midpoint P that can be displaced along or perpendicular to the line connecting the charges.



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17. Does an electric ccharge experience a force due to the field produced by itself ? (yes/No)

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18. Two negative charges of a unit magnitude and a positive charge q are placed along a straight line. At what position and value of q will the system be in equilibrium? (Negative charges are fixed).

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19. Figure shows three arrangements of an electrons e and two protons p(where Dgtd)

(a) Rank the arrangement according to the magnitude of the net electrostatic force on the electron due to the protons placing the largest first.

(b) In situation (c), is the angle between the net force on the electrons and the line labeled horiontal less than or more than 45°?

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20. Figure shows two charge particles on an axis. The charges are free to move. At one point, however, a third charged particle can be placed such that all three particles are in equilibrium.

(a) Is that point to the left of the first two particles to their rightm or between them?

(b) should the third paricle be positively or negatively charged?

(c) Is the equilibrium stable or unstable?

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21. In fig. a central particle of charge $-q$ is surrounded by two circular rings of charged particle of radii r and R, with Rgtr. what is the magnitude and dirction of the net electrostatic force on the central particle due to

the other particles?

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22. Figure shows four situations in which particles of charge +q or -q are fixed in place. In each the particles on the x-axis are equidistant from the y-axis. The particle on the y-axis experiences an electrostatic force F from each of these two particle.

(a) Are the magnitudes F of those force the same or different?

(b) Is the magnitude of the net force on the particle on the y-axis. equal to grater than, or less than 2F?

(c) Do the x-components of the two forces add or cancel?

(d) Do the y-components of the force add or cancel?

(e) Is the direction of the net forcce on the middle particle that of the canceling components or the adding components?

(f) What is the direction of the net force on the middle particle ?

View Text Solution

23. The force between two point electric charges kept at a distance d apart in air is F. If these charges are kept at the sme distance in water, the force between the charges is F'. The ratio F'/F is equal to ..... .

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24. Two small balls having equal positive charge Q (coulumb) on each suspended by two insulating strings of equal length L (metre) from a hook fixed to a stand. The whole set-up is taken in a satellite into space where there is no gravity (state of weightlessness). Then tension (newtons) in each string is:

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25. Suppose we have a large number of identical particles, very small in size. Any two of them at 10cm separation repel with a force of

$3 \times 10^{-10} N$.

(a) If one of them is at 10 cm from a group (of very small size) of n others, how strongly do you expect it to be repelled?

(b) Suppose you measure the repulsion and find it $6 \times 10^{-6} N$. How many particles were there in the group?

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

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27. Two fixed point charges $+4e$ and $+e$ units are separated by a distance a. Where should a third point charge be placed for it to be in equilibrium?

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28. Two insulated identically sized charged copper spheres A and B have their centers separated by a distance of 50 cm. A third sphere of the same size but uncharged is brought in contact with the first, then in contact with the second and finally removed from both. What is the new force of repulsion between A and B?

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29. Two small balls having equal positive charge Q (coulumb) on each suspended by two insulating strings of equal length L (metre) from a hook fixed to a stand. The whole set-up is taken in a satellite into space where there is no gravity (state of weightlessness). Then tension (newtons) in each string is:

Watch Video Solution

30. Find the force on a charge $q_1(=20\mu C)$ due to the charge of $q_2(=10\mu C)$ if the positions of the charges are given as $P_1(1,-1,2)$

and $Q(-1,1,1)$

Watch Video Solution

31. Two particles A and B having charges $8.0 \times 10^{-6} C$ and $-2.0 \times 10(-6) C$ respectively are held fixed with a. separtion of 20cm. Where should a third charged. particle be placed so that it dose not experience a net electric force?.

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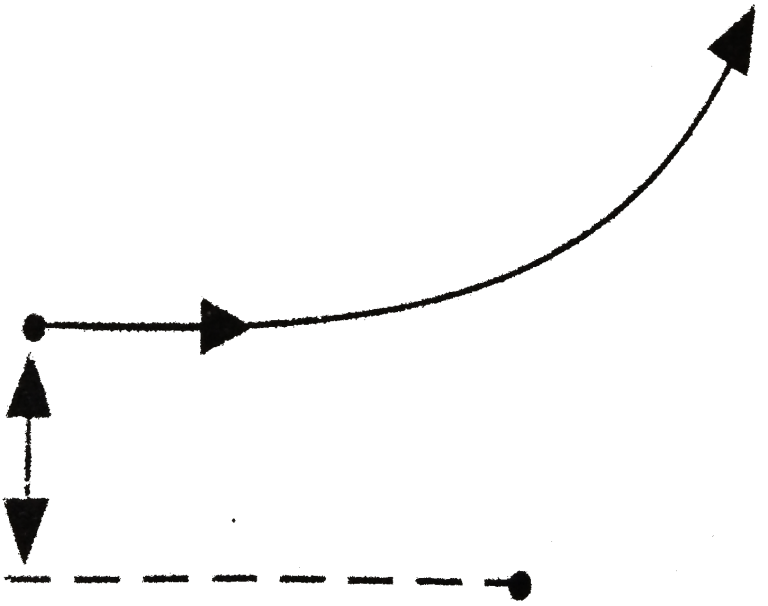
32. A particle of mass m carrying a charge $-q_1$ starts moving around a fixed charge $+q_2$ along a circulare path of radius r. Find the time period of revolution T of charge $-q_1$.

Watch Video Solution

33. A particle with positive charge Q is held fixed at the origen. A second particle with positive charge q is fired at the first paricle, which follows the trajectory as shown in fig.



(a) Is the angular momentum of the second particular momentum of the second particle constant about some axis? Why or why not? Give reason to support your answer.

(b) Does the Coulomb force that one charge exerts on other charges changes if the other charges are brought nearby?(yes/No)

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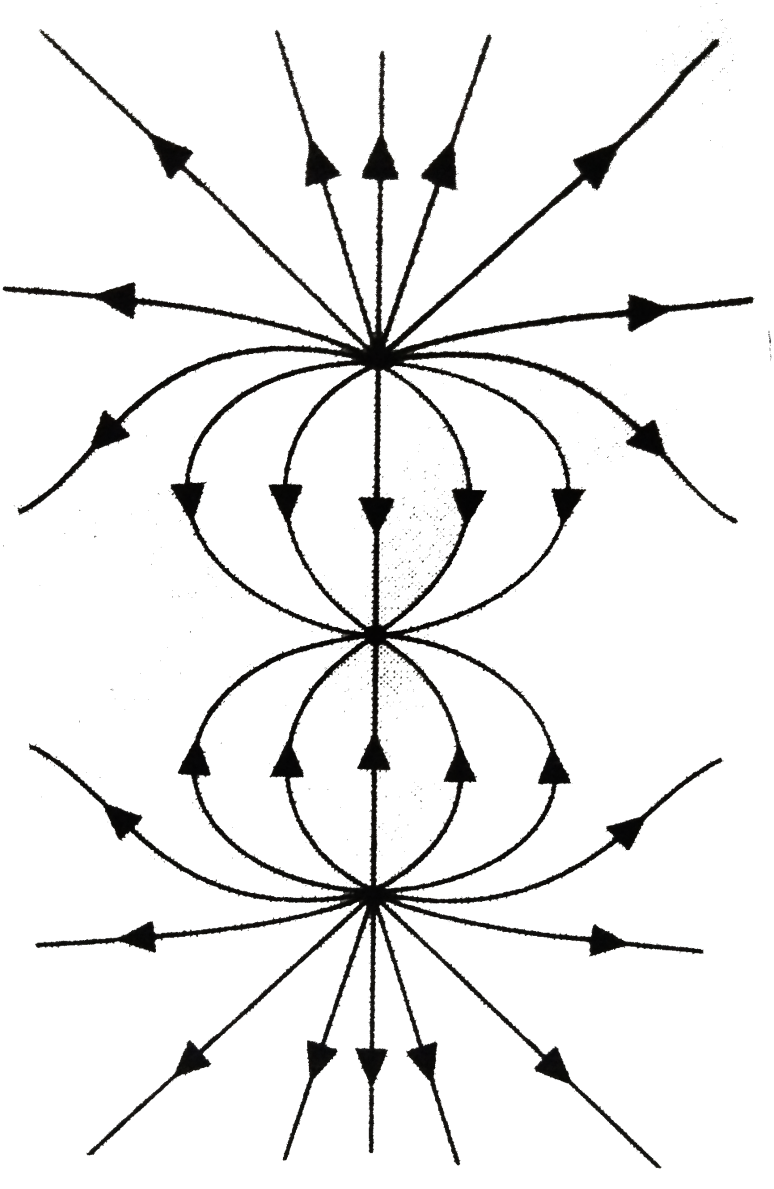
34. Fig. shows some of the electric field lines due to three point charges arranged along the vertical axis. All three charges have the same magnitude.

(a) What are the signs of each of the three charges? Explain your reasoning.

(b) At what points(s) is the magnitude of the electric field the smallest? Explain your reasoning. Explain how the fields produced by each individual point charge combine to give a small net field at this point or points.

(c) Two point charges q and -q are placed at a distance d apart. What are the points at which the resultant electric field is parallel to the line

joining the two charge?



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35. Two point charge Q and 4Q are fixed at a distance of 12cm from each other. Sketch lines of force and locate the neutral point, if any .

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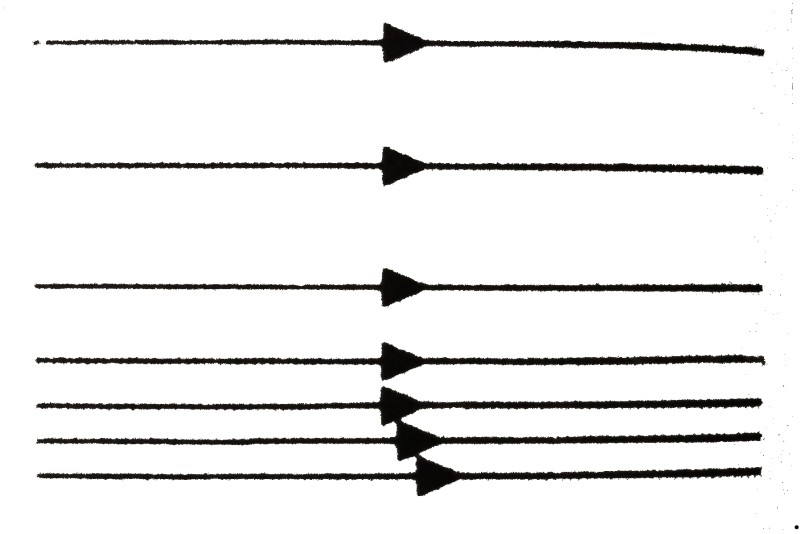
36. Is an electric field of the type shown by the electric lines in fig. physically possible?



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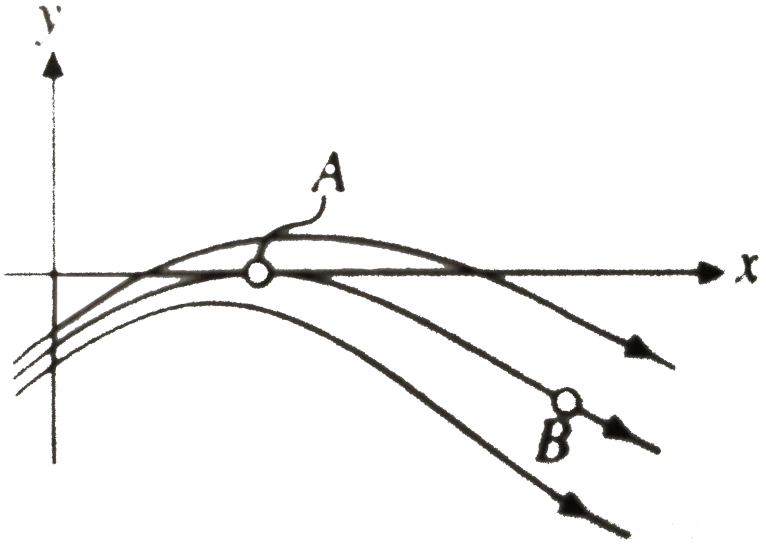
37. Fig. shows three electric field lines.

(a) What is the direction of the electrostatic force on a positive test charge placed at points A and B ?

(b) At which point A or B, will the acceleration of the test charge be greater if the charge is released?



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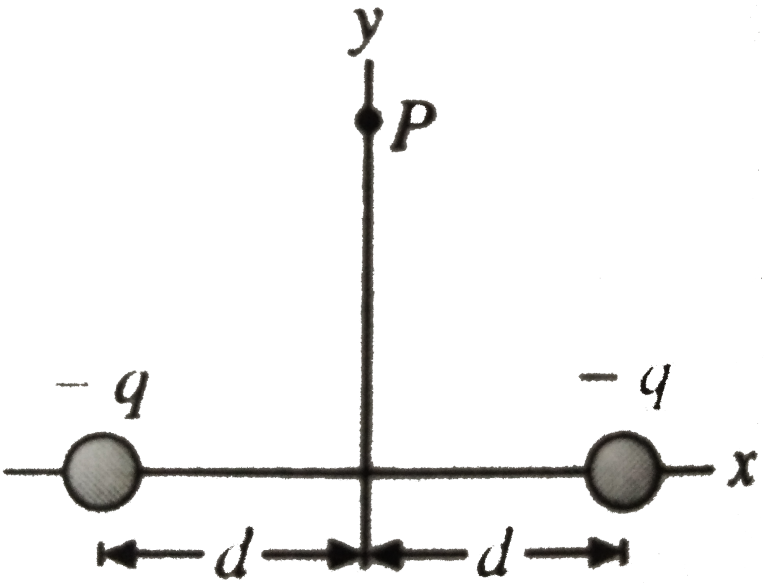
38. In fig, two particles, each of charge -q are arranged symmetrically about the y-axis, each producing an electric field at point P on the y-axis.



(a) Are the magnitudes of the fields at P equal?

(b) Is each electric field directed towards or away form the charge producing it ?

(c) Is the magnitude of the net electric field at P equal to the sum of the magnitudes E of the two field vectors (is it equal to 2E)?

(d) Do the x-components of those two field vectors add or cancel?

(e) Do their y-components add or cancel?

(f) Is the diretion of the net field at P that of the canceling components or the adding components?

(g) What is the direction of the net field?

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39. In fig. a plastic rod in the form of circular are with charge +Q unformly distributed on it produces an electric fieldof magnitude E at the centre of curvature (at the origin). In fig., more circular rods with identical umform charges +Q are addes until the circle is complete. A fifth arrangement (which would be labeled e) is like taht in d except that the roed in the fourth quadrant has charge-Q. Rank all the five arrangements according to the magnitudes of the electric field at the center of curvature, greatest first.

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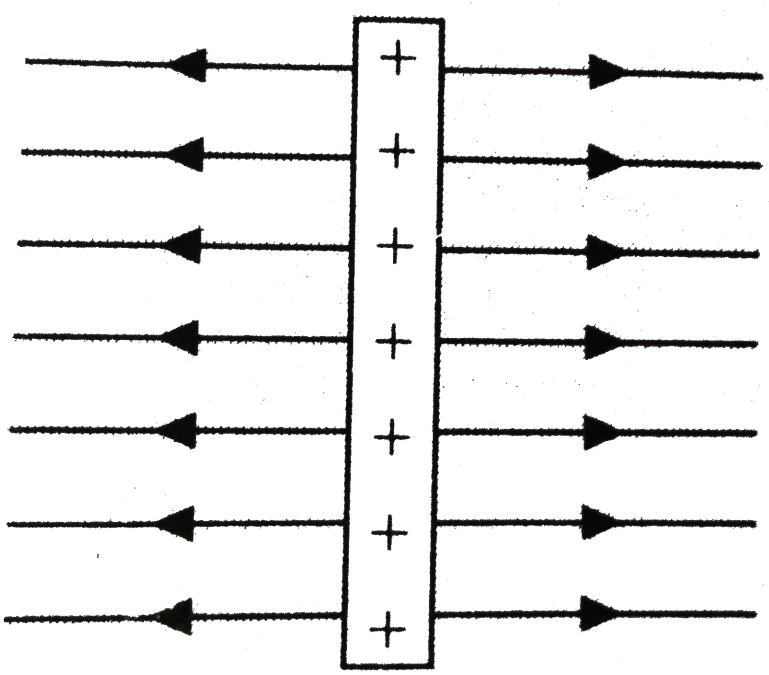
40. Figure shows that E has the same value for all points is front fo an infinitely charged sheet. Is this reasonable? One might think that the field should be stronger near the sheet because the charges are so much

closer.



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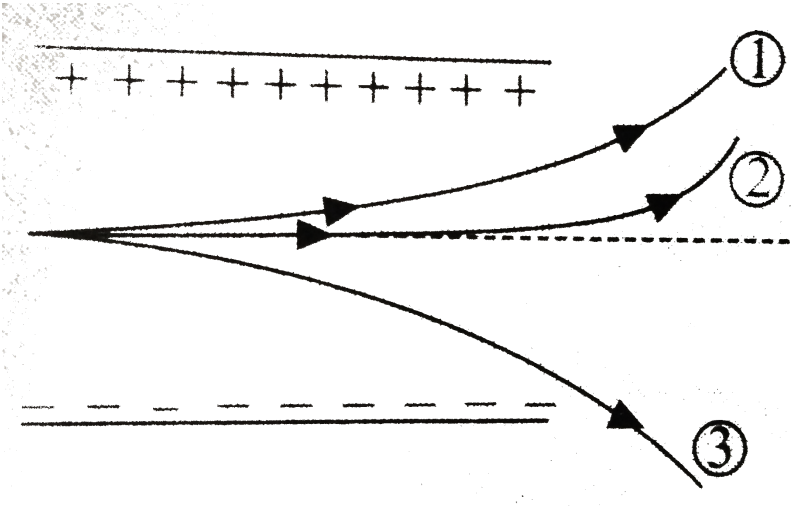
41. Figure shows the tracks of three charged particles in a unform electrostatic field projected parallel to a plate with the same velocity. Give the signs of the three charges. Which of the three charges. Which of the

three particles has the highest charge-to-mass ratio?



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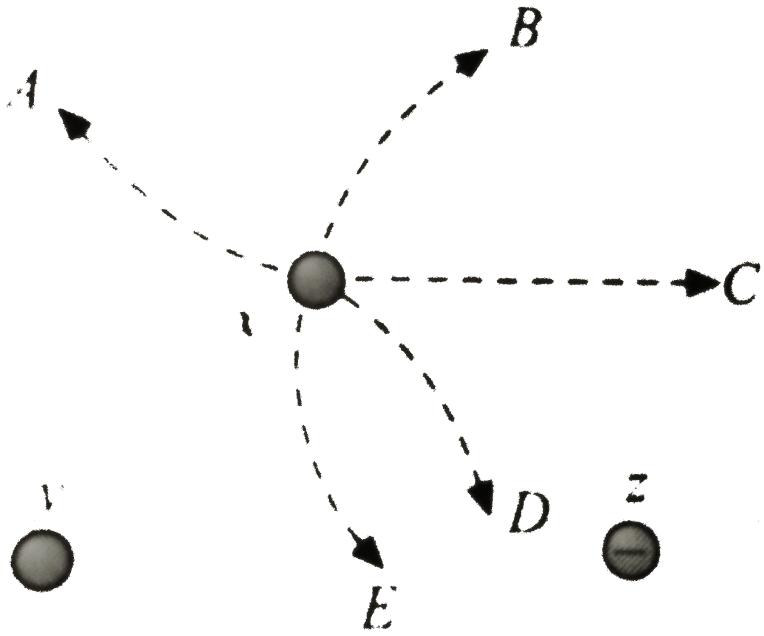
42. Three small spheres x,y, and z carry charges of equal magnitudes and with signs shown in fig. They are palced at the vertices of an isosceles triangle with the distance betwwen x and y equal to the distance between x and z. sphere y and z are held in place, but sphere x is free to move on a frictionless surface.



(a) what is the direction of the electric force on sphere x at the point shown in the figure?

(b) Which path is sphere x likely to take when released?

Watch Video Solution

43. Two identical positive charges are fixed on the y-axis, at equal distances from the origin O. A particle with a negative charges starts on the x-axis at a large distance from O. moves along the x-axis passes through O, and moves far away from O on the other side. Its acceleration

a is taken as positive along its direction of motion. Plot acceleration a of the particle against its x-coordinate.

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44. An electric field is defined in terms of q_0 a small positive charge. If the definition was in terms of a small negative charge of the same magnitude, then compared to the original field the newly defined electric field.

(a) would point in the same direction and have the same magnitude.

(b) would point in the opposite direction and have the same magnitude.

(c) would point in the same direction and have the different magnitude.

(d) would point in the opposite direction and have the different magnitude.

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45. Three identical positive charges Q are arranged at the vertices of an equilateral triangle. The side of the triangle is a. Find the intensity of the

field at the vertex of a regular tetrahedron of which the triangle is the base.

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46. Two point charges of $+5 \times 10^{-19} C$ and $+20 \times 10^{-19} C$ are separated by a distance of 2m. Find the point on the line joining then at which electric field intersity is zero.

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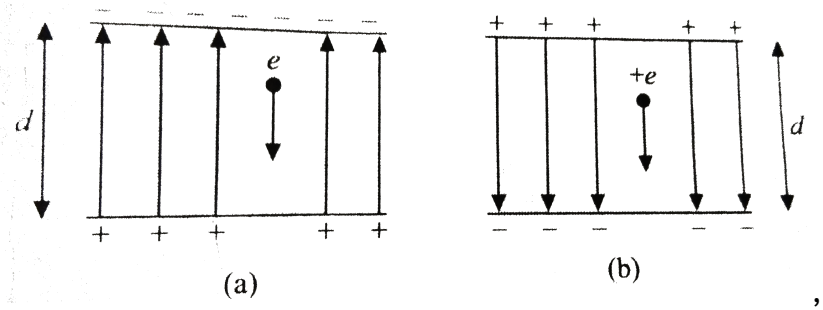
47. An electron (mass m_e)falls through a distance d in a uniform electric field of magnitude E.



The direction of the field is reversed keeping its magnitudes unchanged,

and a proton(mass m_p) falls through the same distance. If the times taken by the electrons and the protons to fall the distance d is t_{electron} and t_{proton} respectively, then the ratio $t_{\text{electron}}/t_{\text{proton}}$.

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48. Two charged metal plates in vacuum are 10cm apart. A uniform electric field of intensity $(45/16) \times 10^3 NC^{-1}$ is applied between the plates. An electron is released between the plates from rest at a point just outside the negative plate.

(a) Calculate how long (t) will the electron take to reach the other plate?

(b) At what velocity (v) will it be electron take to hits teh other plate?

Watch Video Solution

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

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

(b) should be of sign .....

(c) should be placed ..... .

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50. Two point electric charges of unknown magnitudes and signs are placed a certain distance apart. The electric field intensity is zero at a point not between the charges but on the line joining them. Write two essential conditions for this to happen.

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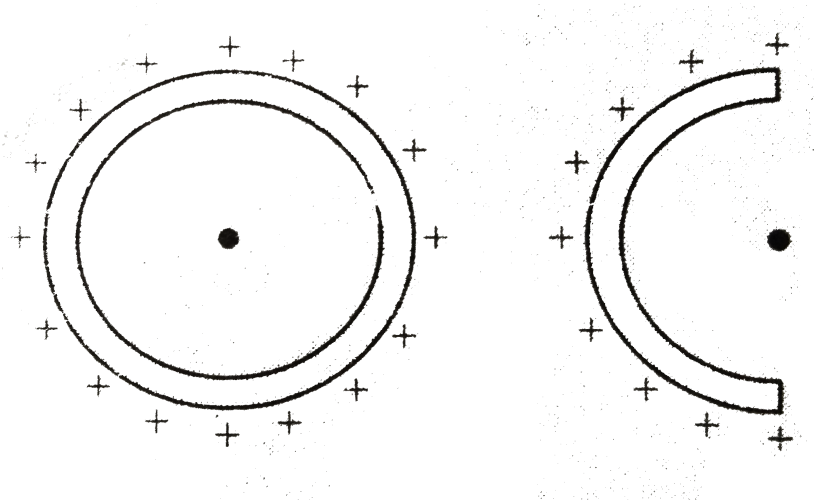
51. Two pieces of plasitic a full ring and a half ring, have the same radius and chage density. Which electric field at the center has the greater

magnitude? Define your answer.



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52. A droplet of ink in an industrial ink-jet printer carries a charge of $1.6 \times 10^{-6} C$ and is deflected onto the by a force of $3.2 \times 10^{-4} N$. Find the strength of the electric field to produce this force.

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53. Two particles A and B having charges $8.0 \times 10^{-6} C$ and $-2.0 \times 10^{-6} C$ respectively are held fixed with a. separation of 20cm.

Where should a third charged. particle be placed so that it dose not experience a net electric force?.

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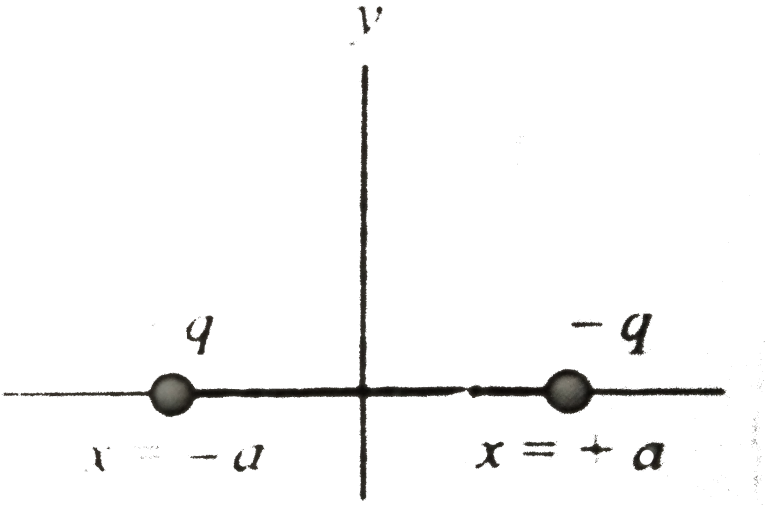
54. Two point charge $\pm q$ are placed on the axis at $x = -a$ and $x = +a$, as shown in fig.

(i) Plot the variation of E along the x-axis.

(ii) Plot the variation of E along the y-axis.



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55. Two point-like charge a and b whose strengths are equal in absolute value are positioned at a certain distance from each other. Assumeing the field strenght is positive in he direction of the r axis. Determine the sign of the charge for each distribution of the field strenght between charge for each distribution of the field strenght between charges src="https://d10lpgp6xz60nq.cloudfront.net/physics_images/BMS_V03_C01_E0 width="80%">

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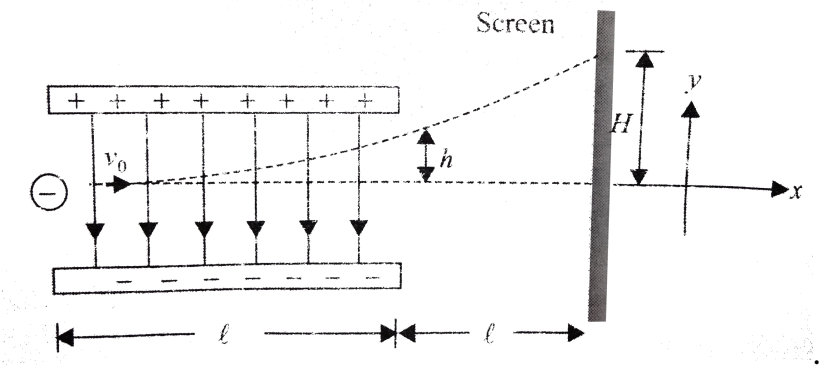
56. An electron moving in a gravitational free space enters a unifrom electric field E with an initial velocity shown in fig.



(a) Find the deflection distance h in the field .

(b) Find an expression for the velocity of electron when it just emerage

from the field.

(c) Find an expression for the total deflection distance H at a vertical screen placed at a distance l from the region of uniform field .(Assume that the field abruptly ends outside the field.).

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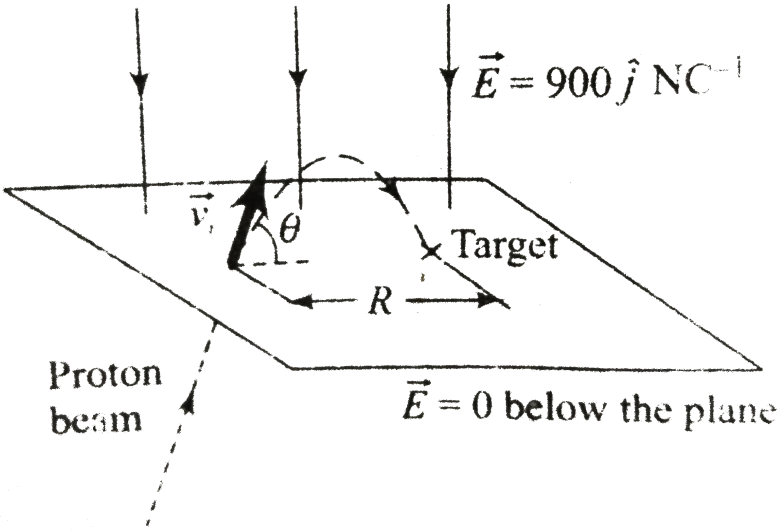
57. Protons are projected with an initial speed $v_i = 6kms^{-1}$ from a fileds-free region $\overrightarrow{E} = -900\hat{j}NC^{-1}$ present above the plane as shown in fig. The initial velocity vector of the protons makes an angle u with the plane. The proton are to hit a target that lies at a horizontal cross the plane and enter the electric field. Find the angle θ at which the protons

must pass through the plane to strike the target.



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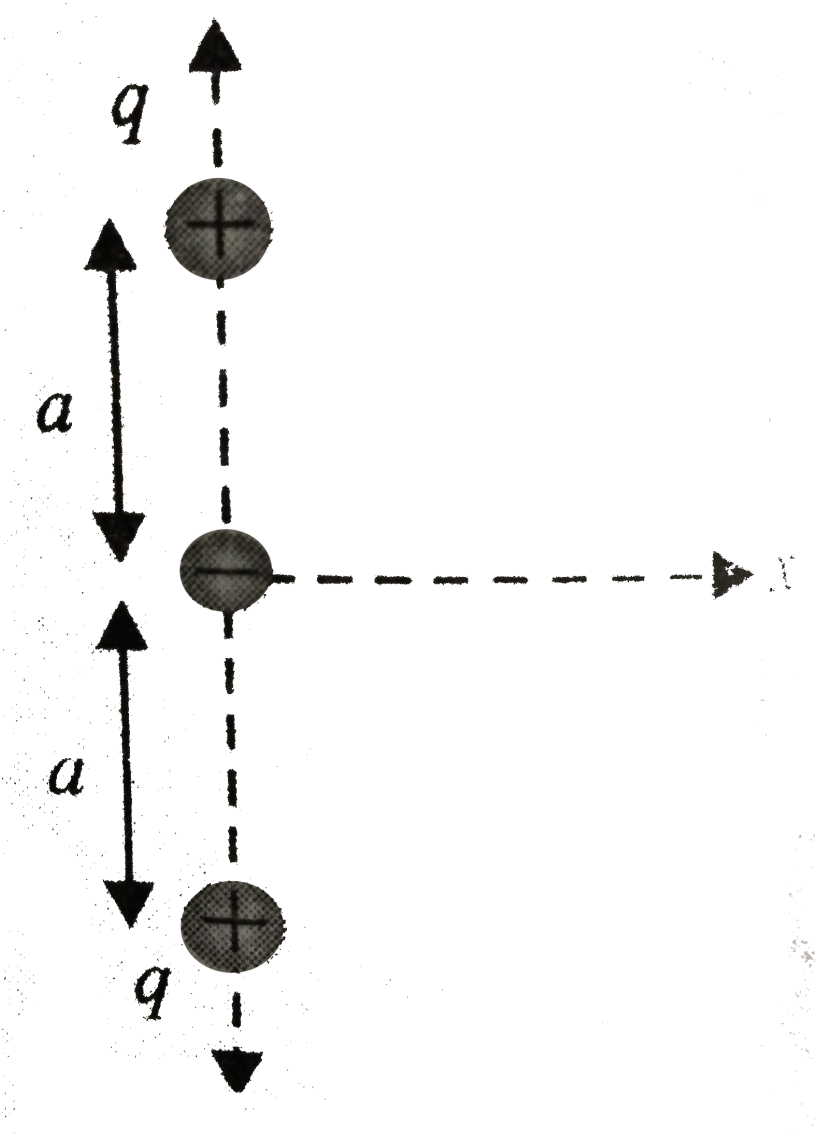
58. Two indentical point charges having magnitude q each are placed as shown if fig. If we place a negative cahrge (of magnitude -q and mass m)at the midpoint of charges and displaced along the x-axis, examine whether it will perform simpe harmonic motion. If yes then find the time period of

oscillation of the particle.



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Subjective Type

1. Calculate the number of electrons in a small, electrically neutral silver pin that has a mass of $10.0g$. Silver has 47 electrins per atom, and its molar mass is $107.87gmol^{-1}$.

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2. A charged particle of radius $5 \times 10^{-7}m$ is located in a horizontal electric field of intensity $6.28 \times 10^{5}Vm^{-1}$. The surrounding medium has the coeffecient of viscosity $\eta = 1.6 \times 10^{-5}Nsm^{-2}$. The particle starts moving under the effect of electric field and finally attains a uniform horizontal speed of $0.02ms^{-1}$. Find the number of electrons on it. Assume gravity free space.

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3. A glass rod rubbed with silk is brought close to two uncharged metallic spheres in contact with each other, inducing charge on them as shown in

Figure (a) [given in the solution]. Discuss what happens when

(i) the shperes are slightly seprated

(ii) the glass rod is subvsequently removed, and finally

(iii) the spheres are separacted apart.

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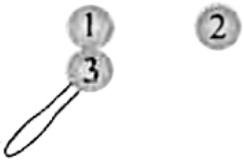
4. Indentical isolated conduction sphers 1 and 2 have equal charges and are separated by a distance that is large compared with their diameters (Fig.a). The electrostatic force acting on spkhere 2 due to sphere 1 is F. Suppose now that a third identical sphere 3, having an insulation handle and initially neutral, is touched first to sphere 1 (Fig. b), then to sphere 2 (Fig. c), and dinally removed (Fig. d). The electrostatic force that now acts on sphere 2 has magnitude F'. What is the $\frac{F'}{F}$?

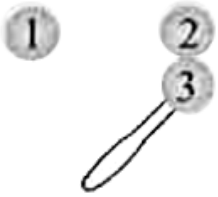
A. (a)

B.



(b)

C.



(c)

D.

(d)

Answer: C

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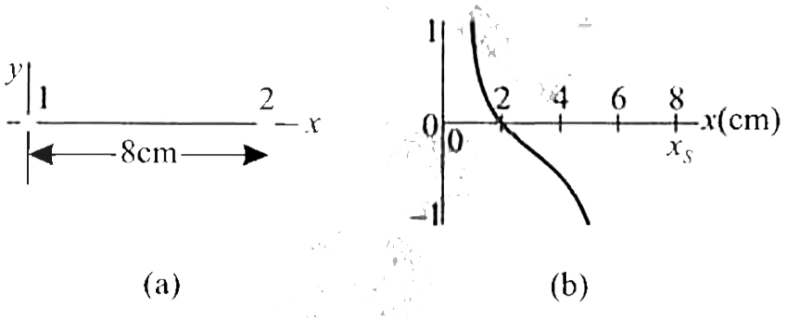
5. In Fig. a, particle 1 (of charge q_1) and particle 2 (of charge q_2) are fixed in place on an x axis, 8.00 cm apart.



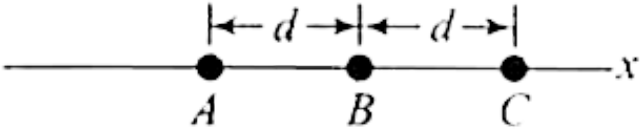
Particle 3 (of charge $q_3 = +8.00 \times 10^{-19} C$) is to be placed on the line between particles 1 and 2 so that they produce a net electrostatic force $F_{\text{net}} = 2F_0$ on it Figure b gives the x component of that force versus the coordinate x at which particle 3 is placed. The scale of the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

Watch Video Solution

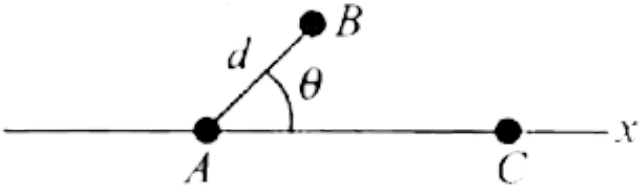
6. Figure (a) shows an arrangement of three charged particles separted by distance d. Particles A and C are fixed on the x-axis, but particle B can be moved along a circle centered on particle A. During the movement, a radial line between A and B makes an angle θ relative to the positive direction of the x-axis (Fig. b). The curves in Fig. c give, for two situations, the magnitude F_{net} of the net electrostatic force on particle A due to the other particles. That net force if given as a function of angle θ and as a

multiple of a basic amount F_0. For example on curve 1, at $\theta = 180^\circ$ we see that $F_{\text{net}} = 2F_0$. (a) For the situation corresponding to curve 1, what is the ratio of the charge of particle C to that of particle B (including

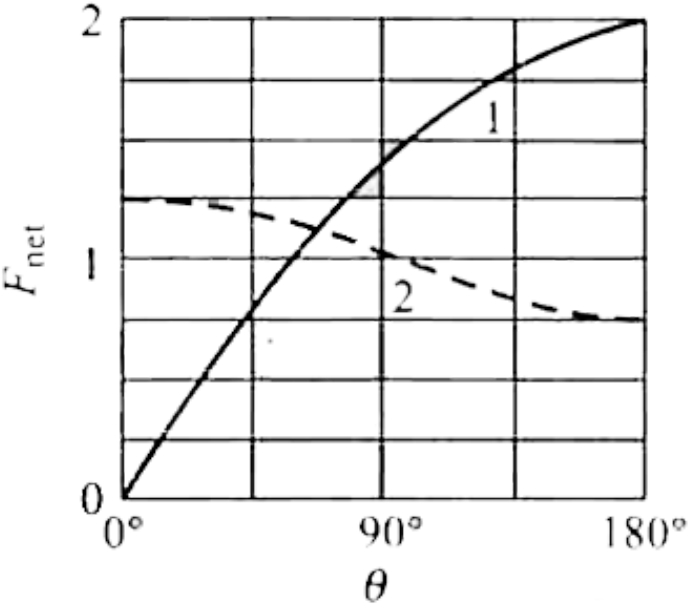
sign)? (b) For the situation corresponding to curve 2, what is that ratio?



(a)



(b)



(c)

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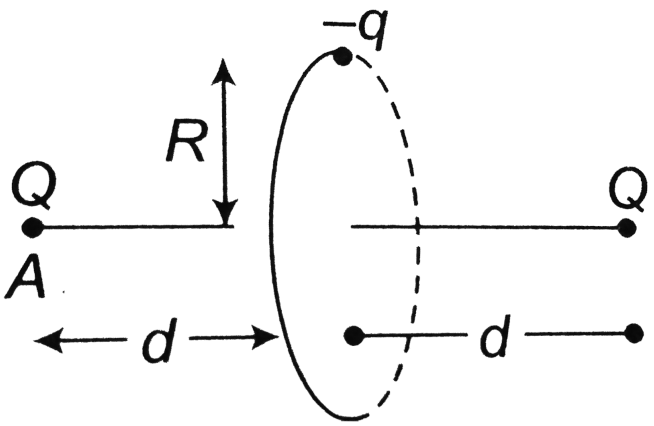
7. Two positive point charges each of magnitude $10C$ are fixed at positions A &B at a seperation $2d = 6m$. A negatively charged particle of mass $m = 90gm$ and charge of magnitude $10 \times 10^{-6}C$ is revolving in a circular path of radius $4m$ in the plane perpendicular to the line AB and bisecting the line AB. Neglect the effect of gravity. Find the angular velocity of the particle



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8. Four point positive charges are held at the vertices of a square in a horizontal plane. Their masses are $1kg, 2kg, 3kg, \&4kg$. Another point positive charge of mass $10kg$ is kept on the axis of the sqaure. The weight of their fifth charge is balanced by the electrostatic force due to those

four charges. If the four charge on the vertices are released such that they can freely move in any direction(vertical, horizontal etc.) then the acceleration of the centres of mass of the four charges immediately after the release is (Use $g = 10m/s^2$)

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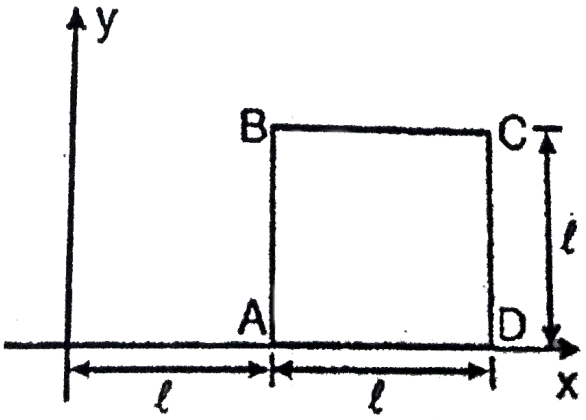
9. A square loop of side 'l' having uniform linear charge density 'λ' is placed in 'xy' plane as shown in the figure. There is a non uniform electric field $\vec{E} = \frac{a}{l}(x+l)\hat{i}$ where a is a constant. Then resultant electric force on the loop if $l = 10cm$, $a = 2N/C$ and charge density $\lambda = 2\mu C/m$ is:



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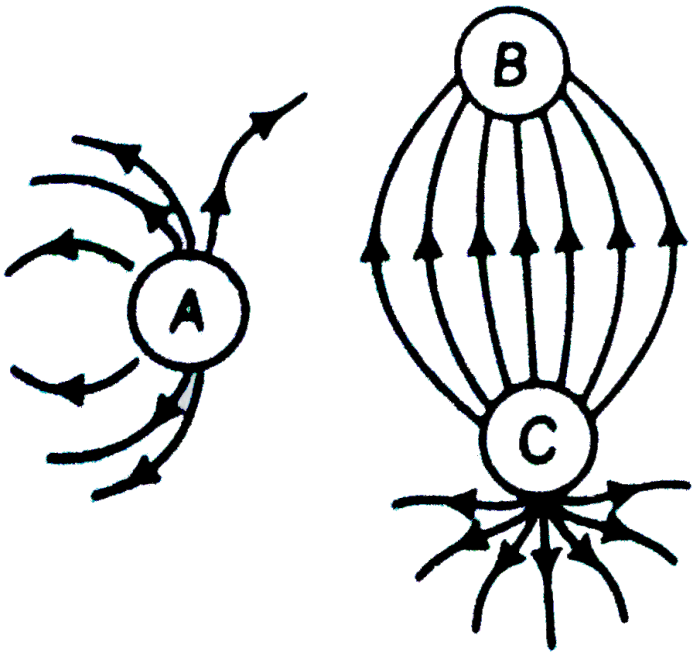
10. Figure shows the electric field lines around three point charges A,B and C



(i) which charges are positve? ltBrgt (ii) which charge has the lragest magnitude? Why?

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

(a) Near A

(b) Near B

(c) Near C

(d) Nowhere.

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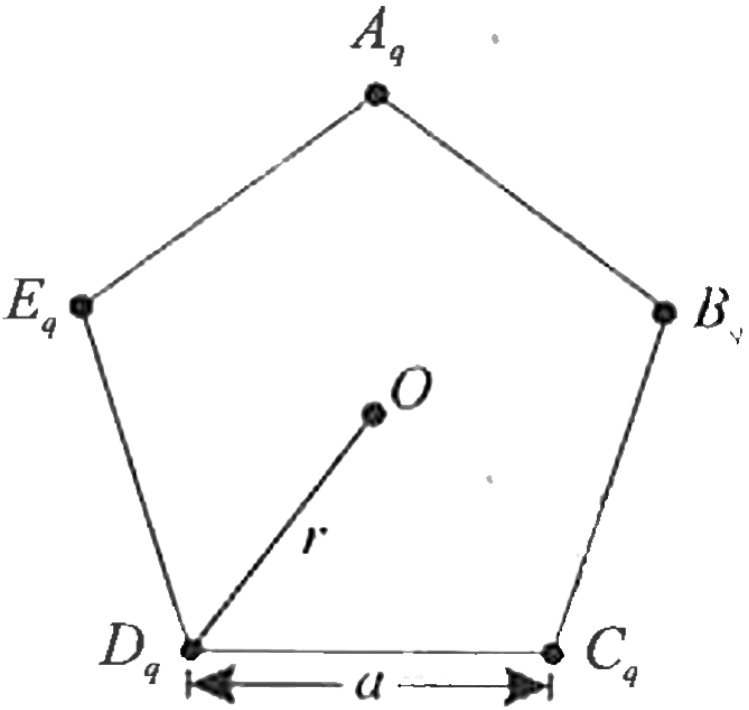
11. Five charges, q each are placed at the coreners of a regular pentagone of side.



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

(ii) What will be the electric field 0 if the charge from one of the corners

(say A) is removed ?

(iii) What will be the electric field at 0 if the charge q at A is replaced by $-q$?

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

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

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13. Electric dipole of moment $\vec{P} = P\hat{i}$ is kept at a point (x, y) in an electric field $\vec{E} = 4xy^2\hat{i} + 4x^2y\hat{j}$. Find the magnitude of force acting on

the dipole.

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14. A dipole with an electric moment $\vec{p}$ is located at a distance r from a long thread charged uniformly with a linear charge density λ. Find the force F acting on the dipole if the vector $\vec{p}$ is oriented along the thread

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15. Light of wavelength 3000A is incident on a thin glass plate of refractive index 1.5 such that angle of refraction into plate is 60^{o} .calculate the thickness of plate which will make it appear dark by reflection?

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Subjective

1. Suppose that $1.0g$ fo hydrogen is separated into electrons and protons. Suppose also that the protons are palced at the earth's north pole and the electrons are placed at the south pole. What is the resulting compression force on earth? (Given that the radius of rarth is 6400 km).

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2. Two identical conducting small spheres are placed with their centers 0.3 m aparts. One is given a charge of 12.0 nC and the other a charge of $-18.0nC$.

(a) Find the electric force exerted by one sphere on the other?

(b) If the spheres are connected by a conducting wire, find the electric force between the two after they attain equilibrium.

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3. It is required to hold equal charges q in equilibrium at the corner of square. What chrages when placed at the center of the square will do

this?

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4. Two point electric charges of value q and $2q$ are kept at a distance d apart from each other in air. A third charge Q is to be kept along the same line in such a way that the net force action on q and $2q$ is zero. Calculate the position of charge Q in terms of q and d.

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5. Two fixed point charges $+4e$ and $+e$ units are separated by a distance a. Where should a third point charge be placed for it to be in equilibrium?

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6. Two identical particles are charged and held at a distance of 1m form each pther. They are found to be attraction each other with a force of

0.027N . Now they are connected by a conducting wire so that charge folws between them. Whe the charge flow stop, they are found to be repelling each other with a force of 0.009N. Find the initial charge on each particle.

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7. Two similarly and equally charged identical metal spheres A and B repel each other with a force of $2 \times 10^{-5} N$. A third identical unchared sphere C is touched with A and then placed at the midpoint between A and B. Find the net electric force on C.

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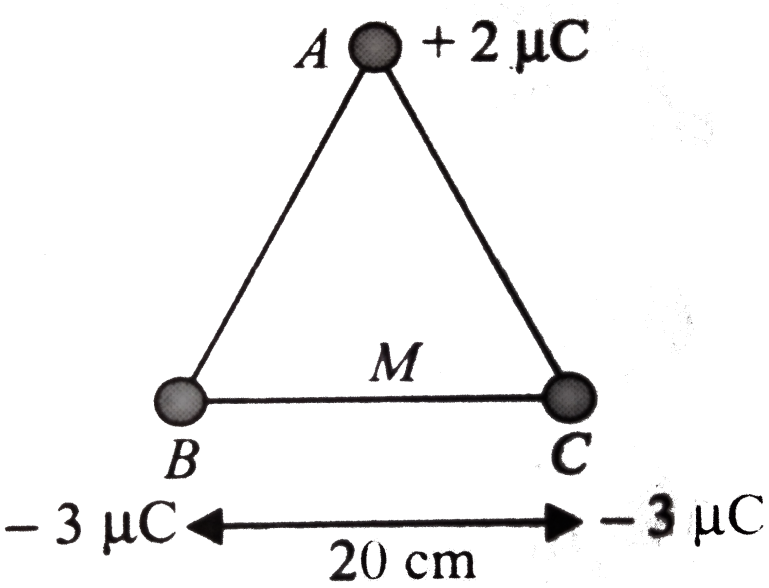
8. Three point charges of $+2\mu C, -3\mu C$, and $-3\mu C$ are kept at the vertices A, B, and C, respectively of an equilatreral triangle of side 20 cm. what should be the sign and magnitude of the charge (q) to be placed at the midpoint (M) of side BC so that the charge at A remains in

equilibrium?



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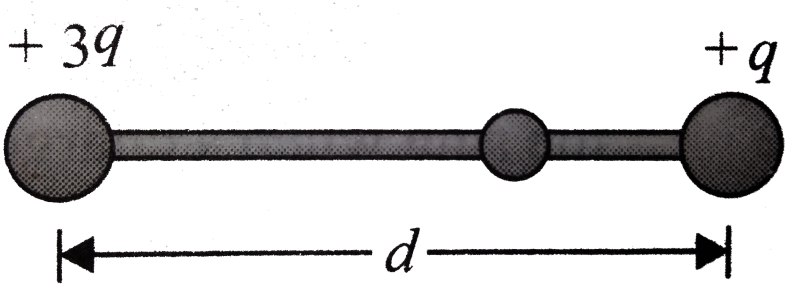
9. Two small beads having positive charges 3q and q are fixed at the opposite ends of a horizontal, insulating rod, extending from the origin to the point x=d as shown in fig. A third small charged bead is free to slide on the rod. At what position is the third bead in equilibrium? Can it

be in stable equilibrium ?



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10. A copper atom consists of copper nucles surrounded by 29 electrons. The atomic weight of copper is $63.5gmol^{-1}$. Let us now take two pieces of copper each weighing 10g. Let one electron from one piece be transferred to another for every 1000 atom in a piece. ltbRgt (a) Find the magnitude of charge appearing on each piece.

(b) What will be the Coulomb force between the two pieces after the transfer of electrons if they are 10cm apart?

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11. A flat square sheet of charge (side 50 cm) carries a uniform surface charge density. An electrons0.5 cm form a point near the center of the sheet experiences a force of $1.8 \times 10^{-12} N$ directed away from the sheet. Determine the total charge on the sheet.

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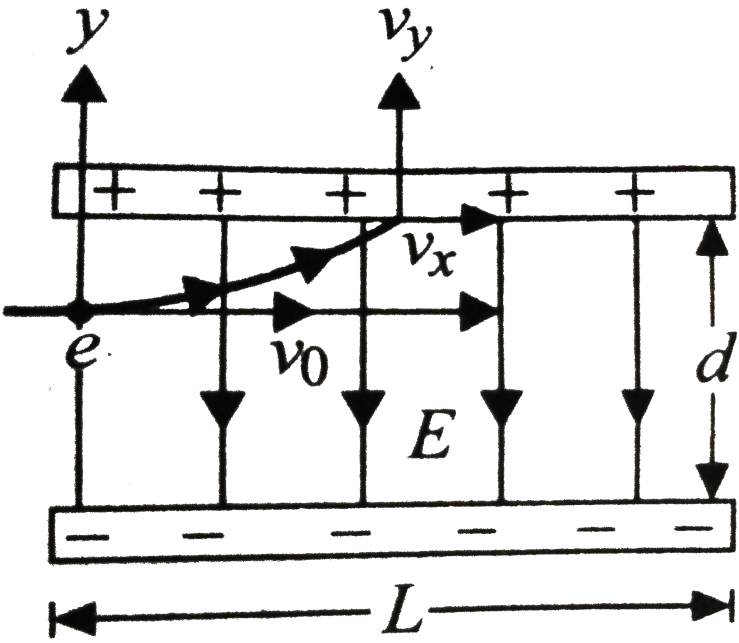
12. A particle of mass 9×10^{-31} kg having a negative charge of $1.6 \times 10^{-19} C$ is projected horizontally with a velocity of $10^{6} ms^{-1}$ into a region between two infinite horizontal parallel plates of metal. The distance between the plates is $d = 0.3cm$ and the particle enters 0.1cm below the top plate, THe top and bottom plates are connected, respectively to the positive and negative terminal of a 30V battery. Find the components of hte velocity of hte paricle just before it hits one of the

plates.



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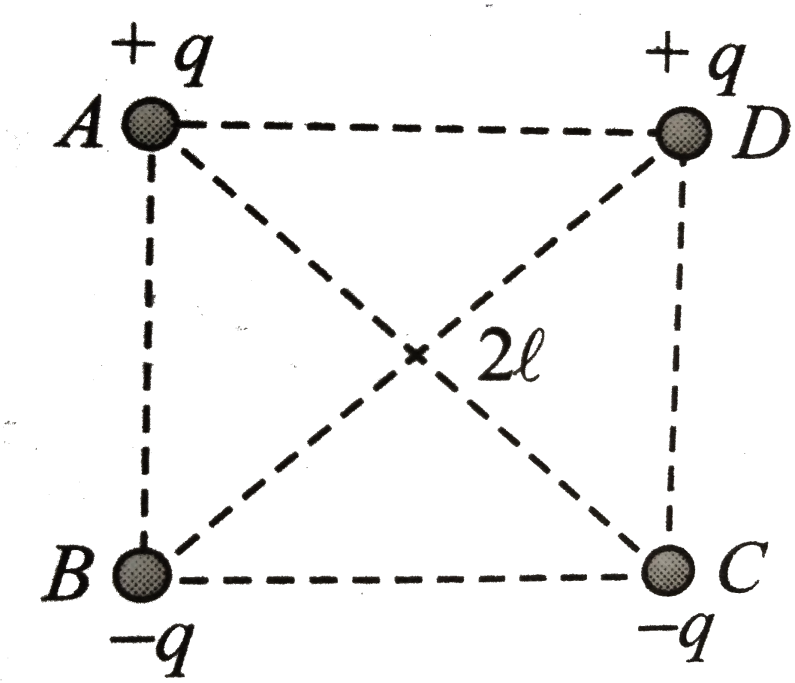
13. Point chages q and -q are located at the verticles of a squre with diagonals 2l as shown in fig. Evaluate the magnitude of the electric field strength at a point located symmetrically with respect to the vertices of

the square at a distanc x from the center.



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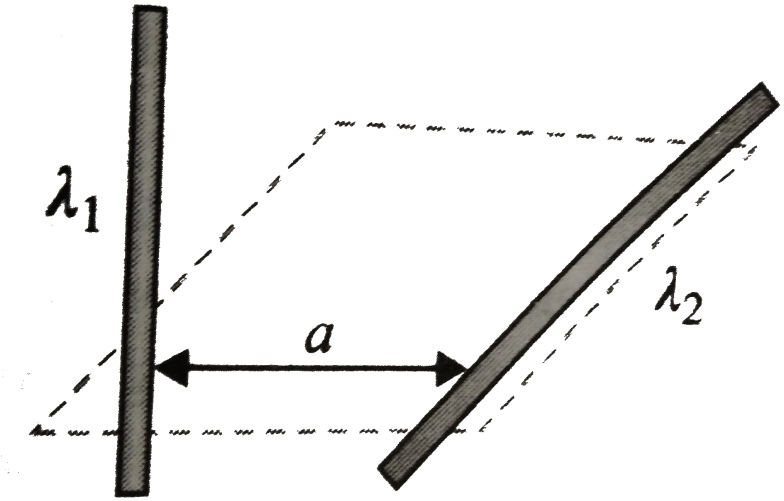
14. Two mutually perpendicular long straight conductors carrying uniformly distributed charges of linear charges densities λ_1 and λ_2 are positon at a distance a from each other. How does the interaction

between the rods depends on a ?



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15. A ring of radius 0.1m is made out of thin metallic wire of area of cross section $10^{-6}m^2$. The ring has a uniform charge of π coulombs. Find the change in the radius of the rig when a charge of $10^{-8}C$ is placed at the center of the ring. Young's modulus of hte metal is $2 \times 10^{11}Nm^{-2}$.

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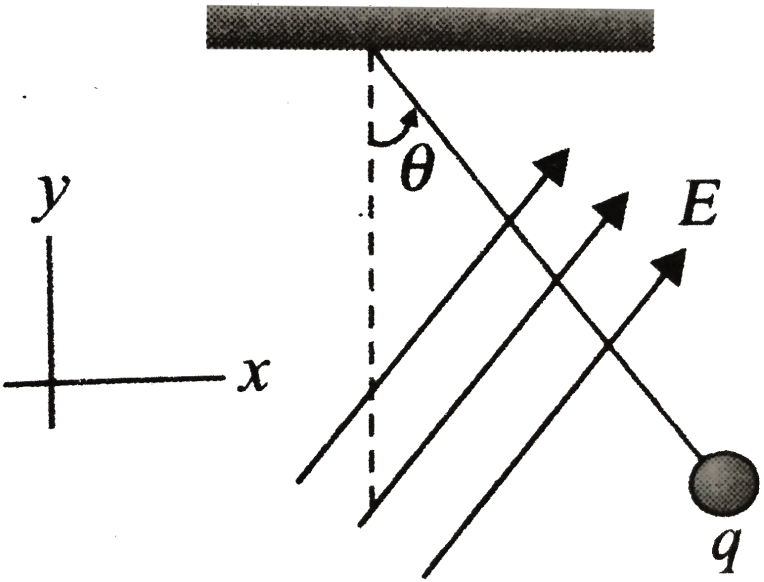
16. A charged cork ball of mass m is suspended on a light sting in the presence of a uniform electric field as shown in fig. When $E = \left(A\hat{i} + B\hat{j}\right)NC^{-1}$, Where A and B positive numbers, the ball is in equilibirum at θ. Find (a) the charge on the ball and (b) the tension in the string.



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17. A ring of radius R has charge $-Q$ distributed uniformly over it. Calculate the charge that should be placed at the center of the ring such

that the electric field becomes zero at apoint on the axis of the ring at distant R from the center of the ring.

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18. Two identical small equally charged conducting balls are suspended from long threads secured at one point. The charges and masses of the balls are such that they are in equilibirum when th distance between them is a(the length of thread $L > > a$). One of the balls is then discharged, Again for the certain value of distance $b(b < < l)$ between the balls, the equilibrium is restored, the value of $\left(a^3 / b^3\right) = (\square)$.

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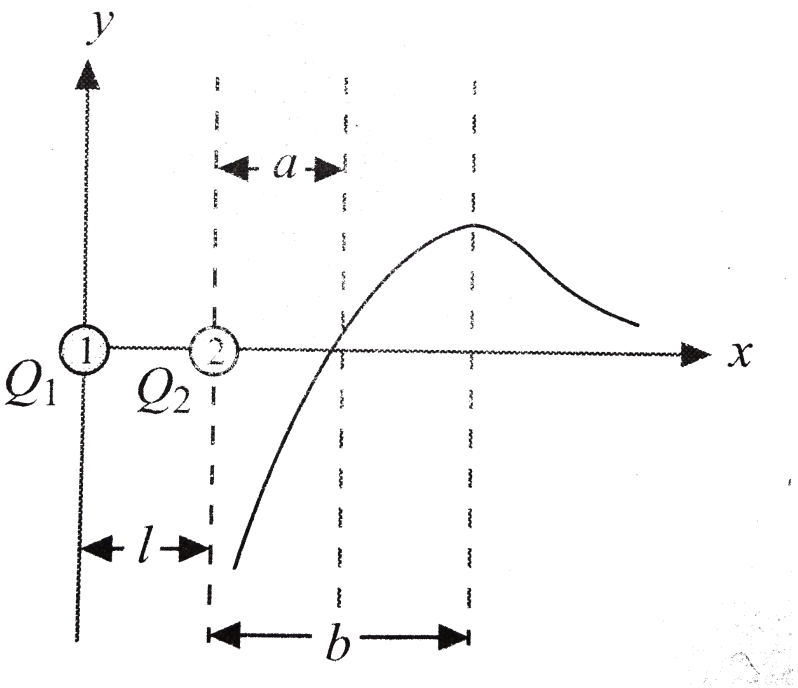
19. Two point like charges Q_1 and Q_2 are positioned at point 1 and 2. The firld intensity to the right of the chaege Q_2 on the line that passes through the two charges varies accoreing to a law that is represented schematically in fig. The field intensity is assumed to be positive if its direction coincides with the positive direction on the x-axis. The distance

between the charges is l.



The ratio of the absolute values of the charges $|Q_1/Q_2|$ is

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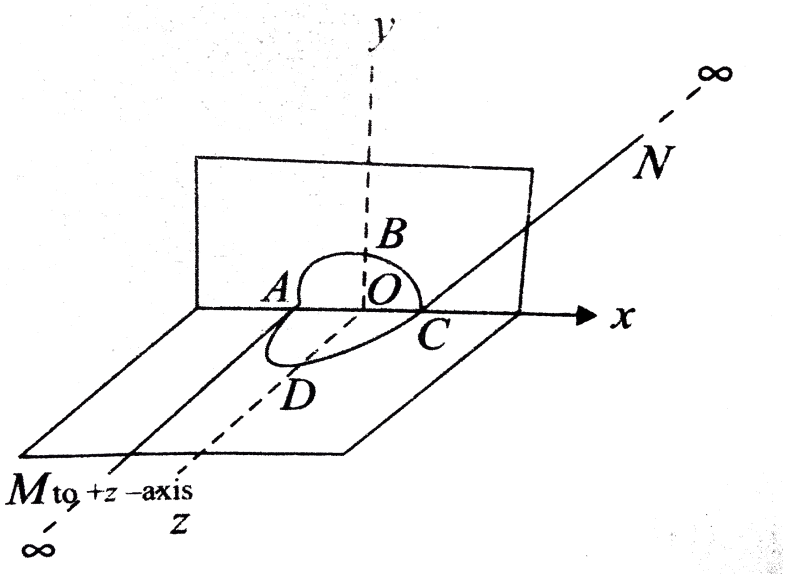
20. Two semicircle wires ABC, and ADC, each of radius R are lying on xy and xz planes, respectively as shown in fig.

if the linear charge density of the semicircle parts and straight parts and

straight parts is λ, Find the electric field entensity $\vec{E}$ at the origin .



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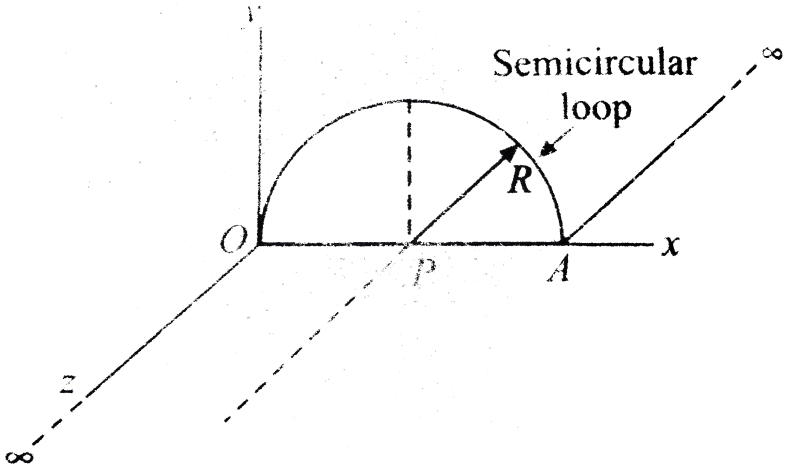
21. An infinte wire having linear charge density λ is arranged as shown in fig. A charge particle of mass m and charge q is released charged q is released from point P. Find the initial acceleration of the particle just

after the particle is released.



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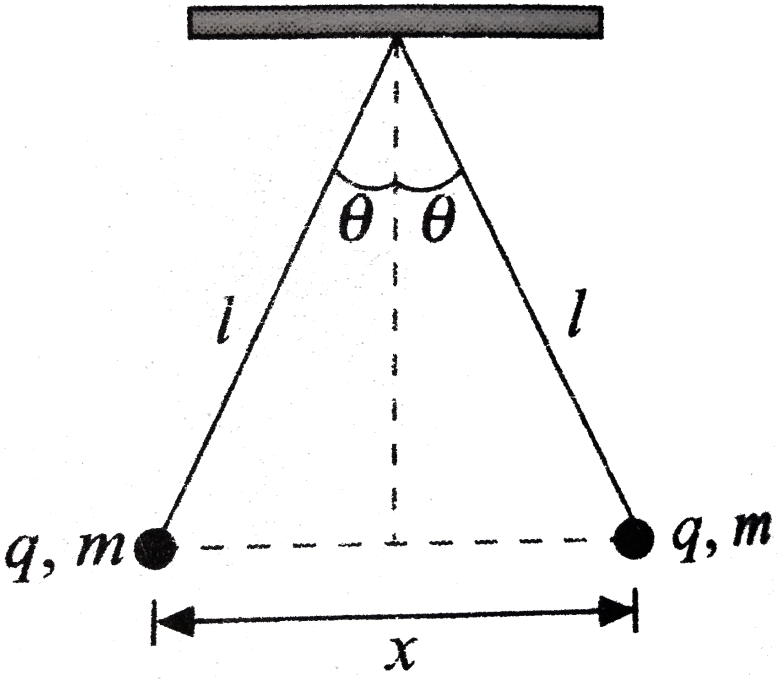
22. Two similar balls, each of mass m and charge q, are hung from a common point by two slik threads, each of length l. Prove that separation between the ball is $x = \left[\frac{q^2 l}{2\pi\varepsilon_0 mg}\right]^{1/3}$, if θ is small

Find the rate $\frac{dq}{dt}$ with which the charge should leak off each sphere if the

velocity of approach varies as $v = a/\sqrt{x}$, where a is a constant.



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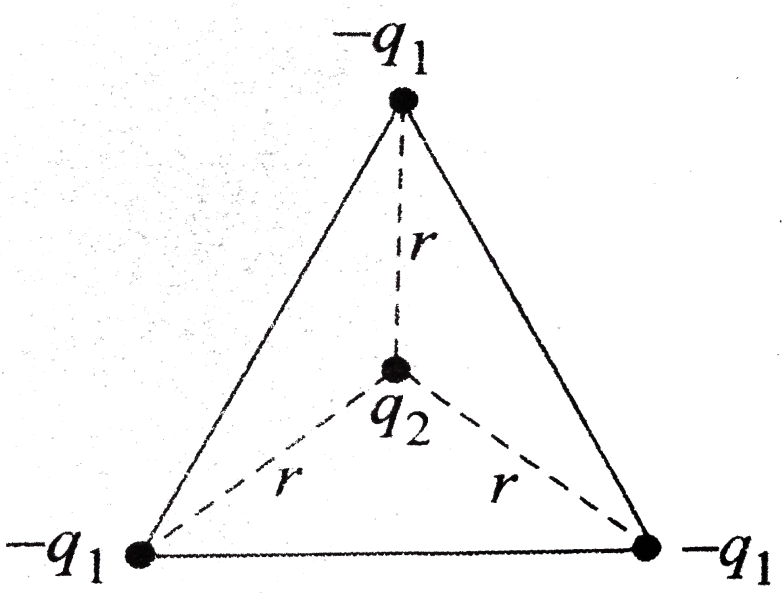
23. Three equal negative charges, $-q_1$ each form the vertices of and equilateral triangle . A particle of mass m and a positive charge q_2 is constrained to move along a line perpendicular to the plane of triangle and through its center, which at a distance r from each of the negative charges as shown in fig. The whole systen is kept in gravity-free space, Find the time period of vibration of the particle for small displacement

from the equilibrium position.



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24. A ball of radius R carries a positive charges whose volume density at a point is given as $\rho = \rho_0(1 - r/R)$, Where ρ_0 is a constant and r is the distance of the point from the center. Assume the permittivities of the ball and the enviroment to be equal to unity.

(a) Find the magnitude of the electric field strength as a function of the distance r both inside and outside the ball.

(b) Find the maximum intensity $E_{\max}$ and the corresponding distance r_m.

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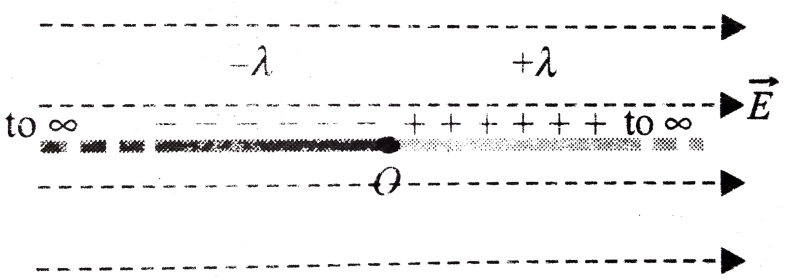
25. A uniform nonconducting rod of mass ma and length l, with charge density λ as shown in fig. is hanged at the midpoint at origin so that it can rotate in a horizontal plane without any friction. A uniform electric field E exists parallel to x axis in the entire region. Calculated the period of small oscillation of the rod .



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26. Electrically charged drops of nercury fall from an altitude h into a sperical metal vessel of radius R. There is a small opening in the upperapart of the vessel. The mass of eanc drop is m, and the charge on

the drop is Q. What will be the number n of the last drop taht can still enter the sphere?

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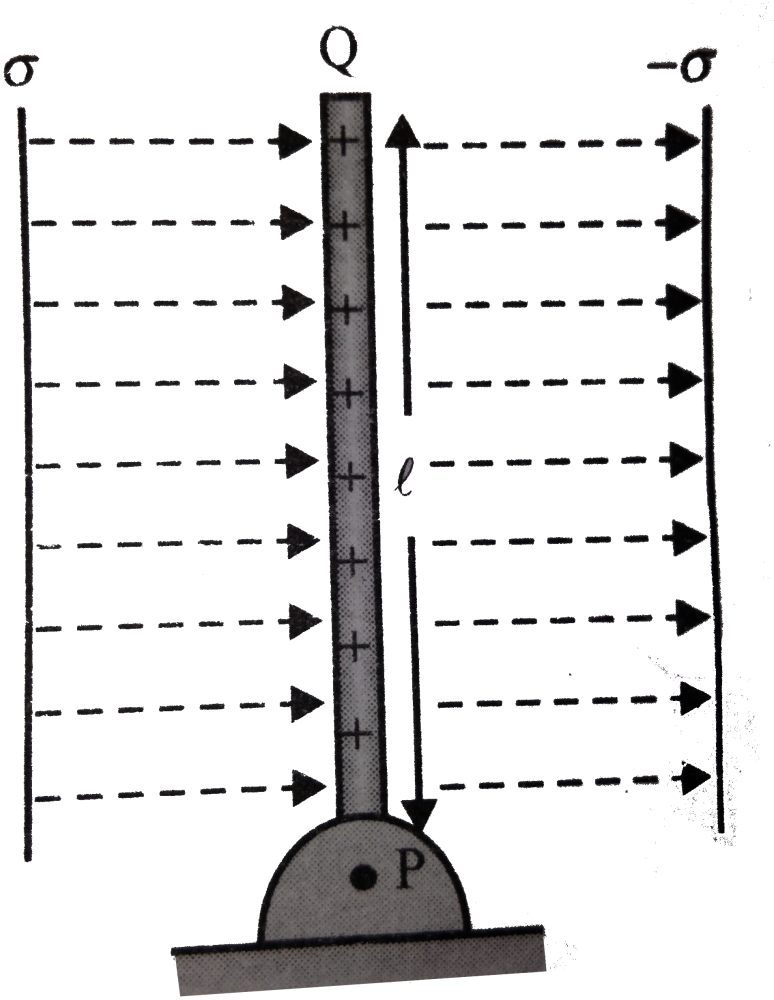
27. A thin rigid insulated rod of mass m and length l carrying a charge Q unformly distrivuted along its length is smoothly pivoted at P. It is palced in between the charged large conducting plates. Disregard gravity.

(a) Find the initial accelaeration of the rod.

(b) Find the angular speed of the rod as the function of angel θ of

rotation $\omega = f(\theta)$, if the rod is allowed to rotate freely .



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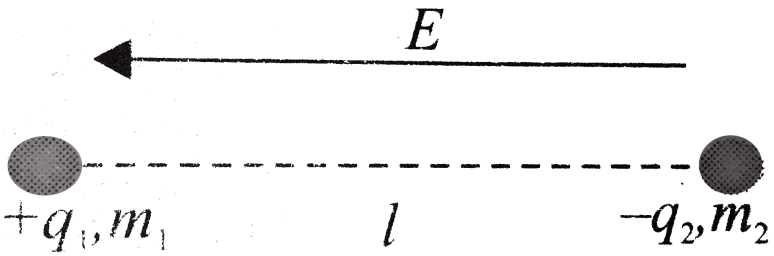
28. Two particles of chargaes and masses $(+ q_1, m_1)$ and $(+ q_2, m_2)$ are reelaesed at two different points in a uniform electric field E established

in free space. If their separation remains unchanged find the separation l between them .



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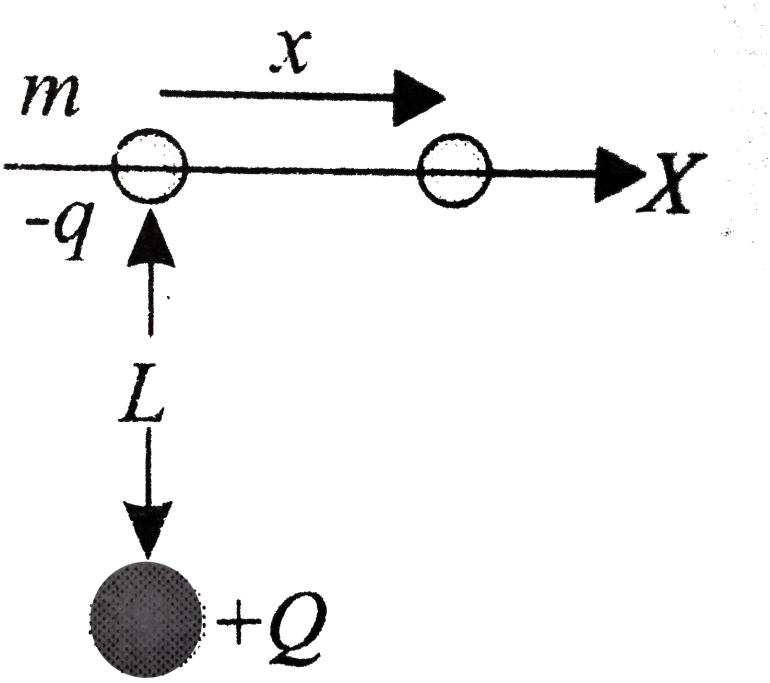
29. A small beads of mass ma having charge -q is constrained to move along a froctionless wire. A positive charges Q lies at a distance L from the wire. Initiallym the bead is just above charge +Q. Show that if the bead is displaced a distance x, where $x << L$, and released, it will exhibit simple harmonic motion. obtain an expression for the tive period

of simple harnonic motion.



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30. A charged particle q of mass m is in wquilibrium at a height h from a horizontal infinite line charge wit uniform linear charge density λ. The charge lies in the vertical plane containing the line charge. If the particle is displaced slightly (vertically) prove that the motion of the charged particle will be simple harmonic. Also find its time period.

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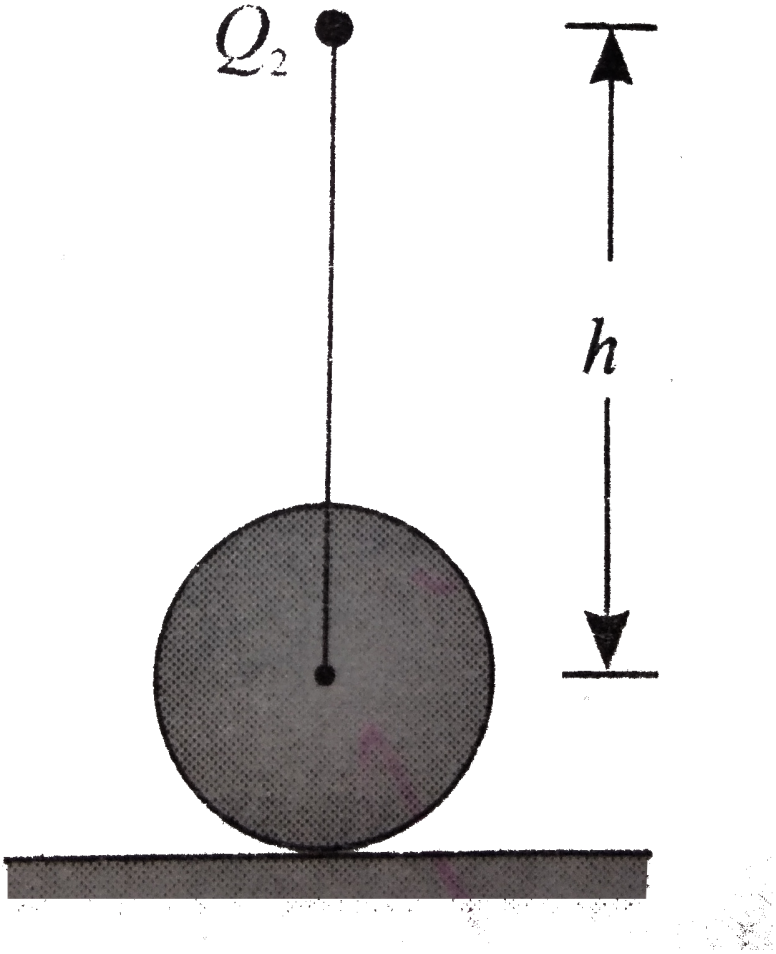
31. A point charge $Q_1 = -125\mu C$ is fixed at the center of an insulated disc of mass 1 kg. The disc rests on a rough horizontal plane. Another charge $Q_2 = 125\mu C$ is fixed verically above the center of the disc at a height h=1m. After the disc is displaced slightly in the horizontall direction (friction is sufficient to prevent slipping), find the period of

oscillation of disc.



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32. Two small balls having the same mass and charge and located on the same vertical at heights h_1 and h_2 are thrown in the same direction

along the horizontal at the same velocity v. The first vall touches the ground at a horizontal distance R from the initial vertical position. At waht heigth h_2 will the second ball be at this instant? Neglect any frictional resistance of air and the effect of any induced charge on the ground.

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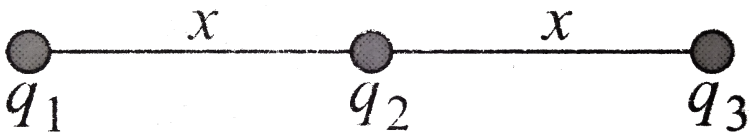
Single Correct

1. Three charged paricles are placed on a straight line as shown in fig. q_1 and q_2 are fixed but q_3 can be moved. Under the action of the forces from q_1, q_2 and q_3 is in equilbrium. What is the relation between q_1 and q_2.



A. $q_1 = 4q_2$

B. $q_1 = -q_2$

C. $q_1 = -4q_2$

D. $q_1 = q_2$

Answer: C

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2. Two particles A and B having charges $8.0 \times 10^{-6} C$ and $-2.0 \times 10(-6) C$ respectively are held fixed with a. separtion of 20cm. Where should a thired charged. particle be placed so that it dose not experience a net electric force?.

A. 5 cm right of B

B. 5cm left of A

C. 20 cm left of A

D. 20 cm right of B

Answer: D

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3. Five balls numbered 1,2,3,4,and 5 are suspended using separated threads. The balls (1,2),(2,4) and (4,1) show electrostatic attraction while balls (2,3) and (4,5) show repulsion. Therefore, ball 1 must be

A. negatively charged

B. Positively charges

C. neutral

D. made of metal

Answer: C

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4. Two point charges repel each other with a force of 100N. One of the charges is increased by 10% and the other is reduced by 10% . The new force of repulsion at the same distance would be

A. 100N

B. 121N

C. 99N

D. none of these

Answer: C

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5. Threee charges $+Q_1,\ +Q_2$ and q are placed on a straight line such that q is somewhere in between $+Q_1$and Q_2. If this system of charges is in equlibirium what should be the magnitude and sign of charge q?

A. $\frac{Q_1Q_2}{\left(\sqrt{Q_1}+\sqrt{Q_2}\right)^2}$, positive

B. $\frac{Q_1+Q_2}{2}$, positive

C. $\frac{Q_1Q_2}{\left(\sqrt{Q_1}+\sqrt{Q_2}\right)^2}$, Negative

D. $\frac{Q_1+Q_2}{2}$,Negative

Answer: C

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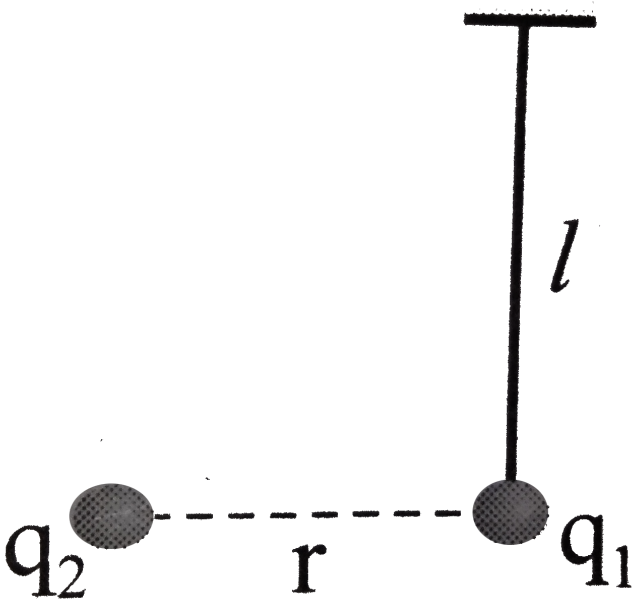
6. An isolated charge q_1 of mass m is suspended freely by a thread of length l. Another charge q_2 is brought near it $(r > > l)$. When q_1 is in equilibrium tension in thread will be



A. 1. mg

B. 2. $> mg$

C. 3. $< mg$

D. 4. none of these

Answer: B

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7. A positively charged ball hangs from a long silk thread. Electric filed at a certain point (at the same horizontal level of ball) due to this charge is E. Let us put a positive test charge q_0 at this point and measure F/q_0 on this charges. then E

A. $> F/q_0$

B. $< F/q_0$

C. $= F/q_0$

D. none of these

Answer: A

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8. Two particle of masses in the ration 1:2 with charges in the ratio 1:1, are placed at rest in a uniform electric field. They are released and allowed to move for the same time. The ratio of their kinetic energies will be finally

A. $2:1$

B. $8:1$

C. $4:1$

D. $1:4$

Answer: A

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9. Three equal charges, each $+q$ are placed on the corners of an equilatreal triangel . The electric field intensity at the centroid of the triangle is

A. kq/r^2

B. $3kq/r^2$

C. $\sqrt{3}kq/r^2$

D. zero

Answer: D

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10. A point charge of $100\mu C$ is placed at $3\hat{i} + 4\hat{j}m$. Find the electric field intensity due to this charges at a point located at $9\hat{i} + 12\hat{j}m$.

A. $8000Vm^{-1}$

B. $9000Vm^{-1}$

C. $2250Vm^{-1}$

D. $4500Vm^{-1}$

Answer: B

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11. Two charge $Q_1 = 18\mu C$ and $Q_2 = -2\mu C$ are separated by a distance R, and Q_1 is on the left of Q_2. The distance of the point where the net electric field is zero is

A. between Q_1 and Q_2

B. left of $Q_1 at R/2$

C. right of Q_2 at R

D. right of Q_2 at $R/2$

Answer: D

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12. An oil drop, carrying six electronic charges and having a mass of $1.6 \times 10^{-12} g$, falls with some terminal velocity in a medium. What magnitude of vertical electric field is required to make the drop move

upward with the same speed as it was formerly moving down ward with ?

Ignore buoyancy.

A. $10^5 NC^{-1}$

B. $10^4 NC^{-1}$

C. $3.3 \times 10^4 NC^{-1}$

D. $3.3 \times 10^5 NC^{-1}$

Answer: C

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

A. 1. $\frac{q}{4\pi\varepsilon_0 a^2}$

B. 2. $\frac{q}{8\pi\varepsilon_0 a^2}$

C. 3. $\frac{q}{16\pi\varepsilon_0 a^2}$

D. 4. zero

Answer: A

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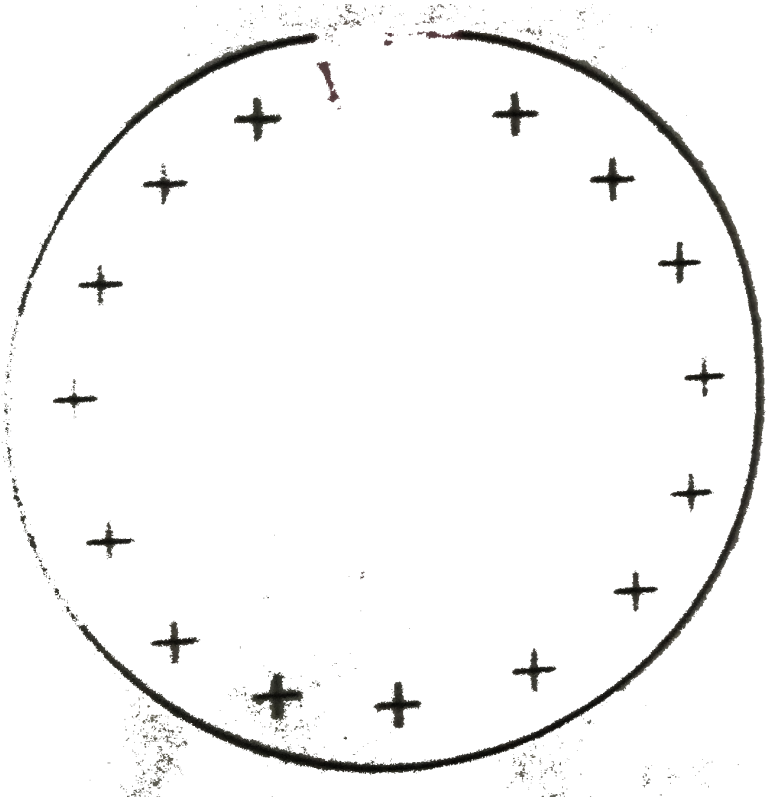
14. A ring of charge with radius $0.5m$ has 0.002π m gap. If the ribg carries a charge of $+1C$ the electric field at the center is



A. $7.5 \times 10^7 NC^{-1}$

B. $7.2 \times 10^7 NC^{-1}$

C. $6.2 \times 10^7 NC^{-1}$

D. $6.5 \times 10^7 NC^{-1}$

Answer: B

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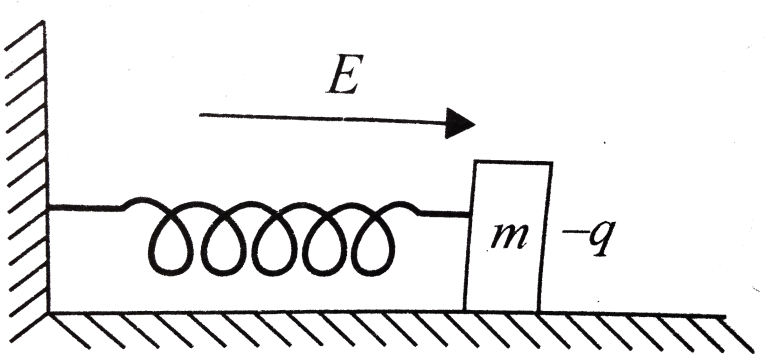
15. A block of mass m containing a net negative chage $-q$ is placed on a froctionless horizontal tabe and is connected to a wall through an unstreached spring of spring constant k. If the horizontal electric field E parallel to spring is switched on , then the maximum compression of the

spring is



A. $\sqrt{qE/k}$

B. $2qE/k$

C. qE/k

D. zero

Answer: B

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16. Three positive charges of equal magnitude q are placed at the vertics of and equilatral triangle of side l. How can the system of charges be palced in equilibrium?

A. by placing a charge $Q = -q/\sqrt{3}$ at the centroid of the triangle

B. by placing a charge $Q = q/\sqrt{3}$ at the centroid of the triangle

C. by placing a charge $Q = q$ at the centroid of the triangle

D. by placing a charge $Q = -q$ at the centroid of the triangle

Answer: A

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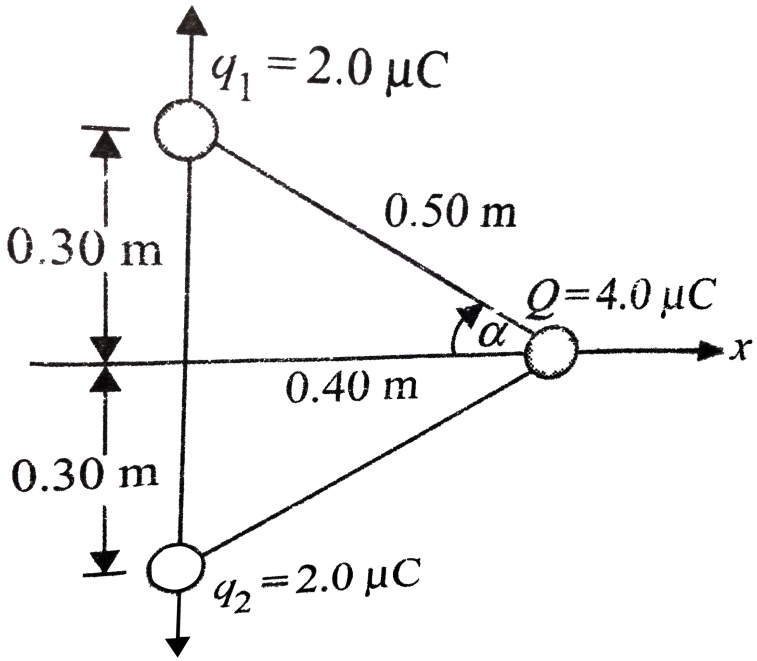
17. In fig two equal positive point charge $q_1 = q_2 = 2.0\mu C$. Interact with a third point charge $Q = 4.0\mu C$. The magnitude as well as direction of the

net force on Q is



A. $0.23N$ in the +x direction

B. $0.46N$ in the +x direction

C. $0.23N$ in the -x direction

D. $0.46N$ in the -x direction

Answer: B

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18. Three uniform spheres each having a mass M and radius a are kept in such a way that each touches the other two. Find the magnitude of the gravitational force on any of the spheres due to the other two.

A. $\frac{1}{4\pi\varepsilon_0}\left(\frac{q}{R}\right)^2$

B. $\frac{\sqrt{3}}{4\pi\varepsilon_0}\left(\frac{q}{R}\right)^2$

C. $\frac{\sqrt{3}}{16\pi\varepsilon_0}\left(\frac{q}{R}\right)^2$

D. $\frac{\sqrt{5}}{16\pi\varepsilon_0}\left(\frac{q}{R}\right)^2$

Answer: C

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

A. $\frac{1}{\pi\varepsilon_0}\left(\frac{q}{L}\right)^2$

B. $\frac{2}{\pi\varepsilon_0}\left(\frac{q}{L}\right)^2$

C. $\frac{1}{2\pi\varepsilon_0}\left(\frac{q}{L}\right)^2$

D. $\frac{1}{4\pi\varepsilon_0}\left(\frac{q}{L}\right)^2$

Answer: D

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20. Four equal point charges, each of magnitude $+Q$, are to be placed in equilibrium at the corners of a square. What should be the magnitude and sign of the point charge that should be placed at the center of the square to do this job?

A. $-\frac{q}{2}(1+2\sqrt{2})$

B. $\frac{q}{2}(1+2\sqrt{2})$

C. $-\frac{q}{4}(1+2\sqrt{2})$

D. $-\frac{q}{4}(1+2\sqrt{2})$

Answer: D

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

A. $-14.4\hat{i} + 10.8\hat{j}$

B. $-14.4\hat{i} - 10.8\hat{j}$

C. $-10.8\hat{i} + 14.4\hat{j}$

D. $-10.8\hat{i} - 14.4\hat{j}$

Answer: C

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22. A positive point charge $50\mu C$ is located in the plane xy at a point with radius vector $\vec{r}_0 = 2\hat{i} + 3\hat{j}$. The electric field vector $\vec{E}$ at a point with

radius vector $\overrightarrow{r} = 8\hat{i} - 5\hat{j}$, where r_0 and r are expressed in meter, is

A. $\left(1.4\hat{i} - 2.6\hat{j}\right) kNC^{-1}$

B. $\left(1.4\hat{i} + 2.6\hat{j}\right) kNC^{-1}$

C. $\left(2.7\hat{i} - 3.6\hat{j}\right) kNC^{-1}$

D. $\left(2.7\hat{i} + 3.6\hat{j}\right) kNC^{-1}$

Answer: C

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23. Four identical charges Q are fixed at the four corners of a square of side a. The electric field at a point P located symmetrically at a distance $a/\sqrt{2}$ from the center of the square is

A. $\frac{Q}{2\sqrt{2}\pi\varepsilon_0 a^2}$

B. $\frac{Q}{\sqrt{2}\pi\varepsilon_0 a^2}$

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

D. $\frac{\sqrt{2}Q}{\pi\varepsilon_0 a^2}$

Answer: B

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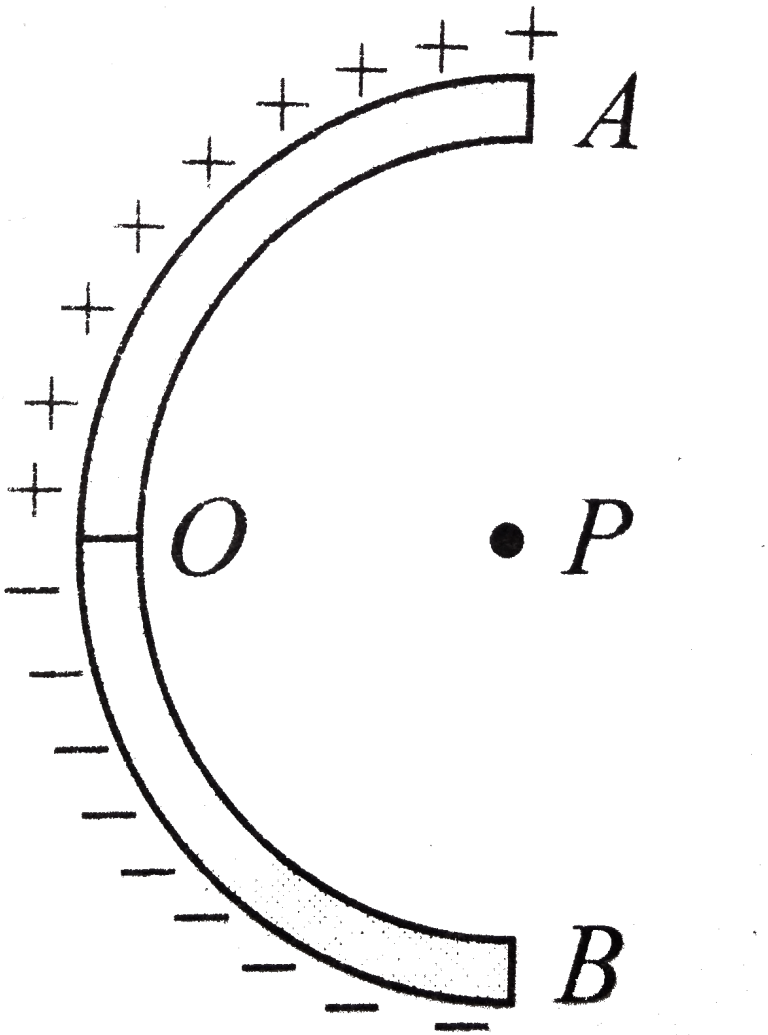
24. A thin glass rod is bent into a semicircle of radius r. A charge +Q is uniformly distributed along the upper half, and a charge -Q is uniformly distributed along the lower half, as shown in fig. The electric field E at P, the center of the semicircle, is



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

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

C. $\frac{4Q}{\pi^2 \varepsilon_0 r^2}$

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

Answer: A

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25. A system consits fo a thin charged wire ring of radius R and a very long uniformly charged thread oriented along the axis of the ring, with one of its ends coinciding with the centre of the ring. The total charge of the ring, with one of the ring so equal to q. The charge of the thread (per unit length) is equal to λ. Find the interaction froce between the ring and the thread.

A. $\frac{\lambda q}{4\pi\varepsilon_0 r}$

B. $\frac{\lambda q}{4\sqrt{2}\pi\varepsilon_0 r}$

C. $\frac{2\sqrt{2}\lambda q}{\pi^2\varepsilon_0 r}$

D. $\frac{4\lambda q}{\pi^2\varepsilon_0 r}$

Answer: B

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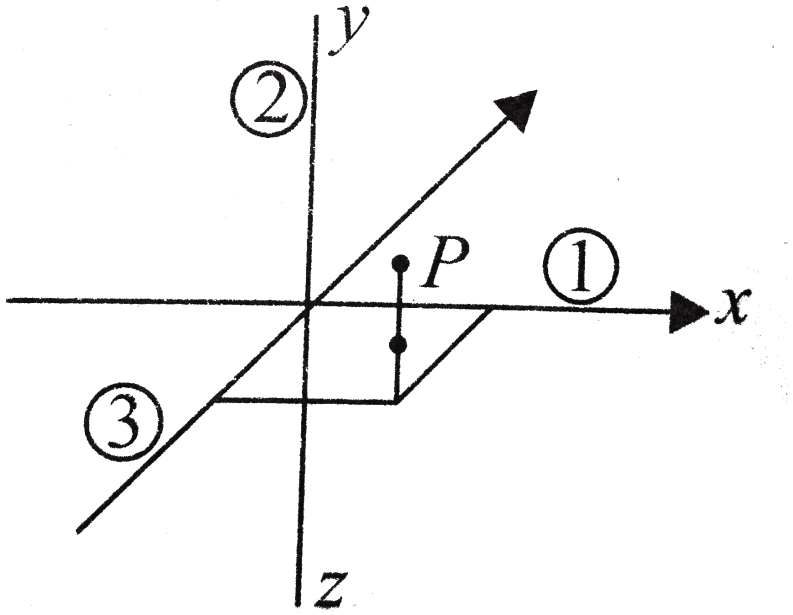
26. Find the electric field vector at P (a,a,a) due to three infinitely long lines of charges along the x-, y- and z-axis, respectively. The charge density i.e. charge per unit length of each wire is (λ),



A. $\frac{\lambda}{3\pi\varepsilon_0 a}\left(\hat{i}+\hat{j}+\hat{k}\right)$

B. $\frac{\lambda}{2\pi\varepsilon_0 a}\left(\hat{i}+\hat{j}+\hat{k}\right)$

C. $\frac{\lambda}{2\sqrt{2}\pi\varepsilon_0 a}\left(\hat{i}+\hat{j}+\hat{k}\right)$

D. $\frac{2\lambda}{\pi\varepsilon_0 a}\left(\hat{i}+\hat{j}+\hat{k}\right)$

Answer: B

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27. A particle of mass m and charge -q moves diametrically through a uniformily charged sphere of radius R with total charge Q. The angular frequency of the particle's simple harminic motion, if its amplitude lt R, is given by

A. $\sqrt{\frac{1}{4\pi\varepsilon_0}\frac{qQ}{mR}}$

B. $\sqrt{\frac{1}{4\pi\varepsilon_0}\frac{qQ}{mR^2}}$

C. $\sqrt{\frac{1}{4\pi\varepsilon_0}\frac{qQ}{mR^3}}$

D. $\sqrt{\frac{1}{4\pi\varepsilon_0}\frac{m}{qQ}}$

Answer: C

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28. A particle of mass m carrying a positive charge q moves simple harmonically along the x-axis under the action of a varying electric field E directed along the x-axis. The motion of the particle is confined between x=0 and x=2l. The angular frequency of the motion is ω. Then which of the following is correct ?

A. $qE = -m\omega^2(x-1)$

B. $qE = m\omega^2(x-1)$

C. Electric field to the right of origin is directed along the positive x-axis for all balues of x.

D. Electric field to the right of origin is directed along the negative x-axis for all balues of x.

Answer: A

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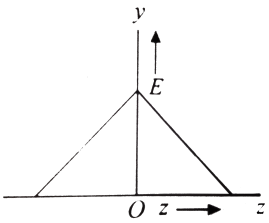
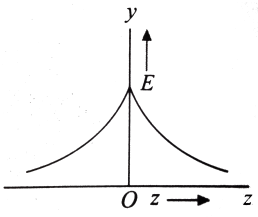
29. A circular ring carries a uniformly distributed positive charge and lies in the xy plane with center at the origin of the cooredinate system. If at a point (0,0,z) the electric field is E, then which of the following graphs is correct?

A.



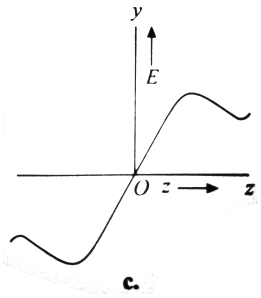
a.

B.

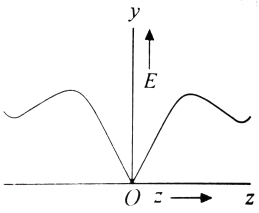


b.

C.



c.

D. 

Answer: C

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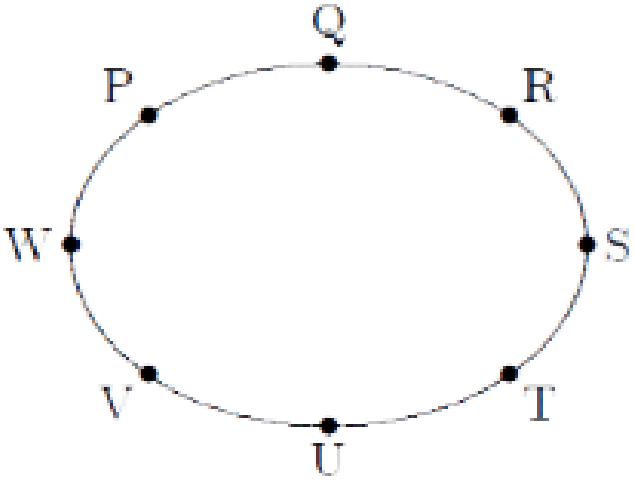
30. A planet travels in an elliptical orbit about a star as shown. At what pair of points is the speed of the planet the same?



A. kq/a^2 at an angle 45° above the +x-axis

B. kq/a^2 at an angle 45° below the -x-axis

C. $3kq/a^2$ at an angle 45° above the -x-axis

D. $3kq/a^2$ at an angle 45° below the +x-axis

Answer: B

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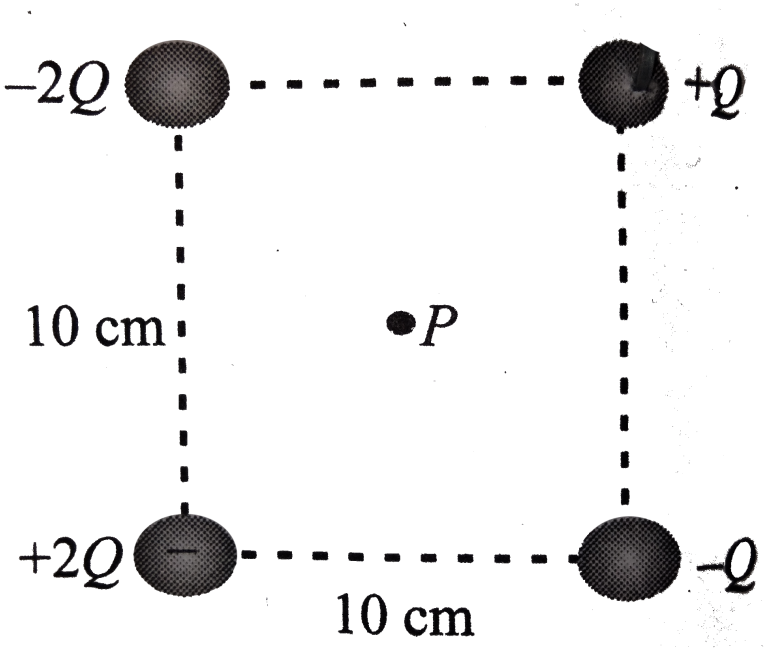
31. Four electrical charge are arranged on the corners of a 10cm square as shown.

What would be the direction of the resulting electric field of the resulting

electric field at the center point P?



A. $\rightarrow$

B. $\uparrow$

C. $\leftarrow$

D. $\downarrow$

Answer: B

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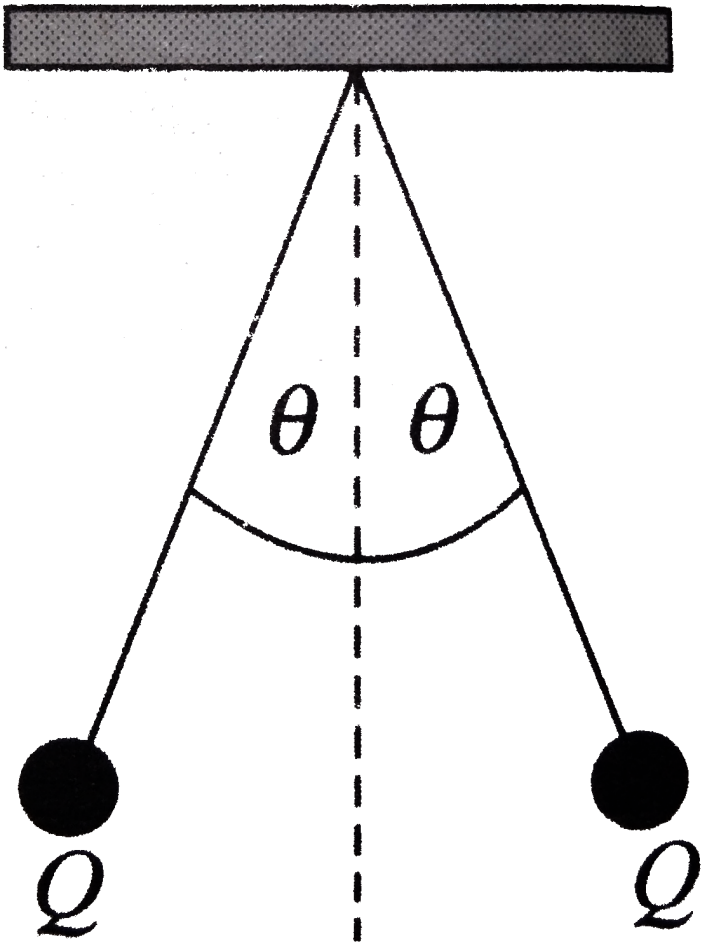
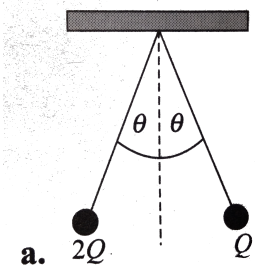
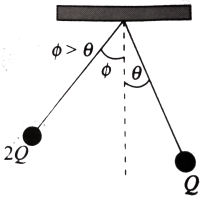
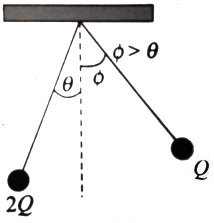
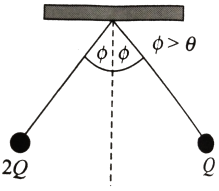
32. two pith balls each with mass m are suspended from insulating threads. When the pith balls are given equal positive charge Q, they hang in equilibirum as shown. We now increase the charge on the left pith ball from Q to 2Q while leaving its mass essentially unchanged. Which of he following diagrams best represent the new equilibrium configuration?



A. a. 

B. b. 

C. c. 

D. d. 

Answer: D

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33. Three positive charges of equal magnitude q are placed at the vertices of and equilateral triangle of side l. How can the system of charges be placed in equilibrium?

A. $1:3$

B. $1:\sqrt{3}$

C. $\sqrt{3}:1$

D. $2:\sqrt{3}$

Answer: B

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34. The maximum electric field at a point on the axis of a uniformly charged ring is E_0. At how many points on the axis will the magnitude of the electric field be $E_0/2$.

A. 1

B. 2

C. 3

D. 4

Answer: D

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35. An electric charged q exerts a force F on a similar electric charge q swparated by a distance r. A third charge $q/4$ is placed midway between the two charges. Now the force F will

A. $become F/3$

B. $become F/9$

C. $become F/27$

D. remain F

Answer: D

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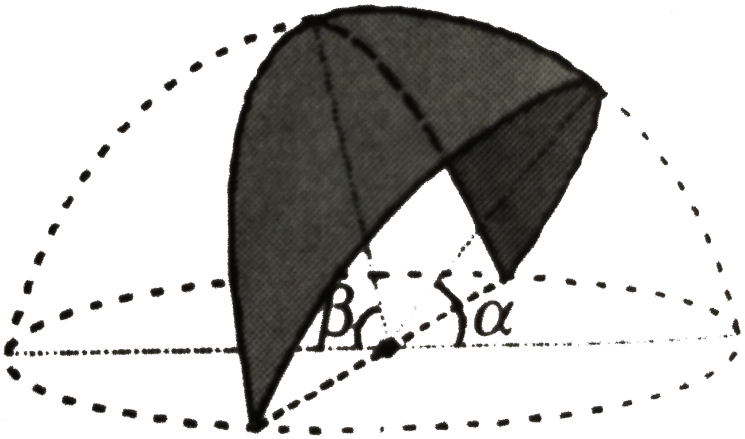
36. The electric field intensity at the center of a uniformly charged hemispherical shell is E_0. Now two portions of the hemisphere are cut from either side, and the remaining portion is shown in fig. If $\alpha = \beta = \pi/3$, then the electric field intesity at the center due to the remaining portion is



A. $E_0/3$

B. $E_0/6$

C. $E_0/2$

D. information insufficient

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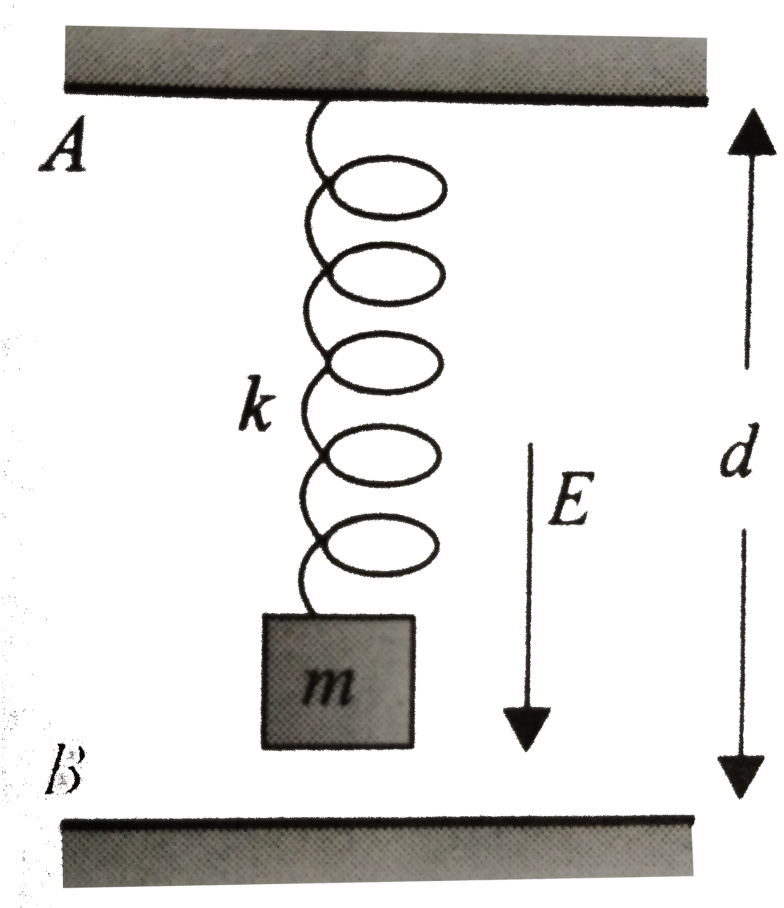
37. A block of mass m is suspended vertically with a spring of spring constant k. The block is made to oscillate in a gravitation field. Its time period is fould to be T. Now the space between the plates is made gravity free, and an electric field E is produced in the downward direction. Now

the block is given a charge q. the new time period of oscillation is



A. T

B. $T + 2\pi\sqrt{\frac{qE}{md}}$

C. $2\pi\sqrt{\frac{qE}{md}}$

D. none of the above

Answer: A

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38. Which of the following four figures correctly show the forces that three charged particles exert on each other.

 ,

A. all of the above

B. none of the above

C. II,III

D. II,III,IV

Answer: C

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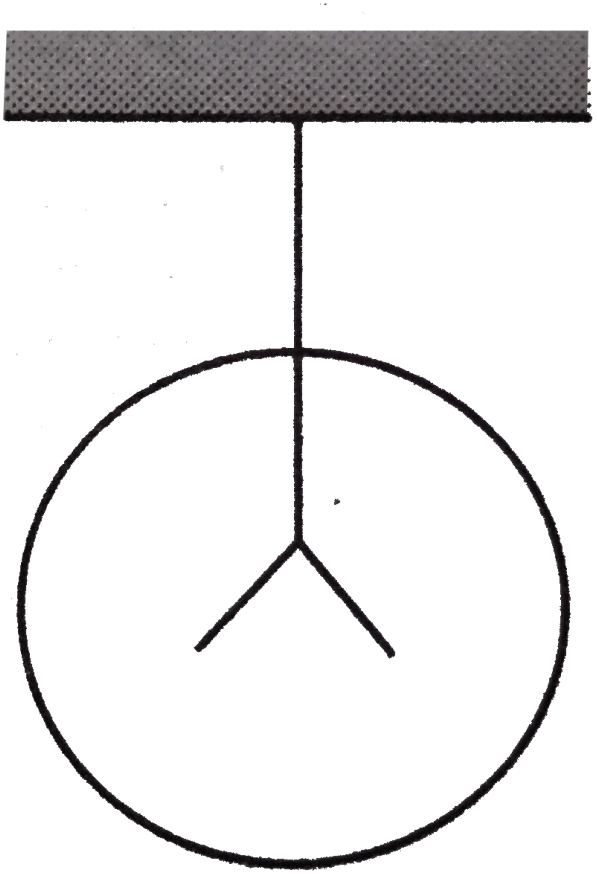
39. An electroscope is given a positive charge, causing its foil leaves to separate. When an object is brought near the top plate of the electroscope, the fiols separated even further. We conclude.



A. that the object is positively charged

B. that the object is electrically neutral

C. that the object is negatively charged

D. none of these

Answer: A

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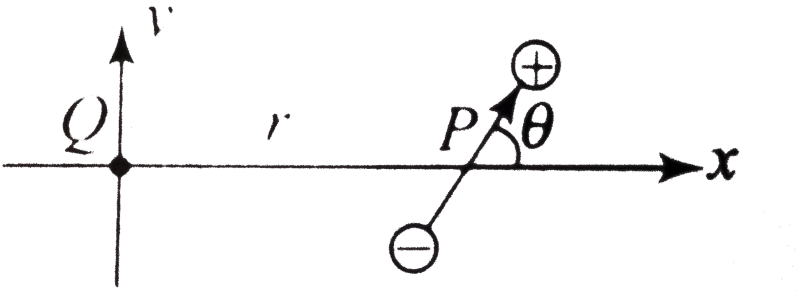
40. A point negative charge -Q is placed at a distance r from a dipole with dipole moment P in the xy plane as shown in fig. The x-component of force acting on the charge-Q is



A. $-\frac{PkQ}{r}\cos\theta\hat{i}$

B. $\frac{PkQ}{r}\cos\theta\hat{i}$

C. $-\frac{2PkQ}{r}\cos\theta\hat{i}$

D. $\frac{2PkQ}{r}\cos\theta\hat{i}$

Answer: C

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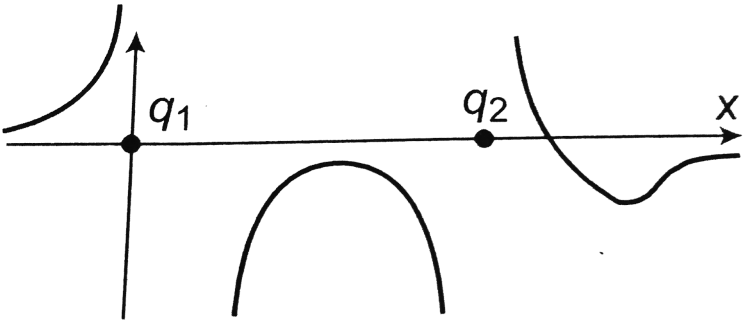
41. Two charges q_1 and q_2 are kept on x-axis and electric field at different points an x-axis is plotted against x. Choose correct statement about nature and magnitudes of q_1 and q_2



A. q_1 is positive , q_2 is negative, $|q_1| > |q_2|$

B. q_1 is positive , q_2 is negative, $|q_1| < |q_2|$

C. q_1 is negative , q_2 is positive, $|q_1| > |q_2|$

D. (q_1) is negative , (q_2) ispositive, $|(q_1)| < |(q_2)|$

Answer: C

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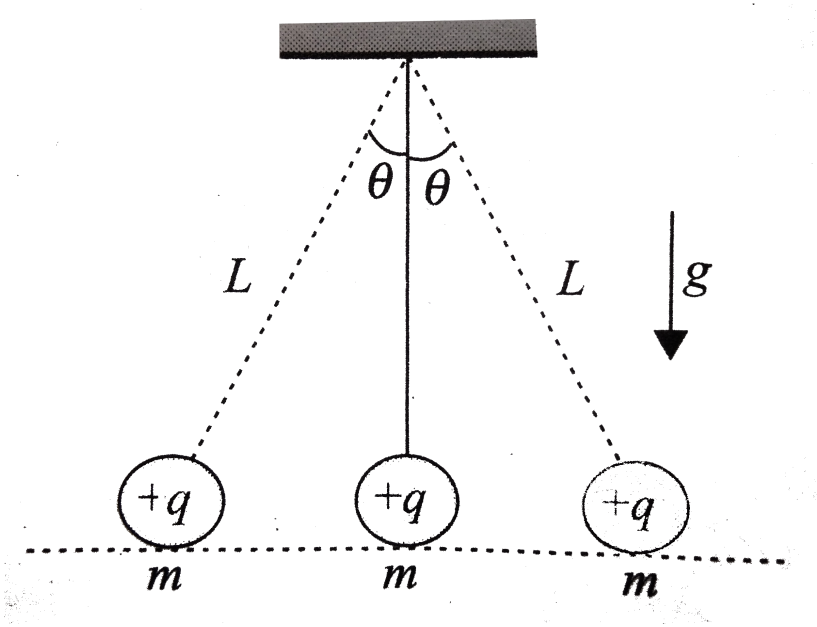
42. Three identical point charges, each of mass m and charge q, hang from three strings as shown in fig. The value of q in term of m, L, and q is



A. $q = \sqrt{(16/5)\pi\varepsilon_0 mgL^2 \sin^2\theta \tan\theta}$

B. $q = \sqrt{(16/15)\pi\varepsilon_0 mgL^2 \sin^2\theta \tan\theta}$

C. $q = \sqrt{(15/16)\pi\varepsilon_0 mgL^2 \sin^2\theta \tan\theta}$

D. none of these

Answer: A

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43. A and B are two points on the axis and the perpendicular bisector, reapectively, of and electric dipole. A and B are far away from the dipole and at equal distance from it. The fields at A and B are $\vec{E}_A$ and $\vec{E}_B$. Then

A. $\vec{E}_A = \vec{E}_B$

B. $\vec{E}_A = 2\vec{E}_B$

C. $\vec{E}_A = -2\vec{E}_B$

D. $\left|\vec{E}_B = \frac{1}{2}\right|\vec{E}_A\Big|$, and $\vec{E}_A$ is perpendicular to $\vec{E}_B$.

Answer: C

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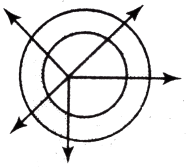
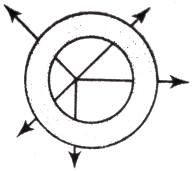
44. A metallic shell has a point charge 'q' kept inisde its cavity. Which one of the following diagrams correctly represents the electric lines of forces?

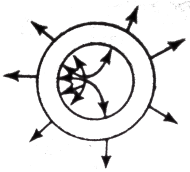
A. a.



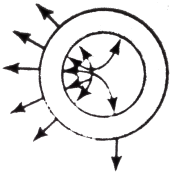
B. b.



C. c.



D. d.



Answer: C

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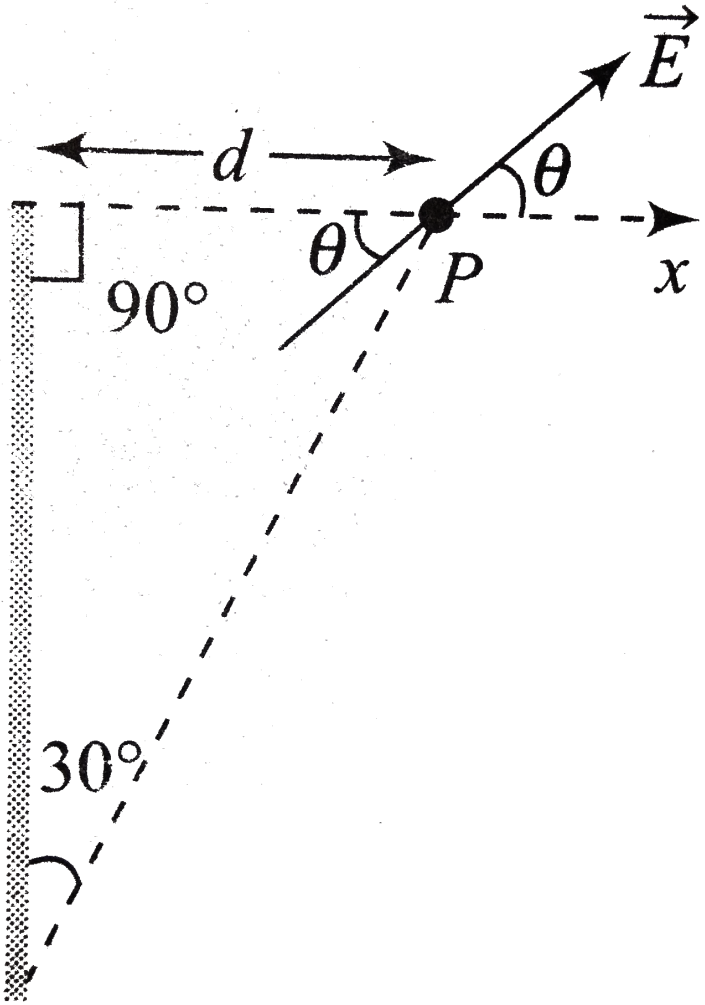
45. The direction (θ) of $\vec{E}$ at point P due to uniformly charged finite rod will be



A. At an angle 30° from the x-axis

B. 45° from the x-axis

C. 60° from the x-axis

D. none of these

Answer: A

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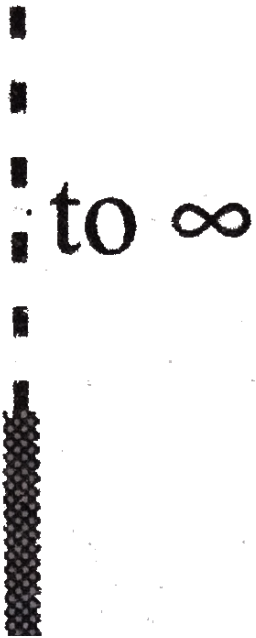
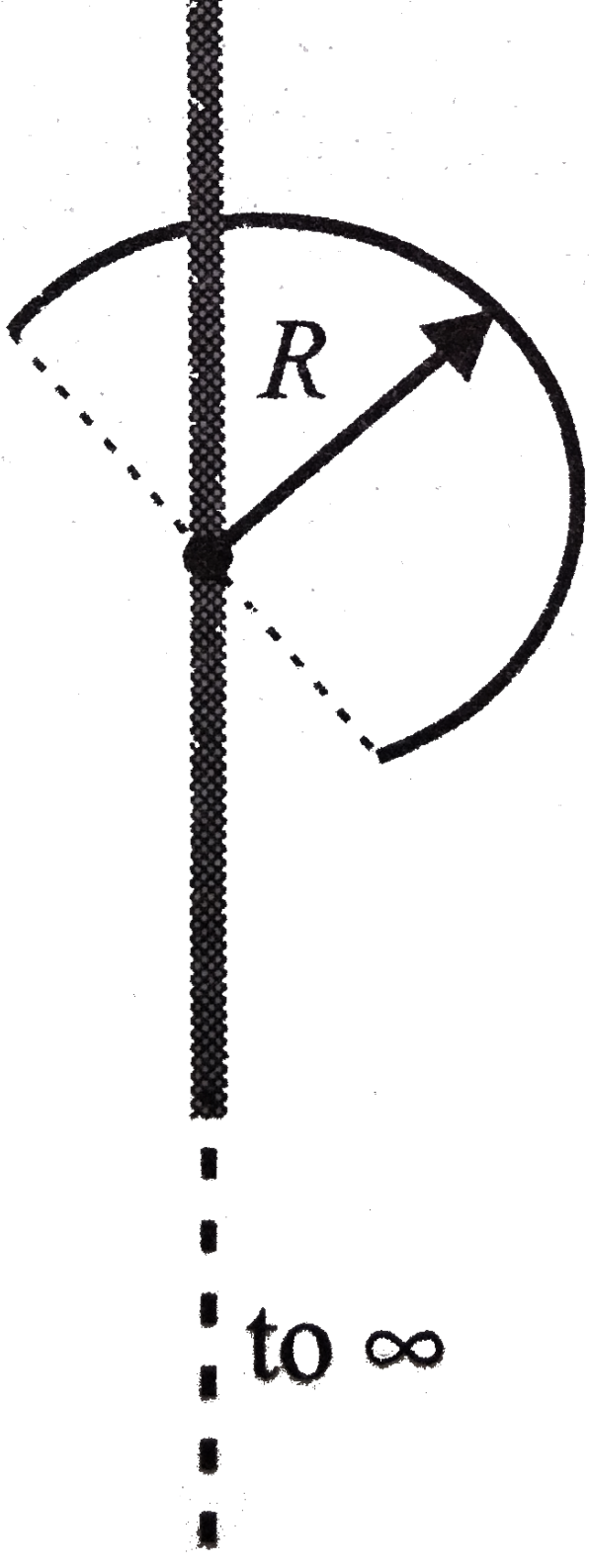
46. Find the force experienced by a semicircular rod having a charge q as shown in fig. Radius of the wire is R, and the line of charge with linear charge density λ passes through its center and is perpendicular to the plane of wire.




R
to ∞

A. $\frac{\lambda q}{2\pi^2\varepsilon_0 R}$

B. $\frac{\lambda q}{\pi^2\varepsilon_0 R}$

C. $\frac{\lambda q}{4\pi^2\varepsilon_0 R}$

D. $\frac{\lambda q}{4\pi\varepsilon_0 R}$

Answer: B

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47. A large sheet carries uniform surface charge density σ. A rod of length $2l$ has a linear charge density λ on one half and $-\lambda$ on the second half. The rod is hinged at mid-point O and makes an angle θ with the normal to the sheet. The maximum torque experienced by the rod is (if θ is variable) :

A. 0

B. $\frac{\sigma\lambda l^2}{2\varepsilon_0}\sin\theta$

C. $\frac{\sigma\lambda l^2}{\varepsilon_0}\sin\theta$

D. $\frac{\sigma\lambda l}{2\varepsilon_0}$

Answer: B

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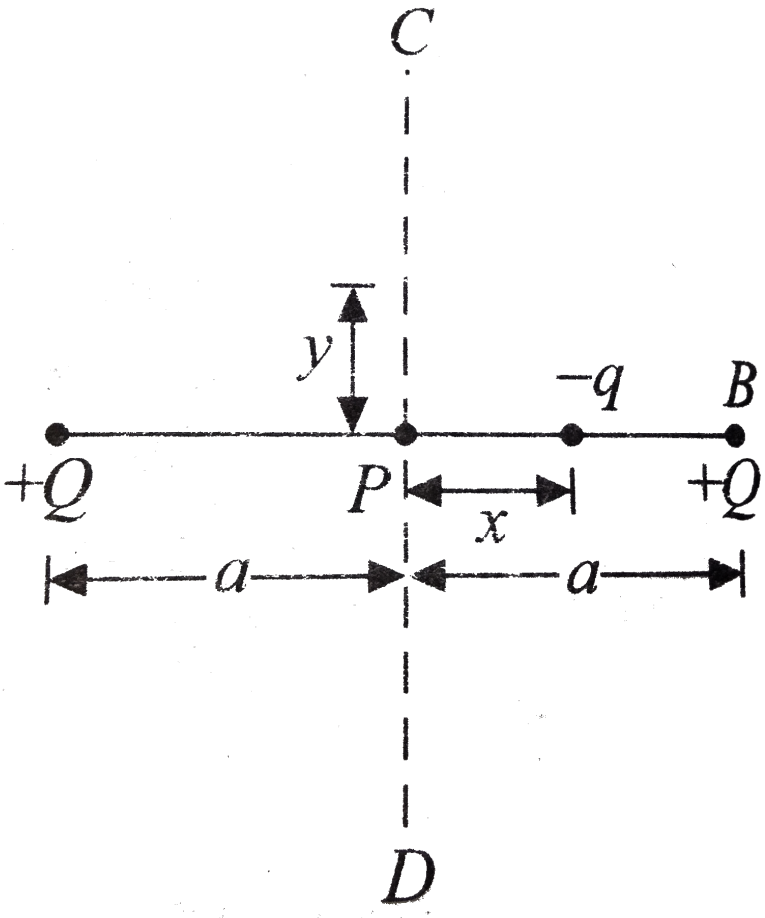
Multiple Correct

1. In the arrangement shown in fig. two positive charges, +Q each,are fixed. Mark the correct statement(s) regarding a third charged particle -q palce at the midpoint P that can be displaced along or perpendicular to

the line connecting the charges.



A. The particle will perform SHM of $x << a$.

B. The particle will oscillate about P but oscillate about P but not harmonically for any x.

C. The particle will perform SHM for $y << a$.

D. The particle will oscillate about P but not harmonically for y comparable to a.

Answer: C::D

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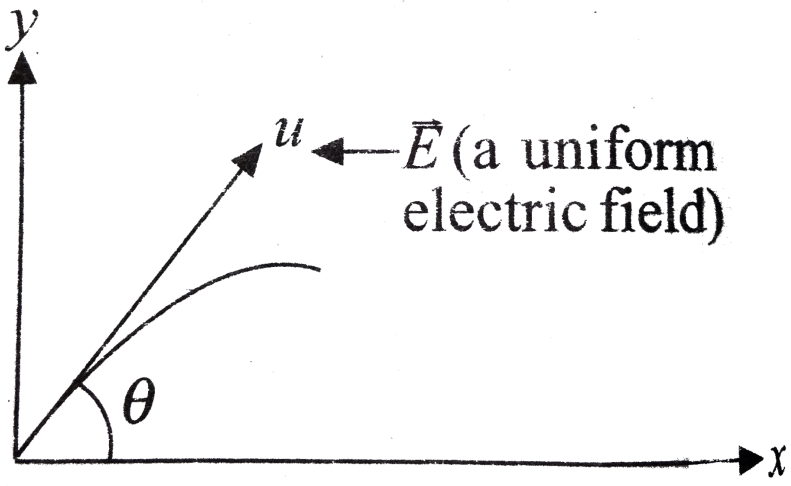
2. A particle of mass ma and charge q has been projected from ground as shown in fig. Mark the correct statement(s) (xy) plane is vertical.



A. The path of motion of the particle may be parabolic.

B. The pathof motion of the particle may be a straight line.

C. Time of flight of the particle is $2u \sin \theta / g$

D. Range of motion of the particle can be less than, greater than, or equal to $u^2 \sin 2\theta / g$.

Answer: A::B::C

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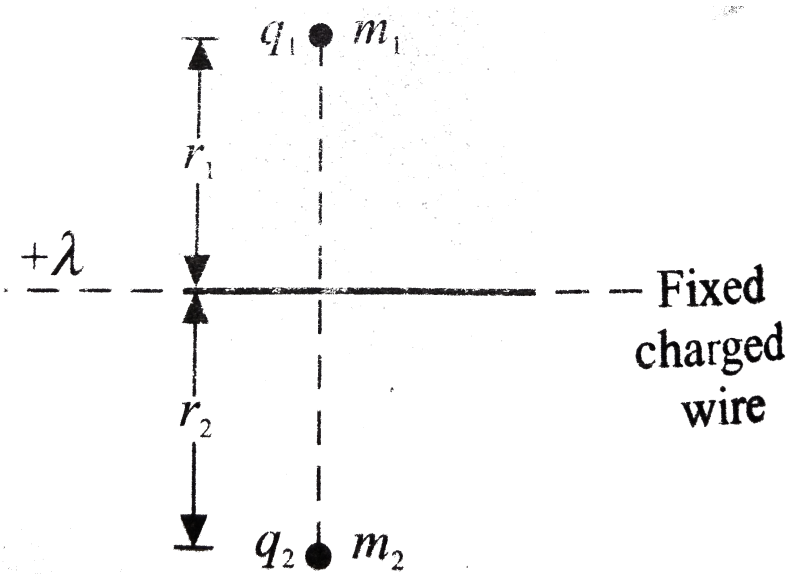
3. In the arrangement shown in fig. The two point charge are in equilibrium. The infinete wire is fixed in the horizontal plane, and the two point charges are placed one above and the other below the wire. Consifering the gravitational effect of the earth, the nature of q_1 and q_2

can be



A. $q_1 \rightarrow$ positive, $q_2 \rightarrow$ positive

B. $q_1 \rightarrow$ positive, $q_2 \rightarrow$ Negative

C. $q_1 \rightarrow$ Negative, $q_2 \rightarrow$ negative

D. $q_1 \rightarrow$ Negative, $q_2 \rightarrow$ positive

Answer: B::C

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4. When an electron moves in a circular path around a stationary nucleus charge at the center

A. the acceleration of the electron changes

B. the velocity of the electon change

C. electric field due to the nucleus at the electron changes

D. none of these

Answer: A::B::C

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5. Two point charges (Q each are placed at (0,y) and (0-y) A point charge q of the same polarity can move along the x-axis. Then

A. the force on q is maximum at $x = \pm y/\sqrt{2}$

B. the charge q is in equilibrium at the origin

C. the charge q performs an oscillatory motion about the origin

D. for any position of q other than origin the force is directed away from origin

Answer: A::B::D

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6. A conducting ball is positively charged and another positive point charge is brought closer to the ball.

A. the ball may attract the point charge

B. the ball may repel th point charge

C. there may be no force between them

D. the ball will only repel the point charge and in no condition it can attract the point charge

Answer: A::B::C

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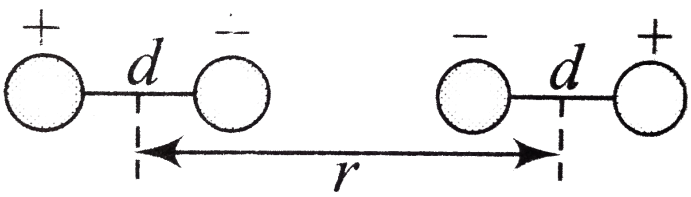
7. We have two electric dipoles. Each dipole consists of two equal and opposite point charges at the ends of an insulating rod of length d. The dipoles sit along the x-axis a distance r aparts oriented as shown in fig. Their separation rgtgtd. The dipole on the left:



A. will feel a force to the left

B. will feel a force to the right

C. wiff feel a torque trying to make it rotate counterclockwise

D. will feel no torque

Answer: A::D

Watch Video Solution

8. Imagine a short diploe at the center of a spherical surface. If the magnitude of the electric field at a certain point on the surface of he sphere is $10NC^{-1}$ then which of the following cannot be the magnitude of the electric field anywhere on the surface of the sphere?

A. $4NC^{-1}$

B. $8NC^{-1}$

C. $16NC^{-1}$

D. $32NC^{-1}$

Answer: A::D

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Comprehension

1. Two small identical conducting balls A and B of charges $+10\mu C$ and $+30\mu C$ respectively, are kept at a sepration of 50 cm. these balls have

beeen connected by a wire for a short time

The final charge on each of the balls A and B will be

A. $10\mu C$and $30\mu C$, respectively `

B. $20\mu C$ on each ball `

C. $30\mu C$ and $10\mu C$, respectively

D. $-40\mu C$ and $80\mu C$, respectively

Answer: B

Watch Video Solution

2. Two small identical conducting balls A and B of charges $+10\mu C$ and $+30\mu C$ respectively, are kept at a separation of 50 cm. these balls have been connected by a wire for a short time

The final charge on each of the balls A and B and force of interaction will be

A. $28.8N$

B. $32.6N$

C. $14.4N$

D. $72N$

Answer: C

Watch Video Solution

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

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

(b) Show that the equilibrium is unstable.

A. left of A at a distance $1/3$ from A

B. right of A at a distance $1/3$ fromB

C. between A and B at a distance $21/3$ from A

D. between A and B at a distance $l/3$ from A

Answer: D

Watch Video Solution

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

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

(b) Show that the equilibrium is unstable.

A. $Q = \left(-\frac{4}{9}\right)q$

B. $Q = \left(\frac{4}{9}\right)q$

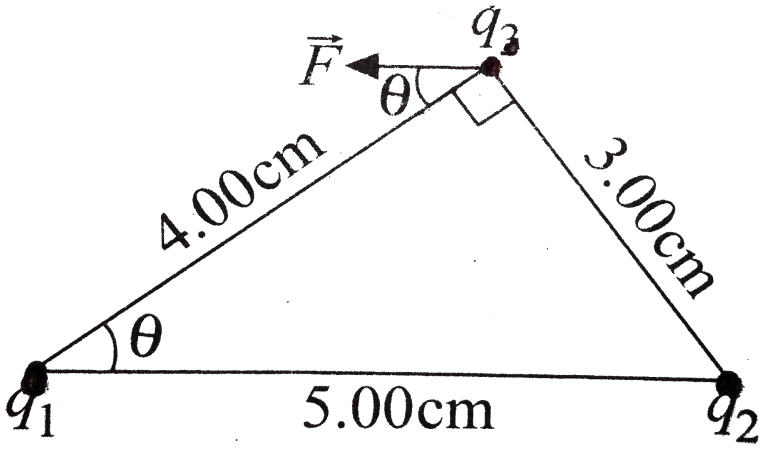
C. $Q = \left(\frac{3}{5}\right)q$

D. $Q = \left(\frac{-3}{5}\right)q$

Answer: A

Watch Video Solution

5. Three charges are placed as shown in fig. the magnitude of q_1 is $2.00\mu C$, but its sign and the value of the charge q_3 is $+4.00\mu C$, and the net force on q_3 is entirely in the negative x-direction



As per the condition given in the problem, the value of q_2 will be

A. $+$, $+$

B. $+$, $-$

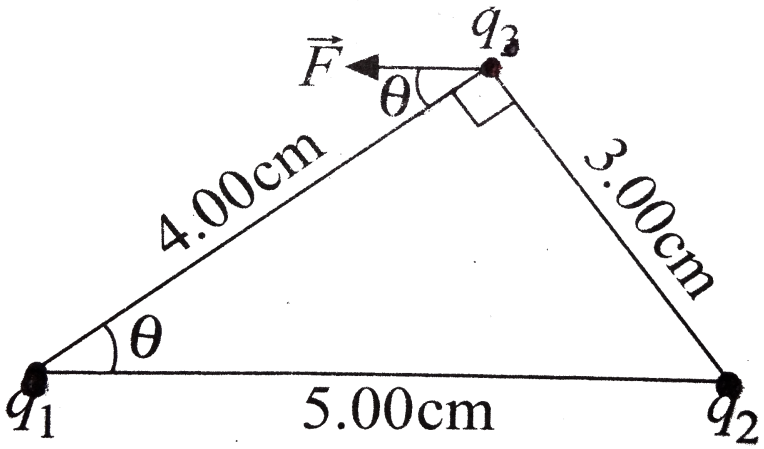
C. $-$, $+$

D. $-$, $-$

Answer: C

Watch Video Solution

6. Three charges are placed as shown in fig. the magnitude of q_1 is $2.00\mu C$, but its sign and the value of the charge q_3 is $+4.00\mu C$, and the net force on q_3 is entirely in the negative x-direction



As per the condition given in the problem, the value of q_2 will be

A. $\frac{54}{64}\mu C$

B. $\frac{27}{32}\mu C$

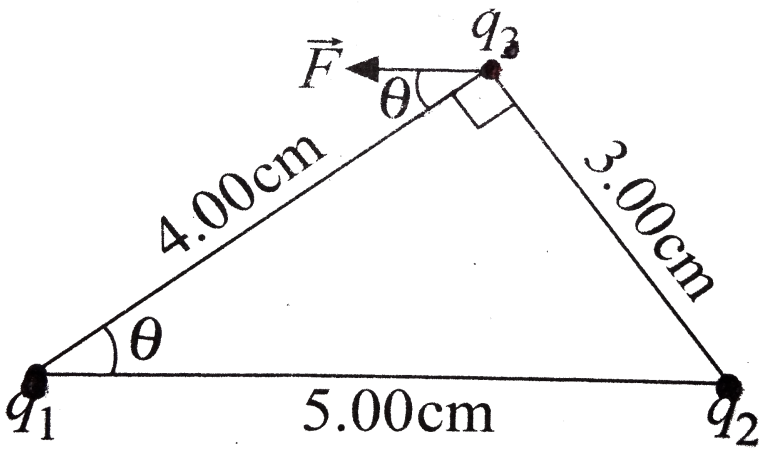
C. $\frac{13}{32}\mu C$

D. $\frac{13}{64}\mu C$

Answer: A

Watch Video Solution

7. Three charges are placed as shown in fig. the magnitude of q_1 is $2.00\mu C$, but its sign is unknown. Value of charge q_2 is unknown and the value of the charge q_3 is $+4.00\mu C$, and the net force on q_3 is entirely in the negative x-direction



As per the condition given in the problem, the sign of q_1 and q_2 will be

A. $25.25N$

B. $32.5N$

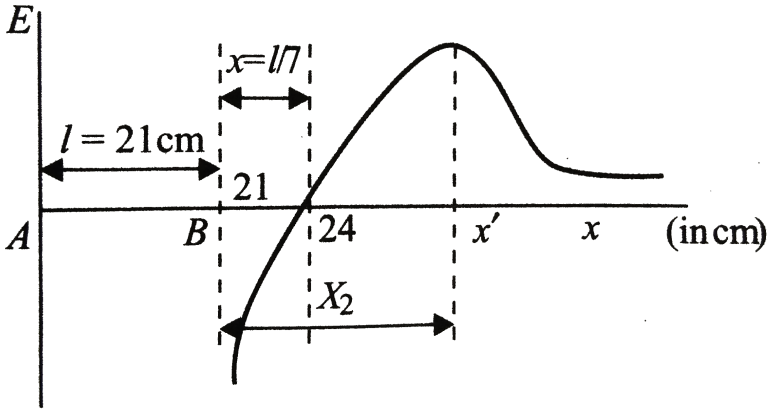
C. $56.25N$

D. $13.5N$

Answer: C

Watch Video Solution

8. Two point charge Q_a and Q_b are positional at point A and B. The field strength to the right of charge Q_b on the line that passes through the two charges varies according to a law represented schematically in fig. (without employing a definite scale). The field strength is assumed to be positive if its direction coincides with the positive direction of the x-axis. The distance between the charges is $l = 21cm$.



(a) Find the sign of the charges.

(b) Find the ratio between the absolute value of charge Q_a and Q_b.

(c) Find the coordinate x of the point where the field strength is maximum.

A. $+$, $-$

B. $-$, $+$

C. $+$, $+$

D. $-$, $-$

Answer: A

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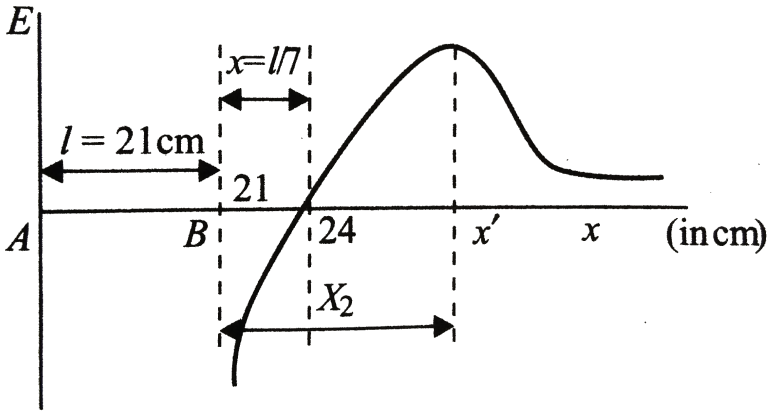
9. Two point charge Q_a and Q_b are positional at point A and B. The field strength to the right of charge Q_b on the line that passes through the two charges varies according to a law represented schematically in fig. (without employing a definite scale). The field strength is assumed to be positive if its direction coincides with the positive direction of the x-axis. The distance between the charges is $l = 21cm$.



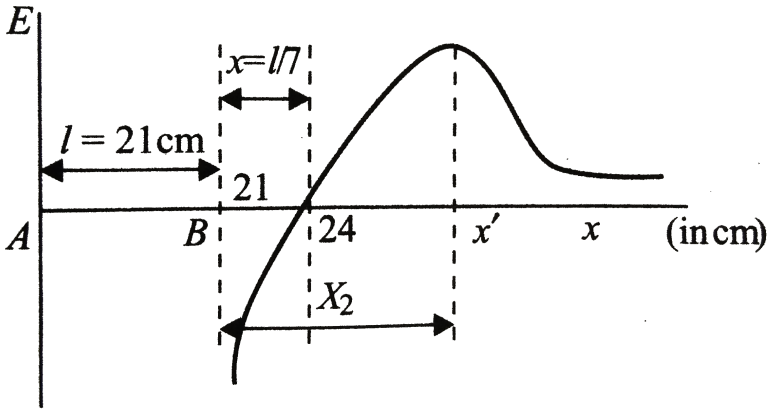
(a) Find the sign of the charges.

(b) Find the ration between the absolute value of charge Q_a and Q_b.

(c) Find the coordinate x of the point where the field strength is maximum.

Watch Video Solution

10. Two point charge Q_a and Q_b are positional at point A and B. The field strength to the right of charge Q_b on the line that passes through the two charges varies according to a law represented schematically in fig. (without employing a definite scale). The field strength is assumed to be positive if its direction coincides with the positive direction of the x-axis. The distance between the charges is $l = 21cm$.



(a) Find the sign of the charges.

(b) Find the ratio between the absolute value of charge Q_a and Q_b.

(c) Find the coordinate x of the point where the field strength is maximum.

A. $\dfrac{l}{(Q_1/Q_2)^{1/3}+1}$

B. $\dfrac{l}{(Q_1/Q_2)^{1/3}-1}$

C. $\frac{l}{(Q_2/Q_1)^{1/3}+1}$

D. $\frac{l}{(Q_2/Q_1)^{1/3}-1}$

Answer: B

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11. Four equal positive charges, each of value Q, are arranged at the four corners of a square of diagonal 2a. A small body of mass m carrying a unit positive charge is placed at height h above the center of the square.

What should be the value of Q in order taht this vody may be in equilibrium?

A. $\pi\varepsilon_0\frac{mg}{2h}\left(h^2+2a^2\right)^{3/2}$

B. $\pi\varepsilon_0\frac{mg}{2h}\left(h^2+a^2\right)^{3/2}$

C. $\pi\varepsilon_0\frac{2mg}{2h}\left(h^2+2a^2\right)^{3/2}$

D. $\pi\varepsilon_0\frac{mg}{2h}\left(h^2-2a^2\right)^{3/2}$

Answer: B

Watch Video Solution

12. Four equal positive charges, each of value Q, are arranged at the four corners of a square of diagonal 2a. A small body of mass m carrying a unit positive charge is placed at height h above the center of the square.

What should be the value of Q in order that this body may be in equilibrium?

A. stable equilibrium

B. unstable equilibrium

C. neutral equilibrium

D. cannot be determined

Answer: A

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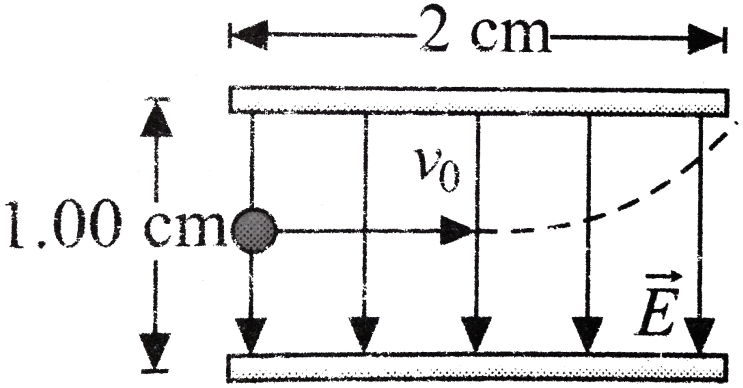
13. An electron is projected with an initial speed $v_0 = 1.60 \times 10^6 ms^{-1}$ into the uniform field between the parallel plates as shown in fig. Assume that the field between the plates is uniform and directed vertically downward, and that the field outside the plates is zero. the electrons enters the field at a point midway between the plates. Mass of electron is $9.1 \times 10^{-31} kg$.



The vertical displacement traveled by the proton as it exits the region between the plated is (mass pf proton is $1.67 \times 10^{-27} kg$).

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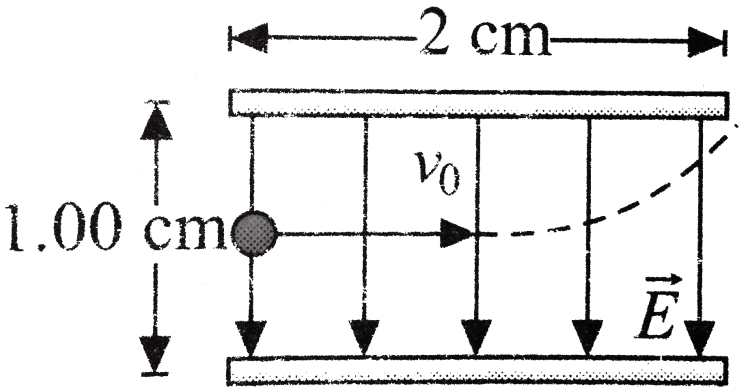
14. An electron is projected with an initial speed $v_0 = 1.60 \times 10^6 ms^{-1}$ into the uniform field between the parallel plates as shown in fig. Assume

that the field between the plates is uniform and directed vertically downward, and that the field outside the plates is zero. the electrons enters the field at a point midway between the plates. Mass of electron is $9.1 \times 10^{-31} kg$.



The vertical displacement traveled by the proton as it exits the region between the plated is (mass pf proton is $1.67 \times 10^{-27} kg$).

A. $124 NC^{-1}$

B. $364 NC^{-1}$

C. $224 NC^{-1}$

D. $520 NC^{-1}$

Answer: B

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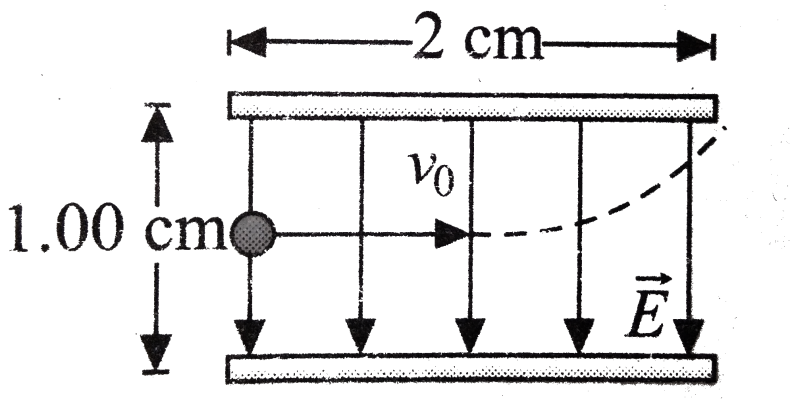
Watch Video Solution

15. An electron is projected with an initial speed $v_0 = 1.60 \times 10^6 ms^{-1}$ into the uniform field between the parallel plates as shown in fig. Assume that the field between the plates is uniform and directed vertically downward, and that the field outside the plates is zero. the electrons enters the field at a point midway between the plates. Mass of electron is $9.1 \times 10^{-31} kg.$



For the condition of hte previous situation, the magnitude of electric field is

A. the proton will hit the upper plate.

B. the proton will hit the lower plate.

C. the proton will not hit either plate.

D. None of these

Answer: C

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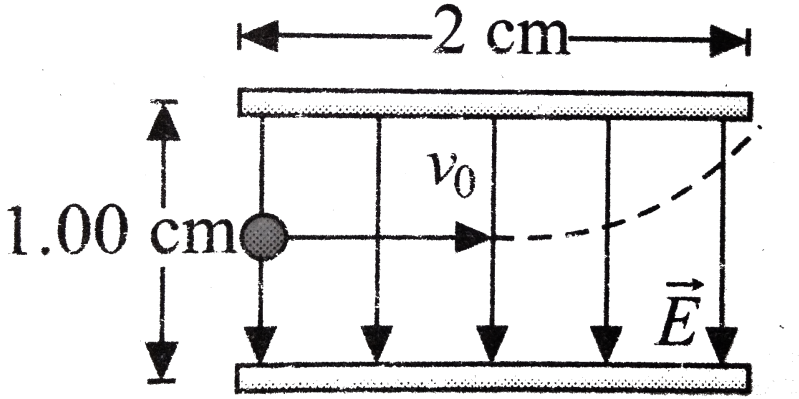
16. An electron is projected with an initial speed $v_0 = 1.60 \times 10^6 ms^{-1}$ into the uniform field between the parallel plates as shown in fig. Assume that the field between the plates is uniform and directed vertically downward, and that the field outside the plates is zero. the electrons enters the field at a point midway between the plates. Mass of electron is $9.1 \times 10^{-31} kg$.



If the electron just misses the upper plate, the time of fight of the electron up to this instant is

A. $1.6 \times 10^{-8} m$

B. $3.25 \times 10^{-8} m$

C. $5.25 \times 10^{-6} m$

D. $2.73 \times 10^{-6} m$

Answer: D

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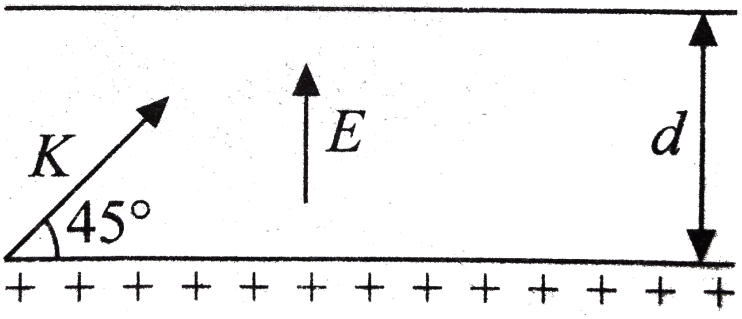
17. An electron is projected as shown in fig. with kinetic energy K, at an angle $\theta = 45^{\circ}$ between two charged plates. Ignore the gravity.



At what distance from the starting point will the electron strike the lower plate?

A. K / qd

B. $2K / qd$

C. $K / 2qd$

D. infinte

Answer: C

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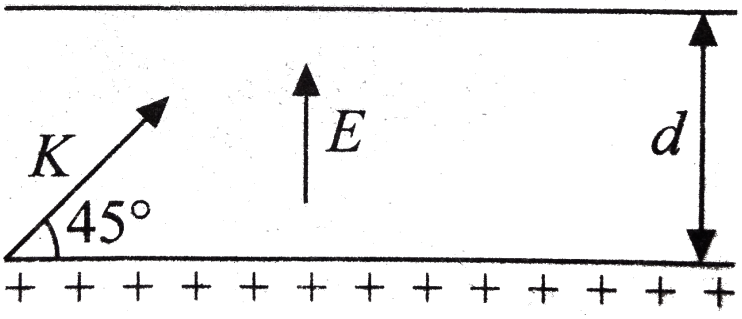
18. An electron is projected as shown in fig. with kinetic energy K, at an angle $\theta = 45^\circ$ between two charged plates. Ignore the gravity.



At what distance from the starting point will the electron strike the lower plate?

A.

B.

C.

D.

Answer: D

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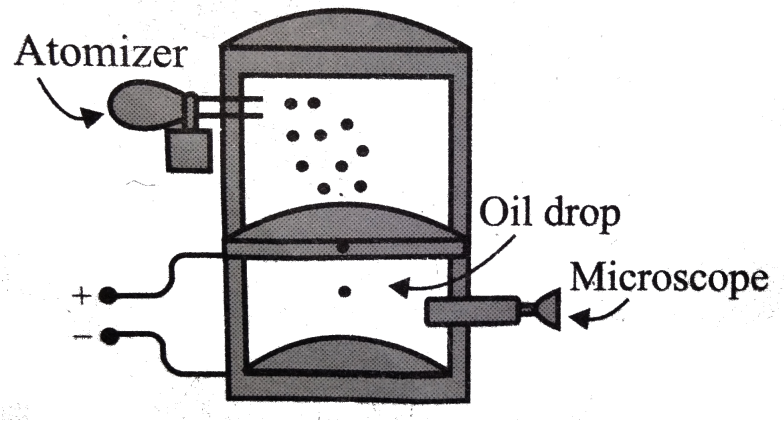
19. In 1909, Robert Millikan war the firest to find the charge of an electron in his now-famous oil-drop experiment. In that experiment, tiny oil drops were sprayed into a uniform electric field between a horizontal pair of opposite charged plates. The drops were pbserved with a magnitue eyepiece, and the electric field was adjusted so that upward force on some negatively charged oil drops was just sufficient to balance the downward force of gravity. That is, when suspended, upward force qE just

equaled mg. Millikan accurately measured the charges on many oil drops and found the values to be whole number multiples of $1.6 \times 10^{-19} C -$ the charge of the electron. For this, he won the Nobel prize.



If a drop of mass $1.08 \times 10^{-14} kg$ remains stationary in an electric field of $1.68 \times 10^{5} NC^{-1}$, then teh charge of this drop is

A. $6.40 \times 10^{-19} C$

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

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

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

Answer: A

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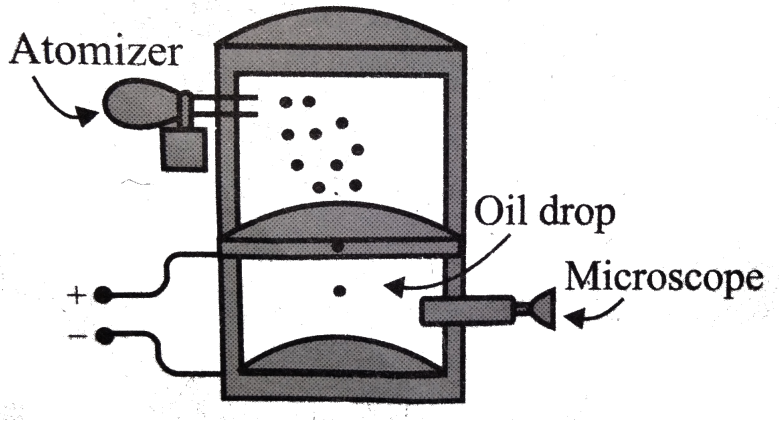
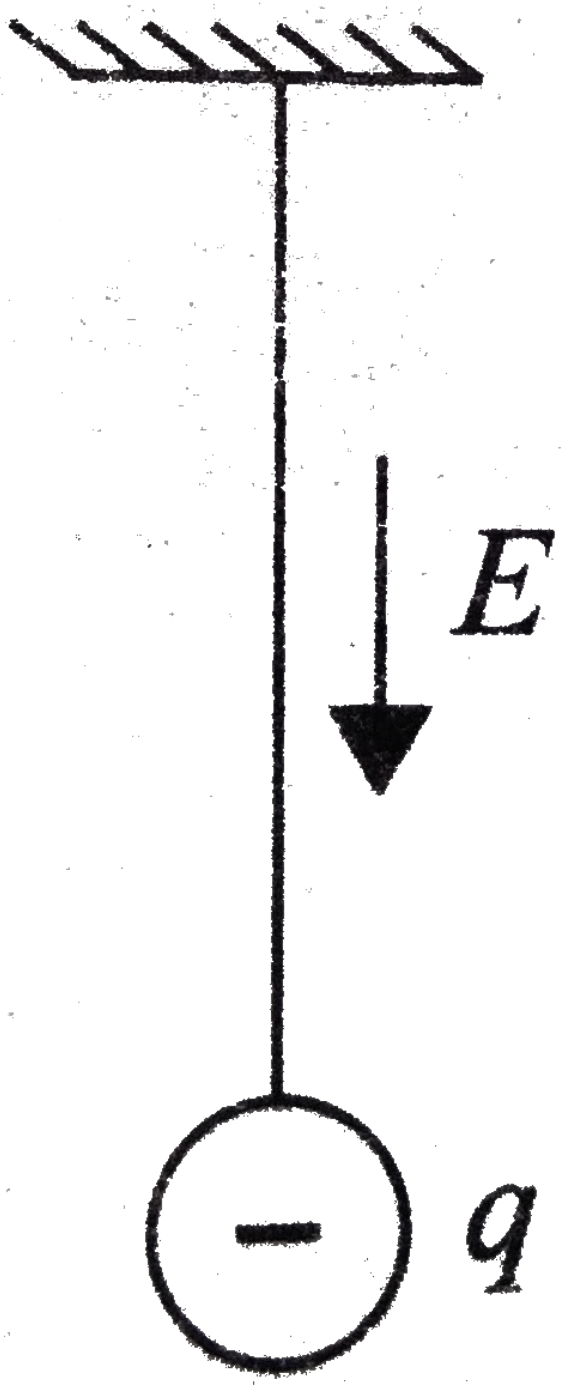
20. In 1909, Robert Millikan was the first to find the charge of an electron in his now-famous oil-drop experiment. In that experiment, tiny oil drops were sprayed into a uniform electric field between a horizontal pair of opposite charged plates. The drops were observed with a minute eyepiece, and the electric field was adjusted so that upward force on some negatively charged oil drops was just sufficient to balance the downward force of gravity. That is, when suspended, upward force qE just equaled mg. Millikan accurately measured the charges on many oil drops and found the values to be whole number multiples of $1.6 \times 10^{-19} C -$ the charge of the electron. For this, he won the Nobel prize.



If a drop of mass $1.08 \times 10^{-14} kg$ remains stationary in an electric field of $1.68 \times 10^{5} NC^{-1}$, then the charge of this drop is

Watch Video Solution

21. A simple pendulum of mass m charged negatively to q coulomb oscillates with a timeperiod T in a down ward electric field E such that `mggtqE..


E
−
q

If the electric field is withdrawn, the new time period

A. $= T$

B. $> T$

C. $< T$

D. any of the above three is possible

Answer: C

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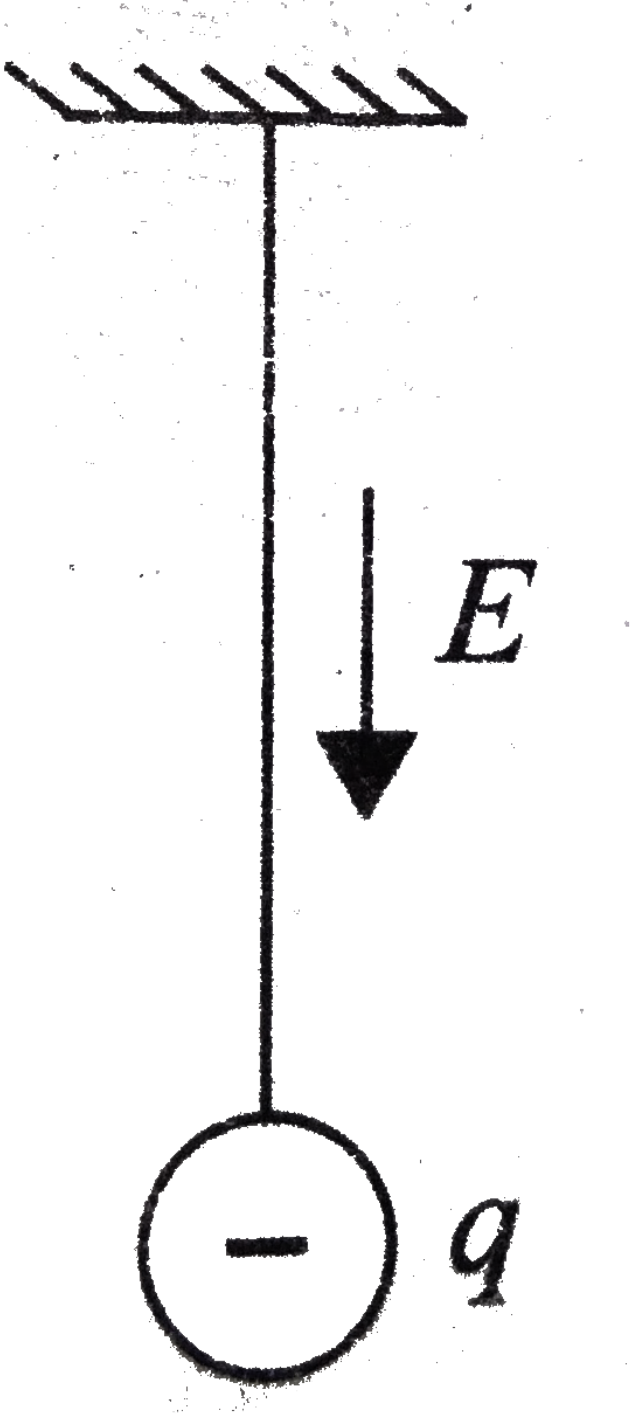
22. A simple pendulum of mass m charged negatively to q coulomb oscillates with a timeperiod T in a down ward electric field E such that `mggtqE..



If the electric field is withdrawn, at equilibrium of he bob, the change in

tension in the string will be (assuming rest condition)

A. mg

B. qE

C. 2qE

D. $qE/2$

Answer: B

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23. There is an insulator rod of length L and of negligible mass with two small balls of mass m and electric charge Q attached to its ends. The rod can rotate in the horizontal plane around a vertical axis crossing it ata distance $L/4$ from one of its ends.

At first the rod is in unstabele equillbrium in a Horizontal uniform electric field of field strenght E. Then we gently displace it from this position. Determine the maximim velocity attained by the ball taht is closer to the axis in the subsequent motion

A. $\sqrt{\frac{2QEL}{m}}$

B. $\sqrt{\frac{2QEL}{5m}}$

C. $\sqrt{\frac{QEL}{5m}}$

D. $\sqrt{\frac{4QEL}{5m}}$

Answer: C

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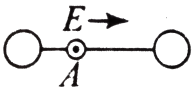
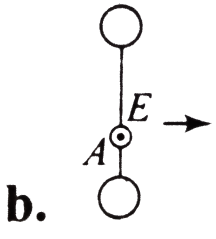
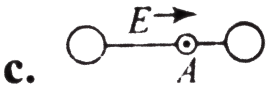
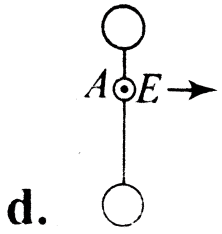
24. There is an insulator rod of length L and of negligible mass with two small balls of mass m and electric charge Q attached to its ends. The rod can rotate in the horizontal plane around a vertical axis crossing it at a distance $L/4$ from one of its ends.

What is the time period of the SHM as mentioned in the above question, if an electric field E is applied along horizontal?

A. **a.** 

B. 

C. 

D. 

Answer: A

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25. There is an insulator rod of length L and of negligible mass with two small balls of mass m and electric charge Q attached to its ends. The rod can rotate in the horizontal plane around a vertical axis crossing it ata distance $L/4$ from one of its ends.

What is the time period of the SHM as mentioned in the above question?

A. $2\pi\sqrt{\frac{mL}{QE}}$

B. $2\pi\sqrt{\frac{2mL}{3QE}}$

C. $2\pi\sqrt{\frac{5mL}{8QE}}$

D. $2\pi\sqrt{\frac{5mL}{4QE}}$

Answer: D

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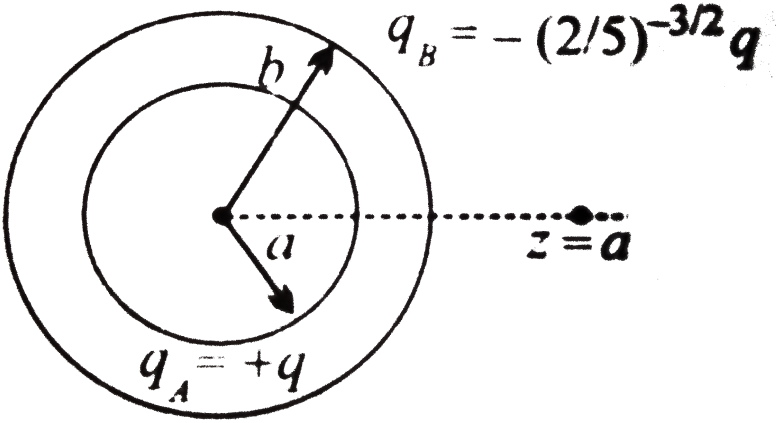
Integer

1. Two concentric rings, one of radius a and the other of radius b, have the charges +q, and $-(2/5)^{-3/2}q$, respectively as shown in fig.



Find the rario b/a if a charge particle palaced on the axis at z =a is i equilibrium.

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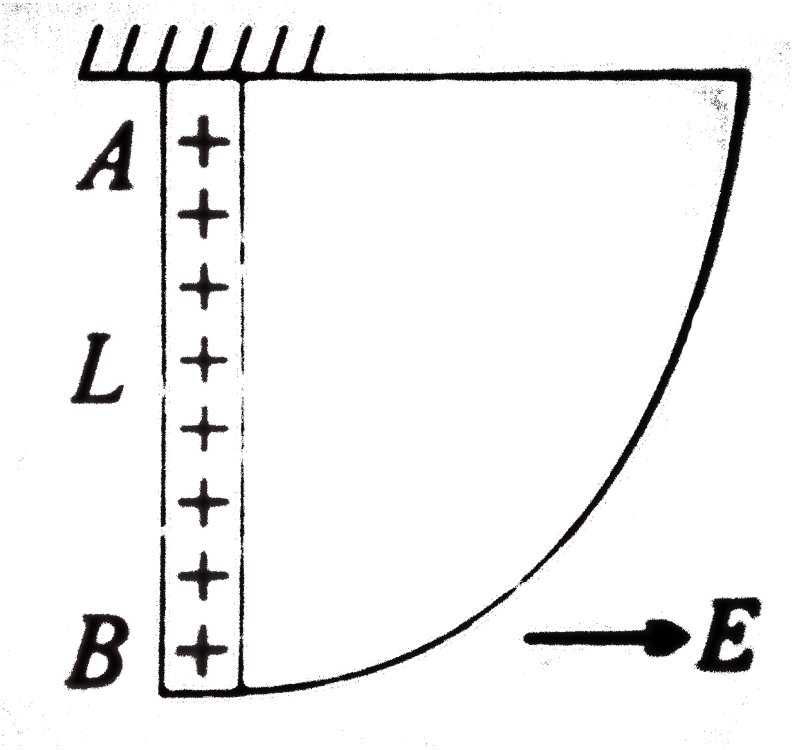
2. A rod AB of length L and mass m is uniformly charged with a charge Q, and it is suspended from end A as shown in fig. The rod can freely rotate about A in the plane of the figure. An electric field E is suddenly switched on in the horizontal direction due to which the rod gets turned by a maximum angle of 90°. The magnitude of E is equal of nMg/Q. Find the

value of n.



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3. Two particle of masses in the ration 1:2 with charges in the ratio 1:1, are placed at rest in a uniform electric field. They are released and allowed to move for the same time. The ratio of their kinetic energies will be finally

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4. There is and electric field E in the +x direction. If the work done by the electric field in moving a charges $0.2C$ through a distance of 2m along a line making an angle of 60° with the x-axis is $1.0J$, what is the value of E in NC^{-1}?

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5. An electric field is given by $E = \left(y\hat{i} + x\hat{k}\right)N/C$. Work done in moving a 1C charge from $r_A = \left(2\hat{i} + 2\hat{j}\right)m$ to $r_B = \left(4\hat{i} + \hat{j}\right)m$ is

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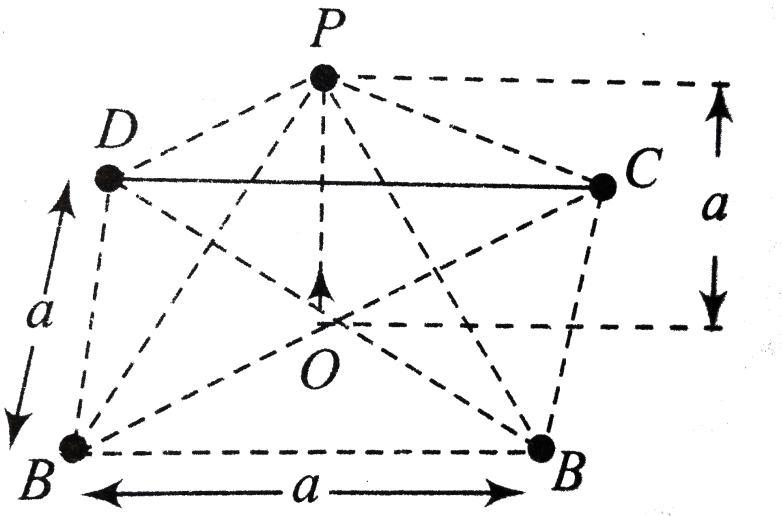
6. Four charge particles each having charge Q=1 C are fixed at the corners of the base(A,B,C, and D) of a square pyramid with slant length $a\left(AP = BP = PC = a = \sqrt{2}m\right)$, a charge -Q is fixed at point P. A dipole with dipole moment p=1 C-m is placed at the center of the bases and perpendicular to its plane as shown in fig. Force on the dipole due to

the charge particles is $\frac{\square}{4\pi\varepsilon_0} N$.



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7. A ring of radius R has charge $-Q$ distributed uniformly over it. Calculate the charge that should be placed at the center of the ring such that the electric field becomes zero at a point on the axis of the ring at distant R from the center of the ring.

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8. Two identical small equally charged conducting balls are suspended from long threads secured at one point. The charges and masses of the balls are such that they are in equilibrium when the distance between them is a(the length of thread $L > > a$). Then one of the balls is discharged. what will be the distance $b(b < < L)$ between the balls when equilibrium is restored?

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Single Correct Ansewr Type

1. A positively charged insulator is brought near(but does not touch) two metallic sphere that are in contact. The metallic spheres are then separated. The sphere which was initially farthest from the insulator will have:

A. no net charge

B. a negative charge

C. a positive charge

D. either a negative or a positive charge.

Answer: C

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2. Five balls numbered 1,2,3,4,and 5 are suspended using separated threads. The balls (1,2),(2,4) and (4,1) show electrostatic attraction while balls (2,3) and (4,5) show repulsion. Therefore, ball 1 must be

A. Positively charged

B. negatively charged

C. neutral

D. made of metal

Answer: C

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3. There are two metallic spheres of same radii but one is solid and the other is hollow, then

A. solid sphere can be given more charge

B. hollow sphere can be given more charge

C. they can be charged equally (maximum)

D. none of the above

Answer: C

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

A. unchaged

B. charged positively

C. charged negatively

D. an insulator

Answer: B

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5. A positively charged rod is brought near to a non-conducting object. The rod is attracted to the object. From this observation. We can't predict whether the object is charged or uncharged. Some additional experments have been performed to identify whether the object is charged or uncharged, these experiments with their observations and conclusions drawn are given. Select the option in which conclusion drawn is correct.

A. A negatively charged rod is brought near to object and the two attract, this shows that the object is neutral.

B. A negatively charged rod is brought near to object and two repel, this shows that the object is negatively charged.

C. A neutral rod is brought near to object and two attract, this shows that the object is negatively charged.

D. All of the above

Answer: D

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6. A point charge +q, is placed at a distance d from an isolated conducting plane. The field at a point P on the other side of the plane is

A. directed perpendicular to the plane and away from the plane

B. directed perpendicular to the plane but towards the plane

C. directed radially away from the point charge

D. directed radially towards the point charge

Answer: A

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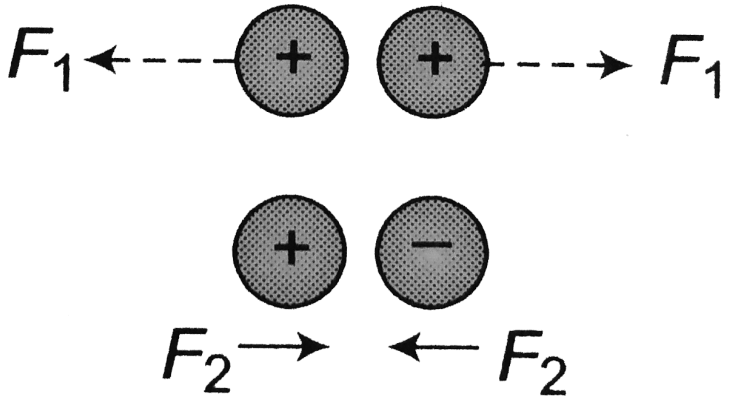
7. In two cases, two identical conducting sphere are given equal charges, in one case of the same type whereas in another case of opposite type. The distance between the spheres is not large comparing with the diameter. Let F_1 and F_2 be the magnitudes of the force of interaction between the spheres, as shown, then



A. $F_1 > F_2$

B. $F_1 = F_2$

C. $F_1 < F_2$

D. information is not sufficient to draw the conclusion

Answer: C

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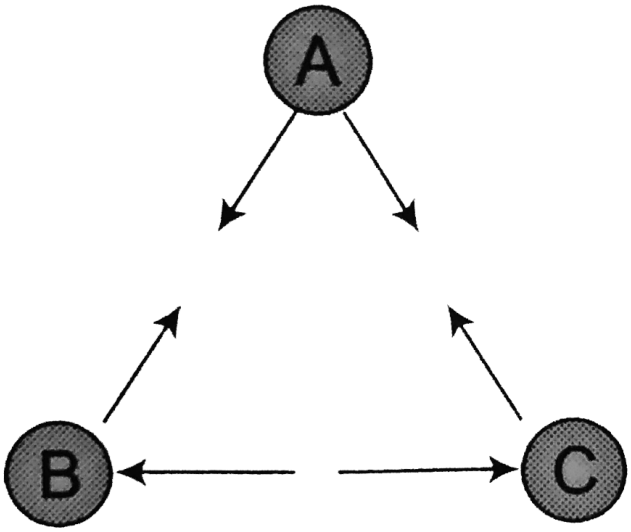
8. The diagram shows the arrangement of three small uniformally charged spheres, A, B and C. The arrow indicate the direction of the electrostatic forces acting between the spheres (for example, the left arrow on sphere A indicates the electronstatic force on sphere A due to sphere B). At least two of the spheres are positively charged. Which sphere, if any, could be negatively charged?



A. sphere A

B. sphere B

C. sphere C

D. no sphere

Answer: A

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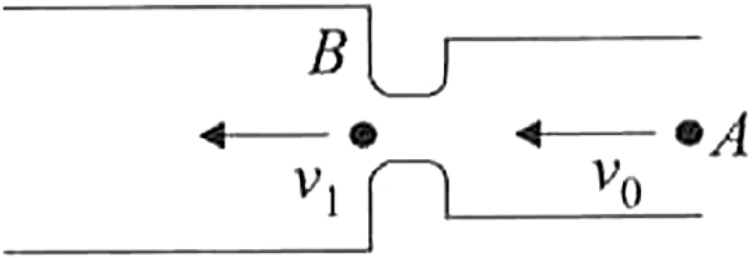
9. The velocity of an electron at point A_1 is V_0 where cross sectional area is A. The velocity of electron at the end of contraction at point B, where cross sectional area is 2A, is V_1. Find the correct option:



A. $V_1 < V_0$

B. $V_1 = V_0$

C. $V_1 > V_0$

D. $V_1 = \frac{V_0}{2}$

Answer: C

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10. Two spherical conductors B and C having equal radii and carrying equal charges in them repel each other with a force F when kept apart at some distance. A third spherical conductor A having same radius as that of B but uncharged, is brought in contact with B, then brought in contact with C and finally removed away from both. The new force of repulsion between B and C is

A. F/4

B. 3F/4

C. F/8

D. 3F/8

Answer: D

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11. Two equally charged, indentical metal spheres A and B repel each other with a force F. The spheres are kept fixed with a distance r between them. A third identical, but uncharged sphere C is brought in contact with A and removed. The magnitude of the net electric force on A is

A. F/4

B. 3F/4

C. F/2

D. F/4

Answer: A

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12. Two small balls having equal positive charge Q (clulomb) on each are suspended by two insulating stirngs of equal length L (meter) from a hook fixed to a stand. The whole set-up is taken in a satellite into space where there is no gravity (state of weightlessness). ltbRgt (i) what is the angle between the two strings.

(ii) What is the tension in each string?

A. $180^\circ, \frac{1}{4\pi\varepsilon_0}.\frac{Q^2}{(2L^2)}$

B. $90^\circ, \frac{1}{4\pi\varepsilon_0}.\frac{Q^2}{L^2}$

C. $180^\circ, \frac{1}{4\pi\varepsilon_0}.\frac{Q^2}{2L^2}$

D. $180^\circ, \frac{1}{4\pi\varepsilon_0}.\frac{QL}{4L^2}$

Answer: a

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13. Two similar spheres having $+q$ and $-q$ charges are kept at a certain distance. The force acts between the two is F. If in the middle of two

spheres, another similar sphere having $+q$ charge is kept,then it experience a force in magnitude and direction as

A. Zero having no direction

B. 8 F towards $+Q$ charge

C. 8 F towards $-Q$ charge

D. 4 F towards $+Q$ charge

Answer: C

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14. Point charges $+4q, -q$ and $+4q$ are kept on the x-axis at points $x = 0, x = a$ and $x = 2a$ respectively, then

A. Only -q is in stable equilibrium

B. None of the charge are in equilibrium

C. All the charge are in unstable equilibrium

D. All the charge are in stable equilibrium

Answer: D

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15. Two identical balls having like charges and placed at a certain distance apart repel each other with a certain force. They are brought in contact and then moved apart to a distance equal to half their initial separation. The force of repulsion between them increases 4.5 times in comparision with the initial value. The ratio of the initial charges of the balls is

A. 2

B. 3

C. 4

D. 6

Answer: A

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16. Two fixed point charges $+4e$ and $+e$ units are separated by a distance a. Where should a third point charge be placed for it to be in equilibrium?

A. x/2

B. 2x/3

C. x/3

D. x/6

Answer: C

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17. Charges 4Q, q and Q and placed along x-axis at positions $x = 0, x = 1/2$ and $x = 1$, respectively. Find the value of q so that force on charge Q is zero

A. Q

B. Q/2

C. $-Q/2$

D. $-Q$

Answer: D

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

A. execute simple harmonic motion about the origin

B. move to the origin and remains at rest

C. move to infinity

D. execute oscillatory but not simple harmonic motion

Answer: D

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19. Two point charges $+4q$ and $+q$ are placed at a distance L apart. A third charge Q is so placed that all the three charges are in equilibrium. Then location and magnitude of third charge will be

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

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

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

D. it should be placed at $(2x/3)$ from smaller charge between them.

Answer: A::C

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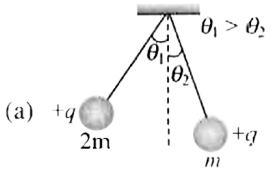
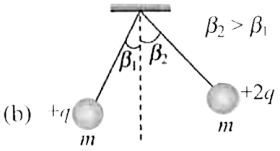
20. If two balls of given masses and charges are released, which of the following is the correct arrangement in equilibrium?

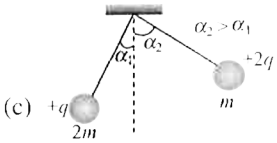
A.



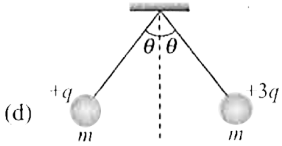
B.



C.



D.



Answer: C::D

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Multiple Correct Answers Type

1. Select the correct statement (s) w.r.t. charges:

A. The aditive property of charge is not an obvisou property, but is related to the fact that charge is a scalar physical quanity.

B. Charge is invariant, i.e., its value is the same in different frames of reference having relative motion.

C. Charge is conserved for an electrically isolated system, this can be concluded from the scalar nature of charge.

D. Charge is conserved for an electrically isolated system this can't be concluded from scalar nature of charge.

Answer: A::B::D

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2. When a positively charged sphere is brought near a metallic sphere, it is observed that a force of attraction exists between the two. It means

A. the metallic sphere is necessarily negatively charged

B. the metallic sphere may be electrically neutral

C. the metallic sphere may be negatively charged

D. nothing can be said about the charge of the metallic spkheres

Answer: B::C

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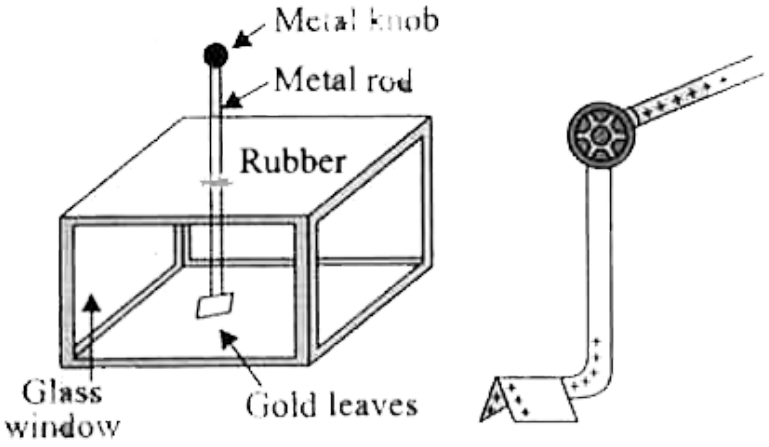
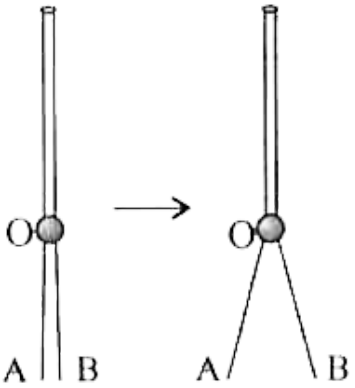
Comprehension Type

1. A leaf electroscope is a simple apparatus to detect any charge on a body. It consist of two metal leaves OA and OB, free to rotate about O. Initially both are very slighty separted. When a charged object is touched to the metal knob at the top of the conduction re, charge flows from knob to the top of the conduction rod, charge flows from knob to the leaves through the conducting rod, charge flows from knob to the leaves through the conduction rod. As the leaves are now charged similarly, they start repelling each other and tet separted (deflected by certain angle).





The angle of deflection in static equilibrium is an indicator of the amount of charge on the charged boy.

When $a + 20C$ rod is touched to the knob, the deflection of leaves was 5°, and when an identical rod of $-40C$ is touched, the deflection was found to be 9°. If an identical rod of $+30C$ is touched, then the deflection may be:

A. 0

B. 2°

C. 7°

D. 11°

Answer: c

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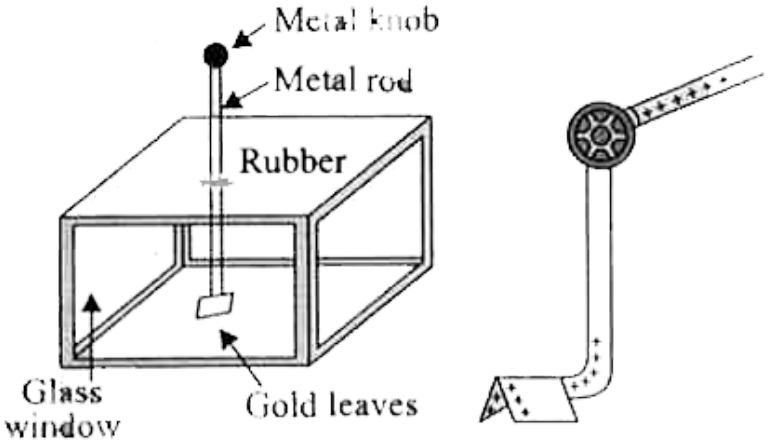
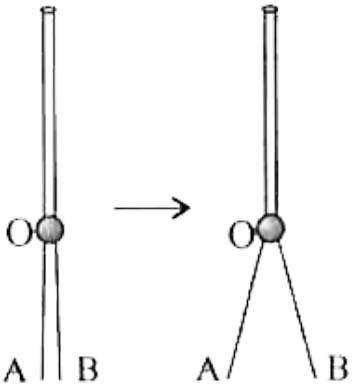
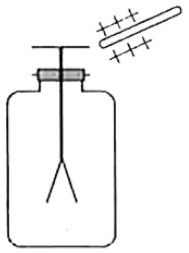
2. A leaf electroscope is a simple apparatus to detect any charge on a body. It consist of two metal leaves OA and OB, free to rotate about O. Initially both are very slighty separted. When a charged object is touched to the metal knob at the top of the conduction re, charge flows from knob to the top of the conduction rod, charge flows from knob to the leaves through the conducting rod, charge flows from knob to the leaves through the conduction rod. As the leaves are now charged similarly, they start repelling each other and tet separted (deflected by certain angle).





The angle of deflection in static equilibrium is an indicator of the amount of charge on the charged boy.

If we perform these steps one by one.

(i) A positively charged rod is brought closer to initially uncharged knob	 (a)
(ii) Then the positively charged rod is touched to the knob	 (b)

(iii) Now the +ve charged rod is removed, and a negatively charged rod is brought closer	 (c)

In which case, the leaves will converge (come closer), as compared to the previous state?

A. (i)

B. (i) and (ii)

C. only (iii)

D. In all cases, the leaves will diverse

Answer: C

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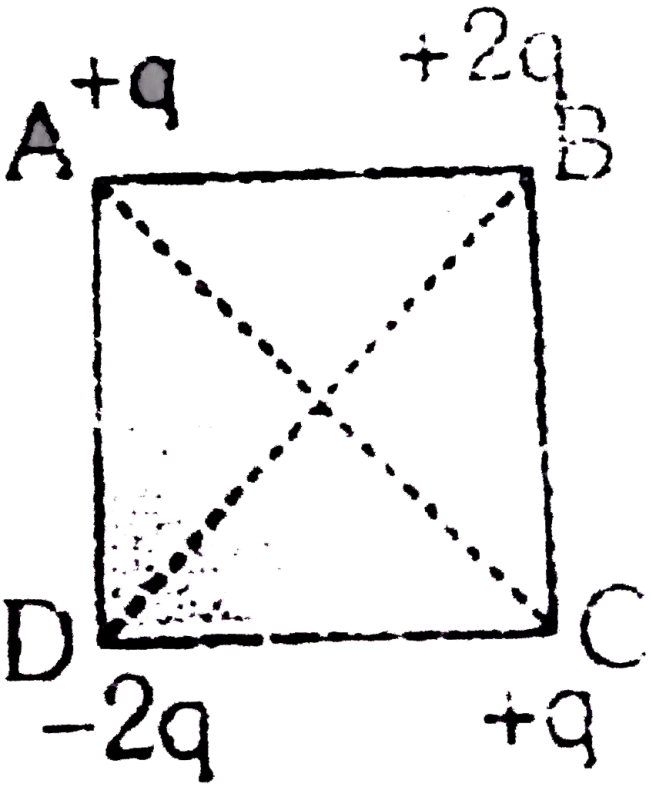
Single Correct Answer Type

1. Four charges are arranged at the corners of a square ABCD as shown in the figure. The force on the charge kept at the centre O will be:



A. Zero

B. along the diagonal AC

C. along the diagonal BD

D. perpendicular to side AB

Answer: C

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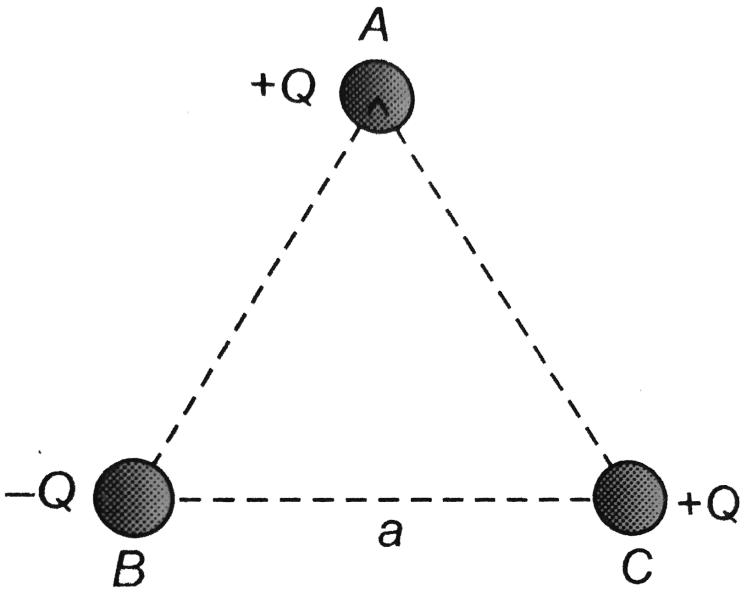
2. Three charges are placed at the vertices of an equilateral trianlge of side a as shown in the following figure. The force experienced by the charge placed at the vertex A in a direction normal to BC is



A. $Q^2 / \left(4\pi\varepsilon_0 a^2\right)$

B. $-Q^2 / \left(4\pi\varepsilon_0 a^2\right)$

C. Zero

D. $Q^2 / \left(2\pi\varepsilon_0 a^2\right)$

Answer: C

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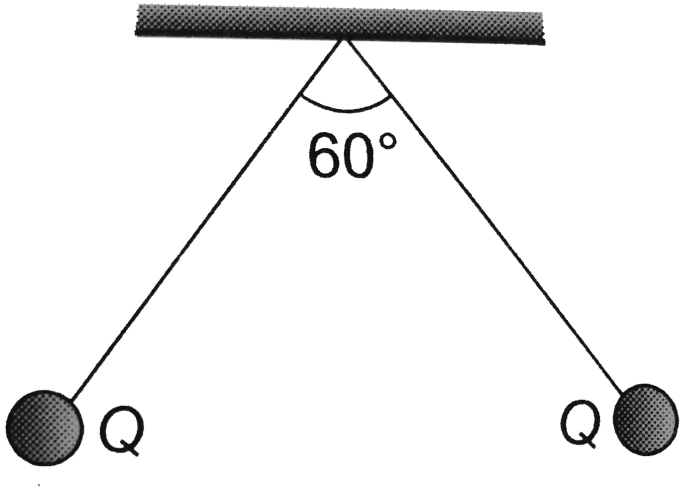
3. Two small spherical balls each carrying a charge $Q = 10\mu C$ are suspended by two insulating threads of equal lengths $1cm$ each, from a point fixed in the ceiling. It is found that in equilibrium threads are sepreated by an angle 60° between them, as shown in figure. What is the tension in the threads

(Given $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 Nm/C^2$)



A. 18 N

B. 1.8 N

C. 0.18 N

D. None of the above

Answer: B

Watch Video Solution

4. Equal charges Q are placed at the four corners A, B, C, D of a square of length a. The magnitude of the force on the charge at B will be

A. $\frac{3Q^2}{4\pi\varepsilon_0 a^2}$

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

C. $\left(\frac{1+2\sqrt{2}}{2}\right)\frac{Q^2}{4\pi\varepsilon_0 a^2}$

D. $\left(2+\frac{1}{\sqrt{2}}\right)\frac{Q^2}{4\pi\varepsilon_0 a^2}$

Answer: C

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5. Four charges equal to $-Q$ are placed at the four corners of a square and a charge q is at its centre. If the system is in equilibrium the value of q is

A. $-\frac{Q}{4}(1+2\sqrt{2})$

B. $\frac{Q}{4}(1+2\sqrt{2})$

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

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

Answer: B

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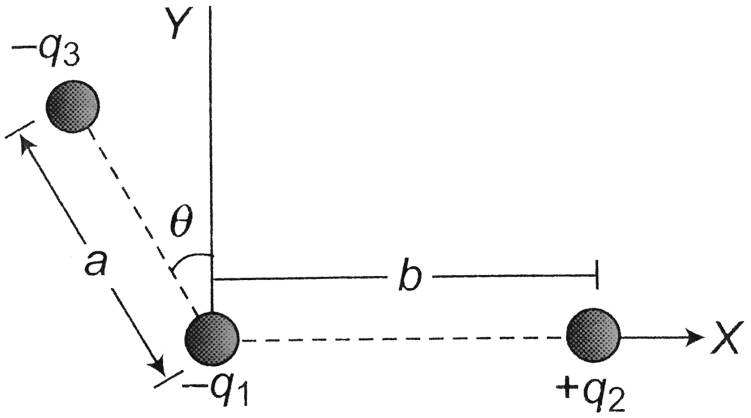
6. Three charges $-q_1$, $+q_2$ and $-q_3$ are placed as shown in the figure. The x-component of the force on $-q_1$ is proportional to



A. $\frac{q_2}{b^2} - \frac{q_3}{a^2}\sin\theta$

B. $\frac{q_2}{b^2} - \frac{q_3}{a^2}\cos\theta$

C. $\frac{q_2}{b^2} + \frac{q_3}{a^2}\sin\theta$

D. $\frac{q_2}{b^2} + \frac{q_3}{a^2}\cos\theta$

Answer: C

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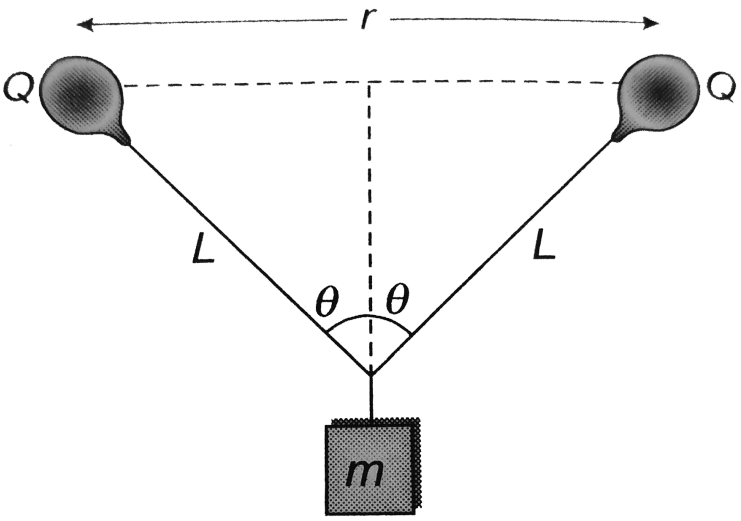
7. Two similar balloons filled with helium gas are tied to Lm long string. A body of mass m is tied to another ends of the strings. The balloons float on air at distance r. If the amount of charge on the ballons is same then

the magnitude of charge on each balloon will be



A. $\left[\frac{mgr^2}{2k}\tan\theta\right]^{1/2}$

B. $\left[\frac{2k}{mgr^2}\tan\theta\right]^{1/2}$

C. $\left[\frac{mgr}{2k}\cot\theta\right]^{1/2}$

D. $\left[\frac{2k}{mgr}\tan\theta\right]^{1/2}$

Answer: A

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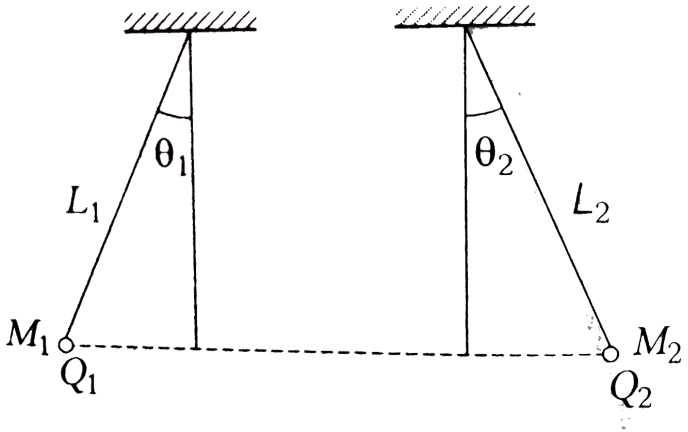
8. Two small spheres of masses M_1 and M_2 are suspended by weightless insulating threads of lengths L_1 and L_2. The spheres carry charges Q_1 and Q_2, respectively. The spheres are suspended such that they are in level with one another and the threads are inclined to the vertical at angle of θ_1 and θ_2 as shown. Which one of the following conditions is essential, if $\theta_1 = \theta_2$?



A. If $m_1 = m_2$

B. $|q_1| = |q_2|$

C. $l_1 = l_2$

D. $\frac{q_1}{m_1} = \frac{q_2}{m_2}$

Answer: A

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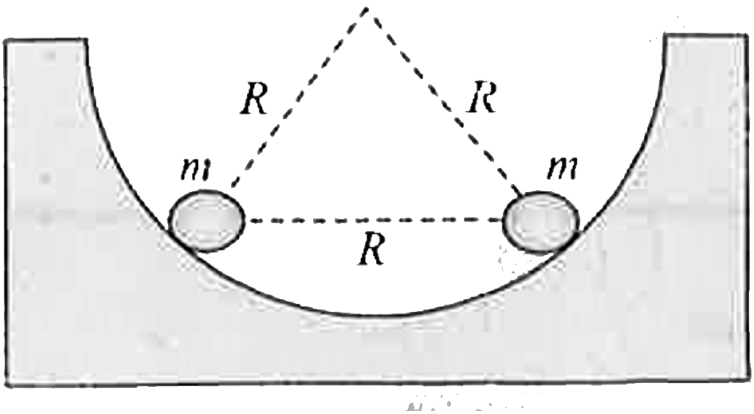
9. Two identical small balls each have a mass m and charge q. When placed in a hemispherical bowl of radius R with frictionless, nonconductive walls, the bead move, and at equilibrium the line joining the balls is horizontal and the distance between them is R (see figure). Neglect any induced charge on the hemispherical bowl. Then the charge on each bead is : (here $K = \frac{1}{4\pi\varepsilon_0}$)



A. $q = R\left(\frac{mg}{K\sqrt{3}}\right)^{1/2}$

B. $q = \left(R\frac{mg}{K\sqrt{3}}\right)^{1/2}$

C. $q = R\left(\frac{\sqrt{3}mg}{K}\right)^{1/2}$

D. $q = \left(R\frac{\sqrt{3}mg}{K}\right)^{1/2}$

Answer: A

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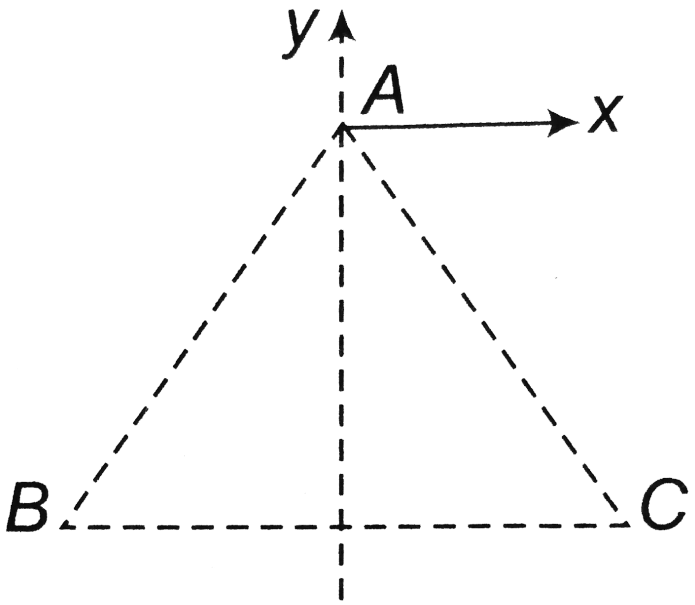
10. Three similar charges $+q$ are placed on 3 corners of an equilateral triangle ABC of side a. How many minimum charges should be placed on a circle of radius a with centre at A so that resultant force on the charge

placed at the centre is $\frac{q^2}{4\pi\varepsilon_0 a^2}$ along x-axis,



A. 4

B. 6

C. 3

D. Any number

Answer: C

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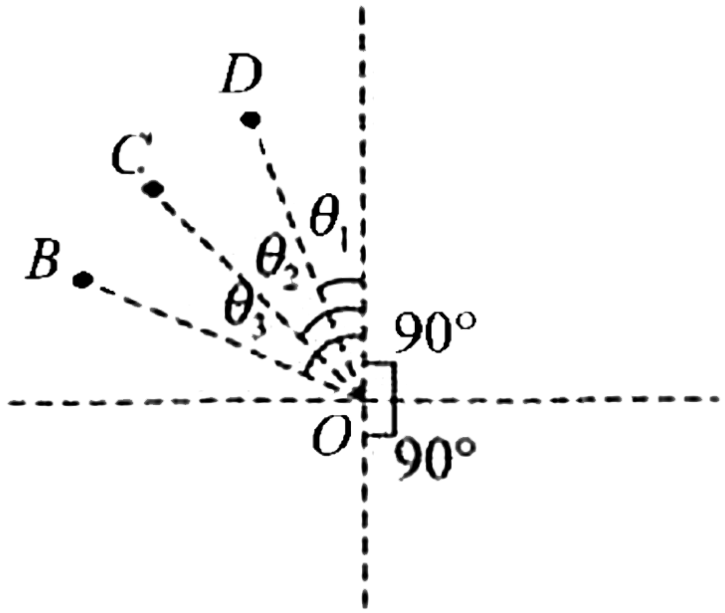
11. Four similar $(+q)$ are placed at origin O, B, C and D as shown. The angles are as shown. Charges at B, C and D are equidistant from O at a distance of a. The forces of repulsion experienced by charge at O due to charges at B and D along CO are equal, given by $\frac{q^2\sqrt{3}}{8\pi\varepsilon_0 a^2}$. Find the relation between θ_1, θ_2 and θ_3:



A. $\theta_3 - \theta_2 = \theta_1$

B. $2\theta_2 = \theta_1 + \theta_3$

C. $\theta_3 = 3(\theta_2 - \theta_1)$

D. None of these

Answer: B

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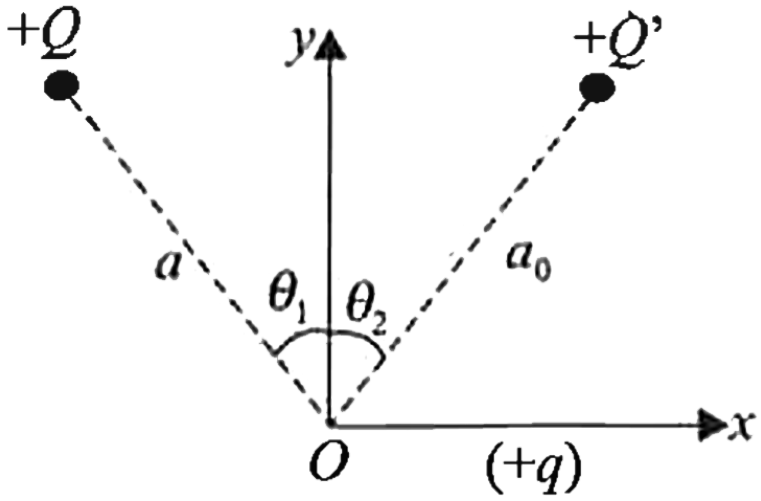
12. In the configuration as shown $+q$ charge is placed at origin and Q and Q are placed at distance a and a_0 respectively from origin. If net electrostatic force on charge $(+q)$ is along negative y-axis and $\theta = \theta_2/2$, then (Q/Q) is equal to:



A. $\frac{a_0^2}{a^2}$

B. $\frac{\pi a_0^2}{a^2}$

C. $\frac{\pi a_0^2}{4\sqrt{2}a^2}$

D. $\frac{\pi a_0^2}{6a^2}$

Answer: D

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13. The insulation property of air breaks down at $E = 3 \times 10^6 V/m$. The maximum charge that can be given to a sphere of diameter 5 m is approximately (in coluombs)

A. 2×10^{-2}

B. 2×10^{-3}

C. 2×10^{-4}

D. 2×10^{-5}

Answer: B

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14. Two point charges $-q$ and $+\frac{q}{2}$ are situated at the origin and at the point $(a, 0, 0)$ respectively. The point along the X-axis where the electric field vanishes is

A. $x = \frac{a}{\sqrt{2}}$

B. $x = \sqrt{2}a$

C. $x = \frac{\sqrt{2}a}{\sqrt{2}-1}$

D. $x = \frac{\sqrt{2}a}{\sqrt{2}+1}$

Answer: C

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15. Two point charges $+4q$ and $+q$ are placed at a distance L apart. A third charge Q is so placed that all the three charges are in equilibrium. Then location. And magnitude of the third charge will be

A. At a distance $\frac{L}{3}$ from $+4q$ charge, $\frac{4q}{9}$

B. At a distance $\frac{L}{3}$ from +4q charge, $-\frac{4q}{9}$

C. At a distance $\frac{2L}{3}$ from +4q charge, $-\frac{4q}{9}$

D. At a distance $\frac{2L}{3}$ from +q charge, $\frac{4q}{9}$

Answer: C

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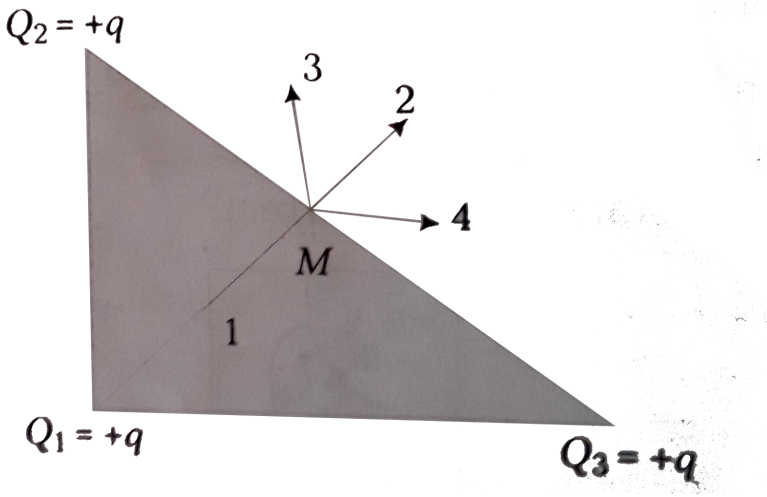
16. Three point charges as shown are placed at the vertices of an isosceles right angled triangle. Which of the numbered vector coincides in direction with the electric field at the mid-point M of the hypotenuse?



A. 1

B. 2

C. 3

D. 4

Answer: B

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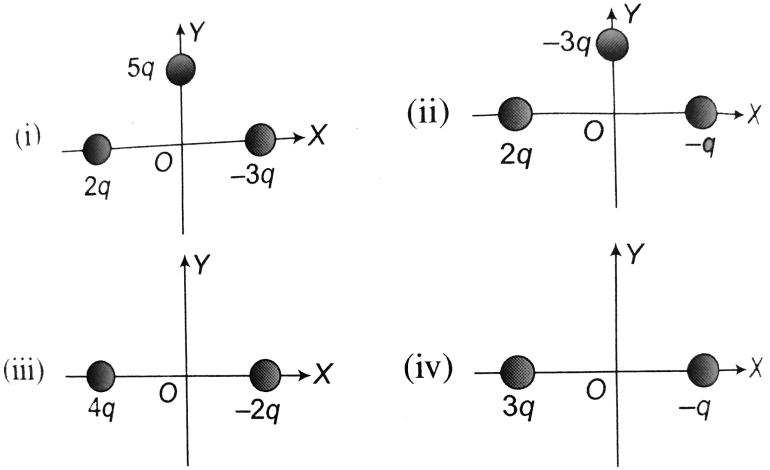
17. In the following four situations charged particles are equal distance from the origin. Arrange them the magnitude of the net electric field at origin greatest first



A. $(i) > (ii) > (iii) > (iv)$

B. $(ii) > (i) > (iii) > (iv)$

C. $(i) > (iii) > (ii) > (iv)$

D. $(iv) > (iii) > (ii) > (i)$

Answer: C

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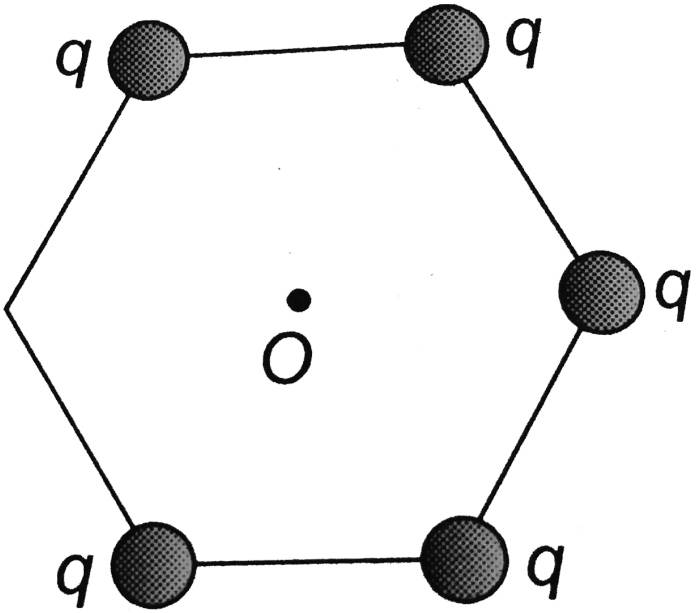
18. Five point charge each having magnitudes q are placed at the corner of hexagon as shown in figure. Net electric field at the centre $'O'$ is $\vec{E}$. To get net electric field at $'O'$ be $6\vec{E}$, charge placed on the remaining

sixth corner should be



A. 6 q

B. $-6q$

C. 5 q

D. $-5q$

Answer: D

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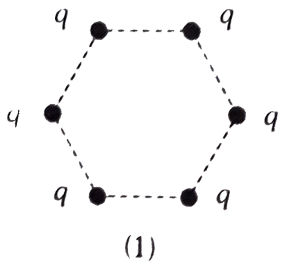
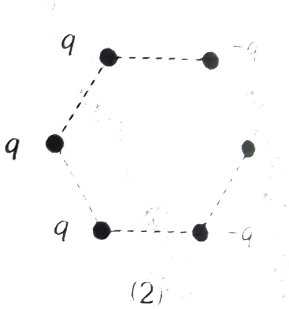
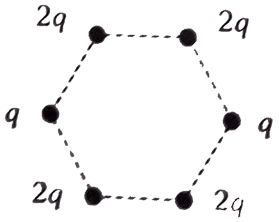
19. Figure below show regular hexagons, with charges at the vertices. In which of the following cases the elecetric field at the centre is not zero ?

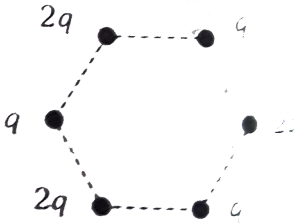


(1)



(2)





A. 1

B. 2

C. 3

D. 4

Answer: B

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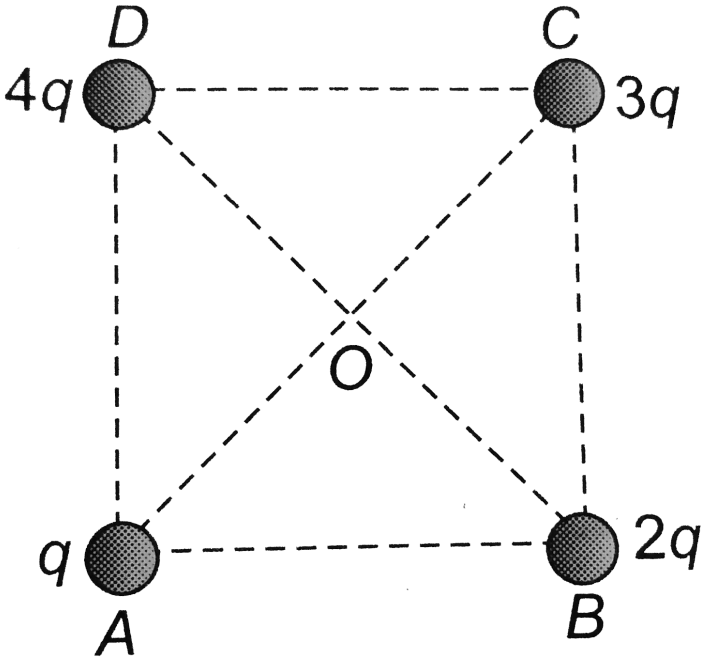
20. Charges q, $2q$, $3q$ and $4q$ are placed at the corners A, B, C and D of a square as shown in the following figure. The directon of electric field at the centre of the square is along



A. AB

B. CB

C. BD

D. AC

Answer: B

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21. Infinite charges of magnitude q each are lying at $x = 1, 2, 4, 8,...$ Metre on X-axis. The value of intensity of electric field at point $x = 0$ due to these charges will be

A. $12 \times 10^9 qN/C$

B. zero

C. $6 \times 10^9 qN/C$

D. $4 \times 10^9 qN/C$

Answer: A

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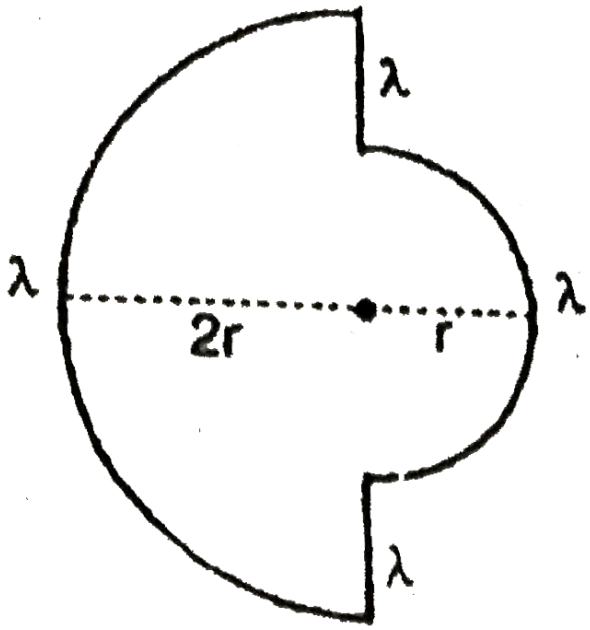
22. Two semicircular rings lying in same plane, of uniform linear charge density λ have radius r and 2r. They are joined using two straight uniformly charged wires of linear charge density λ and length r as shown

in figure. The magnitude of electric field at common centre of semi circular rings is -



A. $\frac{1}{4\pi\varepsilon_0}\frac{3\lambda}{2r}$

B. $\frac{1}{4\pi\varepsilon_0}\frac{\lambda}{2r}$

C. $\frac{1}{4\pi\varepsilon_0}\frac{2\lambda}{r}$

D. $\frac{1}{4\pi\varepsilon_0}\frac{\lambda}{r}$

Answer: D

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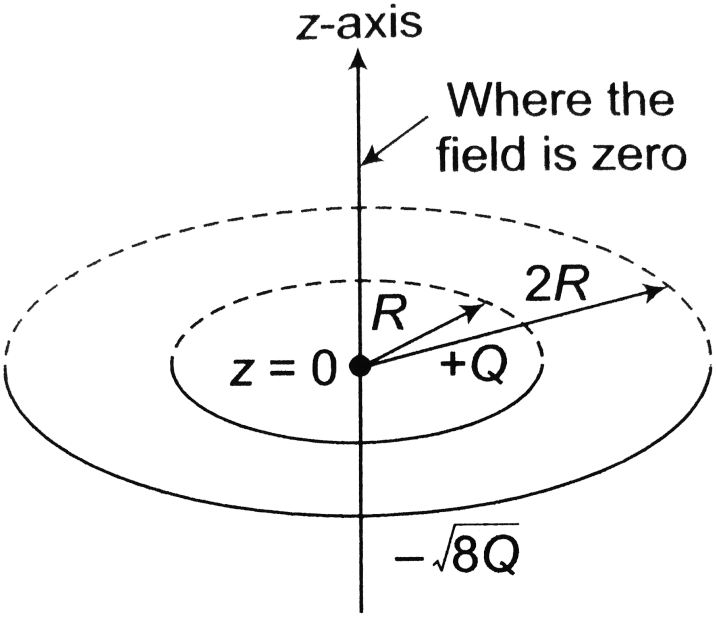
23. Two concentric rings, one of radius R and total charge $+Q$ and second of radius $2R$ and total charge $-\sqrt{8}Q$, lie in $x-y$ plane (i.e., $z=0$plane). The common centre of rings lies at origin and the common axis coincides with z-axis. The charge is uniformly distributed on both rings.

At what distance from origin is the net electric field on z-axis zero?



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

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

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

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

Answer: D

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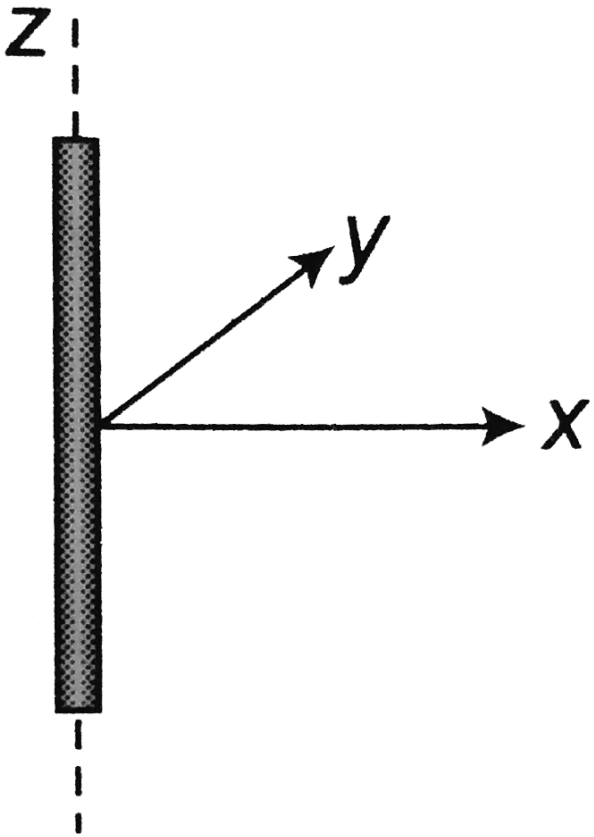
24. An infinitely long wire is kept along z-axis from $z = \infty$ to $z = \infty$, having uniform linear cahrges density $\frac{10}{9} nC/m$. The electric field at

point $(6cm, 8cm, 10cm)$ will be



A. $\left(120\hat{i} + 160\hat{j} + 200\hat{k}\right) V/m$

B. $200\hat{k} V/m$

C. $\left(160\hat{i} + 120\hat{j}\right) V/m$

D. $\left(120\hat{i} + 160\hat{j}\right) V/m$

Answer: D

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Multiple Correct Answer Type

1. When two point charges q_A and q_B are placed at some separation on positive x-axis at points $(x_A, 0)$ and $(x_B, 0)$. Given that $|q_A|$ and $|q_B|$ and $x_B > x_A$. If null point is the point where net electric field due to both the charges is zero, then

A. if both q_A and q_B are positive, null point lies at some point $x_A < x < x_B$

B. if q_A is positive and q_B is negative, null point lies at some point $x < x_A$

C. if q_A is positive and q_B is negative, null point lies at some point $x > x_B$

D. if q_A is negative and q_B is positive, null point lies at some point

$x > x_B$

Answer: A::C::D

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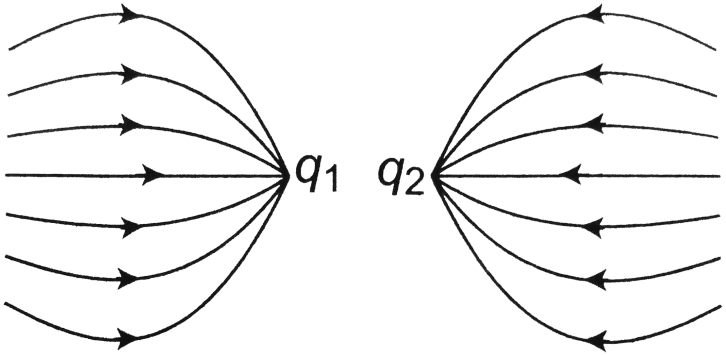
Single Answer Correct Type

1. The given figure gives electric line of force due to two charges q_1 and q_2.

What are the signs of the two charges ?



A. Both are negative

B. Both are positive

C. q_1 is positive but q_2 is negative

D. q_1 is negative but q_2 is positive

Answer: A

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2. Consider the four field patterns shown. Assuming there are no charge in the regions shown, which of the patterns represent a possible electrostatic field?

A. A

B. B

C. C

D. D

Answer: B

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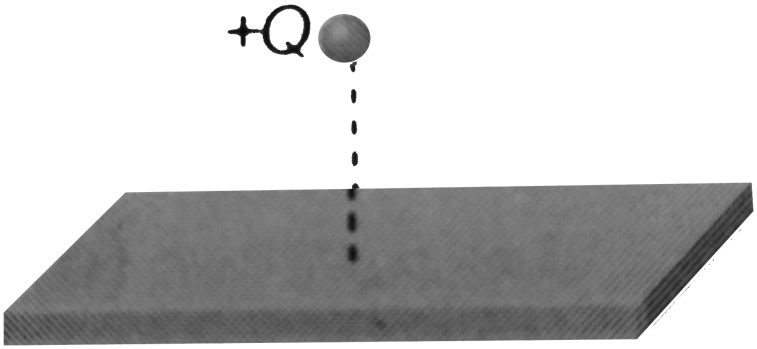
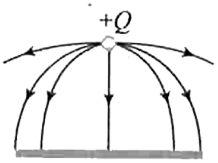
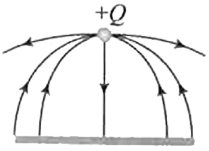
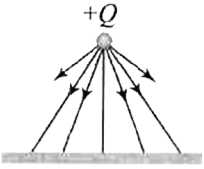
3. A charge Q is fixed at a distance d in front of an infinite metal plate.

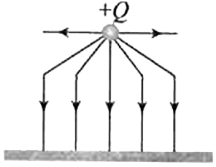
The lines of force are represented by



A. 

B. 

C. 

D. (d) 

Answer: A

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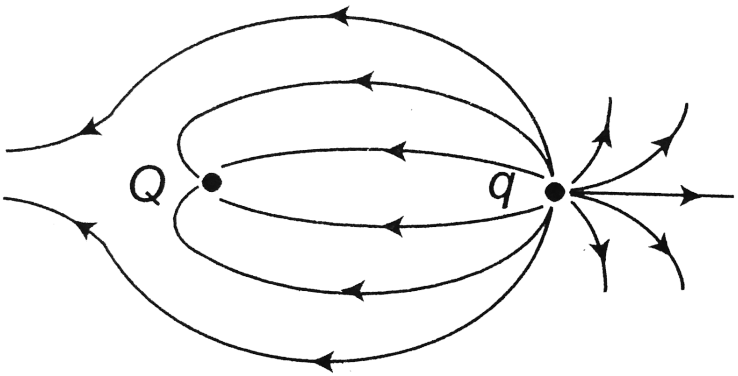
4. The lines of force of the electric field due to two charges q and Q are sketched in the figure. State if



A. Q is positive and $|Q| > |q|$

B. Q is negative and $|Q| > |q|$

C. q is positive and $|Q| < |q|$

D. q is negative and $|Q| < |q|$

Answer: C

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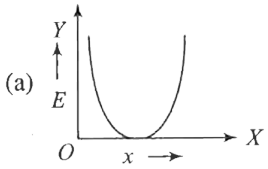
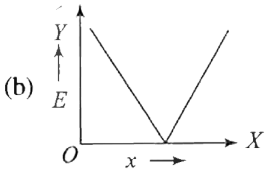
5. Two identical point charges are placed separation of l. P is a point on the line joining charges, at a distance x from any one charge field at P is E. E is plotted against x for value from closeo to zero to slightly less than l. Which following best represents the resulting curve ?

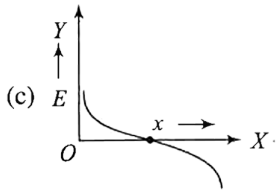
A.

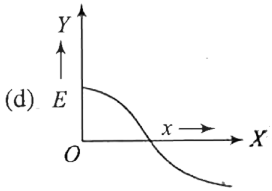


B.



C.





D.

Answer: D

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6. The bob of a pendulum of mass $8\mu g$ carries an electric charge of 39.2×10^{-10} coulomb in an electric field of 20×10^3 volt/meter and it is at rest. The angle made by the pendulum with the vertical will be

A. 27°

B. 45°

C. 87°

D. 127°

Answer: B

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7. Two charges each equal to $\eta q\left(\eta^{-1} < \sqrt{3}\right)$ are placed at the corners of an equilateral triangle of side a. The electric field at the third corner is E_3 where $\left(E_0 = q/4\pi\varepsilon_0 a^2\right)$

A. $E_3 = E_0$

B. $E_3 < E_0$

C. $E_3 > E_0$

D. $E_3 \geq E_0$

Answer: C

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8. Two ppoint chargres $(+Q)$ and the $(-2Q)$ are fixed on the X-axis at positions a and 2a from origin respectively. At what positions on the axis, the electric field is zero

A. Only $x = \sqrt{2}a$

B. Only $x = -\sqrt{2}a$

C. Both $x = \pm\sqrt{2}a$

D. $x = \frac{3a}{2}$ only

Answer: B

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9. A hemisphere is uniformly charged positively. The electric field at a point on a diameter away from the centre is directed

A. perpendicular to the diameter

B. parallel to the diameter

C. at an angle tilted towards the diameter

D. at an angle tilted away from the diameter

Answer: A

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10. An electron falls through a small distance in a uniform electric field of magnitude $2 \times 10^4 NC^{-1}$. The direction of the field reversed keeping the magnitude unchanged and a proton falls through the same distance. The time of fall will be

A. same in both cases

B. more in the case of an electron

C. more in thecase of proton

D. independent of charge

Answer: C

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11. There is a uniform electric field of strength $10^3 V/m$ along y-axis. A body of mass $1g$ and charge $10^{-6} C$ is projected into the field from origin

along the positive x-axis with a velocity $10m/s$. Its speed in m/s after $10s$ is (Neglect gravitation)

A. 10

B. $5\sqrt{2}$

C. $10\sqrt{2}$

D. 20

Answer: C

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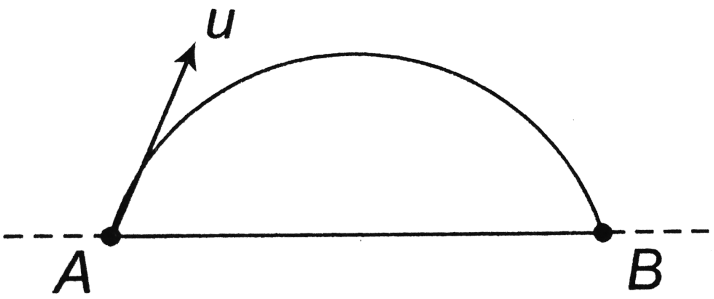
12. In the figure shown there is a large sheet of charge of uniform surface charge density $'\sigma'$.A charge particle of charge $'-q'$ and mass $'m'$ is projected from a point A on the sheet with a speed $'u'$ with the angle of projection such that it lands at maximum distance from A on the sheet.

Neglecting gravity, find the time flight



A. $\frac{2\sqrt{2}mv\varepsilon_0}{\sigma q}$

B. $\frac{\sqrt{2}mv\varepsilon_0}{5\sigma q}$

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

D. $\frac{mv\varepsilon_0}{2\sqrt{2}\sigma q}$

Answer: A

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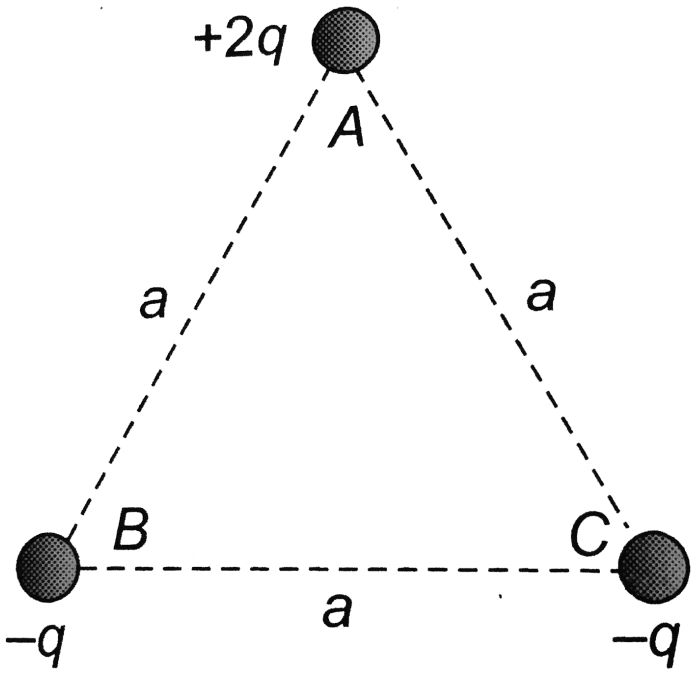
13. Three charges of $(+2q)$, $(-q)$ and $(-q)$ are placed at the corners A, B and C of an equilateral triangle of side a as shown in the adjoining

figure. Then the dipole moment of this combination is



A. qa

B. Zero

C. $qa\sqrt{3}$

D. $\frac{2}{\sqrt{3}}qa$

Answer: C

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

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

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

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

D. $\tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$

Answer: B

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15. An electric dipole is placed at the origin O and is directed along the x-axis. At a point P, far away from the dipole, the electric field is parallel to y-axis. OP makes an angle θ with the x-axis then

A. $\tan\theta = \sqrt{3}$

B. $\tan\theta = \sqrt{2}$

C. $\theta = 45^\circ$

D. $\tan\theta = \dfrac{1}{\sqrt{2}}$

Answer: B

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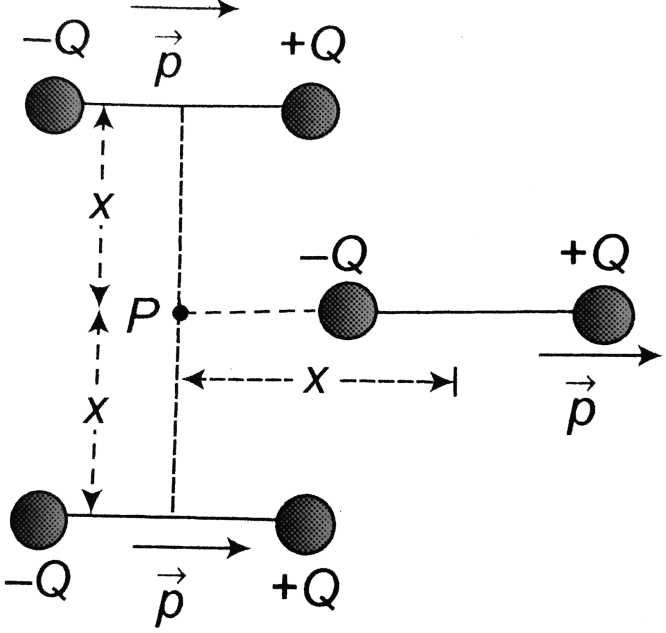
16. Three identical dipoles are arranged as shown below. What will be the net electric field at $P\left(k = \dfrac{1}{4\pi\varepsilon_0}\right)$



A. $\frac{k.\ p}{x^3}$

B. $\frac{2kp}{x^3}$

C. Zero

D. $\frac{\sqrt{2}kp}{x^3}$

Answer: C

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17. Two electric dipoles of moment p and 64p are placed in opposite direction on a line at a distance of 25 cm. The electric field will be zero at point between the dipoles whose distance from the dipole of moment p is

A. 5 cm

B. $\frac{25}{9}cm$

C. 10 cm

D. . $\frac{4}{13}cm$

Answer: A

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18. Two point charges $(+Q)$ and $(-2Q)$ are fixed on the X-axis at positions a and $2a$ from origin respectively. At what positions on the axis, the resultant electric field is zero

A. Only $x = \sqrt{2}a$

B. Only $x = -\sqrt{2}a$

C. Both $x = \pm\sqrt{2}a$

D. $x = \frac{3a}{2}$ only

Answer: B

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19. An electric dipole is kept on the axis of a uniformly charged ring at distance from the centre of the ring. The direction of the dipole moment is along the axis. The dipole moment is p, charge of the ring is Q & radius of the ring is R. The force on the dipole is

A. $\frac{4kPQ}{3\sqrt{3}R^2}$

B. $\frac{4kPQ}{3\sqrt{3}R^3}$

C. $\frac{2kPQ}{3\sqrt{3}R^3}$

D. zero

Answer: D

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20. Two short dipoles $p\hat{k}$ and $\frac{P}{2}\hat{k}$ are located at $(0, 0, 0)$ & $(1m, 0, 2m)$ respectivley. The resultant electric field due to the two dipoles at the point $(1m, 0, 0)$ is

A. $\frac{9P}{32\pi\varepsilon_0}\hat{k}$

B. $\frac{-7P}{32\pi\varepsilon_0}\hat{k}$

C. $\frac{7P}{32\pi\varepsilon_0}\hat{k}$

D. none of these

Answer: B

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21. Total electric force on an electric dipole placed in an electric field of a point charge is :

A. always zero

B. never zero

C. zero when mid-point of dipole coincides with the point charge

D. zero when dipole axis is along any electric line of force.

Answer: B

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22. The locus of the points (in the xy-plane) where the electric field due to a dipole (dipole axis is along x-axis and its equatorial is along y-axis) is perpendicular to its axis, is

A. straight line perpendicular to the axis

B. circle

C. parabola

D. straight line having inclination $\theta = \tan^{-1}\sqrt{2}$ with the axis

Answer: D

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