PHYSICS

BOOKS - HC VERMA

ELECTRIC FIELD AND POTENTIAL

Examples

1. Two charges $10\mu C$ and $-10\mu C$ are placed at points $A.$ and B separated by a distance of 10 cm. Find the electric. field at a point P on

the perpendicular bisector of AB at. a distance of 12 cm from its middle point.

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2. A ring of radius a contains a charge q distributed. uniformly ober its length. Find the electric field at a point. on the axis of the ring at a distance x from the centre.

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3. Three particles, each having a charge of $10\mu C$, are. placed at the vertices of an equilateral triabngle of side. 10 cm. Find the work done by a person in pulling them. apart to infinite separtions.

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4. Two charges $+10\mu C$ and $+20\mu C$ are placed at a. separation of 2 cm. Find the electric

potential due to the. pair at the middle point of the line joining the two charges.

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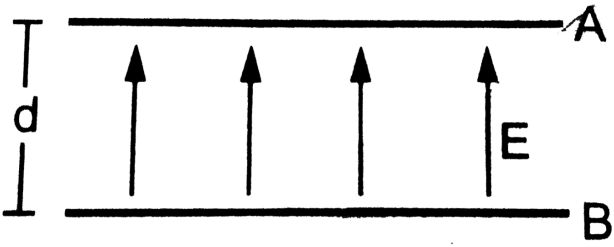
5. shows two metallic plates A and B placed parallel to each other at a separaton d. A uniform electric field E exists between the plates in the direction from plate B to plate A. Find the potential difference between the

plates.



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Worked Out Examples

1. Charges $5.0 \times^{-7} C, \ -2.5 \times^{-7} C$ and $1.0 \times 10^{-7} C$ are

held fixed at the three cornners A, B, C of an equilateral triangle of side 10 cm. find the electric force on

. charge at C due to the rest two.

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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. separation of 20cm. Where should a third charged. particle be

placed so that it dose not experience a net electric force?.

A. 20 cm

B. 40 cm

C. 60 cm

D. 45 cm

Answer: A

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3. Three equal charges, each having a magnitude of. $2.0 \times 10^{-6} C$, are placed at the thre corners of a right. angled triangle of sides 3 cm, 4cm and 5 cm. the force (magnitude) on the charge at the right angled corner is

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4. Two small iron particles, each of mass 280 mg, are. placed at a distance 10 cm apart. If 0.01% of the electron. of one particle are

transferred to the other, find the. electric force between them. Atomic weifht of iron is $56gmol^{-}$ and there are 26 electrons in each atom of iron.

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5. A charge Q is to be divided on two objects. What shouold. be the values of the charges on the objects so that the. force between the objects can be maximum?.

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6. Two particles, each having a mass of 5 g and charge. 1.0×10^{-7} C, stay in limiting wquilibrium on a horizontal. table with a seaprtion of 10 cm between them. The coefficient of friction beteen each partcle and the table. is the same. Find the value of this coefficient.

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7. A vertical electric field of magnitude $4.00 \times 10^5 NC^{-1}$. just prevents a water droplet of mass $1.000x10^{-4}bkg$from. falling., find the charge on the droplet.

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8. Three charges each equal to q, are placed at the three corners of a square of side a . Find the electric field at the fourth corner.

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9. A Charged particle of mass 1.0 g is suspended through a silk thread of length 40 cm in a horizantal electric field of $4.0 \times 10^4 NC^{-1}$. If the particle stays aty a distance of 24 cm from the wall in equilibrium, find the charge on the particle.

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10. A particle a having a charge of $5.0 \times 10^{-7} C$ is fixed in. a vertical wall. A

second particle B of mass 100 g and. having equal charge is supended by a silk thread. of length 30 cm form the wall. The point of suspension is. 30 cm above the particle A. Find the angle of the thread. with the vertical when it stays in equilibrium.

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11. Four particles each having a charge q, are placed on the four vertices of a regular pentagon. The distance of each corner from

the centre is a. Find the electric field at the centre of the pentagon.

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12. Find the electric field at a point P on the perpendicular bisector of a uniformly charged rod. The lengthof the rod is L, the charge on it is Q and the distance of P from the centre of the rod is a.

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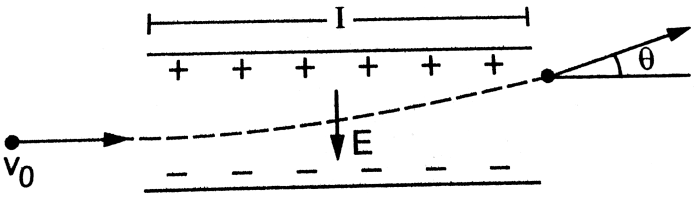
13. A uniform electric field E is created between two parallel charged plates as shown in figure . An electron enters the field symmetrically between the plates with a speed v_0. The length of each plate is l. Find the angle of deviation of the path of the electron as it comes out of the field.



A. $\theta = \tan^{-1}\left(e\dfrac{l}{mv_0^2}\right)$.

B. $\theta = \tan^{-1}\left(eE\frac{l}{v_0^2}\right)$.

C. $\theta = \tan^{-1}\left(eE\frac{l}{mv_0^2}\right)$.

D. $\theta = \tan^{-1}\left(eE\frac{l}{v_0^2}\right)$.

Answer: C

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14. In a circuit, 10 C of charge is passed through a battery

in a given time. The plates of the battery are

maintained

at a potential difference of 12 V. How much work is done

by the battery?.

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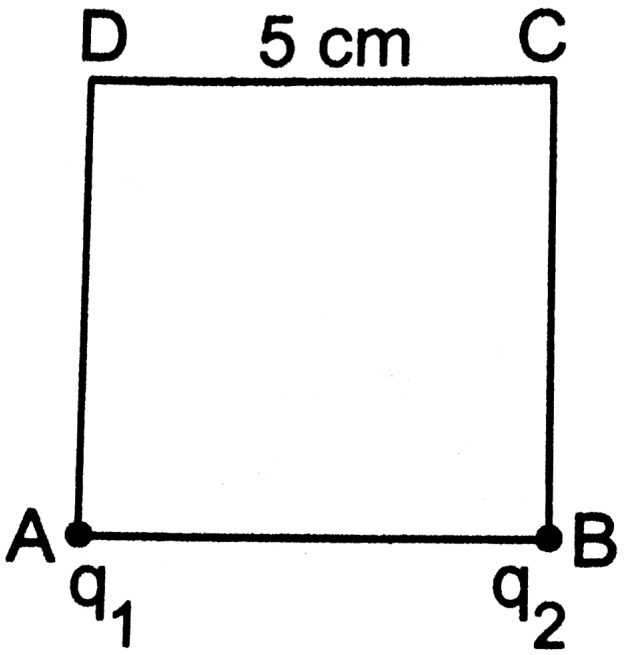
15. charges $2.0 \times 10^{-6} C$ and $1.0 \times 10^{-6} C$ are placed at. corners A and B of a squae of side 5.0cm as shown in. figure .how much work will be done against. the electric field in moving a

charge of `1.0 xx 10^(-6) C from. C to D?.



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16. The electric field in a region is given by $\vec{E} = \left(\frac{A}{x^3}\right)\vec{I}$. Write a suitable SI unit for A.

Write an experssion for. the potential in the region assuming the potential at. infinity to be zero.

A. $\frac{A}{2x^3}$

B. $\frac{A}{2x}$

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

D. $\frac{A}{2x^2}$

Answer: D

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17. Three point charges q, 2q and 8q are to be placed on a 9 cm long straight line. Find the positions where the charges should be placed such that the potential energy of this system is minimum. In this situation, What is the electric field at the position of the charge q due to the other two charges?

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18. The electric dipole moment of an HCl atom is 3.4×10^{-30} Cm. The charges on both atoms

are unlike and of same magnitude. Magnitude of this charge is .....The distance between the charges is 1 A.

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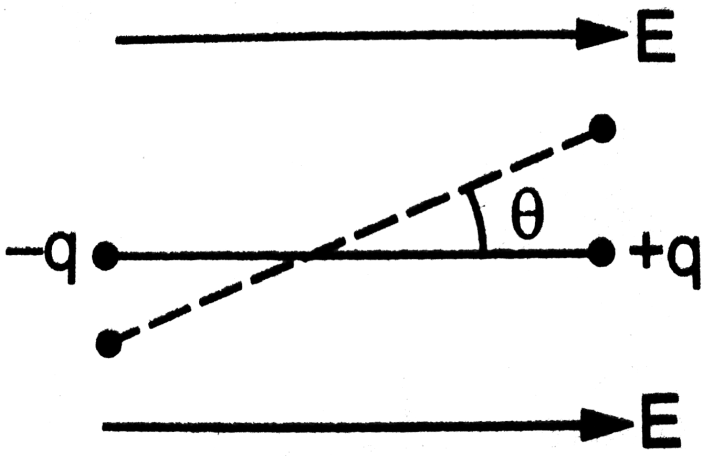
19. show an electric dipole formed by two particles fixed at the ends of a light rod of length l. The mass of each particle is m and the charges are -q and +q . The system is placed in such a way that the dipole axis is parallel to a uniform electric field E that exist

in the region. The dipole is slightly rotated abut its centre and released. Show that for small angular . desplacement, the motin is anguler sumple harmonic and find its time period.



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Short Answer

1. The charge on a proton is $+1.6X10(-19)C$ and that on an electron is $-1.6X10(-19)C$. Does it mean that the electron has a charge $3.2X10(-19)C$ less than the charge of a proton?

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2. Is there any lower limit to the electric force between two

. particles placed at a separation of 1 cm?

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3. Consider two particles A and B having equal charges and placed at some distance. The particle A is slightly displaced towards B. Does the force on B increase as soon as th particle A is displaced? Does the force on the particle A increase as soon as it is displaced?

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4. Can a gravitational field be added vectorially to an electric field to get a total field?

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5. Why dose a phonograph - record attract dust partiules just after it is cleaned?

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6. Does the force on a charge due to another charge depend

. on the charges present nearby?

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7. In some old texts it is mentioned that 4π lines of force

. orginate form each unit positive charge. Comement on

. the statement in view of the fact that 4π is

not an

. interger.

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8. Can two equipotential surfaces cut each other?

A. Yes

B. No

C.

D.

Answer:

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9. If a charge is placed at rest in an electric field, will its path be along a line of force? Discuss the situation when the lines of force are straight and when they are curved.

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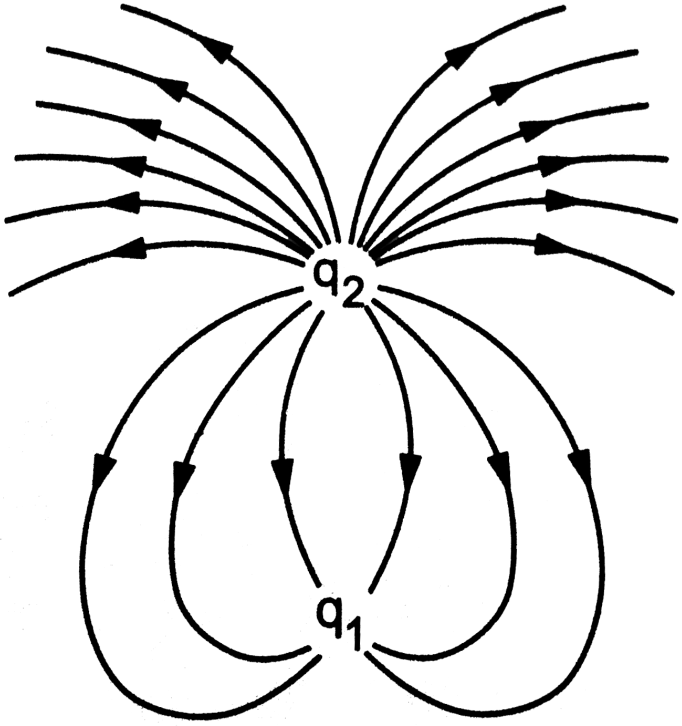
10. Consider the situation shown in (figure) what are the signs of q_1 and q_2 ? If the lines are drawn in proportion to the charge, what is the ratio $\frac{q_1}{q_2}$?



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11. A point charge is taken from a pint A to a pint B in an electric field. Does the work done by the electric field depend on the path of the charge ?

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12. It is said that the separaton between the two charges forming an electric dipole should be small. Small compered to what?

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13. The number of electrons in an insulator is of the same order as the number of electrons in a conductor. What is then the basic difference between a conductor and an insulator ?

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14. When a charged comb is brought near a small piece of paper, it attracts the piece. Does

the paper, it attracts the piece. Does the paper become charged when the conb is brought near it ?

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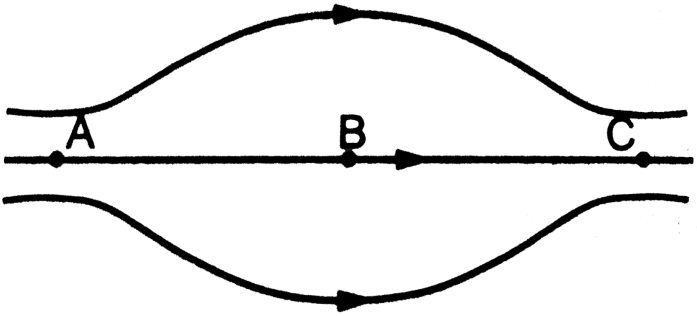
Objective 1

1. Figure shows some of the electric field lines correspoinding to an electric field. The figure

suggests that



A. $E_A > E_B > E_C$

B. $E_A = E_B = E_C$

C. $E_A = E_C > E_B$

D. $E_A = E_C < E_B$

Answer: C

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2. When the separation between two charges is increased, the electric potential energy of the charges

A. increases

B. decreases

C. remains the same

D. may increase or decrease.

Answer: D

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3. If a positive charge is shifted from a low - potential region to a high- potential region, the electric potential energy

A. increases

B. decreases

C. remain the same

D. may increase or decrease

Answer:

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4. Two equal positive charges are kept at points A and B. The electric potential at the points between A and B (exculding these points) is studid while moving from A to b. The potential

A. continuously increases

B. continuously decreases

C. decreases then increases.

D. increase then decrease

Answer:

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5. The electric field at the origin is alo,n,g the positive x-axis. A small circle is drawn with the centre at the origin cutting the axes at points A, B, C and D having coordinates (a,0), (0,a), (-a,0),(0,-a) respectively. Out of the points on the periphery of the circle, the potential is minimum at

A. A

B. B

C. C

D. D

Answer:

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6. If a body is charged by rubbing it , its weight

A. remains precisely constant

B. increases slightly

C. decreases slightly

D. may increase slightly or may decrease slightly.

Answer: D

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7. An electric dipole is placed in a uni8form electric field. The net electric force on the dipole

A. is always zero

B. depends on the orientation of the dipole

C. can never be zero

D. depends on the strength of the diipole.

Answer:

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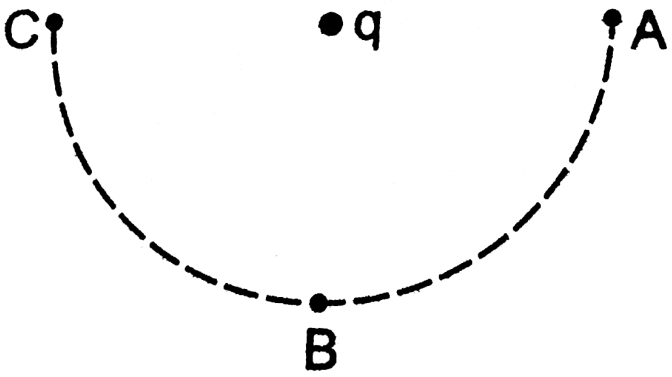
8. Consider the situation of figure . The work done in taking a point charge form P to A is

W_A from P to B is W_B from P to C is W_C.



A. $W_A < W_B < W_C$

B. $W_A > W_B > W_C$

C. $W_A = W_B = W_C$

D. None of these

Answer:

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9. A point charge q is rotated along a circle in the electric field generated by anotherj point charge Q. The work done by the electric field on the rotatin charge in one complete revolution is

A. zero

B. positive

C. negative

D. zero if the charge Q is at the centre and nonzero otherwise.

Answer:

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Objective 2

1. Mark out the correct potons.

A. The totalcharge of the universe is constant.

B. The total positive charge of the universe is constant.

C. The total negativ echarge of the universe is constant.

D. The tottal number of charged particule in the

Answer:

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2. A point charge is brought in an electric field.

The electric field at a near by point

A. will increase if the charge is positive

B. will decrease if the charge is negative

C. may increase if the charge is negative

D. may ecrease if the charge is negative.

Answer:

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3. The electric field and the electric potential at a point are E and V respectively.

A. If E =0, V=0 respectively.

B. If V = 0, E must be zero.

C. If $E \neq 0$, V cannot be zero.

D. If $V \neq 0$, E cannot be zero.

Answer:

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4. The electric potential decreases unifromly from 120 V to 80 V as one moves on the x-axis from x=-1 cm to x=+1 cm. The electric field at the origin

A. must be equal to 20 Vcm $\hat{} -1$

B. may be equal to 20 Vcm $\hat{} (-1)$

C. may be greater than 20 Vcm(-1)

D. may be less than 20Vcm(-1)

Answer: A

5. Which of the following quantites do not depend on the choice of zero potential or zero potential energy?

A. Potential at a point

B. Potential difference between two points

C. Potential energy of a two charge system

D. change in potential energy of a two charge system.

Answer:

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6. An electric dipole is placed in an electric field generated by a point charge

A. The net electric force on the dipole must be zero.

B. The net electric force on the dipole may be zero.

C. The torque on the dipole due to the field must be zero.

D. The torque on the dipole due to the field may be zero.

Answer:

7. A proton and an electron are placed in a uniform electric field.

A. The electric forces acting on them will be equal.

B. The magnitudes of the forces will be equal.

C. Their accelerations will be equal.

D. The magnitudes of their accelerations will be equal.

Answer:

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8. The electric field in a region is directed outward and is proportional to the distance r from the origin, Taking the electric potential at origin to be zero,

A. it is uniform in the region

B. it is proportional to r

C. it is proportional to r^2

D. it increases as one goes away from the origin.

Answer:

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Exercises

1. Find the dimensional formula of ε_0 .

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2. A charge of 1.0 C is placed at the top of your college building and another equal charge at the top of your house. Take the separaton between the two charges to be 2.0 km. Find the force exerted by the charges on each other. How many time of your weight is this force?

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3. At what separation should two equal charges 1.0 C each, be placed so that the force between them equals the weight of a 50 kg person?

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4. Two equal charges are placed at a separtion of 1.0 m. What should be the magnitude of the charges so that the force between them equals of a 50 kg person?

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5. Find the electric force between two protons separated by a distance of 1 fermi $\left(1fermi = 10^{-15}m\right)$. The protons in a nucleus remain at a separation of this order.

A. 230N

B. 2300N

C. 23000N

D. None of the Above

Answer: A

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6. Two chargea $2.0 \times 10^{-6} C$ and 1.0 x 10^(-6) C are placed at a separation of 10 cm. where should a third charge be placed such that it experiences no net force due to these charges.

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7. Suppose the second charge in the previous problem is $-1.0 \times 10^{-6} C$. Locate the position where a third charge will not experience a net force.

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8. Two charged particles are placed at a distance 1.0 cm apart. What is the minimum possible magnitude of the electric force acting each charge?

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9. Estimate the number of electrons in 100 g water. How much is the total negative charge on these electrons?

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10. Suppose all the electrons of 100 g water are lumped together to form a negatively charged particle and all the nuclei are lumped together to form a positively charge particle. If

these two particles are placed 10.0 cm away from each other, fien the force of attraction between them. Compare it with your weight.

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11. Consider a gold nucleus to be a sphere of redius 6.9 fermi in whichprotons and neutrons are distributed. Find the force of repulsion between two protons situated at largest separaton. Why do thes protons not fly apart under this repulsion

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12. Two insulating small spheres are rubbed against each other and placed 1 cm apart. If they attract each other with a force of 0.1 N, how many electrons were transferred from one sphere to the other during rubbing?

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13. Na Cl moecule is bound due to the electreic force between the sodium and the chlorine

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

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

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15. Suppose ana attractive nuclear force acts between two protons which may be written as $F = Ce^{-kr}/r^2$, (a) Write down the dimensional formulae and appporpriate SI units of C and k. (b) Suppose that $k = 1fermi^{-1}$ and that the repulsive electreic force between the protons is just blanced by the attractive nuclear force when the separation is 5 fermi. Find the value of c.

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16. Three equal charges, 2.0×10^{-6} C each, are held fixed at the three corners of a square of side 5 cm. find the Coulomb force experienced by one of the charges due to the rest two.

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17. Four equal charges $2.0 \times 10^{-6} C$ each are fixed at the four corners of a squae of side 5 cm. Find the coulomba force eperienced by one of the charges due to the rest three.

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18. A hydrogen atom contains one proton and one electron. It may be assumed that the electron revolves in a circle of radius 0.53 angstrom $\left(1 angstrom = 10^{-10}\right.$ m and is abbreviated as A) with the proton at the centre. The hydrogen atom is said to be in the ground state in this case. Find the magnitude of the electric force between the proton and the electron of a hydrogen atom in its ground state.

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19. Find the speed of the electron in the ground state of hddrogen atom. The description of ground state is given in the previous problem.

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20. Ten positively charged particles are kept fixed on the x-axis at points x=10cm, 20cm,

30cm, ..., 100cm. The first particle has a charge $1.0 \times 10^{-8} C$, the second 8×10^{-8} C, the third $27 \times 10(-8)$C and so on. The tenth particle has a charge $1000 \times 10^{-8} C$. find the magnitude of the electric force acting on a 1 C charge placed at the origin.

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21. Two charged particles having charge $2.0 \times 10^{-8} C$ each are joined by an insulating string of length 1 m and the system is kept on

a smooth horizontal table. Find the tension in the string.

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22. Two indentical balls, each having a charge of $2.00 \times 10^{-7} C$ and a mass of 100g , are suspended from a common point by two insulating strings each 50 cm long. The balls are held at a separation 5.0cm apart and then released. Find (a) the electric force on one of the charged balls (b) the components of the

resultant force on it alongand perpendicular to the string (c) the tension is the string (d) the components of the resultant force on it along and perpendicular to the string(c) the tension in the string (d) the acceleration of one of the balls. Answers are to be obtained just after the release.

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23. Two identical pith balls are charged by rubbing against each other. They are

suspended from a horizontal rod through two strings of length 20 cm each, the separation between the suspension points being 5 cm. in equilibrium, the separation between the balls in 3 cm. Find the mass of each ball and the tension in the strings. the charge on each ball gas a magnitude $2.0 \times 10^{-8} C$.

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24. Two small spheres, each having a mass of 20 g, are suspended form a common point by

two insulating strings of length 40 cm each. The spheres are identically charged and the speration between the balls at equilibrium is found to be 4 cm . Find the charge on each sphere.

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25. Two indentical pith balls, each carrying charge q, are suspended from a common point by two strings of equal length l. Find the mass

of each ball if the angle between the strings is 2θ in equilibrium.

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26. A particle having a charge of $2.0 \times 10^{-4} C$ is placed directly below and at a separtion of 10 cm from the bob of a simple pendulum at rest. The mass of the bob is 100g. What charge should the bob be given so that the string becomes loose?

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27. Two particles A and B having charges q and 2q respectively are placed on a smooth table with a separation d. A third particle C is to be clamped on the table in such a way that the particles A and B remain at rest on the table under electrical forces. What should be the charge on C and where should it clamped?

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28. Two identically charged particles are fastened to the two ends of a spring of spring constant $100Nm^{-8}C,$ find the extension In the length of the apring. Assume that the extension is small as scompared to the natural length . Justify this assumption after you solve the problem.

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29. A particle A having a charge of $2.0 \times 10^{-6} C$ is held fixed on a horizontal table. A second charged jparticle of mass 80g stays in equilibrium on the table at a distance of 10 cm from the firsst charge. The coefficient of friction between the table and this second jparticle is $\mu = 0.2$. find the range within which the charge of this second particle may lie.

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30. A particle A having a charge of 2.0×10^{-6} C and a mass of 100 g is placed at the bottom of a smoth inclined plane of inclination $30\circ$. Where should another particle B, having same charge and mass, be placed on the incline so that it may remain in equilibrium?

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31. Two particles A and B having equal charges are placed at distance d apart. A third charged particle placed on the perpendicular bisector

at a distance x will experience the maximum Coulomb's force when :

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32. Two particles A and B , ech carrying charge Q are held fixed with a separation D between them. A particle C having mass m and charge q is kept at the middle point of the line AB. (a) If it is displaced throught a distance x perpendicular to AB, what would be the electric force experienced by it .(b) Assuming x

ltltd, show that this force is proportional to x.

(c) under what conditions will the jparicle C execute simple harmonic motion if it is released after such a small displacement? Find the time period of the oscillations if these conditions are stisfied.

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33. Repeat the previous problem if the particle C s displaced through a distance x along the line AB.

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34. The electric force experienced by a charge of $1.0 \times 10^{-6} C$ is $1.5 \times 10^{-3} N$. Find the magnitude of the electric field at the position of the charge.

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35. Two particles A and B having charges of $+2.00 \times 10^{-6} C$ and of -4.00×10^{-6} respectively are held fixed at a separation of

20.0 cm . Locate the point(s) on the line AB where (a) the electric field is zero (b) the electric potential is zero.

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36. A Point charge produces an electric field in room ,What is its direction?

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37. A water particle of mass 10.0 mg and having a charge of $1.50 \times 10^{-6} C$ stays suspended in a room. What is the magnitude of electric field in the room ? What is its direction?

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38. Three identical charges, each having a value $1.0 \times 10^{-8} C,$ are placed at the corners of an equilateral triangle of side 20 cm find

the electric field and potential at the centre of the triangle.

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39. Positive charge Q is distributed uniformly over a circular ring of radius R. A particle having a mass m and a negative charge q, is placed on its axis at a distance x from the centre. Find the force on the particle. Assuming x ltltR, find the time period of

oscillation of the particle if it is released from there.

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40. A rod of length L has a total charge Q distributed uniformly along its length. It is bent in the shape of a semicircle. Find the magnitude of the electric field at the centre of curvature of the semicircle.

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41. A 10 cm long rod carries a charge of $+150\mu C$ distributed uniformly along its length. Find the magnitude of the electric field at a point 10 cm from both the ends of the rod.

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

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43. A wire is bent in the form of a regular hexagon and a total charge q is distributed uniformly on it. What is the electric field at the centre? You may answer this part without making any numerical calculations.

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44. A cjircular wire-loop of radius a carries a total charge Q distributed uniformly over its

length . A small length dL of the wire is cut off. Find the electric field at the centre due to remaining wire.

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

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46. A pendulum bob of mass 80mg and carrying a charge of $2 \times 10^{-8} C$ is at rest in a uniform, horizontal electric field of 20 kVm^{-1}. Find the tension in the thread.

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

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48. A particle of mass 1 g and charge $2.5 \times 10^{-4} C$ is released from rest in an electric field of $1.2 \times 10^{4} NC^{-1}$ (a) Find the electric force and the force of gravity acting on this particle. Can one of these forces be neglected in comparison with the other for approximate analysis? (b) How long will it take for the particle to travel a distance of 40 cm? (c) What will be the speed of the particle after travelling this destance? (d) how much is the

work done by electric force on the particle during this period?

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49. A ball of mass 100g and having a charge of 4.9×10^{-5} C is released from rest in a region where a horizontal electric field of $2.0 \times 10^{4} NC^{-1}$ exists. (a) find the resultant force acting on the ball. (b) What will be the path of the ball ? (c) Where will the ball be at the end of 2 s?

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50. The bob of a simple pendulum has a mass of 40 g and a positive charge of $4.0 \times 10^{-5} C$. It makes 20 oscillations in 45 s. A vertical electric field pointing upward and of magnitude $2.5 \times 10^4 NC^{-1}$ is switched on. How much time will it now take to complete 20 oscillations?

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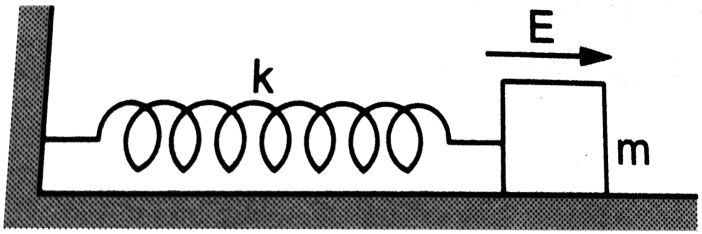
51. A block of mass m having a charge q is placed on a smooth horizontal table and is connected to a wall through an unstressed spring of spring constant k as shown in figure(29.E1) . A horizontal electric field E parallel to the spring is switched on. Find the amplitude of the resulting SHM of the block.



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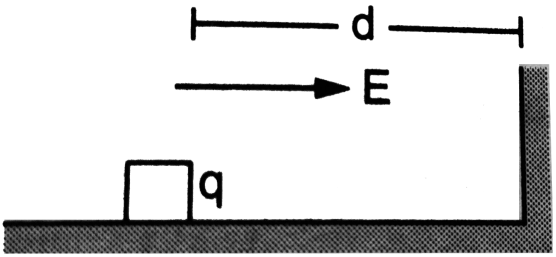
52. A block of mass m containing a net positive charge q is placed on a smooth horizontal table which terminates in a vertical wall as shown in figure(29-E2). The distance of the bolck from the wall is d. A horizontal electric field E to towards right is switched on. Assuming elastic collisions find the time period of the resulting oscillatory motio. Is it a simple harmonic motion?



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53. A Uniform electric field of $10NC^{-1}$ exists in the vertically downward direction. Find the increase in the electric potential as one goes up through a height of 50cm.

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54. 12 j of work has to be done against an existion electric field to take a charge of 0.01 C

from A to B. How much is th potential difference $V_B - V_A$?

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55. Two equal charges, $2.0 \times 10^{-7} C$ each, are held fixed at a separation of 20cm. A third charge of equal magnitude is placed midway between the two the charges. It is now moved to a point 20 cm from both the charges. How much work is done by the electric field during the process?

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56. An electric field of $20N/C$ exists along the x-axis in space. Calculate the potential difference $V_B - V_A$ where the points A and B are given by

a. $A = (0, 0), B = (4m, 2m)$

b. $A = (4m, 2m), B = (6m, 5m)$

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57. Consider the situation of the previous problem. A charge of $2.0 \times 10^{-4} C$ is moved from the point A to the point B. find the change in electrical potential energy $U_B - U_A$ for the cases (a) , (b) and (c).

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58. An electric field $\vec{E} = \overrightarrow{i20 + j} 30 NC^{-1}$ exists in the space. If the potential at the

origin is taken to be zero find the potential at (2m, 2m).

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59. An electric field $\vec{E} = \vec{i}Ax$ exists in the space, where $A = 10Vm^{-2}$. Take the potential at (10m, 20m) to be zero. Find the potential at the origin.

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60. The electric potential existing in space is $V(x, y, z) = A(xy + yz + zx)$.(a) Write the dimensional A. (b) find the expression for the electric field.(c) If A is 10 SI units, find the magnitude of the electric field at (1m, 1m, 1m).

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61. Two charged particles, having equal charges of $2.0 \times 10^{-5} C$ each, are brought from infinity to within a separation of 10 cm.

Find the increase in the electric potential energy during the process.

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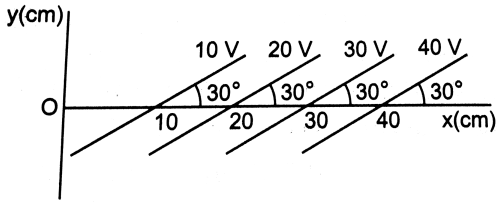
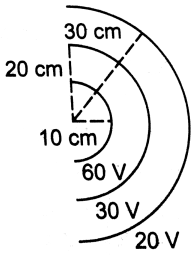
62. Some equipotential surfaces are shown in figure(29.E3) What can you say about the magnitude and the direction of the electric field?





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63. Consider a circular ring of radius r, uniformly charged with linear charge density λ . Find the electric potential aty a point on the exis at a distance x from the centre of the ring. Using this expression for the potential, find the electric field at this point.

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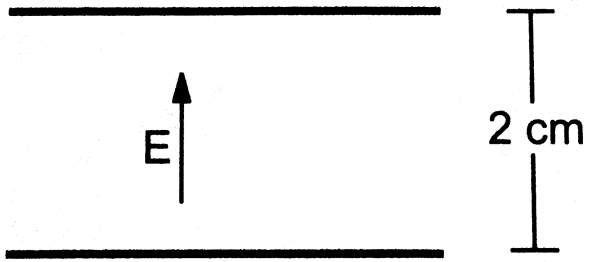
64. An electric field of magnitude $1000NC^{-1}$ is produced between two parallel platees having a separation of 2.0 cm as shown in figure(29.E4) (a) What is the potential difference between the plates? (b) With what minimum speed should an electron be projected from the lower plate in the direction of the field so that it may reach the upper plate? (c) Suupose the electron is projected from the lower plate with the speed calculated in part (b) . The direction of projection makes an angle of $60\circ$ with the field. Find the

mazimum height reached by the electron.



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65. A uniform field of $2.0NC^{-1}$ exists in space in x direction (a) Taking the potential at the origin to be zero, write an experssion for the potential at a general point (x,y,z). (b) At which points, the potential is 25V ? (c) If the

potential at the origin is taken to be 100V , what will be the expression for the potential at a general point? (d) What will be the potential at the origin if the potential at infinity is taken to be zero ? Is it parctical to choose the potential at infinity to be zero?

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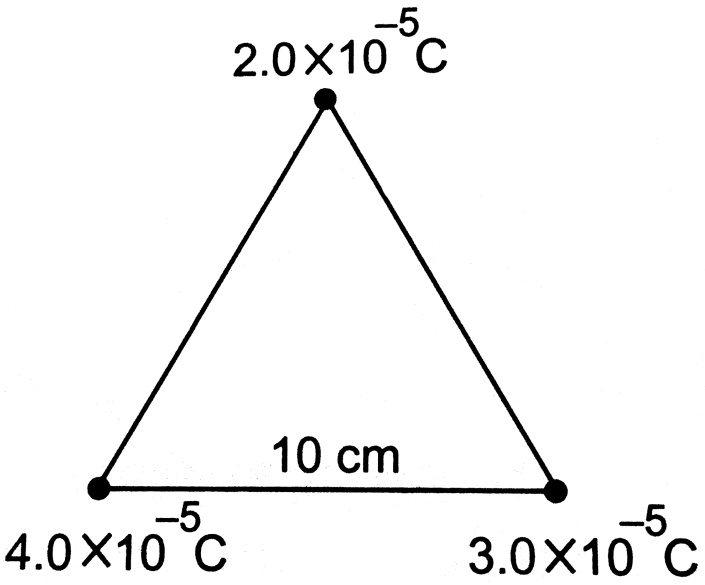
66. How much work has to be done in assembling three charged particles at the vertices of an equilateral triangle as shown in

figure



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67. The kinetc energy of a chargd particle decreased by 10 J as it moves from a point at

potential 100 V to a point at potential 200V .

Find the charge on the particle.

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68. Two identical particles, each having a charge of $2.0 \times 10^{-4} C$ and mass of 10g are kept at 10cm and then released. What would be the speeds of the particles when the separtion becomes large?

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69. Two particles have equal masses of 5.0 g each and opposite charges of $+4.0 \times 10^{-5} C$. They are released from rest with a separation of 1.0 m between them. Find the speeds of the particles when the separation is reduced to 50 cm.

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70. A sample of HCl gas is placed in an electric field of $2.5 \times 10^{4} NC^{-1}$. The dipole moment of each HCl molecule is $3.4 \times 10^{-30} Cm$. find

the maximum torque that can act on a molecule.

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71. Two particles A and B, having opposite charges2.0×10^{-6} and -2.0×10^{-6}C , are placed at a separaton of 1.0 cm.(b) Calculate the electric field at a point on the axis of the dipole 1.0 m away from the centre. (c) Calculate the electric field at a point on the

perpendicular bisector of the dipole and 1.0 m away from the centre.

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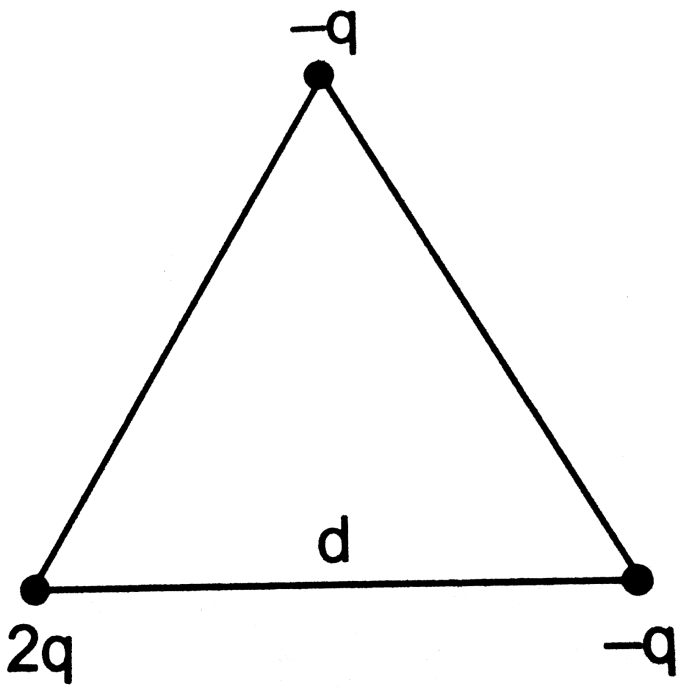
72. Three charges are arranged on the vertices of an equilateral triangle as shown in figure (29.E6) find the dipole moment of the

combination.



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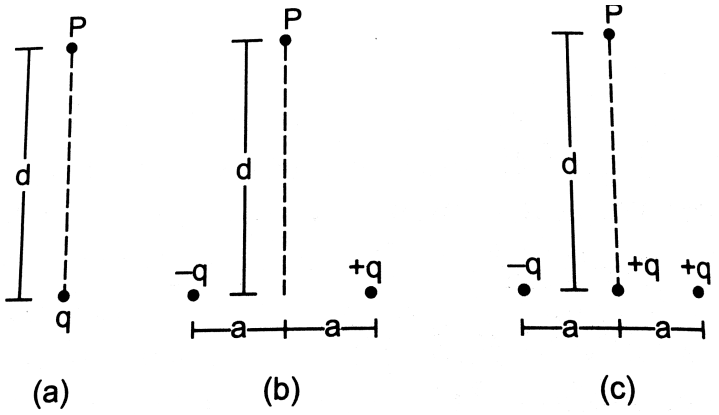
73. find the magnitude of the electric field at the point P in the configuration shown in

figure for $d > > a, Take 2qa = p.$



A. $\frac{1}{4\pi\varepsilon_0}\frac{q}{d^2}$, $\frac{1}{4\pi\varepsilon_0}\cdot\frac{p}{d^3}$

$\frac{1}{4\pi\varepsilon_0}\cdot\left(\frac{\sqrt{(qd)^2+p^2}}{d^2}\right.$

B. $\frac{1}{4\pi\varepsilon_0}\frac{q}{d^2}$, $\frac{1}{4\pi\varepsilon_0}\cdot\frac{p}{d^3}$

$\frac{1}{4\pi\varepsilon_0}\cdot\left(\frac{\sqrt{(qd)+p^2}}{d^3}\right.$

C. $\frac{1}{4\pi\varepsilon_0}\frac{q}{d^2}$, $\frac{1}{4\pi\varepsilon_0}\cdot\frac{p}{d^2}$

$\frac{1}{4\pi\varepsilon_0}\cdot\left(\frac{\sqrt{(qd)^2+p^2}}{d^3}\right.$

D. $\frac{1}{4\pi\varepsilon_0}\frac{q}{d^2}$, $\frac{1}{4\pi\varepsilon_0}\cdot\frac{p}{d^3}$

$\frac{1}{4\pi\varepsilon_0}\cdot\left(\frac{\sqrt{(qd)^2+p^2}}{d^3}\right.$

Answer: D

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74. Two particles, carrying charges -q and +q and having equal masses m each, are fixed at the rod is clamped at an end and is placed in a uniform electric field E with the axis of the dipole along the electric field. The rod is slightly tlted and then released. Neglecting gravity find the time period of small oscillations.

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75. Assume that each atom in a copper wire contributes one free electron. Estimate the number of free electrons in a copper wire having a mass of 6.4g (take the atomic weight of copper of be 64g mol^{-1}).

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