PHYSICS

NCERT - NCERT PHYSICS(GUJRATI)

ELECTRIC CHARGES AND FIELDS

Example

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

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

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

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4. Columb law for electrostatic force between two point charges and newton law for gravitational force between two the distance between the charges and masses respectively (a) compare the strength of these forces by determining the ratio of their magnitudes (i) for an electron and a proton and (ii) for two protons (b) estimate the acceleratons of electron and proton due to the electrical force oftheir mutual attarction when they are 1A

$\left(= 10^{-10} m \right)$ a part

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

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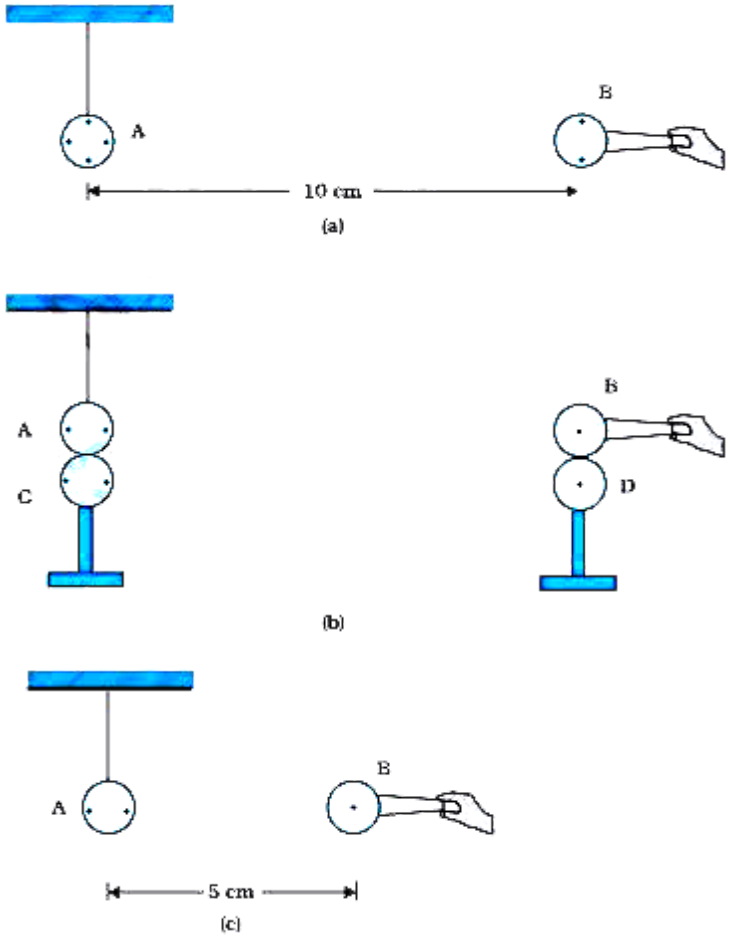
5. A charged metallic sphere A is suspended by a nylon thread another charged metallic sphere b held by an insulating centers is 10 cm as shown in Fig. 1.7(a). The resulting repulsion of A is noted (for example, by shining a beam of light and measuring the deflection of its shadow on a screen). Spheres A and B are

touched by uncharged spheres C and D respectively, as shown in Fig. 1.7(b). C and D are then removed and B is brought closer to A to a distance of 5.0 cm between their centers, as shown in Fig. 1.7(c). What is the expected repulsion of A on the basis of Coulomb's law? Spheres A and C and spheres B and D have identical sizes. ignore the sizes of a and b in comparison to the separation between their

centers



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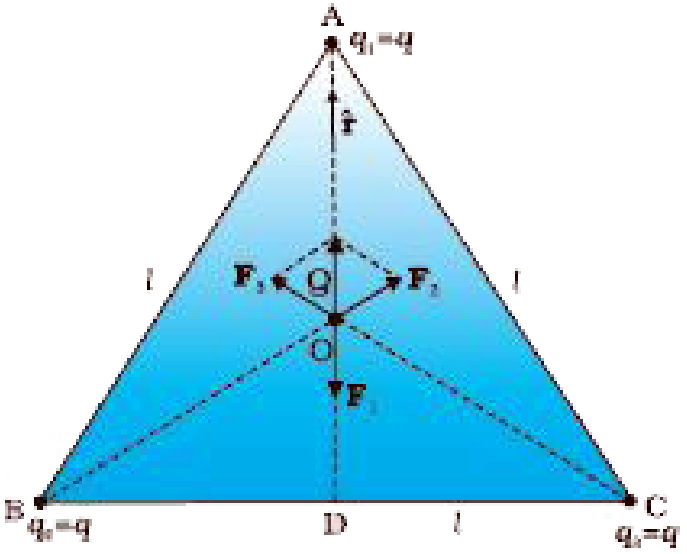
6. consider three charges q_1, q_2, q_3 each equal to q at the vertices of an equilateral triangle of side l what is the force on a charge Q placed at the centroid of the triangle



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7. Consider the charges q, q and -q placed at vertices of an equilateral triangle as shown it figure. What is the force on each charge ?

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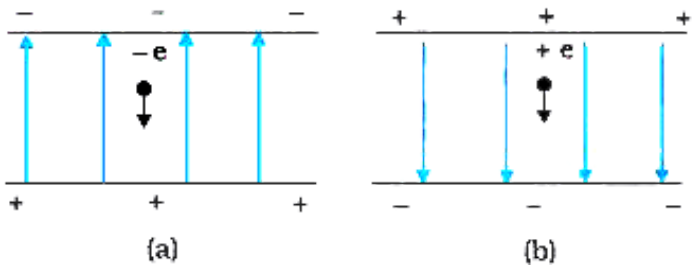
8. An electron falls throgh a distance of 1.5 cm in a uniform electric field of magnitude $2.0 \times 10^4 Nc^{-1}$ the direction of the field is reversed keeping its magnitude unchanged and a proton falls through the same distance compute the time of falls in each case contrast

the situation with that of free fall under gravity



(a) (b)

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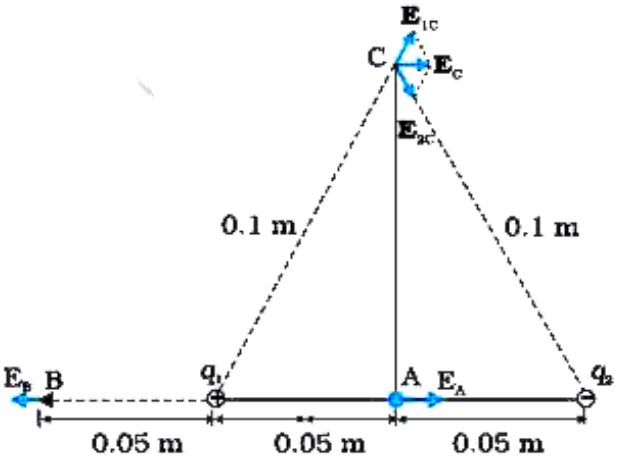
9. Two point charges q_1 and q_2 of magnitude + 10^{-8} c and -10^{-8} c respectively are placed 0.1 m apart calculate the electric fields at

points a, b and c



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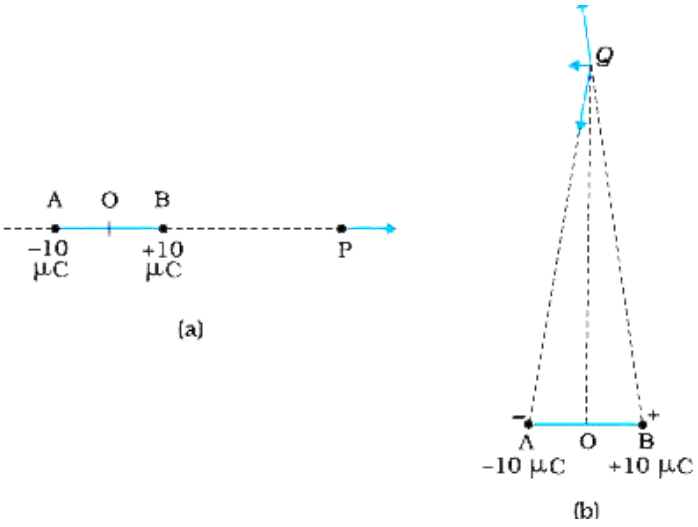
10. Tow charges $\pm 10\mu$ C are placed 5.0 mm apart determine the electric field at (a) a point p on the axis of the dipole 15 cm away from its centre o ont the side of the positive charge as

(a) and (b) a point q 15 cm away from o on a line passing through o and normal to the axis of the dipole as



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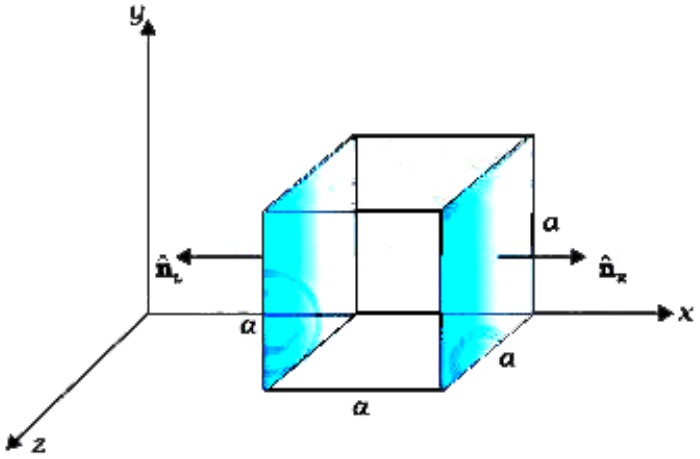
11. The electric field components are $E_x = ax^{-1/2}, E_y = E_z = 0$ in which a =800

N/C $m^{1/2}$ calculate (a) the flux through the cube and (b) the charge within the cube asume that a=0.1 m



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12. An electric field is uniform and in the positive x direction for postive x and uniform

with the same magnitude but in the negative x direction x it is given that E=200 I N/C length 20 cm and radius 5 cm has its centre at the origin and its axis x =-10 cm (a) what is the net ioutward flux through each flate face (b) what is the flux through the side of the cylinder (C) what is the net outward flux thoght the cylinder (d) what is the net charge inside the cylinder

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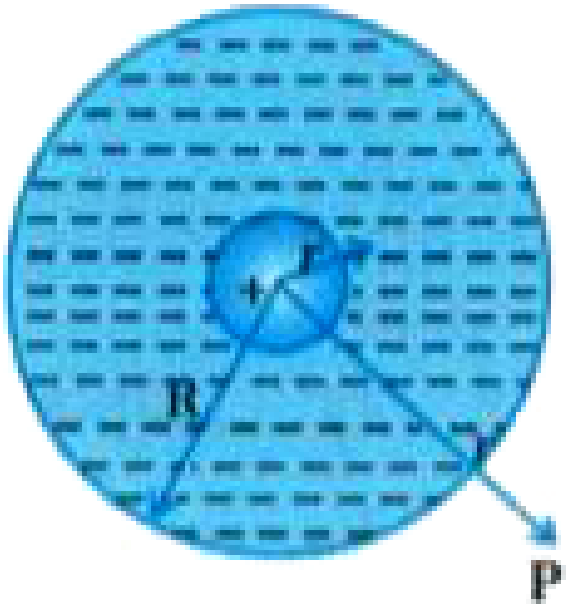
13. An early model for an atom considered it to have a positively charged point nucleus of charge Ze, surrounded by a uniform density of negative charge up to a radius R. The atom as a whole is neutral. For this model, what is the electric field at a distance r from the nucleus ?



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Exercises

1. What is the force between two small charged speres having charges of 2×10^{-7} c and 3×10^{-7} c placed 30 cm apart in air

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2. The electrostatic force on a small sphere of charge 0.4 μ c due to the distance bwtwen the

two spheres (b) what is the force on the second spere due to the first

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3. Check that the ratio ke^2 /G $m_e m_p$ is dimensionaless look up a table of physical constant and determine the value of this ratio what does the ratio signify

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4. (a) explain the menaing of the statement electric charge of a body is quantised

(b) why can one ignore quantisation of electric charge when dealing with macrosocpic large scale charges

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5. When a galss rod is rubbed with a sild cloth charges appear on both a smilar phenomenon is observeed with many other pairs of bodies

expalin how this observation is consistent with the law of conservation of charge

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6. Four point charges $q_A = 2\mu C, q_B = -5\mu C, q_c = 2\mu c$ and $q_d = -5\mu c$ are force on a charge of 1 μ c placed at the centre of the square

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7. (a) an electrostatic field line is a contiuous curve that is field line cannot have sudden breaks why not

(b) explain why two field lines never cross each other at any point

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8. Two point charges $q_A = 3\mu c$ and $q_B = -3\mu$ c are located 20 cm apart in a vacuum

(a) what is the electric field at the midpoint O of the line AB joining the two charges

(b) if a negative test charge of magnitude 1.5×10^{-9} c is placed at this point what is the force experienced by the test charge

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9. A system has two charges $q_A = 2.5 \times 10^{-7}$ c and $Q_B = -2.5 \times 10^{-7}$ c located at points a (0,0,-15 cm) and B:(0,0+15cm) respectively

what are the total charge and electric dipole moment of the system

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10. An electric dipole with dipole moment 4×10^{-9} c m is aligned at 30° calculate the magnitude of the torque acting on the dipole

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11. A polythene piece rubbed with wool is found to have a negative charge of 3×10^{-7} c

(a) estimate the number of electrons transferred (from which to which)

(b) is there a transfer of mass from woool to polythene

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12. (a) Two insulated charged copper spheres a and b have their centres separated by a

distance of 50 cm what is the nutual force of electrostatic repulsion if the charge on each is 6.5×10^{-7} c the radii of a and b negligible compared to the distance of separation

(b) what is the force of repuslion if each spere is charged double the above amount andf the distance between them is haved

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13. Suppose the spheres A and B in Exercise 1.12 have identical sizes. A third sphere of the

same size but unchanged is brought in contact with the first , then brought 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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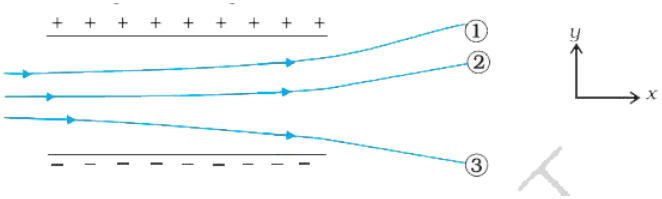
14. Track of three charged particles in a uniform electroastatic field give the sign of the three charges which particle has the

highest charge to mass ratio



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15. Consider a uniform electric field E=$3 \times 10^3 \hat{i}$ N/C (a) what is the flux of this field thriought a square of 10 cm on a side whose plane is parallel to the yz plane (b) hwhat is the flux through the same a 60°m angle with the x axis

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16. What is the net flux of the uniform electric field of exercise through a cube of side 20 cm oriented so that its faces are parallel to the coordinate planers

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

what ist the net charge inside the box (b) if the net outward flux through the surface of the box wre zero could you conclude that there were no charges inside the box why or why not

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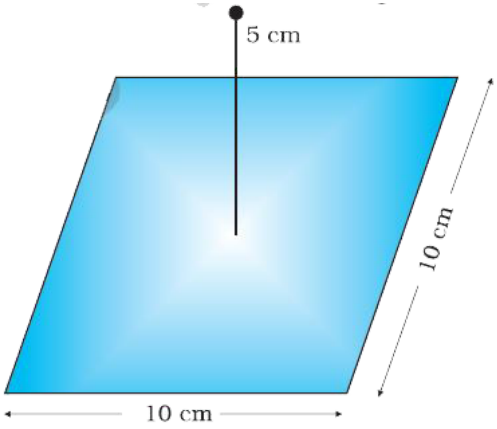
18. A point charge + μ c is a distance 5 cm directly above the centre of a square of side 10 cm as what is the magnitude of the electric

flux through the square



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19. A point charge of 2.0 μ c is at the centre of a cubic gaussian surface 9.0 cm on edge what is the net electric flux through the surface

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20. A point charge causes an elelctric flux of $-1.0 \times 10^3 N\frac{m^2}{C}$ to pass through a spherical gaussioan of 10.0 cm radius centred on the charge (a) if the radius of the gaussian surface wrere doubled how much flux would pas through the surface (b) what is the value of the point charge

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21. A conducting sphere of radius 10 cm has an unknown charge if the electric field 20 cm from the centre of the sphere is 1.5×10^3 N/C and points radialy inward what is the net charge on the sphere

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22. A uniformly charged conducting sphere of 2.4 m diameter has a (a) find the charge on the

sphere (b) what is the total eletric fluxd leaving the surface of the sphere

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

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24. Two large thin metal plates are parallel and close to each other on their inner faces the plates have surface charges densites of opposite region of the first plate (b) in the outer region of the second plate and (c) between the plates

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25. An oil drop of 12 exess electrons is held stationary under a constant eletric field of

$2.55 \times 10^4 NC^{-1}$ the density of the oil is 1.26 g cm^{-3} estimage the radius of the drop (g=9.81 m $s^{-2} e = 1.60 \times 10^{-19}$ C)

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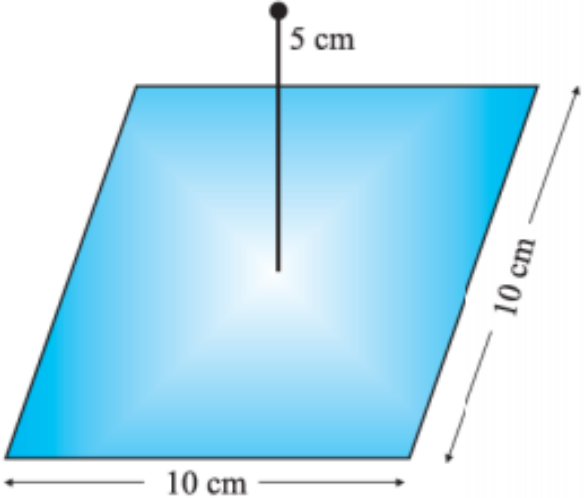
26. Which among the curves cannot possibly represent electrostatic field lines ?



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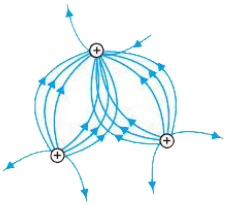
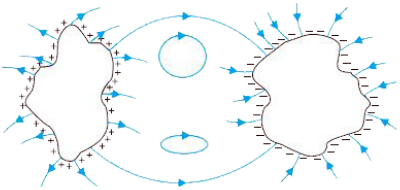


(d)



(e)

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27. In a certain region of space electric field is along the z direction throughuot the

magnitude of electric is however not constant $10^{-5}NC^{-1}$ per meter what are the force torque experienced by a system having a total dipole equal to 10^{-7} cm in the negative z direction

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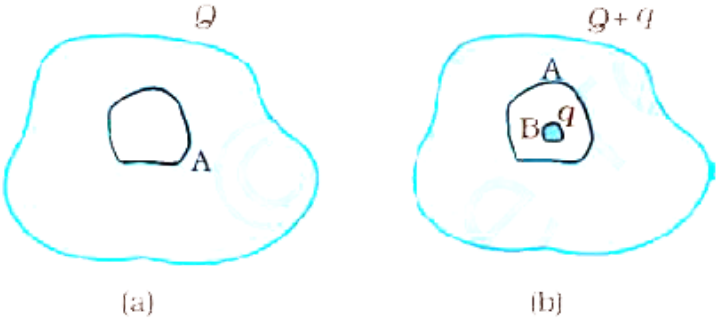
28. (a) a conductor a with a cavity given a charge Q show that the entire charge must appear on the outer surface of the conductor (b) another condluctor B with charge q is

sensitive instrument is to be shielded from the strong electrosatitic fields in its environment suggest a possible way



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29. A hollow charged conductor has a tiny hole cut in to its surface show that the electric field

in the hole is n where n is the charge density near the hole

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30. Obtain the formula for the electric field due to a long thin wire of uniform linear charge density E without using gauss law

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31. It is now established that protons and neutrons are themselves built out of more elementary units called quarks a proton and a neutron consist of three quarks each together with electrons build up ordinary matter suggest a possible quark composition of a proton and neutron

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32. (a) consider an arbitrary electrostic field configuration a small test charge is placed at a null point of the configuration show that the equailibrium of the test charge is necessarly unstable

(b) verify this result for the simple configuration of two charges of the same mangnitude and sign placed a certain distance apart

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33. A particle of mass m and charge enters the region between the two charged plates initally moving along x axis with speed v_x the length of plate is l and an uniform vertical deflectio of the particle at the far edge of the plate is $qEL^2 / 2mv_x^2$

compare this motion with motion of a projectile in gravitational field

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34. Suppose that the particle in exercise in 1.33 an electron projecrted with velocity $v_x = 2.0 \times 10^6 ms^{-1}$ if E between the paltes separted by 0.5 cm is 9.1×10^2 N/C where will the electron strike the uppear plate $\left(|e| = 1.6 \times 10^{-19} c, m_e = 9.1 \times 10^{-31} kg\right)$

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