# Electric Field and Electric Potential

U.K. Sir, T.B. Sir and R.K.D. Sir

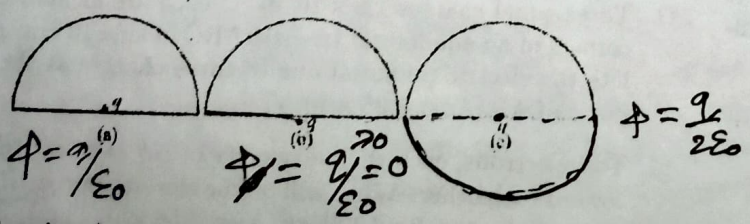
Capital College And Research Center

## Electric Field Theory

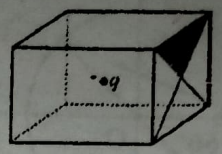
1. Draw the field lines for (a) two equal charges: (b) two equal and opposite charges.
2. what is electric flux? Find an expression for the electric field intensity due to a plane-charged conductor.
3. What is Gaussian Surface? Find the electric field intensity due to a charged sphere at a point (a) on the surface, (b) outside and (c) inside the sphere
4. State and prove Gauss's law in Electrostatics.
5. What is electrostatic shielding? Find an expression for the electric field due to a non-conducting infinite plane sheet of charge.
6. Find an expression for the electric field intensity due to a linear charge.
7. Derive an expression for electric field intensity due to infinite plane sheet of charge.
8. If an electron is released from the rest in an electric field, it starts to move from the point of lower potential to higher potential. Explain why?

## Electric Field Numerical

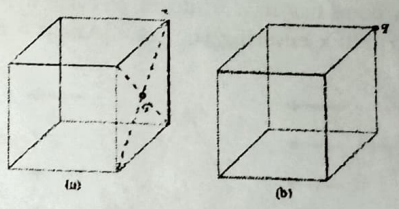
1. A hollow spherical conductor of radius 12 cm is charged to $6 \times 10^{-6}$C. Find the electric field strength at the surface of a sphere, inside the sphere at 8 cm and a distance of 15 cm from the sphere.[Ans: $3.75 \times 10^{6}$N/C, 0,7.41 $\times 10^{5}$N/C ]
2. A charged oil drop remains stationary when situated between two parallel horizontal metal plates between which there is an electric field of intensity $2 \times 10^{4}$Vm–1. If the mass of the drop is $4.\times 10^{-15}$ kg. Find the number of electrons attached to the drop.[Ans:15]
3. Find flux due to the charge q placed as shown in fig.



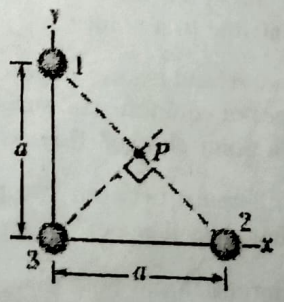

4. A point charge q is placed at the center of the cubical box. Find, (a) the total flux associated with the box (b) the flux emerging through each face of the box (c) the flux through the shaded area of surface




5. If the electric potential in a region is represented as V = 2x + 3y – 4z, obtain the expression for the electric field strength. [Ans:2i+3j+4k]
6. Two plane parallel conducting plates$1.5 \times 10^{-2}$ m apart are held horizontally one above the other in the air. The upper plate maintained a positive potential of 1.5 k volts while the other plate is earthed. Calculate the number of electrons which must be attached to a small oil drop of mass $4.9\times10^{-15}$ kg between the plates to maintain it at rest, assuming that the density of air is negligible in comparison with that of oil.[Ans:3]
7. Find flux due to a point charge q placed (a) at the center of the face (b) corner of the cubical box.



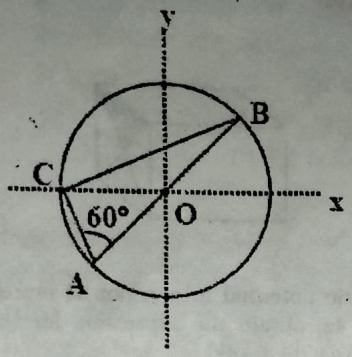

8. In Fig, the three particles are fixed in place and have charges q1=q2=+e and q3=2e. Distance a = 6.00 $\mu$ m. What are the (a) magnitude and (b) direction of the net electric field at point P due to the particles?[Ans:160N/C]




9. There charges q, 3q, and 12q are to be placed on a straight line AB having 12cm length. Two of the charges must be placed at endpoints A and Band the third charge can be placed anywhere between A and B. Find the position of

each charge if the potential energy of the system is to be minimum. In the position of minimum potential energy, what is the force on the smallest charge?

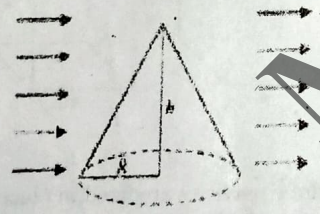
10. Consider a system of three charges q/3, q/3 and -2q/3 placed at points A, B and C, respectively, as shown in the figure. Take O to be the center of the circle of radius R. Find the electric field intensity at point O.




11. The electric field between two parallel plates is 1000.0 N/C. What acceleration would a charge of $2\mu$C and mass $10^{-3}$ kg experience if placed in this field? [ignore this weight] [Ans: $0.2ms^{-2}$]

12. A spherical conductor of radius 12 cm has a charge of $1.6 \times 10^{-7}C$ distributed uniformly on its surface. What is the electric field(a) Inside the sphere (b) Just outside the sphere (c) At a point 18 cm from the centre of the sphere? [Ans: Zero. $10^5$N/C, $4.4 \times 10^4$N/C]

13. In fig., a cone lies in a uniform electric field E. Determine the electric flux entering the cone.[Ans:$\phi = ER/h$]



## Electric Potential Theory

1. Define electric potential. Derive an expression for the potential at a point due to a point Charge

2. What do you understand by an equipotential surface? What will be the shapes of equipotential surfaces in case of a uniform field, and a point charge? Discuss.

3. The potential difference between two points in an electric field is 20V. What does it mean?

4. Define electric potential and potential gradient.

5. What do you mean by equipotential surfaces? Can two equipotential surfaces intersect? Explain.

6. What is the shape of the equipotential surface for a point charge?

7. Derive the expression for the electric potential energy.

## Electric Potential Numerical

1. Four point charges $+3\ \mu$ C, $-3\ \mu$C, $+4\ \mu$C, $-4\ \mu$C are placed at the corner of a square diagonal 0.2 m. Calculate the electric potential at the center[Ans:0V]

2. Two point charges $q_1 = 10 \times 10^{-8}$C and $q_2 = 2 \times 10^8 C$ are separated by a distance of 60cm in air. (a) What distance from the first charge $q_1$ would the electric potential be zero? (b) Also, calculate the electrostatic potential energy of the system. [Ans: 50cm,30 $\mu$ J]

3. The electric potential difference between the ground and a cloud in a particular thunderstorm is $1.2 \times 10^9$ V. What is the magnitude of the change in energy in multiples the electron volt of an electron that moves between the ground and the cloud? [Ans: 1.2 GeV]

4. Two large, parallel conducting plates are 12 cm apart and have charges of equal magnitude and opposite signs on their facing surfaces. An electrostatic force of $3.9 \times 10^{-15}$N acts on an electron placed anywhere between the two plates. (Neglect fringing.) (a) Find the electric field at the position of the electron. (b) What is the potential difference between the plates? [Ans: $2.4 \times 10^4$V, $2.9 \times 10^3$V ]

5. A regular hexagon of side 10 cm has a charge $5\mu$C at each of its vertices. Calculate the potential at the center of the hexagon. [Ans:$2.7 \times 10^6$V ]

6. Find the electric potential energy for four charges of $2\mu$C each placed at the vertices of a square of side 10 cm. [Ans: 1.9J]

7. Find the electric potential at a distance of $0.5 \times 10^{-10}$ m from the proton of the hydrogen atom.[Ans: 29V]

8. Find the electric potential energy between the proton in a hydrogen atom and an electron orbiting the proton at a radius $0.5 \times 10^{-10}$m. The proton has a charge equal to and opposite to that of the electron.[Ans: $-46 \times 10^{19}$J]

9. Calculate the potential at the center of a square of the side 2 m which carries at its four corners charges of + 2n C, + 1n C, − 2n C and − 3n C respectively.

10. Two charged particles are fixed to an x-axis: Particle 1 of charge $q_1 = 2.1 \times 10^{-8}$ C is at position x = 20 cm and particle 2 of charge $q_2 = 4.00\ q_1$ is at position x= 70 cm. At what coordinate on the axis (other than at infinity) is the net electric field produced by the two particles equal to zero?[Ans:$x = -30cm$]

11. Three equal charges $1.8 \times 10^-6V$ C each are located at the corners of an equilateral triangle ABC of side 10 cm. calculate the electric potential due to three charges at the midpoint of AB.[Ans: $8.35 \times 10^5$V]

12. Two electrons, each with a velocity of $10^6$ m/s, are released toward each other. What will be the closest approach? Mass of an electron = $9 \times 10^{-31}$ kg.[Ans: $2.56 \times 10^{-10}$ m]

13. When a charge of 3C is placed in a uniform electric field, it experiences a force of 3000N. What is the potential difference between two points separated by a distance of 1cm?[Ans:1