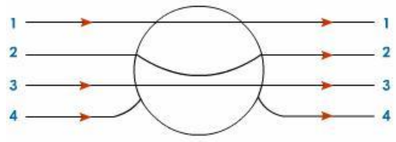
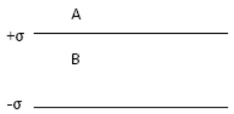
Electric Charge, Force and Field

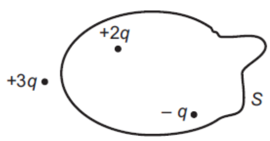
One mark

1. A glass rod is rubbed with wool, what type of charge do they acquire?
2. Name any two basic properties of electric charge.
3. What do you understand by quantization?
4. Three point charges +2q, −q and + 3q are located at three region of a body. What is the total charge of the body?
5. What does $q_1 + q_2 = 0$ signify in electrostatics?
6. The force acting between two point charges q_1 and q_2 kept at some distances apart in the air is attractive or repulsive when (i) $q_1q_q > 0$ (ii) (i) $q_1q_q < 0$.
7. Define dielectric constant of a medium. What is the value of dielectric constant for a metal?
8. How does the force between two charges change, if the dielectric constant of the medium in which they are kept, increases?
9. Name the physical quantity, whose SI unit is Newton coulomb^{-1}.
10. Write the SI unit of (i) Electric field intensity (ii) electric dipole moment.
11. Define 'electric line of force' and give its two important properties.
12. Draw the pattern of electric field around a point charge (i) $q_1 > 0$ (ii) $q_2 < 0$.
13. The electric field lines never cross each other, why?
14. An electric field lines cannot be discontinuous. Why?
15. A metallic sphere is placed in a uniform electric field as shown in fig. Which path is followed by electric field lines and why?



16. Why it is necessary that the field lines from a point charge placed in the vicinity of a conductor must be normal to the surface of the conductor at every point?
17. Sketch the field lines of force for two point charges $q_1$and q_2 for $q_1 = q_2$ and $q_1 > q_2$ separated by distance d.
18. Define electric dipole moment. Is scalars or vector quantity? What is SI unit?
19. What is the angle between the directions of electric field at any point (i) axial point (ii) equatorial point.
20. Define electric flux.
21. Electric flux is a scalar or vector?
22. State Gauss law of electrostatics.
23. Two plane sheet s of charge densities +σ and – σ are kept in air as shown in figure . What are the electric field intensities at points A and B?

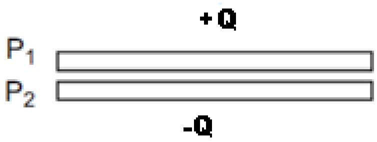




24. Figure shows three point charges +2q, −q and + 3q. Two charges + 2q and −q are enclosed within a surface 'S'. What is the electric flux due to this configuration through the surface 'S'?
25. An electric dipole of dipole moment 20×10^{-6} Cm is enclosed by a closed surface. What is the net flux coming out of the surface?

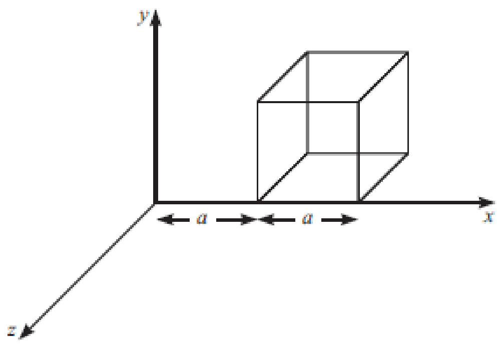
Two marks

1. State the law of conservation of charge. Give two examples to illustrate it.
2. State Coulomb’s law in vector form. Write its significance.
3. Figure shows two large metal plates P_1 and P_2, tightly held against each other and placed between two equal and unlike point charges perpendicular to the line joining them.
   (i) What will happen to the plates when they are released?



   (ii) Draw the pattern of the electric field lines for the system.

4. The electric field E due to a point charge at any point near it is defined as $\vec{E} = \lim_{q \to 0} \frac{\vec{F}}{q}$, where q is the test charge and F is the force acting on it. What is the physical significance of $\lim_{q \to 0}$ in this expression? Draw the electric field lines of a point charge Q when (i) Q > 0 and (ii) Q < 0.
5. State principle of superposition of electrostatic force.
6. Lists properties of electric field lines.
7. Derive an expression for the torque acting on an electric dipole, which is held in a uniform electric field, when the axis of the dipole makes an angle θ with the electric field.
8. Define electric flux. Write its S.I. Units. A spherical rubber balloon carries a charge that is uniformly distributed over its surface. As the balloon is blown up and increases in size, how does the total electric flux coming out of the surface change? Give reason.
9. Using Gauss’s law derive an expression for the electric field intensity at any point near a uniformly charged thin wire of charge/length C/m.
10. Derive an expression for the torque acting on an electric dipole, which is held in a uniform electric field, when the axis of the dipole makes an angle θ with the electric field.
11. Define the term ‘electric dipole moment.’ Is it scalar or vector?
12. Deduce an expression for the electric field at a point on the equatorial plane of an electric dipole of length 2*a*.
13. Plot a graph showing the variation of Coulomb force (*F*) versus $1/r^2$, where *r* is the distance between the two charges of each pair of charges: (1 μC, 2 μC) and (2 μC , – 3 μC). Interpret the graphs obtained.
14. Draw a plot showing the variation of (*i*) electric field (E) and (*ii*) electric potential (V) with distance *r* due to a point charge *Q*.
15. An electric dipole is held in a uniform electric field.
   (*i*) Show that the net force acting on it is zero.
   (*ii*) The dipole is aligned parallel to the field. Find the work done in rotating it through the angle of 180°
15. State Gauss’s law in electrostatic. A cube with each side ‘*a*’ is kept in an electric field given by $\vec{E} = c\hat{i}$, (as is shown in the figure) where *C* is a positive dimensional constant. Find out (*i*) the electric flux through the cube, and
   (*ii*) the net charge inside the cube



Three marks

1. A thin conducting spherical shell of radius R has charge Q spread uniformly over its surface. Using Gauss's law, derive an expression for an electric field at a point outside the shell. Draw a graph of electric field $E(r)$ with distance r from the centre of the shell for $0 \le r \le \infty$.
2. State Gauss's law in electrostatics. Using this law derive an expression for the electric field due to a uniformly charged infinite plane sheet.
3. State Gauss' law in electrostatics. Use this law to derive an expression for the electric field due to an infinitely long straight wire of linear charge density λ Cm^{-1}.
4. What is electric flux? Write its S.I. units. Using Gauss's theorem, deduce an expression for the electric field at a point due to a uniformly charged infinite plane sheet.
5. State Gauss theorem. Obtain an expression for coulomb's law using it.
6. Derive an expression for torque on a dipole in a uniform electric field.
7. Deduce an expression for electric field due a short electric dipole on (i) end-on-position or axial line or TanA -position(ii) broad-side –on position or equatorial line or TanB positon
8. State Gauss's theorem of electrostatics. Derive an expression for electric field intensity at a point near a thin infinite plane sheet of uniformly charged density σ C/m^2 .
9. State Gauss's theorem of electrostatics. Using this theorem, prove that no electric field exists inside a hollow charged conducing sphere.

Numerical

1. Two identical charges, Q each, are at a distance r from each other. A thirds charge q is placed on the line joining the above two charges such that all the three charges are in equilibrium. What is the magnitude, sign and position of the charge q?
2. A charge q is placed at the centre of the line joining two equal charges Q. Show that the system of three will be in equilibrium if q= - Q/4.

5 marks

1. (a) Using Gauss' law, derive an expression for the electric field intensity at any point outside a uniformly charged thin spherical shell of radius *R* and charge density σ C/m^2. Draw the field lines when the charge density of the sphere is (i) positive, (ii) negative.

   (b) A uniformly charged conducting sphere of 2.5 m in diameter has a surface charge density of 100 $\mu C/m^2$. Calculate the
   (i) Charge on the sphere
   (ii) Total electric flux passing through the sphere
2. **(a)** Derive an expression for the torque experienced by an electric dipole kept in a uniform electric field.
   (b) Calculate the work done to dissociate the system of three charges placed on the vertices of a triangle as shown. Here $q = 1.6 \times 10^{-10}$C
3. (*a*) Define electric flux. Write its S.I. units.
   (*b*) Using Gauss's law, prove that the electric field at a point due to a uniformly charged infinite plane sheet is independent of the distance from it.
   (*c*) How is the field directed if (*i*) the sheet is positively charged, (*ii*) negatively charged?
4. (a) Define electric dipole moment. Is it a scalar or a vector? Derive the expression for the electric field of a dipole at a point on the equatorial plane of the dipole.
   (b) Draw the equipotential surfaces due to an electric dipole. Locate the points where the potential due to the dipole is zero.
5. Using Gauss' law deduce the expression for the electric field due to a uniformly charged spherical conducting shell of radius R at a point
   (i) outside and (ii) inside the shell.
   Plot a graph showing variation of electric field as a function of r > R and r < R.
   (r being the distance from the centre of the shell)