## ELECTROSTATIC FORCE AND ELECTROSTATIC FIELD

### VERY SHORT ANSWER QUESTIONS

1. Everyone is made from billions of electrons and protons. Why do we not feel on electrical force of attraction or repulsion when we approach other people or objects?
2. What would be special about an object carrying a charge of $5.34 \times 10^{-20}$ coulomb?
3. What is the electric field intensity at a point inside a uniformly charged rubber balloon?
4. How does the force between two point charges change, if the dielectric constant of the medium in which they are kept decreases?
5. Can two balls, both carrying same type of charge, be attracted to each other?
6. A point charge $q$ is placed at the origin. How does the electric field due to the charge vary with distance $r$ from the origin?
7. What is the direction of electric dipole moment vector of an electric dipole?
8. State Coulomb's law is electrostatics.
9. What is the relation between electric field strength and force?
10. Draw lines of force to represent a uniform electric field.
11. Give two examples of conservative forces in nature.
12. Define electric field at a point.
13. Force between two point electric charges kept a distance $d$ apart in air is $F$. If these charges are kept at the same distance in water, how does the force between them change?
14. Two equal and opposite point charges are separated by a certain distance. What are the points at which the resultant field is parallel to the line joining the two charges?
15. Dielectric constant of water is 80. What is its permittivity?
16. Define dielectric constant of a medium in terms of force between two electric charges.
17. What is the dielectric constant of a metal?
18. Name the physical quantity whose SI unit is $N\cdot C^{-1}$.
19. Name the experiment which established quantum nature of electric charge.
20. How is force between two charges affected when dielectric constant of the medium in which they are placed increases?
21. Four charges of same magnitude and same sign are placed at the corners of a square, of each side 0.1 m. What is electric field intensity at the centre of the square?
22. How does a torque affect the dipole in an electric field?
23. Define electric field intensity at a point.
24. Why does an ebonite rod get negatively charged on rubbing with fur?
25. Two point charges of $+3$ µC each are 100 cm apart. At what point on the line joining the charges will the electric intensity be zero?
26. State the principle of superposition of forces in electrostatics.
27. What is the net force on an electric dipole placed in a uniform electric field?
28. What does $q_1 + q_2 = 0$ signify in electrostatics?
29. What is the basic cause of quantization of charge?
30. Given two point charges $q_1$ and $q_2$ such that the $q_1q_2<0$. What is the nature of the force between them?
31. Is torque on an electric dipole a vector or scalar?
32. In Coulomb’s law, on what factors the value of electrostatic force constant K depends?
33. Give the SI unit of electric permittivity of free space.
34. Does motion of a body affect its charge?
35. Two point charges \( q_2 \) and \( q_1 \) are such that \( q_1 q_2 > 0 \). What is the nature of the force between the two charges?
36. When is an electric dipole in unstable equilibrium in an electric field?
37. When a glass rod is rubbed with silk cloth, the glass acquires a charge of \( 1.6 \times 10^{-13} \) C. What is the charge on the silk cloth?
38. Write the SI unit of charge.
39. What is meant by conservation of charge?
40. Define electric dipole moment. Is it a scalar or a vector quantity?
41. How mass of a body is affected on charging?
42. What is the angle between the directions of electric field at any (i) axial point and (ii) equatorial point due to an electric dipole?

**SHORT ANSWER QUESTIONS**

1. Three charges \(-q, -q\) and \(2q\) are placed at the vertices of an equilateral triangle of each side \(l\). What is the dipole moment of the system?
2. A body A repels another body B, A attracts body C, C repels body D. It is given that body D is positively charged. What is the charge on body B?
3. If \(10^{14}\) electrons are removed from a metal sphere, what will be the charge on the sphere?
4. What is the force of repulsion between two charges of 1 C each, kept 1 m apart in vacuum?
5. Why do experiments with frictional charging work best in very dry weather? Plastics work best for these experiments since they are water-repelling.
6. A plastic comb run through one’s dry hair attracts small bits of paper. Why? What happens if the hair is wet or if it is raining?
7. A charged particle is free to move in an electric field. Will it always move along an electric line of force?
8. Give two properties of electric lines of force. Sketch them for an isolated positive charge.
9. Calculate the Coulomb force between two protons separated by a distance of \(1.6 \times 10^{-5}\) m.
10. Calculate the charge carried by \(1.25 \times 10^{18}\) electrons.
11. Calculate the Coulomb force between 2 \(\alpha\) particles separated by \(3.2 \times 10^{-15}\) m.
12. What kind of charges are produced on each when (i) a glass rod is rubbed with silk and (ii) an ebonite rod is rubbed with wool?
13. Sketch the electric lines of force due to point charges (i) \(q > 0\) (ii) \(q < 0\).
14. If the distance between two equal point charges is doubled and their individual charges are also doubled, what would happen to the force between them?
15. What is meant by the statement that the electric field of a point charge has spherical symmetry whereas that of an electric dipole is cylindrically symmetrical?
16. An ebonite rod held in hand can be charged by rubbing with flannel but a copper rod cannot be charged like this. Why?
17. What is an electric line of force? What is its importance?
18. Vehicles carrying inflammable material usually have metallic ropes touching the ground during motion. Why?
19. What orientation of an electric dipole in a uniform electric field corresponds to stable equilibrium?

20. What is the dimensional formula for \( \varepsilon_0 \)?

21. Give two points of distinction between charge and mass.

22. How many electrons make up one coulomb of negative charge?

23. What do you mean by quantization of electric charge? Explain.

24. The bob of a simple pendulum is a small metal ball of mass \( m \). When it oscillates between the two uncharged plates of a parallel plate capacitor, its time period is \( T \). What would be the effect on the time period if the metal ball is given a positive charge and the capacitor is charged as shown in Fig?

\[
\begin{array}{c}
\text{+} \quad \text{+} \quad \text{+} \quad \text{+} \quad \text{+} \quad \text{+} \quad \text{+} \quad \text{+} \\
\text{E} \\
\text{+q} \\
\text{mg} \\
\text{qE} \\
\end{array}
\]

25. In the previous question, what would be the effect on time period if the upper plate is negatively charged and the lower plate is positively charged?

\[
\begin{array}{c}
\text{+} \quad \text{+} \quad \text{+} \quad \text{+} \quad \text{+} \quad \text{+} \quad \text{+} \quad \text{+} \\
\text{E} \\
\text{+q} \\
\text{mg} \\
\text{qE} \\
\end{array}
\]

26. In the previous question, if the capacitor plates are repositioned as shown in Fig , then what will be the time period?

CONCEPTUAL PROBLEMS

1. Define electric field \( E \) at a point in space due to a distribution of charges. A point charge \( q \) is placed at the origin. How does the electric field due to the charge vary with distance \( r \) from the origin? A sphere of radius \( R \) with a total charge \( Q \) on it is placed with its center at the origin. How does its electric field vary with distance \( r \) from the origin?

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

3. A block of mass \( m \) carrying charge \( q \) is placed on a frictionless horizontal surface. The block is connected to a rigid wall through an unstressed spring of spring constant \( k \). A horizontal uniform electric field \( E \) parallel to the spring is switched on. Find the amplitude of the resulting simple harmonic motion of the block.
4. The electrostatic force between two protons situated at a distance $x$ from each other is $y$ newton. What will be the electrostatic force between two electrons situated at the same distance?

5. A charge placed at a certain distance on the axial line of an electric dipole experiences a force of 16 newton. What will be the force on the charge if the distance of the charge is doubled?

6. How must an electric dipole be placed in a uniform electric field so that it experiences maximum torque? What is the value of the maximum torque?

7. Two identical metallic spheres of exactly equal masses are taken. One is given a positive charge $Q$ coulomb and the other an equal negative charge by friction. Are their masses after charging equal?

8. What is the nature of symmetry of the dipole field?

9. The distance of the field point on the equatorial plane of a small electric dipole is halved. By what factor will the electric field due to the dipole change?

LONG ANSWER QUESTIONS

1. Explain the properties of electric lines of force.

2. Derive an expression for electric field intensity at a point on the axial line of an electric dipole.

3. Explain the term Electrostatic shielding.

4. Prove that electric field intensity is independent of the distance from an infinite sheet of charges.

5. State Coulomb’s law. Derive definition of a unit charge (coulomb) from it.

6. Obtain an expression for the torque on an electric dipole in a uniform electric field and give its unit.

7. Find out electric field strength at any point on any line of an electric dipole. Hence, find out electric field on (i) axial line (ii) equatorial line.

8. Define the term electric field intensity. Write its SI unit. Derive an expression for the electric field intensity at a point on the axis of an electric dipole.