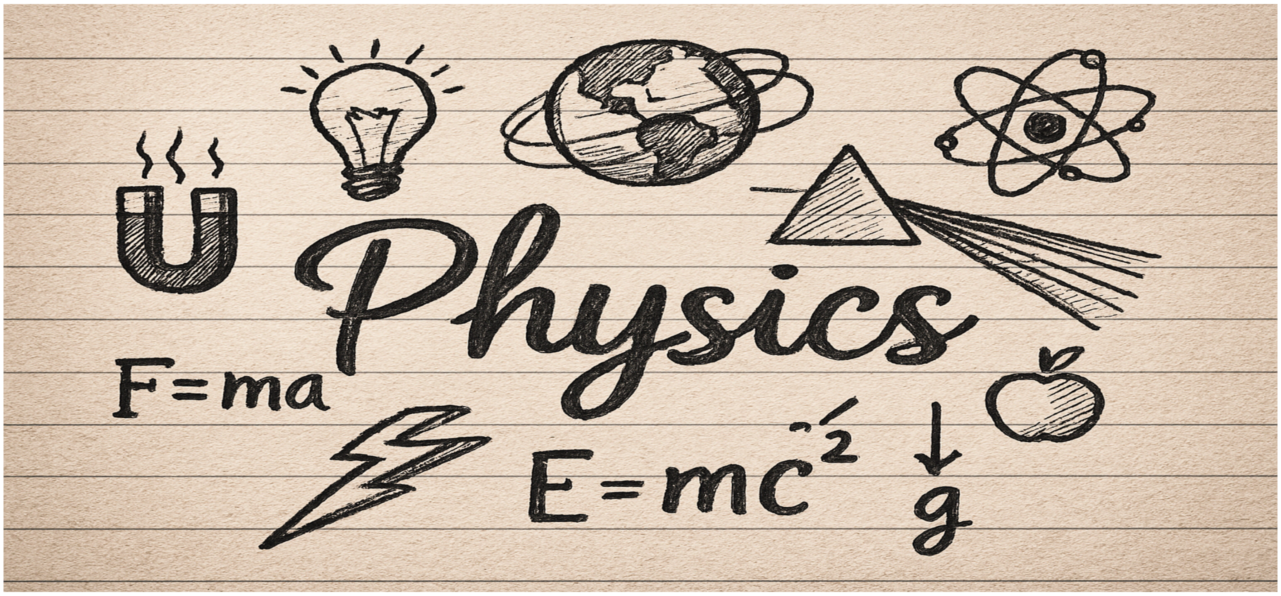

Class: 12th

Subject: Physics

Chapter 12: ELECTROSTATICS

🩸 Important MCQs (Form Keypoints)

1. Coulomb's law states that the electrostatic force between two point charges is:

(a) Directly proportional to distance

(b) Inversely proportional to distance

(c) Directly proportional to product of charges and inversely proportional to square of distance ✅

(d) Independent of distance

2. Electric field intensity at a point is defined as:

(a) Force per unit mass

(b) Force per unit charge ✅

(c) Potential per unit charge

(d) Energy per unit charge

3. Electric flux through a surface is:

(a) Total number of charges on surface

(b) Number of field lines passing through a surface ✅

(c) Work done on a unit charge

(d) Electric potential

4. Electric flux through a vector area A in a field of intensity E is:

(a) Φ = E / A

(b) Φ = EA cosθ ✅

(c) Φ = E + A

(d) Φ = E^2A

5. Gauss's law states that:

(a) Flux through a surface depends on shape only

(b) Flux through any closed surface is zero

(c) Flux through any closed surface = $1/\varepsilon_0$ * total enclosed charge ✅

(d) Flux is inversely proportional to charge

6. Inside a hollow charged metal sphere, the electric field is:

(a) Maximum

(b) Zero ✅

(c) Variable

(d) Equal to surface charge

7. Electric intensity between two oppositely charged parallel plates is:

(a) $E = Q / \varepsilon_0$

(b) $E = \sigma / \varepsilon_0$ ✅

(c) $E = V / Q$

(d) $E = 1 / Q$

8. Electric potential at a point is:

(a) Work done per unit mass

(b) Work done per unit positive charge in bringing it from infinity ✅

(c) Force per unit charge

(d) Electric field intensity

9. Capacitance of a capacitor measures:

(a) Work done in charging it

(b) Electric field between plates

(c) Ability to store charge ✅

(d) Potential difference

10. Capacitance of a parallel plate capacitor is:

(a) C = Q / V ✅

(b) C = V / Q

(c) C = Q * V

(d) $C = V^2 / Q$

🩸 Important MCQs:

1. The force between two point charges is:

(a) Attractive only

(b) Repulsive only

(c) Attractive or repulsive both ✅

(d) Zero

2. According to Coulomb's law, force is inversely proportional to:

(a) r

(b) r^2 ✅

(c) r^1

(d) √r

3. Coulomb's constant k in free space is:

(a) 8.85×10^{-12}

(b) 9×10^9 ✅

(c) 3×10^8

(d) 1.6×10^{-19}

4. The SI unit of electric charge is:

(a) Volt

(b) Newton

(c) Coulomb ✅

(d) Ampere

5. Opposite charges exert a force that is:

(a) Repulsive

(b) Attractive ✅

(c) Zero

(d) Constant

6. The permittivity of free space (ε_0) is:

(a) 8.85×10^{-12} ✅

(b) 9×10^{9}

(c) 1.6×10^{-19}

(d) 3×10^{8}

7. The electric force acts along:

(a) A curved line

(b) A tangent

(c) Line joining the charges ✅

(d) A circle

8. Relative permittivity of air is:

(a) 0.1

(b) 1.0006 ✅

(c) 2.5

(d) 0.5

9. Force between charges decreases when:

(a) Distance decreases

(b) Charge increases

(c) A dielectric is inserted between charges ✅

(d) No medium

10. Coulomb's law was discovered by:

(a) Faraday

(b) Coulomb ✅

(c) Ampere

(d) Ohm

11. Like charges exert a force which is:

(a) Attractive

(b) Repulsive ✅

(c) Zero

(d) Irregular

12. In a medium, electric force becomes:

(a) Greater

(b) Smaller than free space ✅

(c) Zero

(d) Constant

13. Coulomb's law is:

(a) $F = q_1 + q_2$

(b) $F = k (q_1 q_2) / r^2$ ✅

(c) $F = k r^2$

(d) $F = q_1 q_2$

14. If distance becomes double, force becomes:

(a) Same

(b) Twice

(c) Half

(d) One-fourth (¼) ✅

15. The force on charge q_1 due to q_2 is:

(a) Different in magnitude

(b) Same direction

(c) Equal and opposite ✅

(d) Zero

16. The concept of the electric field was introduced by:

(a) Coulomb

(b) Newton

(c) Michael Faraday ✅

(d) Ampere

17. Electric field exists around a charge:

(a) Only when test charge is present

(b) Only when medium is vacuum

(c) Even if no other charge is present ✅

(d) Only when charge moves

18. Electric field intensity E is defined as:

(a) Force × charge

(b) Charge ÷ force

(c) Force per unit charge ✅

(d) Charge per unit distance

19. The SI unit of electric field intensity is:

(a) Coulomb per meter

(b) Newton

(c) Newton per coulomb (N/C) ✅

(d) Coulomb per second

20. The electric field direction is:

(a) Opposite to force

(b) Same as the force on a positive test charge ✅

(c) Same as force on a negative test charge

(d) Opposite to test charge direction

21. Electric field lines were first introduced by:

(a) Coulomb

(b) Newton

(c) Michael Faraday ✅

(d) Ampere

22. Electric field lines around a positive charge +q are directed:

(a) Tangential

(b) Circular

(c) Radially outward ✅

(d) Radially inward

23. Electric field lines around a negative charge −q are directed:

(a) Outward

(b) Curved upward

(c) Radially inward ✅

(d) Circular

24. Electric field lines are closer to each other near the charge because:

(a) Field is weak

(b) Field is uniform

(c) Field is strong ✅

(d) Field is zero

25. "The number of lines per unit area passing perpendicular through an area is proportional to":

(a) Charge

(b) Force

(c) Electric field strength ✅

(d) Potential difference

26. Two identical positive charges produce field lines that:

(a) Attract each other

(b) Repel each other ✅

(c) Merge together

(d) Form a uniform field

27. The neutral zone (zero field spot) appears between:

(a) Positive & negative charges

(b) Two identical positive charges ✅

(c) A charge and a conductor

(d) A charge and an insulator

28. Field lines between plates of a parallel plate capacitor are:

(a) Circular

(b) Random

(c) Converging

(d) Straight, parallel and equally spaced ✅

29. Two field lines never cross each other because:

(a) Lines disappear on crossing

(b) Field becomes zero

(c) E-field can have only one direction at a point ✅

(d) Forces become equal

30. In xerography (photocopier), selenium works as:

(a) Conductor in both light & dark

(b) Insulator in both light & dark

(c) Photoconductor – insulator in dark, conductor in light ✅

(d) Superconductor

31. Electric flux through an area is:

(a) Number of field lines passing through the area ✅

(b) Electric potential

(c) Electric charge

(d) Electric intensity

32. Electric flux is maximum when the area is:

(a) Parallel to field lines

(b) Perpendicular to field lines ✅

(c) Inclined at 45°

(d) Zero

33. Electric flux is zero when the area is:

(a) Perpendicular to field lines

(b) Parallel to field lines ✅

(c) Inclined at 30°

(d) Random

34. The formula for electric flux through an area inclined at angle θ to field lines is:

(a) Φ = E × A

(b) Φ = E × A × cos θ ✅

(c) Φ = E × A × sin θ

(d) Φ = E / A

35. Electric flux is a:

(a) Vector quantity

(b) Scalar quantity ✅

(c) Tensor

(d) Pseudo vector

36. SI unit of electric flux is:

(a) N / C

(b) $N \cdot m^2 / C$ ✅

(c) C / m^2

(d) Volt

37. Total electric flux through a closed surface enclosing a charge q is:

(a) $q \times \varepsilon_0$

(b) q / ε_0 ✅

(c) Zero

(d) Depends on shape

38. Total flux through a closed surface:

(a) Depends on shape

(b) Is independent of shape ✅

(c) Depends on geometry

(d) Always zero

39. If a closed surface is divided into n small patches ΔA_1, ΔA_2, ... ΔA_n, total flux is:

(a) $\Phi = \Sigma E_i \times \Delta A_i$ ✅

(b) $\Phi = E \times A$

(c) $\Phi = E / A$

(d) $\Phi = 0$

40. Electric flux through a closed surface depends on:

(a) Shape of the surface only

(b) Charge enclosed and medium ✅

(c) Area only

(d) Nothing

41. Gauss's law states that the flux through any closed surface is:

(a) Equal to the total charge enclosed

(b) $1 / \varepsilon_0$ times the total charge enclosed ✅

(c) Zero always

(d) Depends on shape of surface

42. The total electric flux through a closed surface enclosing charges q_1, q_2, q_3... q_n is:

(a) $\Phi = q / \varepsilon_0$

(b) $\Phi = \Sigma q_i / \varepsilon_0$ ✅

(c) $\Phi = E \times A$

(d) $\Phi = 0$

43. A hollow conducting sphere with charge q has the electric field inside it:

(a) Maximum at center

(b) Zero ✅

(c) Uniform

(d) Depends on radius

44. The phenomenon of shielding inside a hollow metal sphere is due to:

(a) Gauss's law ✅

(b) Coulomb's law

(c) Faraday's law

(d) Ohm's law

45. Electric intensity E due to an infinite sheet of uniform charge σ is:

(a) $E = \sigma / \varepsilon_0$

(b) $E = \sigma / 2\varepsilon_0$ ✅

(c) $E = 2\sigma / \varepsilon_0$

(d) $E = 0$

46. The direction of electric field due to an infinite sheet of charge is:

(a) Along the sheet

(b) Normal to the sheet ✅

(c) Tangential

(d) Random

47. For two oppositely charged parallel plates, the electric field between the plates is:

(a) Zero

(b) Uniform ✅

(c) Maximum near edges

(d) Varies linearly

48. The field between two parallel plates points:

(a) From negative to positive plate

(b) From positive to negative plate ✅

(c) Randomly

(d) Zero

49. Surface charge density σ on a plate is defined as:

(a) q / V

(b) q / A ✅

(c) E / A

(d) q × A

50. Inside a hollow metal plate of parallel plates setup, the electric field is:

(a) Zero ✅

(b) Maximum

(c) Uniform but not zero

(d) Varies with distance

51. The flux through the curved surface of a cylindrical Gaussian surface around an infinite sheet is:

(a) Maximum

(b) Zero ✅

(c) Depends on radius

(d) Depends on height

52. Gauss's law is useful to calculate electric intensity because:

(a) It measures charge directly

(b) Flux through simple surfaces can be easily evaluated ✅

(c) Field lines disappear

(d) Charge is zero

53. Gaussian surface is an imaginary closed surface:

(a) That passes through the point where field is to be evaluated ✅

(b) That encloses no charge

(c) That is always spherical

(d) That is always cylindrical

54. Electric field due to an infinite plane sheet is independent of:

(a) Surface charge density

(b) Distance from the sheet ✅

(c) Area of sheet

(d) Medium

55. Total flux through any closed surface enclosing a charge is independent of:

(a) Medium

(b) Shape of surface ✅

(c) Charge enclosed

(d) None of the above

56. Electric potential difference between two points A and B is defined as:

(a) Work done per unit charge in moving a positive charge from B to A

(b) Work done per unit charge in moving a positive charge from A to B ✅

(c) Force experienced by a charge

(d) Charge per unit work

57. The unit of electric potential is:

(a) Newton

(b) Joule

(c) Volt ✅

(d) Coulomb

58. One volt is equal to:

(a) 1 joule × 1 coulomb

(b) 1 joule / 1 coulomb ✅

(c) 1 coulomb / 1 joule

(d) 1 newton / 1 coulomb

59. Electric potential at a point in an electric field is defined with respect to:

(a) Zero potential at infinity ✅

(b) Zero potential at the source charge

(c) Maximum potential in the field

(d) Any random point

60. Electric potential and electric potential difference are:

(a) Vectors

(b) Scalars ✅

(c) Equal to field intensity

(d) Always zero

61. Electric intensity E between two parallel plates is related to potential difference ΔV and distance d as:

(a) $E = \Delta V \times d$

(b) $E = \Delta V / d$ ✅

(c) $E = d / \Delta V$

(d) $E = \Delta V + d$

62. The negative sign in $E = -\Delta V / \Delta r$ indicates:

(a) E points along increasing potential

(b) E points along decreasing potential ✅

(c) Magnitude of field

(d) Charge is negative

63. Potential gradient is defined as:

(a) $\Delta V \times \Delta r$

(b) $\Delta V / \Delta r$ ✅

(c) $E \times r$

(d) Force per unit charge

64. The potential at a point due to a point charge q at distance r is:

(a) $V = q / (4\pi\varepsilon_0 r^2)$

(b) $V = q / (4\pi\varepsilon_0 r)$ ✅

(c) $V = q \times r$

(d) $V = 4\pi\varepsilon_0 q / r$

65. Work done in moving a charge q from A to B is related to potential difference ΔV as:

(a) $W = q + \Delta V$

(b) $W = q \times \Delta V$ ✅

(c) $W = \Delta V / q$

(d) $W = q / \Delta V$

66. If a positive charge moves in the direction of electric field without external force, its potential energy:

(a) Increases

(b) Decreases ✅

(c) Remains same

(d) Becomes zero

67. 1 electron-volt (1 eV) is defined as:

(a) Energy acquired by 1 coulomb through 1 volt

(b) Energy acquired by 1 electron through 1 volt ✅

(c) Energy lost by 1 proton through 1 volt

(d) Energy per joule

68. 1 eV is equal to:

(a) 1.6×10^{-19} J ✅

(b) 1.6×10^{-16} J

(c) 1.6×10^{-20} J

(d) 1.6×10^{-18} J

69. A particle with charge 2e falls through a potential difference of 3 V. Energy acquired is:

(a) 3 eV

(b) 6 eV ✅

(c) 1.5 eV

(d) 9 eV

70. Electron volt is a:

(a) Unit of charge

(b) Unit of energy ✅

(c) Unit of potential

(d) Unit of field intensity

71. Electrostatic force between two charges is:

(a) Always attractive

(b) Always repulsive

(c) Can be attractive or repulsive ✅

(d) None of these

72. Gravitational force between two masses is:

(a) Attractive only ✅

(b) Repulsive only

(c) Attractive or repulsive

(d) Zero

73. Coulomb's law and Newton's law of gravitation are similar because:

(a) Both depend on square of distance ✅

(b) Both are vector quantities only

(c) Both are repulsive

(d) Both are medium-independent

74. Electrostatic force is much stronger than gravitational force because:

(a) $G \gg 1/(4\pi\varepsilon_0)$

(b) $1/(4\pi\varepsilon_0) \gg G$ ✅

(c) Charges are smaller than masses

(d) Charges are heavier than masses

75. The charge on an electron was measured using:

(a) Rutherford scattering

(b) Millikan oil drop experiment ✅

(c) Photoelectric effect

(d) Faraday's experiment

76. In Millikan's experiment, a droplet is suspended when:

(a) Gravitational force > electric force

(b) Gravitational force < electric force

(c) Gravitational force = electric force ✅

(d) No force acts

77. The formula to calculate the charge on a droplet in Millikan experiment is:

(a) $q = mg / V$

(b) $q = mg \times d / V$ ✅

(c) $q = V / mg$

(d) q = mg × V × d

78. The minimum value of charge measured by Millikan is:

(a) 1.6×10^{-19} C ✅

(b) 9.8×10^{-19} C

(c) 1.6×10^{-16} C

(d) 9.8×10^{-20} C

79. Capacitance C of a capacitor is defined as:

(a) C = V / Q

(b) C = Q × V

(c) C = Q / V ✅

(d) C = Q + V

80. SI unit of capacitance is:

(a) Volt

(b) Coulomb

(c) Farad ✅

(d) Joule

81. Capacitance of a parallel plate capacitor depends on:

(a) Area of plates

(b) Separation between plates

(c) Medium between plates

(d) All of the above ✅

82. When a dielectric is inserted between plates of a charged capacitor connected to a battery, the capacitance:

(a) Decreases

(b) Increases ✅

(c) Remains same

(d) Becomes zero

83. Dielectric constant ε_r is defined as:

(a) C / C_0 ✅

(b) C_0 / C

(c) V / Q

(d) Q / V

84. Polarization of a dielectric in a capacitor causes:

(a) Increase in E between plates

(b) Decrease in surface charge density on plates ✅

(c) Removal of charges on plates

(d) No effect

85. In a polarized dielectric, the molecules behave as:

(a) Free charges

(b) Dipoles ✅

(c) Only positive charges

(d) Only negative charges

86. The energy stored in a capacitor is given by:

(a) E = C / V

(b) $E = 1/2 * C * V^2$ ✅

(c) E = Q * V

(d) E = V / C

87. The average potential difference while charging a capacitor is:

(a) V

(b) 1/2 * V ✅

(c) 2V

(d) 0

88. Energy stored in a capacitor can also be considered as:

(a) Kinetic energy of charges

(b) Potential energy of electric field between plates ✅

(c) Gravitational potential energy

(d) None of these

89. In an RC circuit, the capacitor:

(a) Charges instantly

(b) Charges gradually over time ✅

(c) Does not charge

(d) Discharges instantly

90. The maximum charge a capacitor attains in an RC charging circuit is:

(a) q = C / V

(b) q = C * V ✅

(c) q = 1/2 * C * V

(d) q = 2 * C * V

91. The time constant (τ) of an RC circuit is defined as:

(a) R + C

(b) R / C

(c) R * C ✅

(d) 1 / (R*C)

92. After a time equal to one time constant, a charging capacitor attains approximately:

(a) 0.37 of q_0

(b) 0.63 of q_0 ✅

(c) q_0

(d) 1.5 q_0

93. Smaller RC values in a charging circuit result in:

(a) Slower charging

(b) Faster charging ✅

(c) No effect

(d) Capacitor cannot charge

94. During discharging of a capacitor through a resistor, the charge on the capacitor:

(a) Increases

(b) Decreases gradually to zero ✅

(c) Remains constant

(d) Increases then decreases

95. Smaller RC values in a discharging circuit cause:

(a) Slower discharge

(b) Faster discharge ✅

(c) No change

(d) Capacitor retains charge permanently

🩸 Important Short Questions (Form Keypoints)

1. What is Coulomb's law?

Answer:

👉 Coulomb's law states that the force between two point charges is directly proportional to the product of their charges and inversely proportional to the square of the distance between them.

2. Define electric field intensity.

Answer:

👉 Electric field intensity is the force experienced per unit positive charge at a point in the field.

3. What is electric flux?

Answer:

👉 Electric flux is the number of electric field lines passing through a surface.

4. Give the formula for electric flux through a vector area.

Answer:

👉 Electric flux through vector area A is given by $\Phi = E \cdot A = EA \cos \theta$, where θ is the angle between field lines and the normal to the surface.

5. State Gauss's law.

Answer:

👉 Gauss's law states that the electric flux through any closed surface is equal to the total charge enclosed divided by ε_0.

6. What is the electric field inside a hollow charged sphere?

Answer:

👉 The electric field inside a hollow charged metal sphere is zero; it is a field-free region.

7. Give the formula for electric intensity between two parallel plates.

Answer:

👉 The electric intensity between two oppositely charged parallel plates is $E = \sigma / \varepsilon_0$, where σ is surface charge density.

8. Define electric potential.

Answer:

👉 Electric potential at a point is the work done in bringing a unit positive charge from infinity to that point.

9. What is capacitance?

Answer:

👉 Capacitance is the ability of a capacitor to store charge per unit potential difference, $C = Q / V$.

10. How does dielectric increase the capacitance of a capacitor?

Answer:

👉 Dielectric polarizes in an electric field, reducing effective field and increasing capacitance: $C = \varepsilon_r C_0$.

🩸 Important Short Questions:

1. Define Coulomb's law.

Answer:

👉 Coulomb's law states that the electrostatic force between two point charges is directly proportional to the product of their charges and inversely proportional to the square of the distance between them.

2. Write the formula for Coulomb's force in free space.

Answer:

👉 $F = 1/(4\pi\varepsilon_0) * (q_1q_2 / r^2)$, where $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\cdot m^2$

3. What is the value of k in SI units?

Answer:

👉 $k = 1/(4\pi\varepsilon_0) = 9 \times 10^9\ N{\cdot}m^2/C^2$

4. State the nature of force between like and unlike charges.

Answer:

👉 Like charges repel; unlike charges attract.

5. Is Coulomb's force a vector or scalar quantity?

Answer:

👉 Coulomb's force is a vector quantity; it has both magnitude and direction.

6. What is meant by the mutual nature of Coulomb's force?

Answer:

👉 The force exerted by q_1 on q_2 is equal in magnitude and opposite in direction to the force exerted by q_2 on q_1 ($F_{12} = -F_{21}$).

7. How does the medium affect Coulomb's force?

Answer:

👉 A medium with relative permittivity ε_r reduces the force: $F = 1/(4\pi\varepsilon_0\varepsilon_r) * (q_1q_2 / r^2)$.

8. Define relative permittivity (ε_r).

Answer:

👉 Relative permittivity is the factor by which a medium reduces the electrostatic force compared to free space.

9. What is the relative permittivity of air?

Answer:

👉 For air, $\varepsilon_r \approx 1.0006$ (nearly same as free space).

10. What is the direction of Coulomb's force?

Answer:

👉 Along the line joining the two charges, repulsive for like charges and attractive for unlike charges.

11. Give the value of the charge on an electron.

Answer:

👉 $q_e = 1.6 \times 10^{-19}$ C

12. State the effect of distance on Coulomb's force.

Answer:

👉 Coulomb's force varies inversely as the square of the distance between the charges ($F \propto 1/r^2$).

13. What happens to Coulomb's force if the charge of one particle is doubled?

Answer:

👉 The force doubles ($F \propto q_1q_2$).

14. What is a dielectric?

Answer:

👉 A dielectric is an insulating medium that reduces the electrostatic force between charges.

15. Write the expression for Coulomb's force in a dielectric medium.

Answer:

👉 $F = 1/(4\pi\varepsilon_0\varepsilon_r) * (q_1q_2 / r^2)$

16. What is a field of force?

Answer:

👉 A field of force is a region in space where a force can be experienced by a body without direct contact. Example: electric field around a charge.

17. Who introduced the concept of electric field and why?

Answer:

👉 Michael Faraday introduced the concept of electric field to describe how electric forces are transmitted from one charge to another through space.

18. Define electric field intensity (E).

Answer:

👉 Electric field intensity at a point is the force experienced by a unit positive charge placed at that point: $E = F / q_0$.

19. What are the SI units of electric field intensity?

Answer:

👉 Electric field intensity is measured in newton per coulomb (N/C).

20. How is the direction of the electric field determined?

Answer:

👉 The direction of electric field is the same as the direction of force on a positive test charge.

21. Who proposed the concept of electric field lines?

Answer:

👉 Michael Faraday proposed the concept of electric field lines to visually represent the electric field.

22. What do electric field lines indicate?

Answer:

👉 Electric field lines indicate the direction and relative strength of the electric field at different points.

23. State any three properties of electric field lines.

Answer:

1. Electric field lines originate from positive charges and end on negative charges.

2. The tangent to a field line at any point gives the direction of the electric field at that point.

3. Field lines are closer where the field is strong and farther apart where the field is weak.

4. No two field lines can cross each other.

24. What is a uniform electric field? Give an example.

Answer:

👉 A uniform electric field is one where the field lines are parallel and equally spaced, so the field strength is constant at all points.

Example: Electric field between the plates of a parallel plate capacitor.

25. Name two applications of electrostatics in daily life.

Answer:

1. Xerography (Photocopier): Uses a charged selenium drum to form images on paper.

2. Inkjet Printer: Uses electric charges to control the placement of ink droplets on paper.

26. State Gauss's Law.

Answer:

👉 Gauss's Law states: "The flux through any closed surface is times the total charge enclosed in it."

27. What is a Gaussian surface?

Answer:

👉 A Gaussian surface is an imaginary closed surface used to calculate electric flux and electric intensity at a point using Gauss's Law.

28. What is the electric field inside a hollow charged metal sphere?

Answer:

👉 The electric field inside a hollow charged metal sphere is zero; the interior is a field-free region.

29. Write the expression for electric intensity due to an infinite sheet of charge.

Answer:

👉 For a plane sheet of uniform surface charge density :

$E = \sigma / (2\varepsilon_0)$

30. What is the electric field between two oppositely charged parallel plates?

Answer:

👉 For two oppositely charged parallel plates with surface charge density :

$E = \sigma / \varepsilon_0$

31. Define electric potential difference between two points.

Answer:

👉 Electric potential difference between two points A and B is the work done in carrying a unit positive charge from A to B while keeping the charge in electrostatic equilibrium:

$\Delta V = W\_AB / q_0 = \Delta U / q_0$

32. What is electric potential at a point?

Answer:

👉 Electric potential at a point is the work done in bringing a unit positive charge from infinity to that point, keeping the charge in equilibrium.

33. State the relation between electric field and potential difference.

Answer:

👉 For uniform electric field between two points separated by distance :

E = - ΔV / d

34. What is the potential gradient?

Answer:

👉 Potential gradient is the rate of change of electric potential with distance:

Potential gradient = ΔV / Δr

35. Write the expression for electric potential at a point due to a point charge q.

Answer:

👉 Electric potential at a distance from a point charge q is:

$V = (1 / 4\pi \varepsilon_0) \times (q / r)$

36. Are electric potential and potential difference scalar or vector quantities?

Answer:

👉 Both electric potential and potential difference are scalar quantities.

37. How is electric potential energy related to potential difference?

Answer:

👉 Electric potential energy change is related to potential difference as:

$\Delta U = q \Delta V$

38. Define electron-volt (eV).

Answer:

👉 One electron-volt is the energy acquired or lost by an electron when it moves through a potential difference of 1 volt:

$1\ eV = 1.6 \times 10^{-19}\ J$

39. Calculate the energy acquired by an electron moving through a potential difference of 5 V.

Answer:

👉 **Energy acquired:**

$\Delta K.E. = e\ \Delta V = (1.6 \times 10^{-19}\ C)(5\ V) = 8.0 \times 10^{-19}\ J$

40. If a particle carries charge 2e and moves through 3 V, find energy acquired.

Answer:

👉 **Energy acquired:**

$\Delta K.E. = q\ \Delta V = (2e)(3\ V) = 6\ eV = 9.6 \times 10^{-19}\ J$

41. Compare electric force and gravitational force.

Answer:

Both vary inversely with square of distance.

- **Electric force** can be attractive or repulsive, gravitational force is always attractive.
- **Gravitational** constant G is very small, so gravitational force is weaker than electrostatic force.
- **Electric force** can be shielded, **gravitational force** cannot.

42. State Coulomb's law for electric force.

Answer:

$F = q_1 q_2 / (4\pi \varepsilon_0 r^2)$

43. What type of force is electrostatic force?

Answer:

👉 Electrostatic force is a conservative force; work done is independent of path.

44. Explain the principle of Millikan's oil drop experiment.

Answer:

- **Oil drops** are sprayed between two parallel plates.
- **Drops** get **charged** due to friction.
- **By adjusting** voltage, electric force balances gravitational force .
- This **allows calculation** of charge on a single droplet, finding electrons charge.

45. Write the formula to calculate charge on an oil drop in Millikan's experiment.

Answer:

q = mgd / V

46. Define a capacitor.

Answer:

👉 A capacitor is a device that stores electric charge and consists of two conductors separated by an insulator (dielectric).

47. What is capacitance?

Answer:

👉 C = Q / V

48. What factors affect the capacitance of a parallel plate capacitor?

Answer:

- Area of the plates (A) – larger area increases C
- **Distance between** plates (d) – larger distance decreases C
- **Dielectric material** between plates – increases C by factor ε_r

49. Define dielectric constant.

Answer:

👉 Dielectric constant is the ratio of the capacitance of a capacitor with a dielectric to its capacitance with vacuum:

ε_r = Cdielectric / Cvaccum

50. Explain electric polarization of a dielectric.

Answer:

- **Dielectric** molecules are neutral, but centers of positive and negative charges coincide.
- In an **electric** field, charges shift slightly → molecules become dipoles.

- **Positive** end of molecule attracted to negative plate, negative end to positive plate.
- **Polarization** reduces effective surface charge density on plates and decreases electric field inside capacitor.

51. Explain how a capacitor stores energy.

Answer:

👉 A capacitor stores energy as electrical potential energy because work is done to deposit charge on its plates.

👉 The energy comes from the potential difference between its plates.

52. Write the formula for energy stored in a capacitor.

Answer:

$U = 1/2\ C\ V^2$,:

U = energy stored,

C = capacitance,

V = potential difference.

53. Why is average potential difference used in calculating energy?

Answer:

👉 During charging, voltage increases from 0 to V.

👉 Average voltage = gives the work done for depositing charge.

54. How can energy be expressed in terms of the electric field?

Answer:

Using $C = (\varepsilon_0 \varepsilon_r A / d)$ and $V = Ed$,

$U = \frac{1}{2} \varepsilon_0 \varepsilon_r E^2 \times$ (volume between plates)

55. What is an RC circuit?

Answer:

- A circuit with resistor (R) and capacitor (C) connected together.
- Used to study charging and discharging of a capacitor.

56. Explain the charging process of a capacitor in an RC circuit.

Answer:

- At t = 0, the capacitor is uncharged, current is maximum.
- **Voltage across** the capacitor increases gradually, current decreases exponentially.

Charging law:

$Q(t) = Q_{max} (1 - e^{-t/RC})$

$V_c(t) = V (1 - e^{-t/RC})$

After long time ($t \gg RC$), capacitor is fully charged, current becomes zero.

57. Define the time constant of an RC circuit.

Answer:

$\tau = R C$

Smaller RC → faster charging/discharging.

58. Explain discharging of a capacitor through a resistor.

Answer:

- **Capacitor** connected to resistor ⟶ stored charge flows through resistor.
- **Charge decreases** from to zero gradually.
- **Voltage across** the capacitor decreases correspondingly.

59. How does resistance affect charging/discharging speed?

Answer:

👉 **Higher resistance** ⟶ slower charging/discharging.

👉 **Lower resistance** ⟶ faster charging/discharging.

👉 Controlled by RC time constant.

60. Relation between voltage and charge during charging.

Answer:

V(t) = q(t) / C

🩸 **Important Long Questions:**

🌟 Q1. Explain Coulomb's Law and derive its mathematical expression.

❖ Introduction:

Electrostatic force is the force of attraction or repulsion between two point charges. In 1874, Charles Coulomb, a French scientist, experimentally measured the force between electric charges and formulated a law, now known as Coulomb's Law.

It states:

- The force between two point charges is directly proportional to the product of their magnitudes.
- The force is inversely proportional to the square of the distance between them.

Mathematically:

Magnitude Form:

$F = k \times (q_1 \times q_2) / r^2$

Where:

- F = electrostatic force between the charges
- q_1, q_2 = magnitudes of the two charges
- r = distance between the charges
- k = Coulomb's constant = $1 / (4\pi\ \varepsilon_0) \approx 9 \times 10^9\ N{\cdot}m^2/C^2$
- ε_0 = permittivity of free space = $8.85 \times 10^{-12}\ C^2/N{\cdot}m^2$

Direction of Force

- The force acts along the line joining the two charges.
- Like charges repel, unlike charges attract.

Vector Form:

$F_{12} = k \times (q_1 \times q_2) / r^2 \times \hat{r}_{12}$

$F_{21} = - F_{12}$

Where $\hat{r}_{12}$ is the unit vector from q_1 to q_2.

Effect of Medium

If the charges are placed in a medium (dielectric), the electrostatic force decreases.

$F = k \times (q_1 \times q_2) / (\varepsilon_r \times r^2)$

Where ε_r = relative permittivity of the medium.

Derivation (Step by Step)

1. Consider two point charges q_1 and q_2 separated by a distance r.

2. Assume the force between them is F, directed along the line joining the charges.

3. Experiments show that $F \propto q_1 \times q_2$ (directly proportional to product of charges)

4. $F \propto 1 / r^2$ (inversely proportional to the square of distance)

5. Combine both proportionalities:

- $F \propto (q_1 \times q_2) / r^2$

6. Introduce a proportionality constant k:

- $F = k \times (q_1 \times q_2) / r^2$

7. In vacuum: $k = 1 / (4\pi \varepsilon_0)$

Thus the final expression:

- $F = 1 / (4\pi \varepsilon_0) \times (q_1 \times q_2) / r^2$

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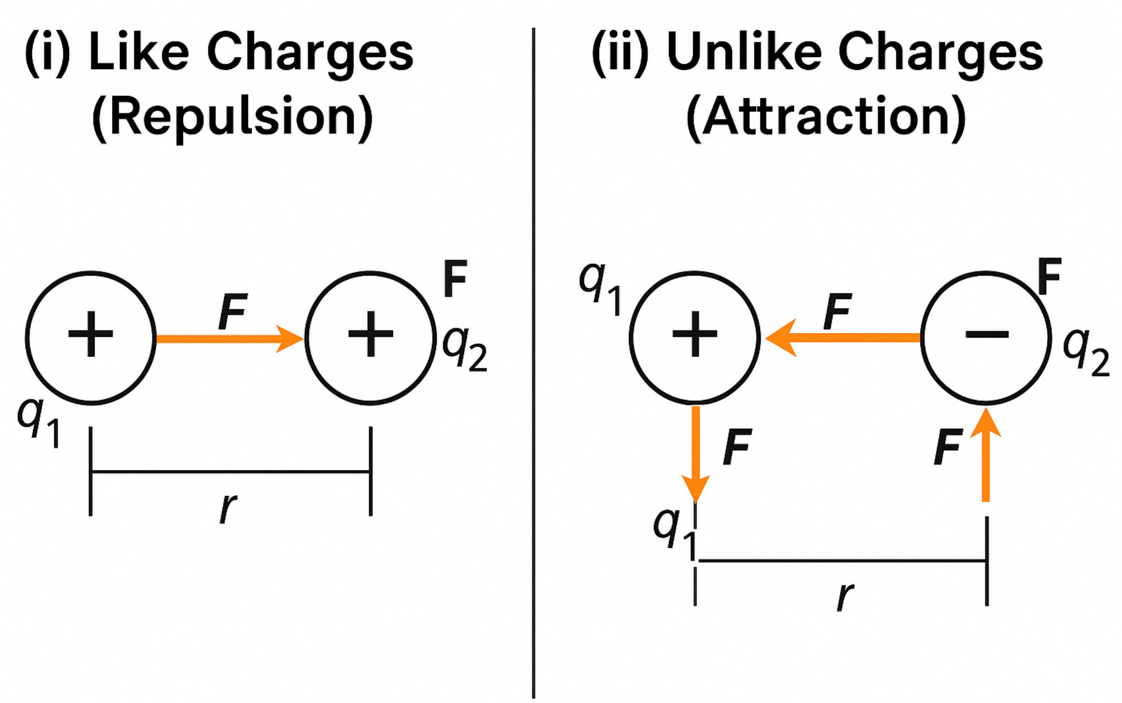

✦ **Summary:**

- Coulomb's Law gives the magnitude and direction of electrostatic force.
- Force is along the line joining the charges.
- Like charges repel, unlike charges attract.
- Force decreases in a dielectric medium.
- The vector form indicates the direction of forces.

🌟 **Q2: Explain the concept of a field of force and describe how Michael Faraday introduced the idea of an electric field.**

❖ **Definition of a Field of Force:**

A field of force is a region in space in which a particle experiences a force without direct contact with the source. A particle placed in this region is affected by the force even though there is no physical contact.

Examples:

1. Newton's law of gravitation: Every mass attracts every other mass with a force proportional to the product of their masses and inversely proportional to the square of the distance between them.

2. Coulomb's law: Two electric charges exert a force on each other proportional to the product of their charges and inversely proportional to the square of the distance between them.

- **These laws allow** calculation of the magnitude and direction of forces.

Origin of Forces:

- The origin of these forces is still unknown.
- They are accepted as fundamental forces of nature.

Faraday's Concept of Electric field:

- **Michael Faraday** (1791–1867) proposed that a charge produces a region around itself where other charges experience a force. This region is the electric field.
- **The electric field** exists even if no other charge is present, but the force can be measured only when a small test charge is placed in the field.

Two-Step Interaction of Electric Field:

1. The source charge creates an electric field in the surrounding space.

2. The electric field exerts a force on a test charge placed in it.

Vector Nature of Electric Field:

- The electric field is a vector quantity, and its direction is the same as the force on a positive test charge.

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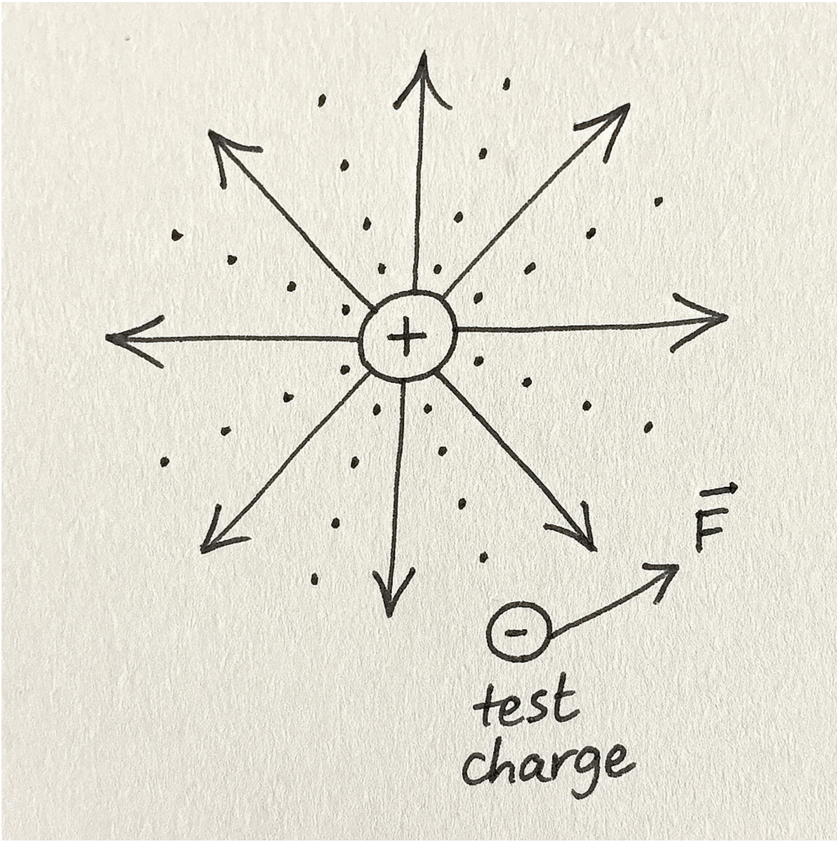

✦ **Summary:**

- A field of force is a region where a particle experiences force without contact.
- Electric field is the region around a charge where other charges experience force.
- **Faraday's concept** explains force transmission without contact.
- The field exists even without a test charge, but force is measured when a test charge is present.
- Direction and strength of the field can be represented using field lines or dots.

🌟 Q.3: Explain the concept of electric field lines and their significance.

❖ **Answer:**

Concept of Electric Field Lines:

Electric field lines are a visual representation of the electric field around a charge. They show both the direction and the strength of the field at various points in space.

- **Direction:** The tangent to a field line at any point gives the direction of the electric field.
- **Strength:** The density of the field lines represents the strength of the field. Closer lines indicate a stronger field, while lines farther apart indicate a weaker field.

Faraday's Contribution:

Michael Faraday introduced the concept of lines of force:

1. Positive charge: Field lines radiate outward, showing the direction a positive test charge would move.

2. Negative charge: Field lines point inward, indicating attraction of a positive test charge.

Significance of Electric Field Lines:

1. They provide a visual map of the electric field.

2. Direction of field at any point can be determined by the tangent to the lines.

3. Strength of the field is represented by the density of lines.

4. They help predict the force experienced by a positive test charge.

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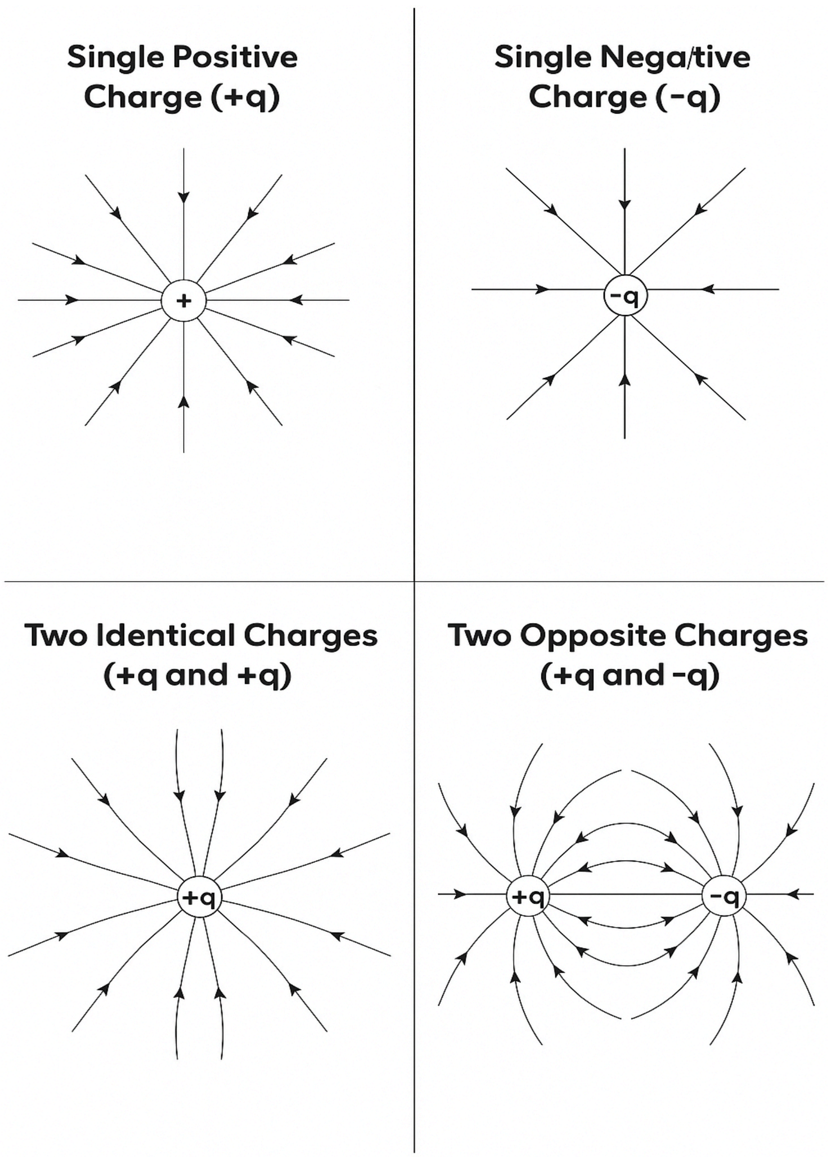

✦ **Summary:**

- Electric field lines represent the field visually, showing both direction and strength.
- Introduced by Faraday, they explain how charges exert forces in space.
- Closer lines = stronger field, tangent to lines = field direction.
- They are a powerful tool to understand electric fields without complex calculations.

🌟 **Q.4: Describe the working of an inkjet printer using electrostatics.**

❖ **Answer:**

Working Principle:

An inkjet printer uses the principles of electrostatics to precisely control the placement of ink droplets on paper. The printer ejects a thin stream of ink through a small nozzle. This stream breaks into tiny droplets, each of which can be individually manipulated using electric charges.

✦ **Steps of Operation:**

1. Ejection of Ink Droplets:

- The ink is forced out of a small nozzle and breaks into extremely small droplets in a controlled manner.

2. Charging the Droplets:

- During their flight, the droplets pass through a charging electrode, which can give them a net electric charge.
- The charge on each droplet is controlled electronically based on the image to be printed.

3. Deflection of Charged Droplets:

- Droplets then pass between deflection plates, which form a parallel plate capacitor.
- Charged droplets are deflected by the electric field between the plates into a gutter, so they do not reach the paper.
- Uncharged droplets are not deflected and travel straight, hitting the paper to form the print.

4. Controlled Printing:

- The printer's computer system controls which droplets are charged or uncharged according to the digital image.
- In this way, ink is deposited only where required, creating a high-resolution image on paper.

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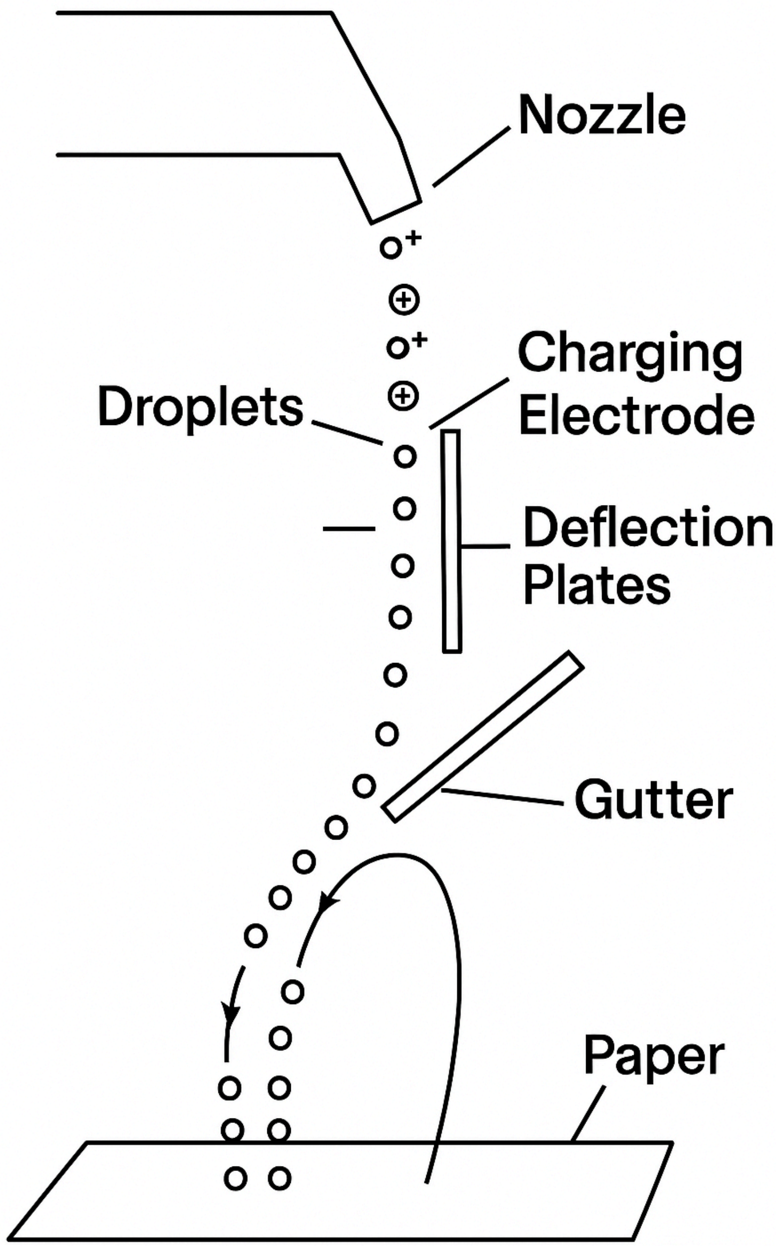

✦ **Summary:**

- Ink droplets are ejected and charged electronically.
- Deflection plates remove unwanted droplets.
- Only uncharged droplets hit the paper, forming the print.

- Electrostatics ensures precision and high-quality printing.

🌟 **Q.5: State and explain Gauss's Law.**

❖ **Answer:**

Gauss's Law (Definition):

"The electric flux through any closed surface is equal to $1/\varepsilon_0$ times the total charge enclosed within the surface."

Mathematically:

$\Phi E = Q_{enclosed} / \varepsilon_0$

where:

ΦE = electric flux through the closed surface

$Q_{enclosed}$ = total charge inside the surface

ε_0 = permittivity of free space

Concept of Electric Flux:

- Electric flux is the number of electric field lines passing through a surface.
- The flux is stronger where more field lines pass, and weaker where fewer lines pass.

Concept of Gaussian Surface:

- A Gaussian surface is an imaginary closed surface surrounding charges.
- It is chosen to match the symmetry of the charge distribution (sphere, cylinder, plane)
- Helps in simplifying the calculation of flux and electric field.

Key Points:

1. Gauss's law applies to any closed surface.

2. It is used to calculate electric field intensity for symmetric charge distributions.

3. Common shapes for Gaussian surfaces: spheres, cylinders, planes.

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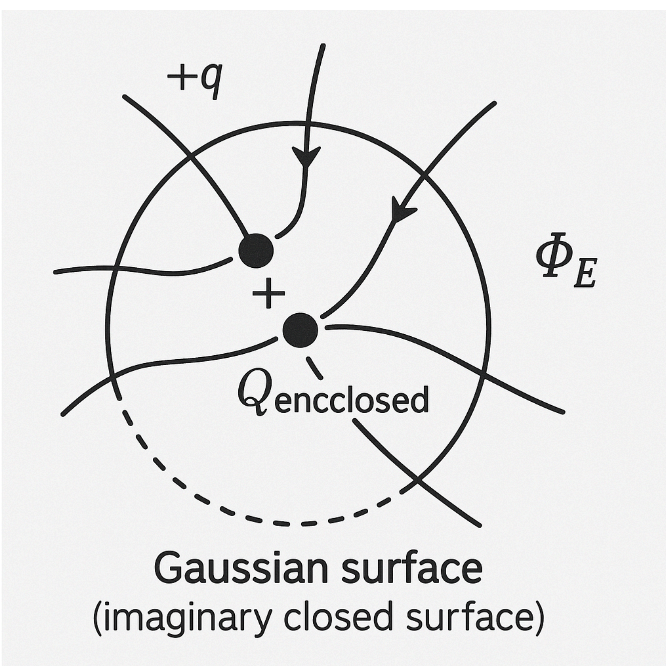

✦ **Summary:**

- Gauss's Law connects electric flux through a closed surface to the enclosed charge.
- A Gaussian surface is an imaginary surface used for flux calculation.
- Applicable for any closed surface and useful in symmetric charge distributions.

🌟 **Q.6: Define electric potential and electric potential difference. Explain their relation with electric potential energy.**

❖ **Answer:**

1. Electric Potential (V):

Electric potential at a point is the work done in bringing a unit positive charge from infinity to that point, keeping it in electrostatic equilibrium.

Formula:

$V = W \div q$

Where:

- V = electric potential at the point
- W = work done by an external force
- q = test charge (unit positive charge)

Unit: Volt (V), where 1 V = 1 Joule per Coulomb (1 J/C)

2. Electric Potential Difference (ΔV):

Electric potential difference between two points A and B is the work done per unit charge in moving a positive test charge from A to B against the electric field.

Formula:

$\Delta V = V(B) - V(A) = W_{AB} \div q$

- Where W_{AB} is the work done to move charge q from A to B.
- Potential difference is a scalar quantity.

3. Relation with Electric Potential Energy (U):

Electric potential energy of a charge q at a point:

$\mathbf{U = q \times V}$

Change in potential energy when moving a charge from A to B:

$\mathbf{\Delta U = U(B) - U(A) = q \times \Delta V}$

Interpretation:

- Moving with the field ⟶ loses potential energy, gains kinetic energy.
- Moving against the field ⟶ gains potential energy, work done by external force.

✦ **Summary:**

- **Electric potential:** Work per unit charge from infinity.
- **Potential difference:** Work per unit charge between two points.

Relation: $\Delta U = q \times \Delta V$

Both are scalar quantities measured in volts (V).

🌟 **Q.7: Explain how a charge gains potential energy and kinetic energy when moving in an electric field.**

❖ **Answer:**

1. Charge moving with the electric field:

- Consider a positive charge placed in an electric field.
- If the charge moves in the direction of the electric field, it is accelerated by the field.
- **As a result,** the charge loses electric potential energy and gains kinetic energy.

Example: A positive charge released near a negatively charged plate moves toward it, converting potential energy into motion.

2. Charge moving against the electric field:

- If the **charge moves** opposite to the direction of the electric field, it is moving against the electrostatic force.

- **To maintain** uniform motion (no acceleration), an external force must act on the charge, equal in magnitude but opposite to the electric force.
- **The work** done by this external force is stored as electric potential energy in the charge.

Example: Moving a positive charge from a negative plate to a positive plate requires work by an external agent.

3. Uniform motion condition:

For the charge to move without acceleration (electrostatic equilibrium), the external force F_ext must satisfy:

- F_ext = q × E (opposite to the electric field)
- Here, q = charge, E = electric field intensity.

This ensures the charge moves slowly and uniformly, allowing its potential energy to change without gaining unwanted kinetic energy.

✦ **Summary:**

With the field: Potential energy ⬇️ ⟶ Kinetic energy ⬆️

Against the field: External work ⬆️ ⟶ Potential energy ⬆️

Uniform motion: External force = electric force (opposite)

🩸 Exercise Questions:

🌟 12.1 The potential is constant throughout a given region of space. Is the electrical field zero or non-zero in this region? Explain.

❖ **Answer:**

1. Conceptual Explanation:

Electric potential (V) is related to electric field (E) through the potential gradient:

$E = - \Delta V / \Delta r$

- Where ΔV is the potential difference and Δr is the distance over which the potential changes.
- If the potential is constant throughout a region, then $\Delta V = 0$.

Therefore, $E = - (0/\Delta r) = 0$

2. Conclusion:

The electric field in a region of constant potential is zero.

- **Reason:** There is no change in potential to produce a force on a test charge.
- A test charge placed anywhere in this region will experience no electrostatic force and will remain at rest.

🌟 12.2 : Suppose that you follow an electric field line due to a positive point charge. Do electric field and the potential increase or decrease?

❖ **Answer:**

1. Electric Field Around a Positive Point Charge:

A positive point charge produces an electric field in the surrounding space.

- **Direction:** Field lines radiate outward from the positive charge.
- **Magnitude:** Electric field strength decreases with distance from the charge.

Formula: $E = (1 / 4\pi\varepsilon_0) \times (Q / r^2)$

E = electric field

Q = source charge

r = distance from charge

2. Electric Potential Around a Positive Point Charge:

Electric potential at a distance r from a positive point charge is:

$V = (1 / 4\pi\varepsilon_0) \times (Q / r)$

- Potential decreases with distance from the charge.
- **Reason:** Work is needed to move a unit positive charge away from the source charge against the electric field.

3. Following an Electric Field Line:

If you move along the field line outward from the positive charge:

- Electric field (E) decreases because $E \propto 1/r^2$
- Electric potential (V) decreases because $V \propto 1/r$

If you move toward the charge along the field line:

- Both E and V increase, reaching maximum at the surface of the charge (conceptually).

4. Physical Interpretation:

- Moving with the field lines is like moving from higher potential to lower potential.
- The electric field is strongest near the charge and weakens with distance.
- The potential energy of a positive test charge decreases as it moves along the field line away from the source charge, and its kinetic energy increases if it is free to move.

✦ Summary:

- Electric field (E) decreases along the field line as distance from the positive charge increases.
- Electric potential (V) decreases along the field line moving outward.
- Moving along a field line is moving from higher potential to lower potential.

🌟 12.3 How can you identify which plate of a capacitor is positively charged?

❖ **Answer:**

1. Using a Positive Test Charge:

- A positive test charge (q) is brought near one of the plates.
- If the test charge is repelled, the plate is positively charged.
- If the test charge is attracted, the plate is negatively charged.

2. Using Electric Field Direction:

- Electric field lines originate from the positive plate and terminate on the negative plate.
- By observing the direction of field lines between the plates, the plate from which lines start is positive.

3. Using Connection to a Battery:

- In a charged capacitor connected to a battery, the plate connected to the positive terminal of the battery becomes positively charged.
- The plate connected to the negative terminal becomes negatively charged.

4. Physical Interpretation:

- Positive charges accumulate on the positive plate.
- Negative charges accumulate on the negative plate, creating an electric field from positive to negative plate.

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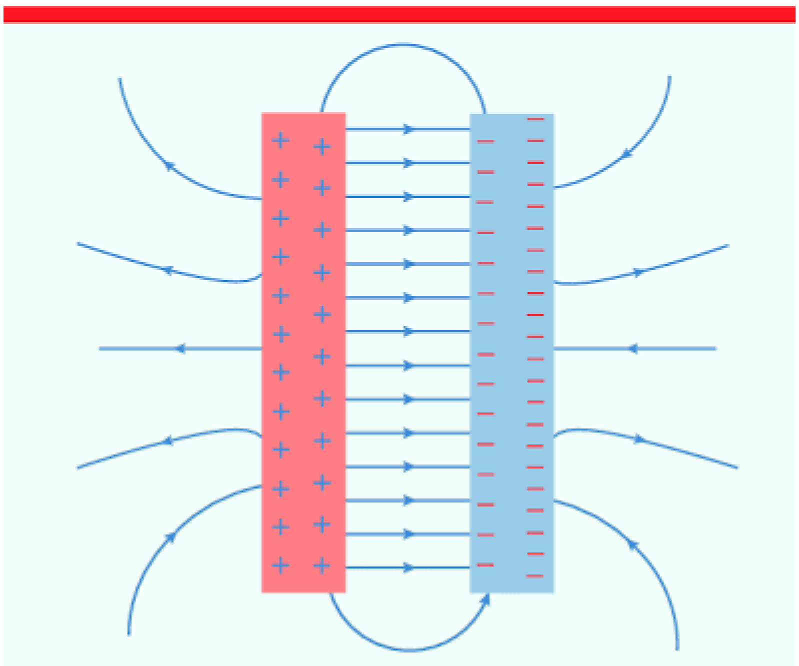

✦ **Summary:**

- A positive plate repels a positive test charge.
- Electric field lines originate from positive plates.
- **Battery connection:** Positive terminal → Positive plate.

🌟 **12.4 Describe the force or forces on a positive point charge when placed between parallel plates.**

❖ **Answer:**

Case (a): Plates with Similar and Equal Charges

1. Situation:

- Both plates carry positive charges of equal magnitude.
- Electric field lines emanate outward from both plates.

2. Forces on the Positive Point Charge:

- The charge is repelled by both plates.
- The repulsive forces from the two plates act in opposite directions.
- If the plates are identical and charges equal, the forces cancel each other at the midpoint.

Net force at midpoint: $F_{net} = 0$

At other points, the charge experiences a net force away from the nearer plate toward the farther plate.

3. Physical Interpretation:

- The positive charge moves away from the nearer plate due to stronger repulsion.
- At the midpoint, the electric field is zero (neutral point).

Case (b): Plates with Opposite and Equal Charges

1. Situation:

- One plate is positively charged, the other negatively charged.
- Electric field lines originate from the positive plate and terminate on the negative plate.

2. Forces on the Positive Point Charge:

- The charge is repelled by the positive plate and attracted toward the negative plate.
- Both forces act in the same direction, from the positive plate to the negative plate.

Net force: F = qE, along the direction of the electric field.

3. Physical Interpretation:

- If the charge is free, it accelerates toward the negative plate.
- Its potential energy decreases, while kinetic energy increases as it moves along the field.
- If kept in electrostatic equilibrium, an external force opposite to F must be applied.

🌟 12.5 Why do electric lines of force never cross?

❖ **Answer:**

1. Definition:

- Electric field lines (lines of force) represent the direction of the electric field at any point.
- The tangent to the line at any point gives the direction of the electric field at that point.

2. Reason Lines Never Cross:

- If two electric lines were to cross at a point, there would be two different directions of the electric field at that same point.
- But electric field at a point can have only one direction.

Therefore, electric lines of force can never intersect or cross each other.

3. Physical Interpretation:

- Crossing lines would imply two different forces acting simultaneously in different directions on a positive test charge at that point.
- This is physically impossible, as the force has a unique direction determined by the field.

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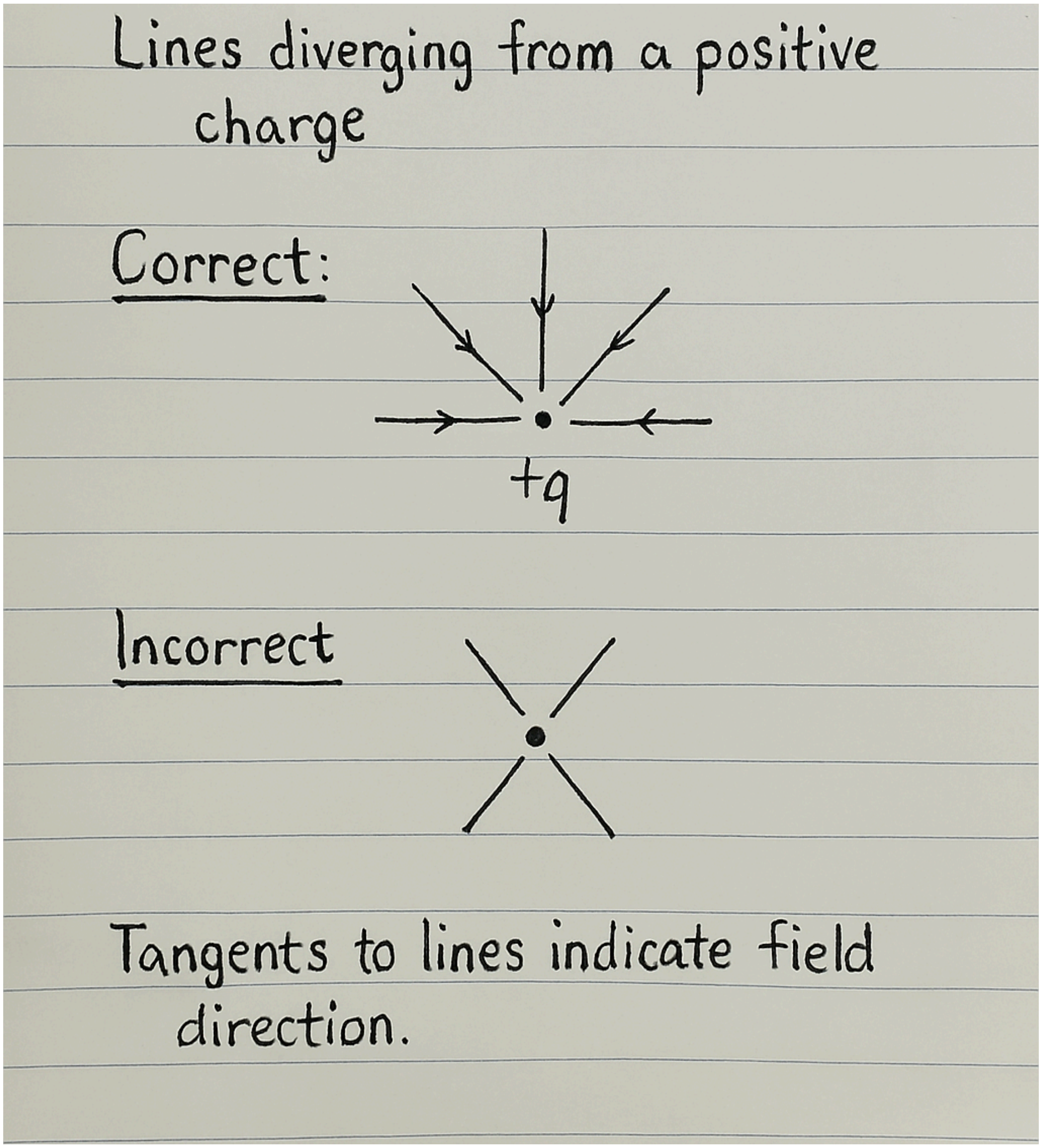

✦ **Summary:**

- An electric field is a vector quantity with one direction at a point.
- Lines of force represent the direction of the field.

Hence, lines never cross, maintaining uniqueness of field direction.

🌟 **12.6 If a point charge q of mass m is released in a non-uniform electric field with field lines pointing in the same direction, will it make a rectilinear motion?**

❖ **Answer:**

1. Situation:

A point charge q of mass m is released in a non-uniform electric field. The field lines are parallel and point in the same direction, but the field strength varies along the path.

2. Force on the charge:

F = q E

Here, E is the electric field at the position of the charge.

Since the field is non-uniform, E depends on position x:

F(x) = q E(x)

3. Acceleration of the charge:

From Newton's second law:

$F = m a \longrightarrow a(x) = F(x)/m = q E(x)/m$

The acceleration changes as the charge moves because E(x) varies.

4. Nature of motion:

- The force is along the direction of the field lines (parallel).

Therefore, the charge will move in a straight line (rectilinear motion).

Its speed changes depending on the local field strength.

✦ **Summary:**

- **Field lines:** parallel (same direction)
- **Electric field:** non-uniform (varies in magnitude)
- **Motion:** rectilinear along the field lines
- **Acceleration:** variable

🌟 **12.7 Is E necessarily zero inside a charged rubber balloon if the balloon is spherical? Assume that charge is distributed uniformly over the surface.**

❖ **Answer:**

1. Situation:

A spherical rubber balloon is charged, and the charge is uniformly distributed over its surface.

Question: What is the electric field E at a point inside the balloon?

2. Using Gauss's Law:

Choose a Gaussian surface inside the balloon (a sphere of radius $r < R$, where R is radius of balloon).

Total charge enclosed by this Gaussian surface:

$Q_{enclosed} = 0$ (because all the charge is on the outer surface)

Gauss's law:

$\Phi_E = \oint E \cdot dA = Q_{enclosed} / \varepsilon_0$

Since $Q_{enclosed} = 0$:

$\oint E \cdot dA = 0$

This implies:

$E = 0$ everywhere inside the sphere

3. Conclusion:

- The electric field inside a spherical charged conductor or balloon is zero, provided the charge is uniformly distributed on the surface.
- **Any point** inside is in electrostatic equilibrium.

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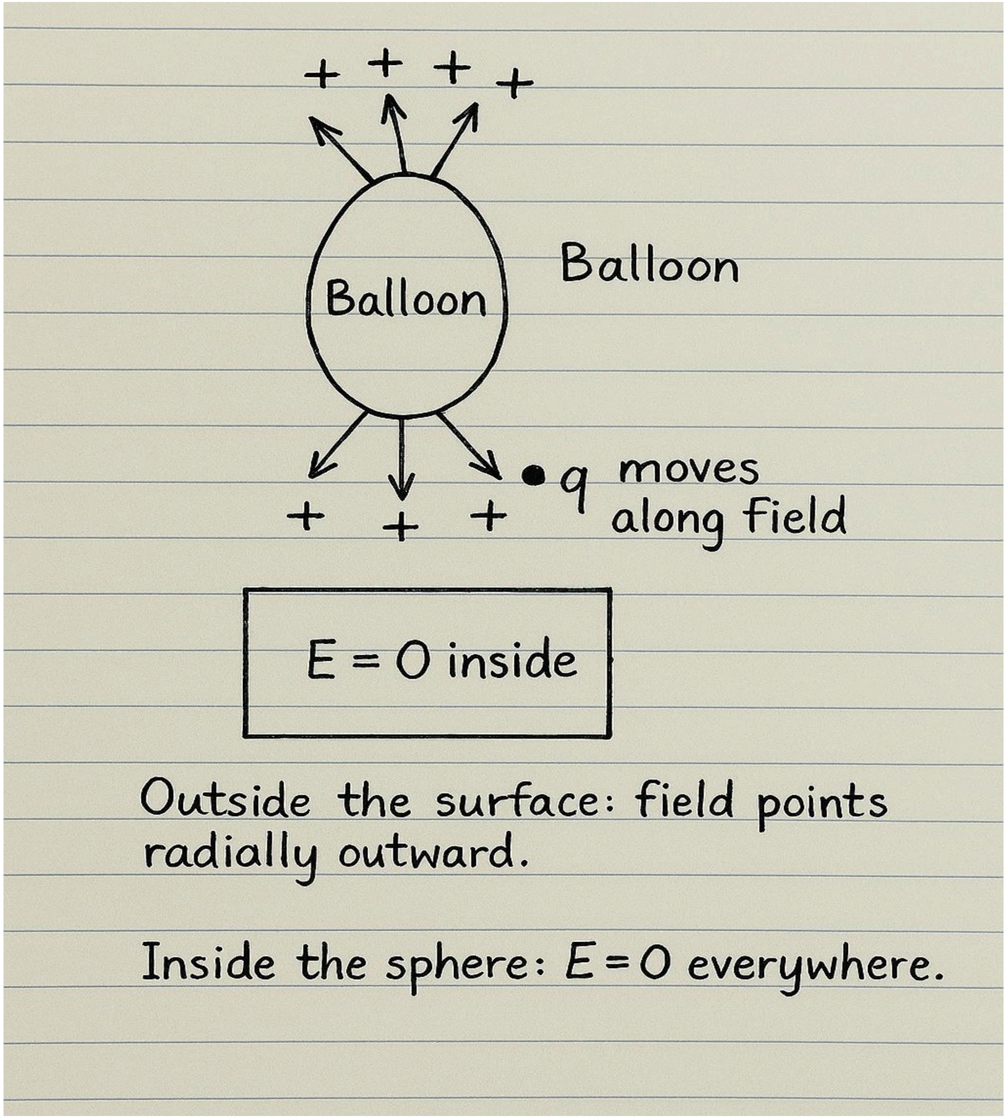

✦ **Summary:**

Charge: uniform on spherical surface

Gaussian surface inside: encloses no charge

Electric flux: $\Phi_E = 0 \longrightarrow E = 0$

Result: field-free region inside the balloon

🌟 12.8 Is it true that Gauss's law states that the total number of lines of force crossing any closed surface in the outward direction is proportional to the net positive charge enclosed within the surface?

❖ **Answer:**

1. Gauss's Law Statement:

Gauss's law states:

The net electric flux through any closed surface is equal to $1/\varepsilon_0$ times the total charge enclosed within the surface.

Mathematically:

$\Phi E = \oint E \cdot dA = Q_{enclosed} / \varepsilon_0$

Here,

ΦE= electric flux through the closed surface

E = electric field at each point on the surface

dA = infinitesimal area vector on the surface

$Q_{enclosed}$ = total charge enclosed

ε_0 = permittivity of free space

2. Interpretation in Terms of Lines of Force:

- Electric field lines can be thought of as lines of force.

- The number of lines crossing a closed surface outward is proportional to the net positive charge enclosed.
- If there is a net negative charge, the lines point inward.

3. Key Point:

- Gauss's law is true for any closed surface, regardless of its shape.
- The law does not depend on the number of lines drawn, but the flux is proportional to the total charge enclosed.

✦ Summary:

- Total electric flux $\propto$ net enclosed charge
- Outward flux $\rightarrow$ net positive charge
- Inward flux $\rightarrow$ net negative charge
- True for any closed surface, shape independent

🌟 12.9 Do electrons tend to go to region of high potential or of low potential?

❖ Answer:

1. Nature of electrons:

- Electrons carry negative charge (q = -e).

By definition, electric potential difference is the work done in moving a positive charge from one point to another.

2. Movement in an electric field:

- Positive charges move from higher potential to lower potential (along the field lines).
- Negative charges (electrons) experience force opposite to the electric field.

Therefore, electrons tend to move from lower potential to higher potential.

3. Relation with potential energy:

Potential energy of a charge q in an electric potential V is:

$U = q V$

- For an electron ($q = -e$), U decreases if it moves toward higher V.
- Nature favors decrease in potential energy, so electrons move toward higher potential regions.

✦ **Summary:**

- Electrons move opposite to field lines.
- They tend to go from low potential to high potential.
- This movement reduces their electric potential energy.

Note:

This chapter is designed to provide a solid foundation of knowledge, with the goal of deepening understanding and encouraging further exploration of the subject. The content has been carefully selected to support effective learning and inspire students to engage with the topic more deeply.

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Purpose: To contribute to education by offering insightful, valuable content that enhances learning and understanding.