Class – 12 – Physics Chapter wise Mock test
Chapter – 01 – Electric field & Charges

Maximum Marks: 70 **Time allowed: 3 hours**

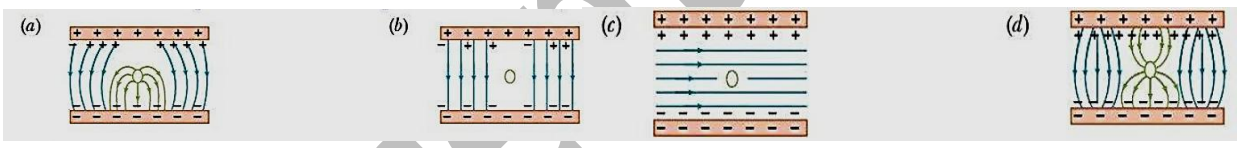
General Instructions:

1. There are 33 questions in all. All questions are compulsory.
2. This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
3. All the sections are compulsory.
4. **Section A** contains **sixteen questions, twelve MCQ and four Assertion Reasoning based of 1 mark each, Section B** contains **five questions of two marks each, Section C** contains seven questions of three marks each, **Section D** contains **two case study-based questions of four marks each** and **Section E** contains **three long answer questions of five marks each.**
5. There is no overall choice. However, an internal choice has been provided in one question in Section B, one question in Section C, one question in each CBQ in Section D and all three questions in Section E. You have to attempt only one of the choices in such questions.
6. Use of calculators is not allowed.

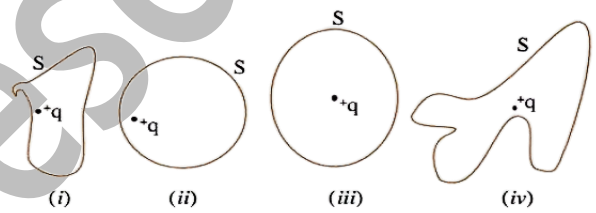
SECTION – A

1. Which statement is true for Gauss law?
(a) All the charges whether inside or outside the Gaussian surface contribute to the electric flux.
(b) Electric flux depends upon the geometry of the Gaussian surface.
(c) Gauss theorem can be applied to non-uniform electric field.
(d) The electric field over the Gaussian surface remains continuous and uniform at every point.

2. Which of the diagrams correctly represents the electric field between two charged plates if a neutral conductor is placed in between the plates?



3. The Electric flux through the surface



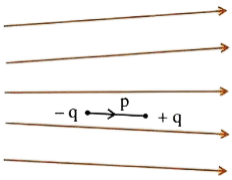
(a) in Fig. (iv) is the largest.
(b) in Fig. (in) is the least.
(c) in Fig. (ii) is same as Fig. (ii) but is smaller than Fig. (iv)
(d) is the same for all the figures.

4. A hemisphere is uniformly charged positively. The electric field at a point on a diameter away from the centre is directed
(a) perpendicular to the diameter
(b) parallel to the diameter
(c) at an angle tilted towards the diameter
(d) at an angle tilted away from the diameter

5. An electric dipole placed in a non-uniform electric field can experience
(a) a force but not a torque.
(b) a torque but not a force.

(c) always a force and a torque. (d) neither a force nor a torque.

6. Figure shows electric field lines in which an electric dipole p is placed as shown. Which of the following statements is correct?

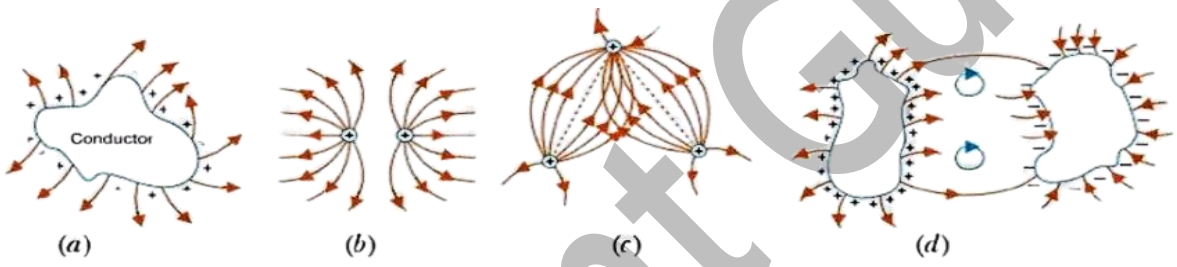


(a) the dipole will not experience any force.
(b) the dipole will experience a force towards right.
(c) the dipole will experience a force towards left.
(d) the dipole will experience a force upwards.

7. If $\oint \overrightarrow{E}.\ \overrightarrow{ds} = 0$ over a surface, then
(a) the electric field inside the surface and on it is zero.
(b) the electric field inside the surface is necessarily uniform.
(c) the number of flux lines entering the surface must be equal to the number of flux lines leaving it.
(d) all charges must necessarily be outside the surface.

8. Two charges are at distance d apart in air. Coulomb force between them is F. If a dielectric material of dielectric constant K is placed between them, the Coulomb force now becomes
(a) F/K (b) FK (c) F/K^2 (d) K^2F

9. Which among the curves shown in figure possibly represent electrostatic field lines?



10. A square sheet of side 'a' is lying parallel to XY plane at z = a. The electric field in the region is $\overrightarrow{E} = cz^2\hat{k}$. The electric flux through the sheet is
(a) a^4 c (b) $\frac{1}{3}a^3$ c (c) ac (d) 0

11. Two point charges placed in a medium of dielectric constant 5 are at a distance r between them, experience an electrostatic force 'F'. The electrostatic force between them in vacuum at the same distance r will be
(a) 5F (b) F (c) F/2 (d) F/5

12. Consider an uncharged conducting sphere. A positive point charge is placed outside the sphere. The net charge on the sphere is then,
(a) negative and uniformly distributed over the surface of sphere
(b) positive and uniformly distributed over the surface of sphere
(c) negative and appears at a point on the surface of sphere closest to point charge
(d) zero

13. The magnitude of the electric field due to a point charge object at a distance of 4.0 m is 9 N/C. From the same charged object the electric field of magnitude, $16NC^{-1}$ will be at a distance of
(a) 1 m (b) 2 m (c) 3 m (d) 6 m

In the following questions, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct answer out of the following choices.

(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false and R is also false.

14. **Assertion(A):** A negative charge in an electric field moves along the direction of the electric field.
Reason (R): On a negative charge a force acts in the direction of the electric field.

15. **Assertion(A):** In a non-uniform electric field, a dipole will have translatory as well as rotatory motion.
Reason (R): In a non-uniform electric field, a dipole experiences a force as well as torque.

16. **Assertion (4)** All the charge in a conductor gets distributed on whole of its outer surface.
Reason (R): In a dynamic system, charges try to keep their potential energy minimum.

SECTION – B

17. Two electric field lines cannot cross each other. Also, they cannot form closed loops. Give reasons

18. Define electric dipole moment. Is it a scalar or a vector quantity? What are its SI unit?

OR

What is the nature of electrostatic force between two point electric charges q_1 and q_2 if
(a) $q_1 + q_2 > 0$?
(b) $q_1 + q_2 < 0$?

19. (a) Define electric flux. Write its SI unit.
(b) 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 come out of the surface change? Give reason.

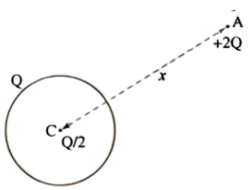
20. Two identical point charges, q each, are kept 2 m apart in air. A third point charge Q of unknown magnitude and sign is placed on the line joining the charges such that the system remains in equilibrium. Find the position and nature of Q.

21. A metallic spherical shell has an inner radius R_1 and outer radius R_2. A charge Q is placed at the centre of the spherical cavity. What will be surface charge density on (i) the inner surface, and (ii) the outer surface?

SECTION – C

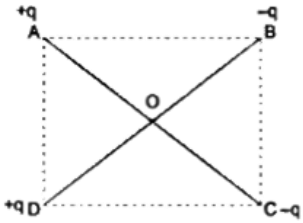
22. Two charged conducting spheres of radii a and b are connected to each other by a wire. Find the ratio of the electric fields at their surfaces.

23. A thin metallic spherical shell of radius R carries a charge Q on its surface. A point charge $\frac{Q}{2}$ is placed at the centre C and another charge +2Q is placed outside the shell at A at a distance x from the centre as shown in the figure.

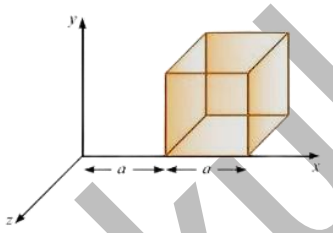


(i) Find the electric flux through the shell.
(ii) State the law used.
(iii) Find the force on the charges at the centre C of the shell and at the point A.

24. (a) The distance of a far-off point on the equatorial plane of an electric dipole is halved. How will the electric field be affected for the dipole?
(b) Two identical electric dipoles are placed along the diagonals of a square ABCD of side $\sqrt{2}$ m as shown in the figure. Obtain the magnitude and direction of the net electric field at the centre (O) of the square.



25. State Gauss's law in electrostatics. A cube with each side 'a' is kept in an electric field given by $\vec{E} = C \times \hat{r}$, (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.



26. A spherical conducting shell of inner radius r_1 and outer radius r_2 has a charge Q.
(a) A charge q is placed at the centre of the shell. Find out the surface charge density on the inner and outer surfaces of the shell.
(b) Is the electric field inside a cavity (with no charge) zero; independent of the fact whether the shell is spherical or not? Explain.

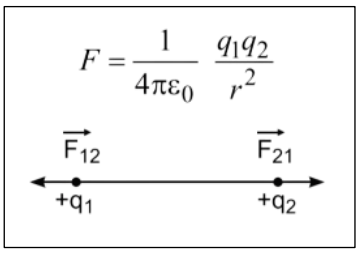
27. Two charges q and -3q are placed fixed on x-axis separated by distance 'd'. Where should a third charge 2q be placed such that, it will not experience any force?

28. A hollow conducting sphere of inner radius r_1 and outer radius r_2 has a charge Q on its surface. A point charge -q is also placed at the centre of the sphere.
(a) What is the surface charge density on the (i) inner and (ii) outer surface of the sphere?
(b) Use Gauss' law of electrostatics to obtain the expression for the electric field at a point lying outside the sphere.

SECTION – D

Case Study Based Questions

29. **Read the following paragraph and answer the questions that follow. [4]**
Coulomb's law states that the electrostatic force of attraction or repulsion acting between two stationary points charges is given by where F denotes the force between two charges q_1 and q_2 separated by a distance r in free space, ε_0 is a constant known as permittivity of free space. Free space is vacuum and may be taken to be air practically. If free space is replaced by a medium, then ε_0 is replaced by ($\varepsilon_0 k$) or ($\varepsilon_0 \varepsilon_r$), where k is known as dielectric constant or relative permittivity.



Q1. In Coulomb's law, $F = k\frac{q_1 q_2}{r^2}$, then on which of the following factors does the proportionality constant k depends?
a. Electrostatic force acting between the two charges
b. Nature of the medium between the two charges
c. Magnitude of the two charges
d. Distance between the two charges

Q2. Dimensional formula for the permittivity constant ε_0 of free space is:
a. $[ML^{-3}T^4A^2]$ b. $[M^{-1}L^3T^2A^2]$ c. $[M^{-1}L^{-3}T^4A^2]$ d. $[ML^{-3}T^4A^{-2}]$

Q3. The force of repulsion between two charges of 1 C each, kept 1 m apart in vacuum is:

a. $\frac{1}{9\times10^9}N$ b. $9\times10^9 N$ c. 9×10^7 N d. $\frac{1}{9\times10^{12}}N$

Q4. Two identical charges repel each other with a force equal to 10 mg wt when they are 0.6 m apart in air. (g = 10 ms^{-2}). The value of each charge is:

a. 2 mC b. 2×10^{-7} mC c. 2 mC d. 2 μC

Q5. Coulomb's law for the force between electric charges most closely resembles with:

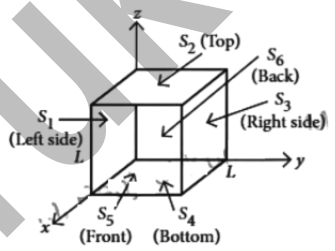
a. law of conservation of energy b. Newton's law of gravitation

c. Newton's 2nd law of motion d. law of conservation of charge

30. Read the text carefully and answer the questions: [4]

Electric Flux through a Cube

Net electric flux through a cube is the sum of fluxes through its six faces. Consider a cube as shown in figure, having sides of length L = 10.0 cm. The electric field is uniform, has a magnitude $E = 4.00 \times 10^3$ N C^{-1} and is parallel to the xy plane at an angle of 37° measured from the +x-axis towards the +y-axis.



(i) Electric flux passing through surface S_6 is

(a) -24 N m^2 C^{-1} (b) 24 N m^2 C^{-1} (c) 32 N m^2 C^{-1} (d) -32 N m^2 C^{-1}

(ii) Electric flux passing through surface S_1 is

(a) -24 N m^2 C^{-1} (b) 24 N m^2 C^{-1} (c) 32 N m^2 C^{-1} (d) -32 N m^2 C^{-1}

(iii) The surfaces that have zero flux are

(a) S_1 and S_3 (b) S_5 and S_6 (c) S_2 and S_4 (d) S_1 and S_2

(iv) The total net electric flux through all faces of the cube is

(a) 8 N m^2 C^{-1} (b) -8 N m^2 C^{-1} (c) 24 N m^2 C^{-1} (d) zero

(v) The dimensional formula of surface integral E-ds of an electric field is

(a) $[ML^2 T^{-2}A^{-1}]$ (b) $[ML^3T^{-3}A^{-1}]$ (c) $[M^{-1}L^3 T^{-3} A]$ (d) $[ML^{-3} T^{-3}A^{-1}]$

(i) The cause of charging is:

(a) none of these (b) the actual transfer of protons

(c) the actual transfer of electrons (d) the actual transfer of neutrons

SECTION – E

31. Find expressions for the force and torque on an electric dipole kept in a uniform electric field.

OR

(i) Define torque acting on a dipole of dipole moment $\vec{p}$ placed in a uniform electric field $\vec{E}$. Express it in the vector form and point out the direction along which it acts.

(ii) What happens if the field is non-uniform?

(iii) What would happen if the external field $\vec{E}$ is increasing (i) parallel to $\vec{p}$ and (ii) anti- parallel to $\vec{p}$?

32. Find an expression for the electric field strength at a distant point situated (i) on the axis and (ii) along the equatorial line of an electric dipole.

OR

Derive an expression for the electric field intensity at a point on the equatorial line of an electric dipole of dipole moment $\vec{p}$ and length 2a. What is the direction of this field?

33. (i) Use Gauss' law to obtain an expression for the electric field due to an infinitely long thin straight wire with uniform linear charge density λ.
(ii) An infinitely long positively charged straight wire has a linear charge density λ. An electron is revolving in a circle with a constant speed v such that the wire passes through the centre, and is perpendicular to the plane, of the circle. Find the kinetic energy of the electron in terms of magnitudes of its charge and linear charge density λ on the wire.
(iii) Draw a graph of kinetic energy as a function of linear charge density λ.