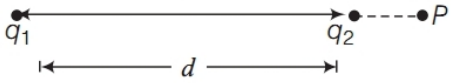
Previous Years

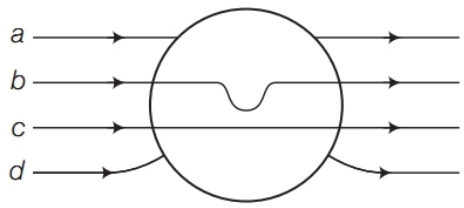
Examination Questions

1 Mark Questions

1. A point charge is placed at the centre of a hollow conducting sphere of inner radius r and outer radius $2r$. The ratio of the surface charge density of the inner surface to that of the outer surface will be ..... . **Delhi 2020**
2. Torque acting on an electric dipole placed in an uniform electric field is maximum when the angle between the electric field and the dipole moment is ..... . **All India 2020**
3. Draw the pattern of electric field lines, when a point charge $-Q$ is kept near an uncharged conducting plate. **Delhi 2019**
4. Draw a pattern of electric field lines due to two positive charges placed a distance d apart. **All India 2019**
5. Draw the pattern of electric field lines due to an electric dipole. **All India 2019**
6. Why do the electrostatic field lines not form closed loop? **All India 2014, Delhi 2012**
7. Two identical balls having same positive charge q coulomb are suspended by two insulating strings of equal length. What would be the effect on the force when a plastic sheet is inserted between the two? **All India 2014**
8. Why do the electric field lines never cross each other? **All India 2014**
9. Why must electrostatic field at the surface of a charged conductor be perpendicular to every point on it? **Foreign 2014, Delhi 2012**
10. Two point charges q_1 and q_2 are placed at a distance d apart as shown in the figure. The electric field intensity is zero at the point P on the line joining them as shown. Write two conclusions that you can draw from this. **Delhi 2014C**



11. Define dipole moment of an electric dipole. Is it a scalar quantity or a vector quantity? **Foreign 2012; All india 2011**
12. Draw a plot showing the variation of electric field E with distance r due to a point charge q. **Delhi 2012**
13. A proton is placed in a uniform electric field directed along the positive X-axis. In which direction, will it tend to move? **Delhi 2011C**
14. In which orientation, a dipole placed in a uniform electric field is in (i) stable equilibrium (ii) unstable equilibrium? **Delhi 2011**
15. Two point charges having equal charges separated by 1m distance experience a force of 8 N. What will be the force experienced by them, if they are held in water at the same distance? (Given, $K_{water} = 80$). **All India 2010C**
16. A metallic sphere is placed in a uniform electric field as shown in the figure. Which path is followed by electric field lines and why? **Foreign 2010**



17. Point out whether the following statement is right or wrong.

    The mutual forces between two charges do not get affected by the presence of other charges. **All India 2010**

2 Marks Questions

18. Derive the expression for the torque acting on an electric dipole when it is held in a uniform electric field. Identify the orientation of the dipole in the electric field in which it attains a stable equilibrium. **Delhi 2020**

19. Derive an expression for the electric field due to a dipole of dipole moment **p** at a point on its perpendicular bisector. **Delhi 2019**

20. An electric dipole of length 4 cm when placed with its axis making an angle of 60° with a uniform electric field, experiences a torque of $4\sqrt{3}$ N-m. Calculate the potential energy of the dipole, if it has charge ± 8 nC. **Delhi 2014**

21. An electric dipole of length 2 cm when placed with its axis making an angle of 60° with a uniform electric field, experiences a torque of $8\sqrt{3}$ N-m. Calculate the potential energy of the dipole if it has charge of ± 4 nC. **Delhi 2014**

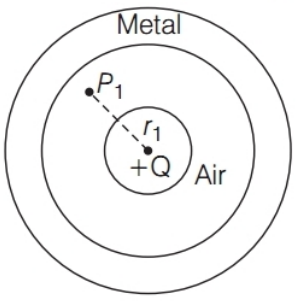
22. An electric dipole of length 1cm when placed with its axis making an angle of 60° with a uniform electric field, experiences a torque of $6\sqrt{3}$ N-m. Calculate the potential energy of the dipole, if it has charge ± 2 nC. **Delhi 2014**

23. An electric dipole is placed in a uniform electric field **E** with its dipole moment **p** parallel to the field. Find

(i) the work done in turning the dipole till its dipole moment points in the direction opposite to **E**.

(ii) the orientation of the dipole for which the torque acting on it becomes maximum. **All India 2014C**

24. A small metal sphere carrying a charge $+Q$ is located at the centre of a spherical cavity in a large uncharged metallic spherical shell. Write the charges on the inner and outer surfaces of the shell. Write the expression for the electric field at the point P_1. **Delhi 2014C**



25. Point charge $(+Q)$ is kept in the vicinity of an uncharged conducting plate. Sketch electric field lines between the charge and the plate. **Foreign 2014**

26. Two concentric metallic spherical shells of radii R and $2R$ are given charge Q_1 and Q_2 respectively. The surface charge densities on the outer surfaces of the shells are equal. Determine the ratio $Q_1:Q_2$. **Foreign 2013**

27. Calculate the amount of work done in turning an electric dipole of dipole moment 3×10^{-8} C - m from its position of unstable equilibrium to the position of stable equilibrium in a uniform electric field of intensity 10^3 NC^{-1}. **Foreign 2011**

28. 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 (1 μC, – 3 μC). Interpret the graphs obtained. **All India 2011C**

29. Two identical metallic spherical shells A and B having charges + 4 Q and – 10 Q are kept a certain distance apart. A third identical uncharged sphere C is first placed in contact with sphere A and then with sphere B, then spheres A and B are brought in contact and then separated. Find the charge on the spheres A and B. **All India 2011C**

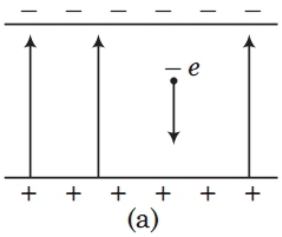
30. A dipole with a dipole moment of magnitude p is in stable equilibrium in an electrostatic field of magnitude E. Find the work done in rotating this dipole to its position of unstable equilibrium. **All India 2010C**

31. A dipole is present in an electrostatic field of magnitude 10^6 NC^{-1}. If the work done in rotating it from its position of stable equilibrium to its position of unstable equilibrium is 2×10^{-23} J, then find the magnitude of the dipole moment of this dipole. **All India 2010C**

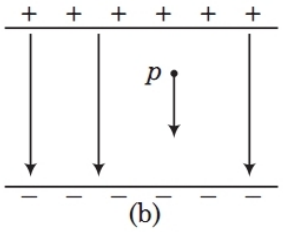
32. Deduce the expression for the electric field **E** at a point r due to a system of two charges q_1 and q_2 with position vectors $\mathbf{r}_1$ and $\mathbf{r}_2$ with respect to common origin. **Delhi 2010C**

3 Marks Questions

33. An electron falls through a distance of 1.5 cm in a uniform electric field of magnitude 2.0×10^4 N/C (Fig. a)



(i) Calculate the time it takes to fall through this distance starting from rest.



(ii) If the direction of the field is reversed (Fig. b) keeping its magnitude unchanged, calculate the time taken by a proton to fall through this distance starting from rest. **2018C**

34. (i) Derive the expression for electric field at a point on the equatorial line of an electric dipole.

(ii) Depict the orientation of the dipole in (a) stable, (b) unstable equilibrium in a uniform electric field. **Delhi 2017**

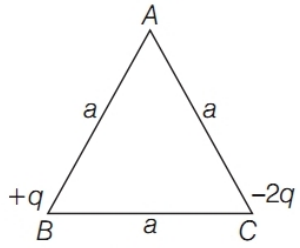
35. (i) Obtain the expression for the torque τ experienced by an electric dipole of dipole moment **p** in a uniform electric field **E**.

(ii) What will happen, if the field were non-uniform? **Delhi 2017**

36. A thin circular ring of radius r is charged uniformly so that its linear charge density becomes λ. Derive an expression for the electric field at a point P at a distance x from its centre along the axis of the ring. Hence, prove that at large distances ($x >> r$), the ring behaves as a point charge. **Delhi 2016**

37. An electric dipole of dipole moment **p** is placed in a uniform electric field **E**. Obtain the expression for the torque τ experienced by the dipole. Identify two pairs of perpendicular vectors in the expression. **Delhi 2015C**

38. Two point charges $+q$ and $-2q$ are placed at the vertices B and C of an equilateral ΔABC of side a as given in the figure. Obtain the expression for



(i) the magnitude and

(ii) the direction of the resultant electric field at the vertex A due to these two charges. **All India 2014C**

39. Define the term electric dipole moment. Is it a scalar or vector? Deduce an expression for the electric field at a point on the equatorial plane of an electric dipole of length $2a$. **All India 2013**

40. An electric dipole is kept in a uniform electric field. Derive an expression for the net torque acting on it and write its direction. State the conditions under which the dipole is in (i) stable equilibrium
(ii) unstable equilibrium. **Delhi 2012C**

41. Sketch the pattern of electric field lines due to

(i) a conducting sphere having negative charge on it.

(ii) an electric dipole. **All India 2011C**

5 Marks Questions

42. (i) Derive an expression for the electric field at any point on the equatorial line of an electric dipole.

(ii) 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. **Delhi 2019**

43. (i) Derive an expression for the electric field E due to a dipole of length $2l$ at a point distant r from the centre of the dipole on the axial line.

(ii) Draw a graph of E *versus* r for $r >> l$.

(iii) If this dipole is kept in a uniform external electric field E_0, diagrammatically represent the position of the dipole in stable and unstable equilibrium and write the expressions for the torque acting on the dipole in both the cases. **All India 2017**

44. (i) Define torque acting on a dipole of dipole moment **p** placed in a uniform electric field **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 **E** is increasing (a) parallel to **p** and (b) anti-parallel to **p**? **Foreign 2016**

Previous Years

Examination Questions

1 Mark Questions

1. How does the electric flux due to a point charge enclosed by a spherical Gaussian surface get affected when its radius is increased? **Delhi 2016**

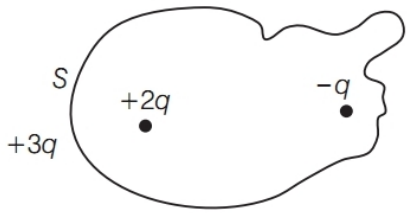
2. What is the electric flux through a cube of side 1 cm which encloses an electric dipole? **All India 2015**

3. What is the flux due to electric field $\mathbf{E} = 3\times10^3\,\hat{\mathbf{i}}\,\mathrm{NC}^{-1}$ through a square of side 10 cm, when it is held normal to $\mathbf{E}$? **All India 2015C**

4. Two charges of magnitudes $-2Q$ and $+Q$ are located at points $(a, 0)$ and $(4a, 0)$, respectively. What is the electric flux due to these charges through a sphere of radius $3a$ with its centre at the origin? **All India 2013**

5. A charge q is placed at the centre of a cube of side l. What is the electric flux passing through each face of the cube? **All India 2010; Foreign 2010**

6. 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? **Delhi 2010**



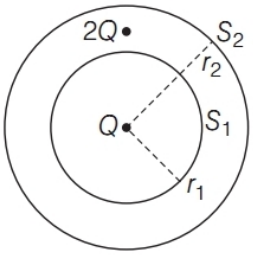
2 Marks Questions

7. Given a uniform electric field $\mathbf{E} = 5\times10^3\,\hat{\mathbf{i}}\,\mathrm{NC}^{-1}$. Find the flux of this field through a square of side 10 cm whose plane is parallel to the YZ-plane. What would be the flux through the same square if the plane makes an angle of 30° with the X-axis? **Delhi 2014**

8. Given a uniform electric field $\mathbf{E} = 2\times10^3\,\hat{\mathbf{i}}\,\mathrm{NC}^{-1}$. Find the flux of this field through a square of side 20 cm whose plane is parallel to the YZ-plane. What would be the flux through the same square if the plane makes an angle of 30° with the X-axis? **Foreign 2014**

9. Given a uniform electric field $\mathbf{E} = 4\times10^3\,\hat{\mathbf{i}}\,\mathrm{NC}^{-1}$. Find the flux of this field through a square of side 5 cm whose plane is parallel to the YZ-plane. What would be the flux through the same square if the plane makes an angle of 30° with the X-axis? **Delhi 2014C**

10. A sphere S_1 of radius r_1 encloses a net charge Q.



If there is another concentric sphere S_2 of radius $r_2 (r_2 > r_1)$ enclosing charge $2Q$. Find the ratio of the electric flux through S_1 and S_2. How will the electric flux through sphere S_1 change if a medium of dielectric constant K is introduced in the space inside S_2 in place of air? **All India 2014**

11. A thin straight infinitely long conducting wire having linear charge density λ is enclosed by a cylindrical surface of radius r and length l, its axis coinciding with the length of the wire. Find the expression for the electric flux through the surface of the cylinder. **All India 2011**

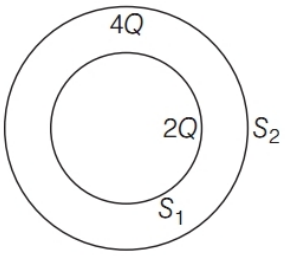
12. Show that the electric field at the surface of a charged spherical conducting shell is given by $E = \dfrac{\sigma}{\varepsilon_0}\hat{\mathbf{n}}$, where σ is the surface charge density and $\hat{\mathbf{n}}$ is a unit vector normal to the surface in the outward direction. **All India 2010**

13. A spherical conducting shell of inner radius R_1 and outer radius R_2 has a charge Q. A charge q is placed at the centre of the shell.

(i) What is the surface charge density on the (a) inner surface, (b) outer surface of the shell?

(ii) Write the expression for the electric field at a point to $x > R_2$ from the centre of the shell. **All India 2010C**

14. Consider two hollow concentric spheres S_1 and S_2 enclosing charges $2Q$ and $4Q$ respectively as shown in the figure. (i) Find out the ratio of the electric flux through them. (ii) How will the electric flux through the spheres S_1 change if a medium of dielectric constant ε_r is introduced in the space inside S_1 in place of air? Deduce the necessary expression.



Foreign 2010

3 Marks Questions

15. State Gauss's law on electrostatics and derive an expression for the electric field due to a long straight thin uniformly charged wire (linear charge density λ) at a point lying at a distance r from the wire.

Delhi 2020

16. 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.

(i) What is the surface charge density on the (a) inner and (b) outer surface of the sphere?

(ii) Use Gauss's law of electrostatics to obtain the expression for the electric field at a point lying outside the sphere. **All India 2020**

17. (i) An infinitely long thin straight wire has a uniform linear charge density λ. Obtain the expression for the electric field E at a point lying at a distance x from the wire by using Gauss' law.

(ii) Show graphically the variation of this electric field E as a function of distance x from the wire. **All India 2020**

18. Two large charged plane sheets of charge densities σ and -2σ C/m^2 are arranged vertically with a separation of d between them. Deduce expressions for the electric field at points (i) to the left of the first sheet (ii) to the right of the second sheet and (iii) between the two sheets.

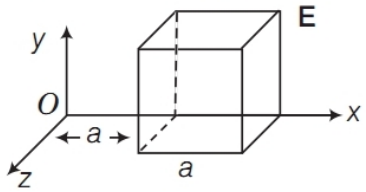
All India 2019

19. A spherical conducting shell of inner radius r_1 and outer radius r_2 has a charge Q.

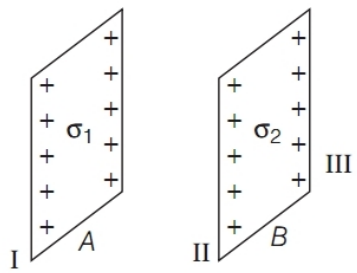
(i) A charge q is placed at the centre of the shell. Find out the surface charge density on the inner and outer surfaces of the shell.

(ii) Is the electric field inside a cavity (with no charge) zero independent of the fact whether the shell is spherical or not? Explain. **All India 2019**

20. Define electric flux and write its SI unit. The electric field components in the figure shown are $E_x = \alpha x$, $E_y = 0$, $E_z = 0$, where $\alpha = \frac{100\text{N}}{\text{Cm}}$. Calculate the charge within the cube, assuming $a = 0.1$ m. **2018C**

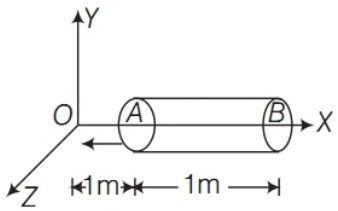


21. Two infinitely large plane thin parallel sheets having surface charge densities σ_1 and $\sigma_2 (\sigma_1 > \sigma_2)$ are shown in the figure. Write the magnitudes and directions of the net fields in the regions marked II and III.



Foreign 2014

22. A hollow cylindrical box of length 1 m and area of cross -section 25 cm^2 is placed in a three-dimensional coordinate system as shown in the figure. The electric field in the region is given by $\mathbf{E} = 50\,x\hat{\mathbf{i}}$, where E is in NC^{-1} and x is in metre.



Find

(i) net flux through the cylinder.

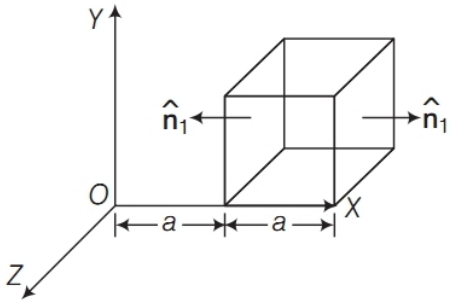
(ii) charge enclosed by the cylinder.

Delhi 2013

23. (i) State Gauss's law.

(ii) A thin straight infintely long conducting wire of linear charge density λ is enclosed by a cylindrical surface of radius r and length l. Its axis coinciding with the length of the wire. Obtain the expression for the electric field indicating its direction at a point on the surface of the cylinder. **Delhi 2012**

24. State Gauss' law in electrostatics. A cube with each side a is kept in an electric field given by $\mathbf{E} = Cx\hat{\mathbf{i}}$ as shown in the figure, where C is a positive dimensional constant. Find out



(i) the electric flux through the cube.

(ii) the net charge inside the cube.

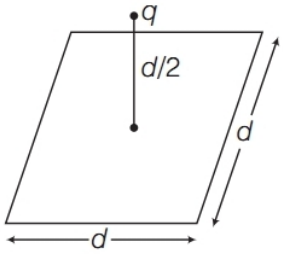
Foreign 2012

25. Using Gauss' law obtain the expression for the electric field due to uniformly charged spherical shell of radius R at a point outside the shell. Draw a graph showing the variation of electric field with r, for $r > R$ and $r < R$. **All India 2011**

5 Marks Questions

26. (i) Define electric flux. Is it a scalar or a vector quantity?

A point charge q is at a distance of $d/2$ directly above the centre of a square of side d as shown in the figure. Use Gauss' law to obtain the expression for the electric flux through the square.



(ii) If the point charge is now moved to a distance d from the centre of the square and the side of the square is doubled, explain how the electric flux will be affected. **CBSE 2018**

27. (i) Use Gauss' law to derive the expression for the electric field (**E**) due to a straight uniformly charged infinite line of charge density λ C/m.

(ii) Draw a graph to show the variation of E with perpendicular distance r from the line of charge.

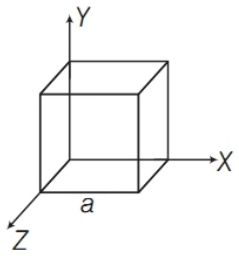
(iii) Find the work done in bringing a charge q from perpendicular distance r_1 to $r_2 (r_2 > r_1)$. **CBSE 2018**

28. (i) Use Gauss' theorem to find the electric field due to a uniformly charged infinitely large plane thin sheet with surface charge density σ.

(ii) An infinitely large thin plane sheet has a uniform surface charge density +σ. Obtain the expression for the amount of work done in bringing a point charge q from infinity to a point of distant r in front of the charged plane sheet. **All India 2017**

29. (i) An electric dipole of dipole moment **p** consists of point charges $+q$ and $-q$ separated by a distance $2a$ apart. Deduce the expression for the electric field **E** due to the dipole at a distance x from the centre of the dipole on its axial line in terms of the dipole moment **p** . Hence, show that in the limit $x >> a, \mathbf{E} \longrightarrow 2\,\mathbf{p}/(4\pi\varepsilon_0 x^3)$.

(ii) Given the electric field in the region $\mathbf{E} = 2x\hat{\mathbf{i}}$, find the net electric flux through the cube and the charge enclosed by it. **All India 2015; Delhi 2015**

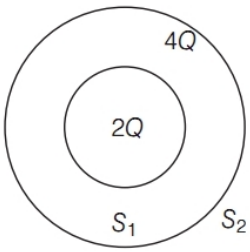


30. (i) Define electric flux. Write its SI unit. Gauss' law in electrostatics is true for any closed surface, no matter what its shape or size is. Justify this statement with the help of a suitable example.

(ii) Use Gauss' law to prove that the electric field inside a uniformly charged spherical shell is zero. **Delhi 2015**

31. (i) Deduce the expression for the torque acting on a dipole of dipole moment p in the presence of uniform electric field E.

(ii) Consider two hollow concentric spheres S_1 and S_2 enclosing charges $2Q$ and $4Q$ respectively as shown in the figure (a) find out the ratio of the electric flux through them. (b) How will the electric flux through the sphere S_1 changes if a medium of dielectric L is introduced in the space inside S_1 in place of air? Deduce the necessary expression?



All India 2014

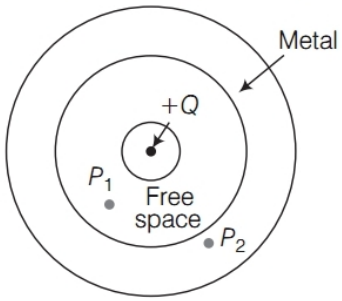
32. Using Gauss' law, deduce the expression for the electric field due to a uniformly charged spherical conducting shell of radius R at a point

(i) outside the shell (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) **All India 2013**

33. (i) Define electric flux. Write its SI unit.

(ii) A small metal sphere carrying charge $+Q$ is located at the centre of a spherical cavity inside a large uncharged metallic spherical shell as shown in the figure.Use Gauss' law to find the expressions for the electric field at points P_1 and P_2. **Delhi 2012C**



34. (i) Define electric flux. Write its SI unit.

(ii) Using Gauss' law prove that the electric field at a point due to a uniformly charged infinite plane sheet is independent of distance from it.

How is the field directed if the sheet is

(a) positively charged?

(b) negatively charged? **Delhi 2012**

35. (i) State Gauss' law. Use it to deduce the expression for the electric field due to a uniformly charged thin spherical shell at points

(a) inside the shell and

(b) outside the shell.

(ii) Two identical metallic spheres A and B having charges + $4Q$ and $-10Q$ are kept a certain distance apart. A third identical uncharged sphere C is first placed in contact with sphere A and then with sphere B. Then, spheres A and B are brought in contact and then separated. Find the charges on the spheres A and B. **All India 2011C**