Brain International School
Vikas Puri, New Delhi

ASSIGNMENT NO. 1

SUBJECT: PHYSICS **CLASS-XII** **APRIL-MAY'2026**

CH: 1- (ELECTRIC CHARGE AND FIELD)

LIST OF DERIVATION

1. A thin circular ring of radius r is charged uniformly so that its linear charge density becomes λ. Drive an expression for the electric field at a point P at a distance x from it along the axis of the ring. Hence, prove that at large distance (x $\gg$ r), the ring behaves as a point charge.

   [$CBSE = 2020,$]

2. Deduce the expression for the electric field E due to a system of two charges q_1 and q_2 with position vectors r_1 and r_2 at a point r with respect to common origin.

   [$CBSE = 2010,$]

3. Define electric field intensity and derive an expression for it at a point on the axial line of a dipole. Also determine its direction.

   [CBSE = 2017]

4. 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?

   [CBSE (D) – 2019,2017, (AI) – 2016,2013, (F) – 2015,2009]

5. 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.

   [$CBSE = 2020,$ (AI) – 2016,2014,2008, (F) – 2016, (DC) – 2015]

6. 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.

   [$CBSE = 2020,$ CBSE (AIC) – 2017, (AI) – 2007,2006,2005, (D) – 2009,04]

7. Using Gauss's law, obtain the expression for electric field intensity at a point due to an infinitely large, plane sheet of charge of charge density $\sigma\ Cm^{-2}$. How is the field directed if the sheet is (i) positively charged (ii) negatively charged?

   [CBSE (AI) – 2017,2015,2010,2005,2004,]

8. Using Gauss's law, deduce the expression for the electric field due to uniformly charged spherical conducting shell of radius R at a point (i) outside and (ii) inside the shell. Plot a graph showing variation of electric field as a function of r > R and r< R.

   [CBSE (AI) – 2015,2013,2007,2004, (D) – 2011,2009,2008,2006,2004]

9. Two large parallel plane sheets have uniform charge densities $+\sigma \; and \; -\sigma$. Determine the electric field (i) between the sheets, and (ii) outside the sheets.

[CBSE = 2019]

10. State Gauss's Theorem in electrostatics. Using this theorem, prove that no electric field exists inside a hollow charged conducting sphere.

[CBSE = 2002]

11. An infinitely large thin plate sheet has a uniform surface charge density $+\sigma$ .obtain the expression for the amount of work done in bringing a point charge q from infinityto a point, distant r, in front of the charged plane sheet.

[CBSE = 2017]

12. A long-charged cylinder of linear charge density $+\lambda_1$ is surrounded by a hollow coaxial conducting cylinder of linear charge density $-\lambda_2$. Use Gauss's law to obtain expression for the electric field at a point (i) in the space between the cylinders, and (ii) outside the largest cylinder.

[***CBSE F 17***]

NUMERICALS

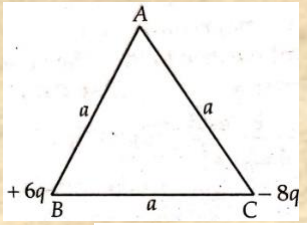
1. A metallic spherical shell has an inner radius R_1 and outer radius R_2. A charge Q is placed at the centre of the spherical cavity. What will be surface charge density on (i) the inner surface, and (ii) the outer surface?

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

3. An arbitrary surface encloses a dipole. What is the electric flux through this surface?

4. The sum of two-point charges is 7μC. They repel each other with a force of 1 N when kept 30 cm apart in free space. Calculate the value of each charge.

5. Two-point charges +6q and −8q are placed at the vertex's 'B' and 'C' of an equilateral triangle ABC of side 'a' as shown in figure. (a) 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.



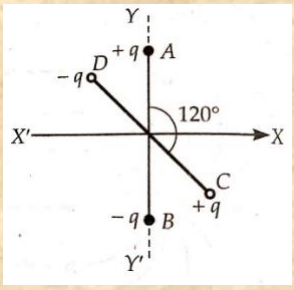
6. An electric dipole of dipole moment 4×10^{-5}C m is placed in a uniform electric field of 10^{-3} NC^{-1}making an angle of 30° with the direction of the field. Determine the torque exerted by the electric field on the dipole.

7. An electric dipole is placed at an angle of 60° with an electric field of magnitude 4×10^{5} NC^{-1}. It experiences a torque of $8\sqrt{3}$ Nm. If the length of the dipole is 4 cm, determine the magnitude of either charge of the dipole.

Ans: 10^{-3}C

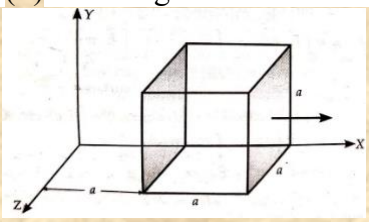
8. Two small identical electrical dipoles AB and CD, each of dipole moment 'p' are kept at an angle of 120° as shown in figure. What is the resultant dipole moment of this combination? If this system is subjected

to electric field ($\vec{E}$) directed along +X direction, what will be the magnitude and direction of the torque acting on this?



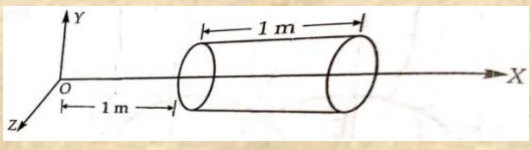
9. If $\vec{E} = 6\,\hat{\imath} + 3\,\hat{\jmath} + 4\,\hat{k}$, calculate the electric flux through a surface of area 20 units in Y - Z plane.

10. The electric field components in figure are $E_x = \alpha\, x^{1/2}$, $E_y = E_z = 0$, in which α=800 N/Cm^2. Calculate (i) the flux ϕ_E through the cube and (ii) the charge within the cube. Assume that a = 0.1m.



11. Given a uniform electric field $\vec{E} = 5\times10^3\hat{\imath}$ NC^{-1}, find the flux of this field through a square of 10 cm on a side whose plane is parallel to the Y-Z plane. What would be the flux through the same square if the plane makes at 30° angle with the X-axis?

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

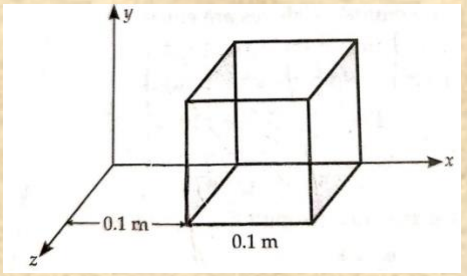


Find

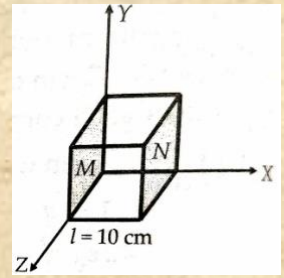
(i) Net flux through the cylinder,

(ii) charge enclosed by the cylinder.

13. The electric field components due to a charge inside the cube of side 0.1 m are as shown. $E_x = \alpha x$, where α = 500N/C-m $E_y = 0$, $E_z = 0$



14. Electric field in figure is directed along +X direction and given by $E_x = 5\,Ax + 2\,B$, where E is in NC^{-1} and x is in metre, A and B are constants with dimensions. Taking A= 10 $NC^{-1}\,m^{-1}$ and B = 5 NC^{-1}, calculate(i) the electric flux through the cube. (ii) net charge enclosed within the cube.



CH: 2- (ELECTRIC POTENTIAL AND CAPACITANCE)

LIST OF DERIVATION

1. (a) Obtain an expression for the electric potential at a point due to group of N point charges.
   (b) Give two differences between the nature of electric potential of a single point charge and an electric dipole.

   [$CBSE\ D\ 19$]

2. Drive an expression for the electric potential due to a point charge.

3. Drive an expression for the electric potential at any point along the axial line of an electric dipole.

   [$CBSE\ D\ 18$]

4. (a) Drive an expression for the electric potential at any point on the equatorial line of an electric dipole.
   (b) Draw the equipotential surfaces corresponding to a uniform electric field in the z-direction.

   [$CBSE\ D\ 19$]

5. (a) Write two properties by which electric potential is related to the electric field.
   (b) Two-point charges $q_1\ and\ q_2$, separated by a distance of r_{12} are kept in an external electric field. Derive an expression for the potential energy of the system of two charges in the field.

   [$CBSE\ OD\ 15\ ;D\ 17C$]

6. Derive an expression for the potential energy of an electric dipole placed in a uniform electric field. Hence discuss the conditions of its stable and unstable equilibrium.

   [$CBSE\ D\ 08,19$]

7. A charge Q is distributed uniformly over a metallic sphere of radius R. Obtain the expression for the electric field (E) and electric potential (V) at a point $0 < x < R$. show on a plot the variation of E and V with x for $0 < x < 2R$.

   [$CBSE\ F\ 17$]

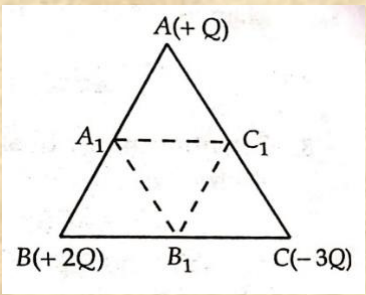
8. Find the expression for the potential energy of a system of two-point charges Q_1 and Q_2 located at $\overrightarrow{r_1}$ and $\overrightarrow{r_2}$, respectively in an external field $\overrightarrow{E}$.

   [$CBSE\ 2106,20$]

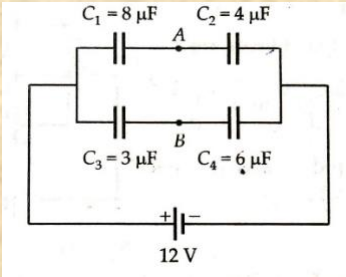
9. (i) write two important characteristics of equipotential surfaces.
   (ii) can two equipotential surfaces intersect each other? Give reasons.
   (iii) why do the equipotential surface get closer to each other near the point charges.
   (iv) draw the equipotential surface due to an electric dipole.
   (v) draw the equipotential surface due to point charges.

NUMERICALS

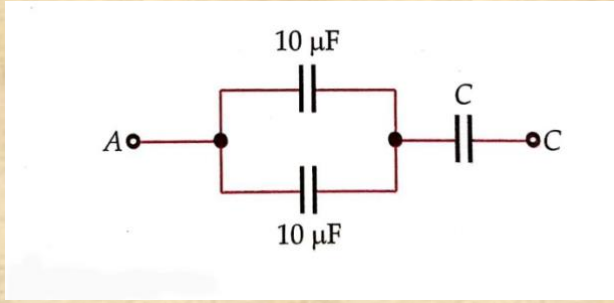
1. Three-point charges, + Q, + 2Q and – 3Q are placed at the vertices of an equilateral triangle ABC of side l. If these charges are displaced to the midpoints A_1, B_1 and C_1 respectively, find the amount of the work done in shifting the charges to the new locations.



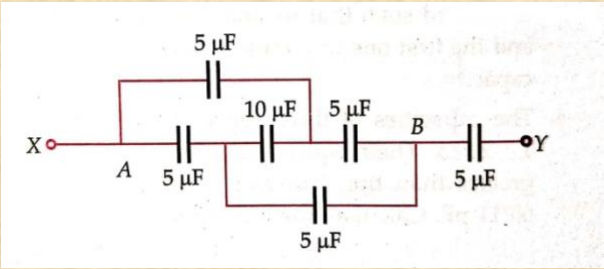
2. An electric dipole of length 2 cm is placed with its axis making an angle of 60° to a uniform electric field of 10^5 N/C. If it experiences a torque of $8\sqrt{3}$ Nm, calculate the
   (i) magnitude of the charge on the dipole, and
   (ii) potential energy of the dipole.
3. Two charges, of magnitude 5 nC and -2 nC, are placed at points (2 cm, 0, 0) and (x cm, 0, 0) in a region of space, where there is no other external field. If the electrostatic potential energy of the system is $-$ 0.5 μ J, what is the value of x?
4. N drops of mercury of equal radii and possessing equal charges combine to form a big drop. Compare the charge, capacitance and potential of bigger drop with the corresponding quantities of individual drops.
5. Four capacitorsC_1,C_2, C_3, and $C_4$are connected to a battery of 12 V, as shown in figure. Find the potential difference between the points A and B.



6. Calculate the capacitance of the capacitor in figure. If the equivalent capacitance of the combination between A and B is 15 μF.



7. Find the resultant capacitance between the points X and Y of the combination of capacitors shown in figure.

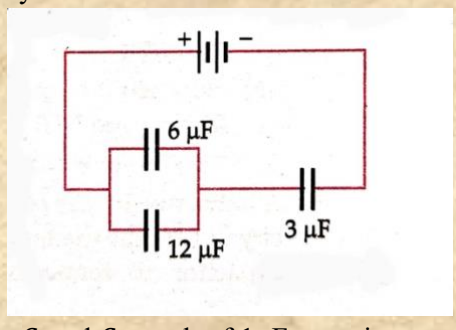


8. In the following arrangement of capacitors, the energy stored in the 6 μF capacitor is E. Find the value of the following:

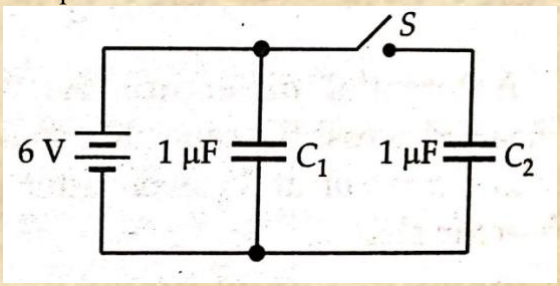
(i) Energy stored in 12 μF capacitor.

(ii)Energy stored in 3 μF capacitor.

(iii) Total energy drawn from the battery.

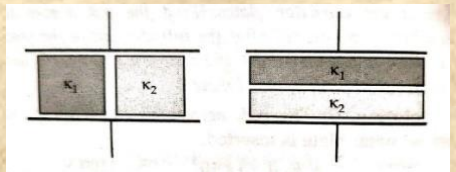


9. Figure shows two identical capacitors, C_1 and C_2, each of 1μF capacitance connected to a battery of 6V . Initially switch 'S' is closed. After some time 'S' is left open and dielectric slabs of dielectric constant κ = 3 are inserted to fill completely the space between the plates of the two capacitors. How will the (i) charge and (ii) potential difference between the plates of the capacitors be affected after the slabs are inserted?

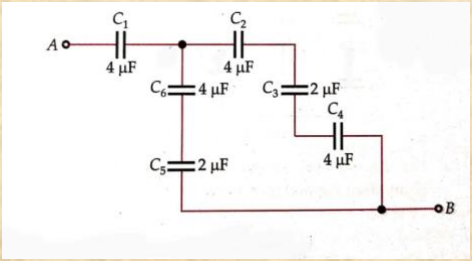


10. (a) Find the ratio of the capacitances of a capacitor filled with two dielectrics of same dimensions but of dielectric constant κ_1 and κ_2, respectively.

(b) A capacitor is filled with two dielectrics of the same dimensions but of dielectric constants $\kappa_1 = 2$ and $\kappa_2 = 3$. Find the ratio of capacities in two possible arrangements.



11. Calculate the equivalent capacitance between the points A and B of the circuit given below.



12. A network of four capacitors each of 12 μF capacitance is connected to a 500 V supply as shown in figure. Determine (a) equivalent capacitance of the network, (b) charge on each capacitor.