CHAPTER 11
ELECTROSTATICS

* $1e = 1.6 \times 10^{-19} C$
* $\varepsilon_o = 8.85 \times 10^{-12} C^2 N^{-1} m^{-2}$
* $k = 9 \times 10^9 Nm^2 C^{-2}$
* Eular constant, $e = 2.718$
* Mass of proton $= 1.67 \times 10^{-27} kg$
* Mass of neutron $= 1.67 \times 10^{-27} kg$
* Mass of electron $= 9.11 \times 10^{-31} kg$
* $1 eV = 1.6 \times 10^{-19} J$
* $1 J = 6.25 \times 10^{18} eV$
* 1 Ampere $= 6.25 \times 10^{18}$ electrons/second

FORMULAS

* $F = k\frac{q_1 q_2}{r^2}$

* $q = ne$

* $\varepsilon_r = \frac{\varepsilon}{\varepsilon_0}$

* $F_{med} = \frac{F_{vac}}{\varepsilon_r}$

* $E = \frac{F}{q_0}$ E: Intensity of electric field

* $E = \frac{kq}{r^2}$

* $\phi = EA\cos\theta$ ϕ: Electric Flux

* Surface Charge Density:

$$\sigma = \frac{Q}{A}$$

* Electric Field Intensity Due To An Infinite Sheet of Charge:

$$E = \frac{\sigma}{2\epsilon_0}$$

Date:

Day: M T W T F S

* Electric Field Intensity between two oppositely charged parallel plates:

$$E = \frac{\sigma}{\varepsilon_0}$$

* $V = \frac{U}{Q}$ or $V = \frac{W}{Q}$

* $U = \frac{k q_1 q_2}{r}$

* $\Delta W = q_0 E \Delta r$

* $V = k\frac{Q}{r}$

* $E = -\frac{\Delta V}{\Delta r}$

* $K.E = q_0 V$

* For Capacitor:

$$Q = CV$$

$$E = \frac{V}{d}$$

$$C_{vac} = \frac{\varepsilon_0 A}{d}$$

Date:

Day: M T W T F S S

* $C_{med} = \frac{\varepsilon_0 \varepsilon_r A}{d}$

* $\varepsilon_r = \frac{C_{med}}{C_{vac}}$

* SERIES COMBINATION OF CAPACITORS

→ Q = constant

→ $V = V_1 + V_2 + V_3$

→ $\frac{1}{C_e} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$

* PARALLEL COMBINATION OF CAPACITORS

→ V = constant

→ $Q = Q_1 + Q_2 + Q_3$

→ $C_e = C_1 + C_2 + C_3$

* ENERGY STORED IN A CAPACITOR

$U = \frac{QV}{2}$

$U = \frac{CV^2}{2}$

$U = \frac{Q^2}{2C}$

Date:

Day: M T W T F S S

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

* ENERGY DENSITY (u)

$$u = \frac{\text{Energy}}{\text{Volume}}$$

$$u = \frac{1}{2} \varepsilon_0 \varepsilon_r E^2$$

* SI UNIT OF ELECTRIC FIELD INTENSITY

NC^{-1} or Vm^{-1}

* ELECTRIC FIELD LINES:

For -ve charge : Radially inward

For +ve charge : Radially outward

→ Field Lines can never overlap

→ Electric field will be zero b/w two similar charges having same nature and same charge. If one have smaller charge than the other, in this case electric field will be zero near smaller one.

→ No null point exist between opposite charges.

Date:

Day: M T W T F S S

* Electric Field makes an angle with the plane then electric flux will be:

$$EA \sin\theta$$

* Electric field lines can never pass through a conductor.

* To bring a charged particle to rest, how much 'E' must be applied:

$$F = W$$

$$qE = mg$$

$$E = \frac{mg}{q}$$

* UNIFORM ELECTRIC FIELD:

No change in magnitude and direction

* Electric Field lines are always perpendicular to the metal surface

* +ve is known as high potential because a test charge will normally move from +ve to -ve

* Potential is a scalar quantity

* eV → unit of energy

* When a dielectric is inserted b.w the plates of capacitor, then it is seen that the charge storing capacity of capacitor is increased by the dielectric which permits it to store ε_r times more charge for the same potential difference.

* ε_r :
  - → Dimentionless Quantity
  - → Always greater than unity ($\varepsilon_r > 1$)
  - → Independent of size and shape of dielectric

* FOR CHARGING OF CAPACITOR:

$$q = q_0 (1 - e^{-t/RC})$$

* FOR DISCHARGING OF CAPACITOR

$$q = q_0 e^{-t/RC}$$

* Capacitor can never charge up fully

* TIME CONSTANT (RC)

The time constant is the duration of time for the capacitor in which 63.2% of its maximum value charge is deposited on the plates.

* The smaller the resistance or the capacitance, the smaller the time constant, the faster the charging and discharging rate of the capacitor and vice versa.

* A capacitor charges completely in a time equal to : 5 x RC

* Electric field is zero inside a conductor

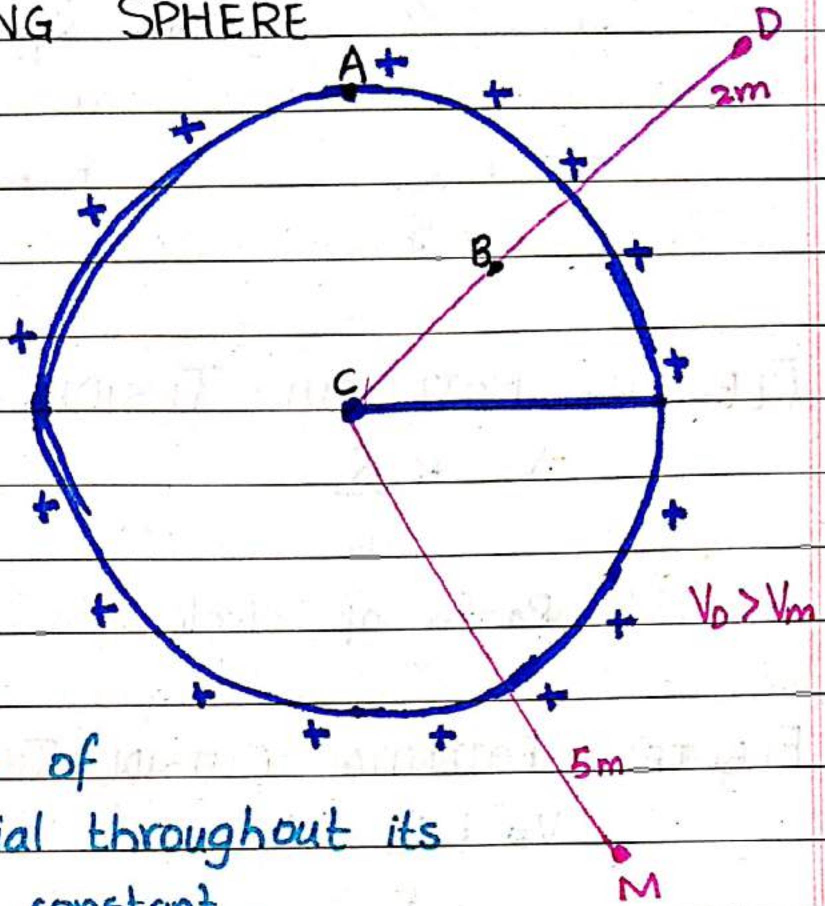
* DIRECTION OF ELECTRIC FIELD:
The tangents to the electric lines of force at a point gives the direction of electric field at that point

* ELECTROSTATIC EQUILIBRIUM:
The condition established by charged conductors in which the excess charge has optimally distanced itself so as to reduce the total amount of repulsive forces.

* GAUSS'S LAW:

$$\phi = \frac{Q}{\epsilon_0}$$

* ELECTRIC POTENTIAL DUE TO A CHARGED CONDUCTING SPHERE



The magnitude of electric potential throughout its volume remain constant

$$V_A = k\frac{Q}{r}$$

$$V_B = \frac{kQ}{r}$$

$$V_c = \frac{kQ}{r}$$

Within the sphere at any point the magnitude of electric potential is independent of distance from its centre

For a point outside its volume electric potential depends upon r.

Day: M T W T F S S

$V_D = k\frac{Q}{2}$

$V_m = k\frac{Q}{5}$

so electric field outside the sphere is the same as that from a point charge

* ELECTRIC POTENTIAL INSIDE A SPHERE

$$V = k\frac{Q}{R}$$

R: Radius of circle

* ELECTRIC POTENTIAL OUTSIDE THE SPHERE

$$V = k\frac{Q}{r}$$

r: Distance from centre of the sphere

* eV

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

* In capacitor charges are stored whereas in battery chemicals are stored

* In Series Combination of Capacitor:
The equivalent capacitance will be smaller than the smallest capacitance connected in circuit.

Date:

Day: M T W T F S S

* IN PARALLEL COMBINATION OF CAPACITOR:

The total capacitance is greater than the greatest capacitor's capacitance.

* To Find Electric Field midway b·w Charged Particles:

$$E_1 + E_2 = \frac{kQ_1}{r^2} + k\frac{Q_2}{r^2}$$

MCQ: Two point charges one with charge $+8 \times 10^{-9}$C and other with charge -2×10^{-9} C are separated by 4m. The electric field in N/c midway between them is:

Sol:

$$E_1 + E_2 = \frac{kQ_1}{r^2} + \frac{kQ_2}{r^2}$$

* $r = \frac{4}{2} = 2$

$$E_1 + E_2 = \frac{(9 \times 10^9)(+8 \times 10^{-9})}{2^2} + \frac{(9 \times 10^9)(-2 \times 10^{-9})}{2^2}$$

$= 18 + 4.5$

$= 22.5$ N/c

* Three capacitors having same capacitance are connected in the form of equilatoral triangle. The capacitance b·w any two corners will be:

$$\frac{3C}{2}$$

Date:

Day: M T W T F S S

* A proton or an electron when accelerated by a potential difference of 1kV, have a K·E of :

1 keV

* A 25eV has a speed of :

3×10^6 m/s

Solution:

$$K \cdot E = eV$$

$$\frac{1}{2} mv^2 = eV$$

$$v^2 = \frac{2eV}{m}$$

$$= \frac{(2)(25)(1.9 \times 10^{-19})}{9.11 \times 10^{-31}}$$

$$v = 3 \times 10^6 \, m/s$$

* OPEN CIRCUIT:

The circuit in which terminal voltage of a battery is equal to emf of the battery

* Selenium is an LDR (Light Dependent Resistor)

* The charge developed in the glass rod on rubbing it with silk is positive charge
The charge developed in ebonite rod on rubbing it with fur is negative charge

Day:

* The gravitational force between two masses is always attractive

* Charge can usually be detected and measured with the help of Gold-leaf electroscope

* In CGS System, For air $k=1$
In SI System, For air $k = 9\times10^9 Nm^2 kg^{-2}$

* Work done in moving any charge over equipotential surface is zero.

* If we go along an electric line of force, electric potential decreases

* Electric field intensity inside a conductor is zero. However, magnetic lines of force lie both inside and outside a magnet

* In uniform electric field electric lines of force are parallel and equidistant

* In strong electric field the electric lines of force are closer while in weak electric field they are far apart from one another.

Day: M T W T F S S

* When a charge particle is in uniform electric field it will experience two forces:
  - → mg (weight) acting downward
  - → qE, acting vertically upwards

$$mg = qE$$

$$q = \frac{mg}{E}$$

Similarly for 'a'

$$ma = qE$$

$$a = \frac{qE}{m}$$

* 1eV = Unit of energy esp used for atomic particles

* Electric potential is a scalar quantity

* D.C supply stores charges on the plate (in capacitor)
* A.C supply doesnot store charge on capacitor plates

* If Q is charge, V is potential difference, m is mass of particle

$$v = \sqrt{\frac{2QV}{m}}$$

Date:

Day: M T W T F S S

* There will be attraction b·w two neutrons due to gravitational force and nuclear force. Electrical force b·w two neutrons is zero bcz they donot have any charge.