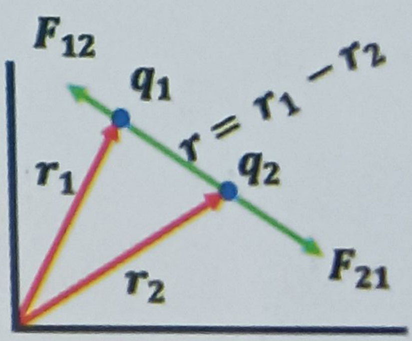
Electrostatics

$F_e = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$	q_1 and q_2 are charge on two bodies r = distance between two bodies ε_0 = permittivity of free space its value is $8.854 \times 10^{-12}\ C^2/Nm^2$
Dielectric Constant (Relative permittivity of the medium)	$K = \varepsilon_r = \frac{\varepsilon}{\varepsilon_0}$

Vector Form of Coulomb's Law



$$\overrightarrow{F_{12}} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r_{12}^2}\widehat{r_{12}}$$

$$\overrightarrow{F_{21}} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r_{21}^2}\widehat{r_{21}}$$

Force between Multiple Charges

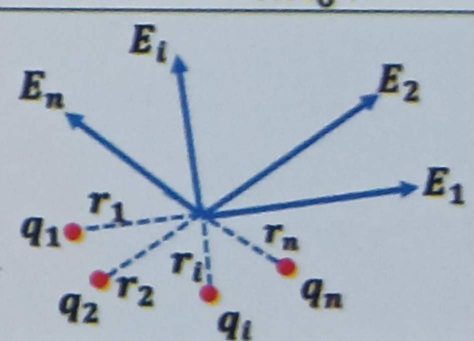
$$\overrightarrow{F_{12}} = \frac{1}{4\pi\varepsilon_0}\left(\frac{q_1 q_2}{r_{12}^2}\widehat{r_{12}} + \frac{q_1 q_2}{r_{13}^2}\widehat{r_{13}} + \cdots + \frac{q_1 q_2}{r_n^2}\widehat{r_n}\right)$$

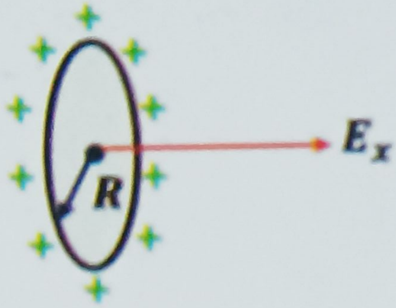
Electric Field

Electric Field Intensity	$E = \lim_{q_0 \to 0}\frac{F}{q_0}$
Electric Field due to a Point Charge	$E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$

Electric Field due to System of Charges

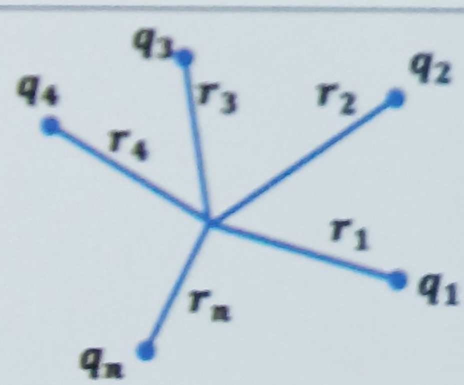
$$E(r) = \frac{1}{4\pi\varepsilon_0}\sum_{i=1}^{n}\frac{q}{r_i^2}\widehat{r_i}$$

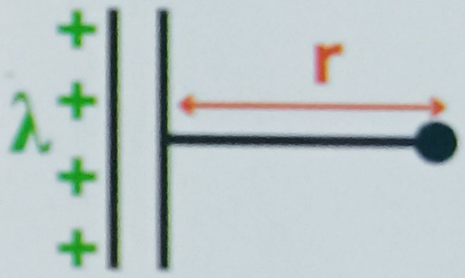
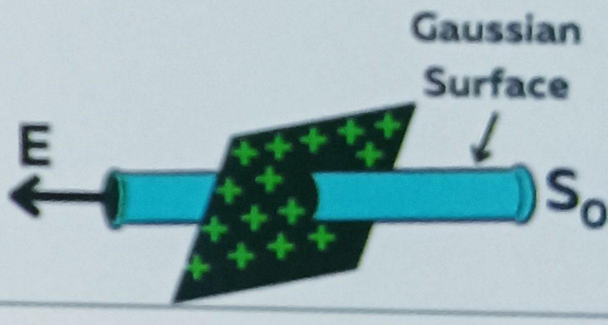
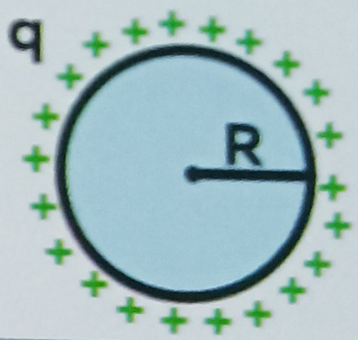


Electric field due to the line charge distribution	$E = \frac{1}{4\pi\varepsilon_0}\int_L \frac{\lambda}{r^2} dL\hat{r}$ λ = linear charge density
Electric Field of a Ring of Charge 	$E_x = \left(\frac{1}{4\pi\varepsilon_0}\right)\frac{qx}{(x^2 + R^2)^{3/2}}$

$E_x = 0$ at $x = 0$ i.e., field is zero at the centre of the ring.	$E = \frac{1}{4\pi\varepsilon_0}\frac{q}{x^2}$ For $x \gg r$	$E_{max} = \frac{2}{\sqrt{3}}\left(\frac{1}{4\pi\varepsilon_0}\frac{q}{R^2}\right)$

Electric Potential

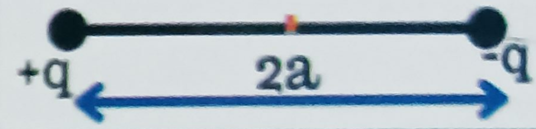
Electric Potential	$V = \frac{W}{q}$
Electric Potential due to a Point Charge	$V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$
Potential due to System of Charges $V = \frac{1}{4\pi\varepsilon_0}\sum_{i=1}^{n}\frac{q_i}{r_i}$	
Potential Gradient	Potential Gradient $= \frac{dV}{dr}$

Electric Flux	$\Delta\phi_E = E\Delta S \cos\theta$
Gauss's Theorem The electric flux over any enclosed surface is $\frac{1}{\varepsilon_0}$ times the total charge enclosed by the surface	$\phi_E = \oint_S E.dS = \frac{1}{\varepsilon_0}\sum q$
Applications of Gauss's Theorem	
Electric Field Intensity due to an Infinite Line Charge $E = \frac{1}{2\pi\varepsilon_0}\frac{\lambda}{r}$	
Electric Field Near an Infinite Plane Sheet of Charge $E = \frac{\sigma}{2\varepsilon_0}$	
Electric Field outside the Charged Spherical Shell $E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$	
Electric Field inside the Charged Spherical Shell $E = 0$	

Electric Dipole

Electric Dipole

Dipole Moment, $p = q \times 2a$

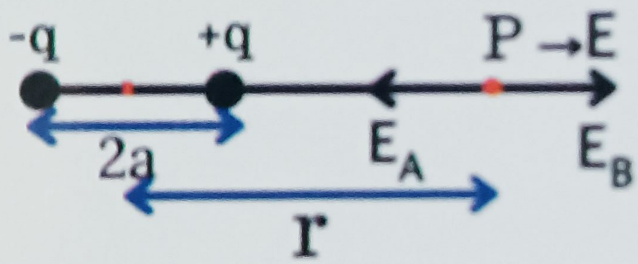


Electric Field Intensity and Potential due to an Electric Dipole

On Axial Line

$$E = \frac{1}{4\pi\varepsilon_0}\frac{2pr}{(r^2 - a^2)^2}$$

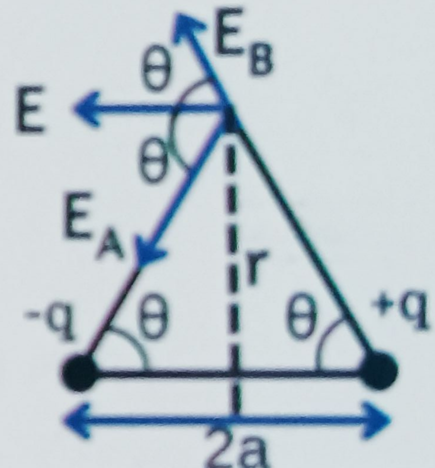
$$V = \frac{1}{4\pi\varepsilon_0}\frac{p}{(r^2 - a^2)}$$



On Equatorial line

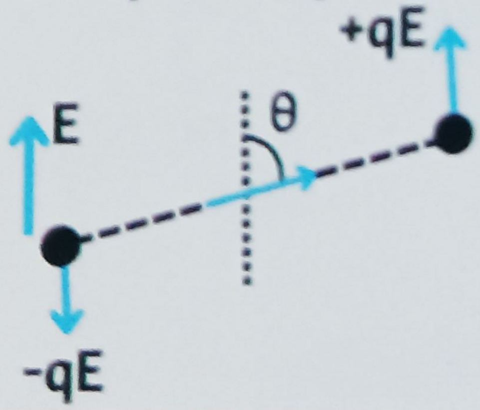
$$E_x = \frac{1}{4\pi\varepsilon_0}\frac{p}{(r^2 + a^2)^{3/2}}$$

$$V = 0$$



Torque on Dipole in a Uniform External Field

$$\tau = Ep\sin\theta = p \times E$$



Potential Energy of a Dipole in a Uniform Electric Field

$$W = pE(\cos\theta_1 - \cos\theta_2)$$

If, $\theta_1 = 90$ & $\theta_2 = \theta$

$$W = pE(\cos 90^\circ - \cos\theta)$$

$$= -pE\cos\theta = -p.E$$

Capacitor

Capacitance of a Conductor	$C = \frac{q}{V}$
Capacitance of an Isolated Spherical Conductor	$C = 4\pi\varepsilon_0 R$

Parallel Plate Capacitor

Electric Field	Electric potential	Capacitance
$E = \frac{\sigma}{\varepsilon_0}$	$\Delta V = \frac{q}{A\varepsilon_0} d$	$C = \frac{KA\varepsilon_0}{d}$ For air K = 1

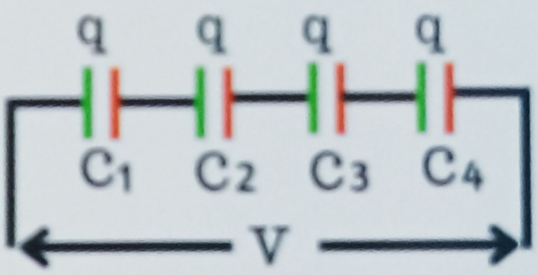
Combination of Capacitors

In Series

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \dots$$

For Different Potential Differences

$$V = V_1 + V_2 + V_3 \dots$$



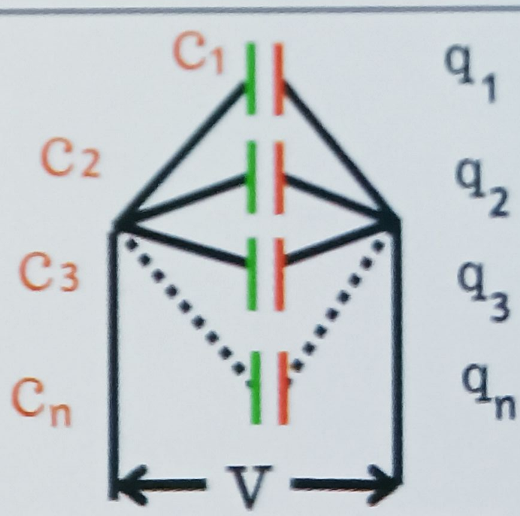
In Parallel

$$C = C_1 + C_2 + C_3 \dots$$

Total Charge on Capacitors

$$q = q_1 + q_2 + q_3 \dots$$

1



Potential Energy Stored in a Capacitor	$U = \frac{1}{2}CV^2 = \frac{1}{2}\frac{q^2}{C}$

NEET 2023 PYQ'S (Chapter 14-15)

- The ratio of frequencies of fundamental harmonic produced by an open pipe to that of closed pipe having the same length is **2:1**

- An electric dipole is placed at an angle of 30∘ with an electric field of intensity 2×10^5 NC^{-1}. It experiences a torque equal to 4 Nm. Calculate the magnitude of charge on the dipole, if the dipole length is 2 cm: **2mC**

- If $\oint \vec{E}\cdot\overrightarrow{dS} = 0$ over a surface is 0, then : **the number of flux lines entering the surface must be equal to the number of flux lines leaving it**

- An electric dipole is placed as shown in the figure. The electric potential (in 10^2 V) at point P due to the dipole is **(3/8)qK**