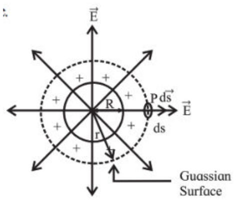
Electric Field Intensity due to a uniformly charged hollow sphere (shell):

Consider a hollow sphere of radius R, uniformly charged with surface charge density σ and placed in a dielectric medium with permittivity ε (=εo.k).
Total charge q on the hollow sphere = σ A = σ 4πR²
To find electric field intensity at a point P, which is r away from the center of this hollow sphere, we construct a concentric Gaussian sphere centered around O and having radius r.



Let ds be a small area around P (which is on the Gaussian surface).
Electric Field at P is directed radially outwards and the angle θ between E and ds is zero. Thus cos θ =1
dϕ = flux through ds = $\bar{E}.\overline{ds}$= E.ds.cosθ = E.ds
Thus, total flux through the Gaussian surface ϕ = $\oint d\phi$
ϕ=$\oint \bar{E}.\overline{ds}$= $\oint E.ds$= E$\oint ds$=E(4πr²)
by Gauss' Theorem ϕ = q/εo
thus, q/εo = E(4πr²)

thus, $E = \frac{q}{4\pi\varepsilon o r^2}$

But q= σ (4πR²)

Thus, $E = \frac{q}{4\pi\varepsilon o r^2} = \frac{\sigma\, 4\pi R^2}{4\pi\varepsilon o r^2}$

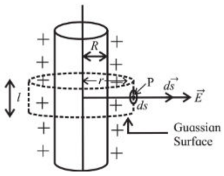
Thus $E = \frac{\sigma R^2}{\varepsilon o.r^2}$

Case 1: Point P is on the hollow sphere (r=R)
then $E = \frac{q}{4\pi\varepsilon o\, R^2} = \frac{\sigma}{\varepsilon o}$

Case 2: Point P in inside the hollow sphere, then the charge enclosed by the Gaussian Sphere will be q=0. Thus E=0

Electric Field Intensity due to a uniformly charged infinite long straight Wire:

Consider a uniformly charged wire of infinite length having a constant linear charge density λ (=q/l), kept in a material medium of permittivity ε (=εok).
To find the electric intensity a point P, r away from the charged wire, we imagine a Gaussian cylinder of radius r and length l. Consider a very small area ds at P, which is on the Gaussian cylinder.



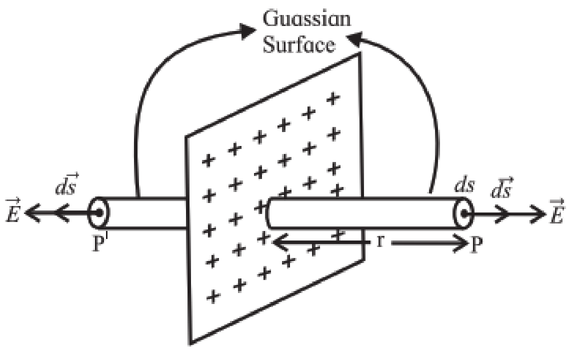
Electric Field at P is directed radially outwards and the angle θ between E and ds is zero. Thus cos θ =1
dϕ = flux through ds = $\bar{E}.\overline{ds}$= E.ds.cosθ = E.ds
Thus, total flux through the Gaussian surface ϕ = $\oint d\phi$
ϕ=$\oint \bar{E}.\overline{ds}$= $\oint E.ds$= E$\oint ds$=E(2πrl)
by Gauss' Theorem ϕ = q/εo
Thus, q/εo = E(2πrl)

Thus, $E = \frac{q}{2\pi\, \varepsilon o\, r\, l}$

Thus, $E = \frac{\lambda}{2\pi r\varepsilon o}$ (Since λ = q/l)

Electric Field Intensity due to a uniformly charged infinite Plane Sheet:

Consider a uniformly charged infinite plane sheet with surface charge density σ (=q/A)
Electric field E is directed outwards and perpendicular to the sheet and equal on both side at the same distance from the sheet.
To find the electric field at point P on either side of the sheet, we consider a Gaussian cylindrical surface of length 2r and area of cross section A with axis perpendicular to the sheet and the ends include point P
Electric Field at P is directed outwards and the angle θ between E and ds is zero. Thus cos θ =1



Total flux ϕ = $[\oint E.ds]_P + [\oint E.ds]_{P'}$= EA + EA = 2EA
by Gauss' Theorem ϕ = q/εo = σA/εo
Thus, σA/εo = 2EA

Thus, $E = \frac{\sigma}{2\varepsilon o}$