

Department of Physics, Bennett University

Tutorial Set-1

1. A charge Q is distributed uniformly over a ring of radius R centered at the point C . Find the electric field at a point P lying along the axis of the ring and at a distance a from the point C .
2. A charge Q is distributed uniformly on the surface of a circular disc of radius R . Calculate the electric field along the axis of the disc at a distance z from the center of the disc.
3. A positive charge $Q = 10$ mC is placed at the center of a cavity formed inside a spherical conducting shell having an inner radius R_1 and outer radius R_2 .
 - (a) Obtain the total charges induced at the inner and outer surfaces of the shell.
 - (b) Will the charge be distributed uniformly or non uniformly on the the inner and outer surfaces?
 - (c) How would your answer change if the point charge is not placed at the center of the cavity?
4. Consider a spherical shell formed by two concentric spheres of radii R_1 and R_2 ($R_2 > R_1$) and having a uniform volume charge density of ρ . There is no charge anywhere else. Using Gauss' law obtain the electric field produced by the charge distribution everywhere. Also, evaluate $\vec{\nabla} \cdot \vec{E}$ everywhere.
5. Consider a spherical volume charge distribution given by

$$\begin{aligned} \rho(r) &= \rho_0 + \alpha r & 0 < r < R \\ &= 0 & r > R \end{aligned}$$

where, r is the distance from the center of the sphere and ρ_0 and α are constants.

- (a) Calculate the total charge contained inside the sphere of radius R .
 - (b) Use Gauss' law to obtain the electric field everywhere due to the charge distribution.
 - (c) Obtain $\vec{\nabla} \cdot \vec{E}$ within and outside the sphere of radius R .
 - (d) Obtain $\vec{\nabla} \times \vec{E}$ within and outside the sphere.
6. A charge of 50 nC is distributed uniformly around a circular ring of radius 2 m.
 - (a) Obtain the electrostatic potential at a point on the axis at a distance of 5 m from the plane of the ring.
 - (b) What is the work done in moving a point charge of 10 nC from the center of the ring to the point P ?
 - (c) What is the net work done in moving the point charge of 10 nC from a point on the axis at a distance 5 m above the plane to a point on the axis at a distance 5 m below the plane?
 7. Consider an electrostatic field given by

$$\vec{E} = 2(x + 4y)\hat{x} + 8x\hat{y}$$

Obtain the potential difference between the origin and a point with coordinates (4,2,0).

8. A point charge 1.2 nC is located at a point with coordinates $(x_0 = 2, y_0 = 3, z_0 = 3)$. Calculate the potential difference between two points with coordinates (in the Cartesian system) $(2,2,3)$ and $(-2,3,3)$.