

Chapter23
Gauss' Law

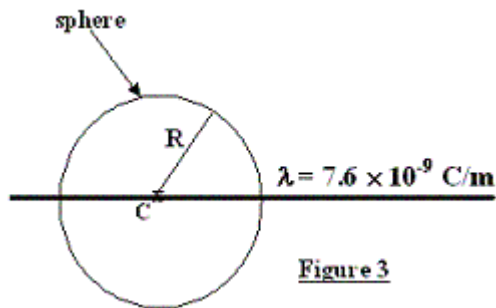
Flux

Q1. For the electric field: $E = (24 i + 30 j + 16 k)$ N/C, where i , j , and k are the unit vectors in the directions of x , y , and z , respectively, the electric flux through a 2.0 m^2 portion of the yz -plane is: Ans: $48 \text{ Nm}^2/\text{C}$.

Q2. When a piece of paper is held with one face perpendicular to a uniform electric field, the electric flux is $48 \text{ Nm}^2/\text{C}$. When the plane of the paper makes 30 degrees with the direction of the electric field the electric flux through it is: Ans: $24 \text{ Nm}^2/\text{C}$

Flux of an Electric Field

Q3. An infinitely long line has a charge density of 7.6 nano-C/m . Calculate the electric flux through a spherical surface of radius $R = 7.7 \text{ cm}$ whose center, C , lies on the line charge as shown in Figure 3. Ans: $132 \text{ (Nm}^2)/\text{C}$



m major2-001-Q0ajor2-001-Q0

Q4. If a rectangular area is turned in a uniform electric field from a position where the maximum electric flux goes through it to a position where only half the maximum flux goes through it, what is the turned angle? Ans: 60 degrees

Gauss' Law

Q5. A point charge $Q = 6 \text{ micro-C}$ is placed at the center a rectangular box with dimensions $a = b = 0.4 \text{ m}$ and $c = 0.6 \text{ m}$. Find the total electric flux through the surface of the box. Ans: $6.78 \times 10^5 \text{ Nm}^2/\text{C}$

Q6. Charges q and Q are placed on the x axis at $x = 0$ and $x = 2.0 \text{ m}$, respectively. If $q = -40 \text{ pico-C}$ and $Q = +30 \text{ pico-C}$, determine the net electric flux through a spherical surface of radius 1.0 m centered on the origin. Ans: $-4.5 \text{ Nm}^2/\text{C}$

Gauss' Law and Coulomb's Law

Q7. The electric field everywhere on the surface of a hollow sphere of radius 11 cm is measured to be equal $3.8 \times 10^4 \text{ N/C}$ and points radially inward towards the center of the sphere. How much charge is enclosed by this surface? Ans: $-5.1 \times 10^{-8} \text{ C}$.

Q8. A positive point charge q sits at the center of a hollow spherical shell. The shell, with radius R and negligible thickness, has net charge $-2q$. The electric field strength outside the spherical shell (at $r > R$) will be: Ans: kq/r^2 radially inwards.

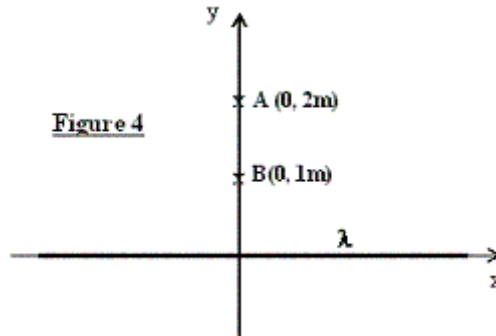
A Charged Isolated Conductor

Q9. A point charge ($q = -10.0$ micro-C) is at the center of a metallic sphere that has a radius of 20.0 cm. The electric field 0.500 m away from the center of the sphere is found to be -432 kV/m. What is the charge density on the metallic sphere? Ans: -4.00 micro-C/m²

Q10. A spherical conducting shell of inner radius r_1 and outer radius r_2 has a net charge of 2 micro-C. If a point charge of -4.0 micro-C is placed at the geometrical center of the spherical shell, what is the charge on the outer surface of the spherical shell? Ans: -2.0 micro-C

Applying Gauss' Law: Cylindrical Symmetry

Q11. Consider an infinitely long line of charge density 2.0 micro-C/m lying along the x-axis as shown in Figure 4. What is the ratio of electric field strength at point A to that at point B? Ans: 0.50



Q12. An infinite line of charge produces an electric field of 6.0×10^4 N/C at a perpendicular distance of 2.5 m from its axis. Calculate the linear charge density. Ans: 8.3×10^{-6} C/m.

Applying Gauss' Law: Planar Symmetry

Q13. Two infinite non-conducting parallel surfaces carry uniform charge densities of 0.20 nano-C/m² and -0.60 nano-C/m². What is the magnitude of the electric field at a point between the two surfaces? Ans: 45 N/C

Q14. Figure 4 shows cross-sections through two large, parallel non-conducting sheets with identical distributions of negative charge. The surface charge density for each sheet is 7.00×10^{-15} C/m². What is the electric field at point A? Ans: 7.91×10^{-4} N/C downward

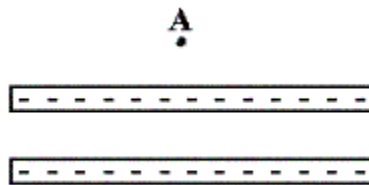


Figure 4

Applying Gauss' Law: Spherical Symmetry

Q15. Which one of the graphs shown in Figure 2 represents the variation of the magnitude of the electric field with the distance from the center of a solid charged conducting sphere of radius R in electrostatic equilibrium? Ans: #5

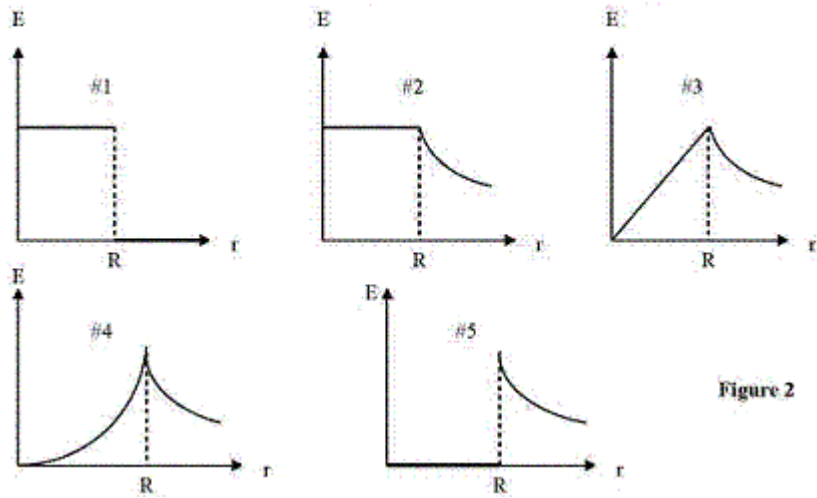


Figure 2

Q16. Two conducting spheres are far apart. The smaller sphere carries a total charge of 4 micro-C, and the larger sphere carries a total charge of 2 micro-C. The larger sphere has a radius that is twice that of the smaller sphere. After the two spheres are connected by a thin conducting wire, the charges on the smaller and larger spheres, respectively, are: Ans: 2 micro-C and 4 micro-C