2nd Assignment
Subject : Physics II (Electrodynamics)

Gauss's Law

Problem 2.16 A long coaxial cable (Fig. 2.26) carries a uniform *volume* charge density ρ on the inner cylinder (radius a), and a uniform *surface* charge density on the outer cylindrical shell (radius b). This surface charge is negative and of just the right magnitude so that the cable as a whole is electrically neutral. Find the electric field in each of the three regions: (i) inside the inner cylinder ($s < a$), (ii) between the cylinders ($a < s < b$), (iii) outside the cable ($s > b$). Plot $|\mathbf{E}|$ as a function of s.

Problem 2.17 An infinite plane slab, of thickness $2d$, carries a uniform volume charge density ρ (Fig. 2.27). Find the electric field, as a function of y, where $y = 0$ at the center. Plot E versus y, calling E positive when it points in the $+y$ direction and negative when it points in the $-y$ direction.

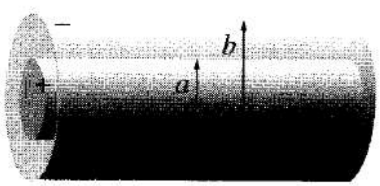


Figure 2.26

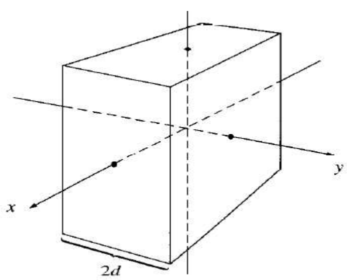


Figure 2.27

3. A point charge q is fixed at the tip of a cone of semi-vertical angle θ. Derive the expression of electrical flux through the base of the cone.

Electrostatic Potential

Problem 2.21 Find the potential inside and outside a uniformly charged solid sphere whose radius is R and whose total charge is q. Use infinity as your reference point. Compute the gradient of V in each region, and check that it yields the correct field. Sketch $V(r)$.

Problem 2.22 Find the potential a distance s from an infinitely long straight wire that carries a uniform line charge λ. Compute the gradient of your potential, and check that it yields the correct field.

Problem 2.47 Two infinitely long wires running parallel to the x axis carry uniform charge densities $+\lambda$ and $-\lambda$ (Fig. 2.54).

(a) Find the potential at any point (x, y, z), using the origin as your reference.

Problem 2.32 Find the energy stored in a uniformly charged solid sphere of radius R and charge q. Do it three different ways:

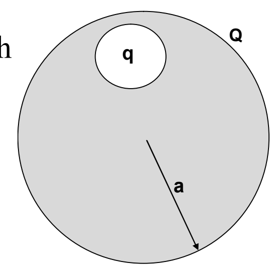
(i) $U = \frac{1}{2}\iiint \rho V d\tau$

(ii) $U = \frac{\epsilon_0}{2} \underset{All\ Space}{\iiint} \left|E^2\right| d\tau$

(iii) $U = \frac{\epsilon_0}{2} \oiint V\vec{E}\cdot d\vec{s} + \frac{\epsilon_0}{2}\iiint \left|E^2\right| d\tau$

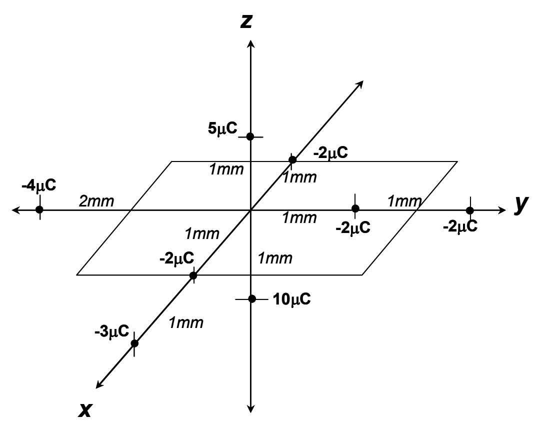
Electrostatic Properties of Metal

1. A solid conducting sphere of radius a, contains a charge q in a spherical cavity (with radius R) and carries charge Q on the outer surface, as shown in the figure. Calculate the surface charge density of the inner surface of the cavity and the outer surface of the solid sphere. [2] What will be the surface charge densities, if the conducting sphere is grounded? [2] What will be the electric field outside the conducting sphere in the grounded condition? [2]



Multipole Expansion

1. Find out dipole moment of the following charge configuration. What is the electrostatic potential of this charge configuration at a distant point (0.4m, 0.3m, 0)?



Problem 3.30 Two point charges, $3q$ and $-q$, are separated by a distance a. For each of the arrangements in Fig. 3.35, find (i) the monopole moment, (ii) the dipole moment, and (iii) the approximate potential (in spherical coordinates) at large r (include both the monopole and dipole contributions) Consider origin as the reference point.

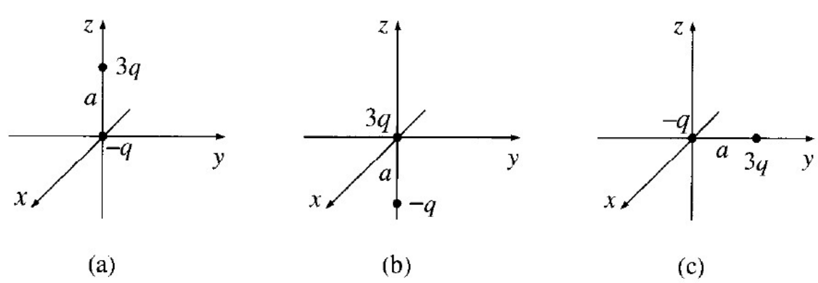


Figure 3.35