3rd Assignment
Subject : Physics II (Electrodynamics)
Date: 25^{h} Feb 2014

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.

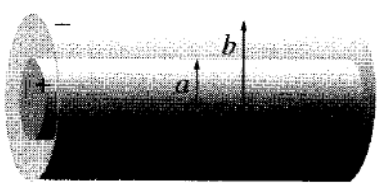


Figure 2.26

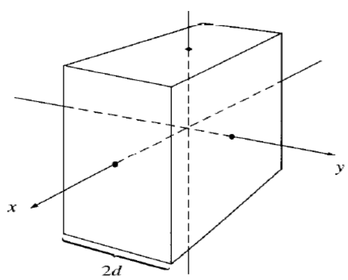
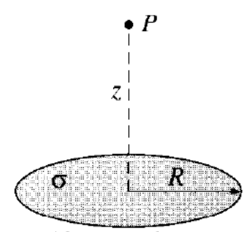


Figure 2.27



(c) Uniform surface charge

Fig.1

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 : Find potential at a distance z above the center of the charge distribution shown in the Fig.1. Find the expression of electric field at that point.

Electrostatic Potential Energy

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

(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

Problem 2.36 Two spherical cavities, of radii a and b, are hollowed out from the interior of a (neutral) conducting sphere of radius R (Fig. 2.49). At the center of each cavity a point charge is placed—call these charges q_a and q_b.

(a) Find the surface charges σ_a, σ_b, and σ_R.

(b) What is the field outside the conductor?

(c) What is the field within each cavity?

(d) What is the force on q_a and q_b?

(e) Which of these answers would change if a third charge, q_c, were brought near the conductor?

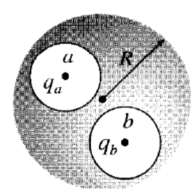


Figure 2.49

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)?