2.5 PROBLEMS

Problem 2.5.1. A point charge of 10 μC is at an unspecified location inside a cube of side 2 cm. Find the electric flux though the surfaces of the cube. Ans: 1.13×10^6 N.m^2/C.

Problem 2.5.2. It is found that there is a net flux of 1.0×10^4N.m^2/C inward through the surface of a sphere of radius 5 cm. (a) How much charge is inside the sphere? (b) Where is the charge located? Ans: (a) 8.85×10^{-8} C.

Problem 2.5.3. A point charge q is at the center of a cube of side a. Find the electric flux through one of its sides.

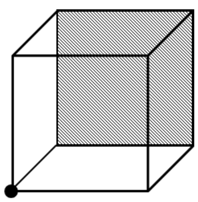

Figure 2.31: Problem **??**

Problem 2.5.4. A charge q is placed at one of the corners of a cube of side a. Find the electric flux through the shaded face shown in the Fig. 2.31. Assume $q > 0$.

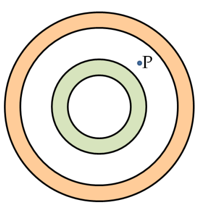

Figure 2.32: Problem 2.5.5

Problem 2.5.5. A non-conducting spherical shell of inner radius a_1 and outer radius b_1 is uniformly charged with charged density ρ_1 inside another non-conducting spherical shell of inner radius a_2 and outer radius b_2 which is also uniformly charged with charge density ρ_2. Find electric field at space point P at a distance r from the common center such that (a) $r > b_2$, (b) $a_2 < r < b_2$, (c) $b_1 < r < a_2$, (d) $a_1 < r < b_1$, and (e) $r < a_1$.

Problem 2.5.6. A non-conducting sphere of radius R has non-uniform charge density given by the following function of the distance r from the center of the sphere: $\rho = \rho_0 \frac{r}{R}$, where ρ_0 is constant with units of charge density. Find the electric field (a) at an arbitrary point outside the sphere, and (b) at an arbitrary point inside the sphere. Ans: (a) $\frac{\rho_0}{4\epsilon_0}\frac{R^3}{r^2}$, (b) $\frac{\rho_0}{4\epsilon_0 R} r^2$.

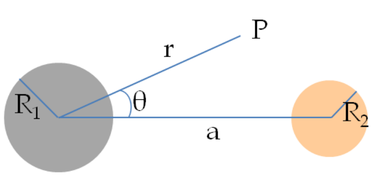

Figure 2.33: Problem 2.5.7

Problem 2.5.7. Two non-conducting spheres of radii R_1 and R_2 are uniformly charged with charge densities ρ_1 and ρ_2 respectively. They are separated at center-to-center distance a. Find the electric field at point P located at a distance r from the center of sphere 1 and is in the direction θ from the line joining the two spheres assuming their charge densities are not affected by the presence of the other sphere. Hint: Work one sphere at a time and use superposition principle.

Problem 2.5.8. Two non-conducting uniformly charged thin straight wires of line charge densities λ_1 and λ_2 respectively are placed a distance d apart. Find the electric field at a distance s from wire #1 and at an angle θ from the line joining 1 and 2. Hint: Work one wire at a time and use superposition principle.

Problem 2.5.9. A spherical cavity of radius a is cut in a non-conducting sphere R of uniform charge density ρ. The center of the cavity is at a distance d from the center of the sphere. Find the electric field at points P_1, P_2 and P_3 shown in the figure. The point P_1 is at a distance $(d-a)$ from the center, point P_2 is directly above the center of the cavity perpendicular to the line joining the centers of the sphere and the cavity, and point P_3 is a distance d above the center of the sphere above the center perpendicular to the line joining the centers of the sphere and cavity. Hint: Fill hole with $\pm\rho$.

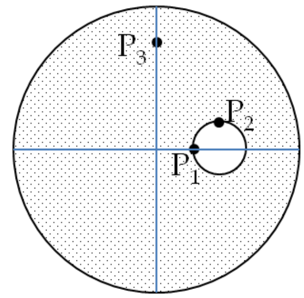

Figure 2.34: Problem 2.5.9

Problem 2.5.10. A disk of radius R is cut in a non-conducting large plate that is uniformly charged with charge density σ (coulomb per square meter). Find the electric field at a height h above the center of the disk. ($h >> R$, $h << l$ or w). Hint: Fill hole with $\pm\sigma$. Ans: $\frac{\sigma h}{\sqrt{R^2+h^2}}$.

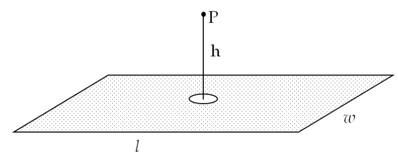

Figure 2.35: Problem 2.5.10