Week 8, Session 1 Problems

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10/11 (204) or 10/12 (209)

1 Gauss' Law

1.1 Uniformly Charged Sphere

Suppose that there is a ball of radius R with charge Q uniformly distributed through the volume. What is the volume charge density ρ? What is the electric field $\vec{E}$ at all points in space?

(*Source: Vetri Velan and Dan Parker*)

1.2 Non-Uniformly Charged Sphere

Suppose that there is a ball of radius R with volume charge density $\rho = A*R/r^2$ for $0 \leq r \leq R/2$ and $\rho = A/r$ for $R/2 \leq r \leq R$. If the total charge in the ball is Q, what is A? Find the electric field $\vec{E}$ at all points in space.

1.3 Generalizing for Spheres

Suppose that there is a ball of radius R with non-uniform volume charge density $\rho(r)$ in spherical coordinates. What is the electric field at all points in space? Leave your answer in terms of $\rho(r)$.

(*Source: Vetri Velan and Dan Parker*)

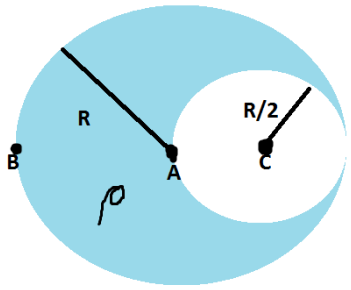
1.4 Sheets and Slabs

Suppose we have two infinite sheets of charge of negligible thickness. One has uniform surface charge density $-\sigma$ while the other has σ. These sheets are separated by a distance D, in which there is an infinite slab of thickness D and uniform volume charge density ρ that fills this space. Calculate the electric field at all points in space.

(*Source: Vetri Velan and Dan Parker*)

1.5 Superposition (hint hint)

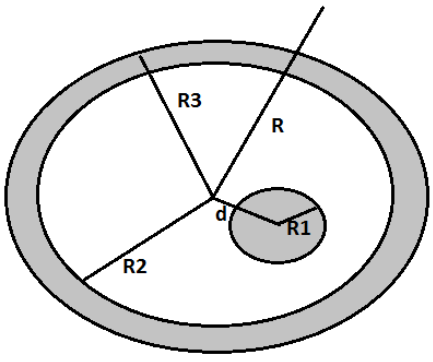
A sphere of radius R carries a volume charge density ρ. A spherical cavity of radius $R/2$ is then scooped out and left empty, where this cavity's diameter goes from the center of the original sphere to its edge. (a) What is the magnitude and direction of the electric field at point A? (b) What is the direction and magnitude of the electric field at point B? (c) What is the magnitude and direction of the electric field at point C? Points A and C are at the centers of the respective spheres.



(*Source: Slightly modified from Giancoli 22.61*)

1.6 Conductors

A very long solid nonconducting cylinder of radius R_1 is uniformly charged with charge density ρ. It is surrounded by a cylindrical metal (conducting) tube of inner radius R_2 and outer radius R_3, which has no net charge. If the axes of the two cylinders are parallel, but displaced from each other by a distance d, determine the resulting electric field in the region $R > R_3$, where the radial distance R is measured from the metal cylinder's axis.



(*Source: Giancoli 22.40*)