Question 22.5 A spherical Gaussian surface encloses a point charge q. If the point charge is moved from the center of the sphere to a point away from the center, does the electric field at a point on the surface change? Does the total flux through the Gaussian surface change? Explain.

Question 22.14 In a certain region of space, the electric field $\mathbf{E}$ is uniform.

(a) Use Gauss's law to prove that this region of space must be electrically neutral; that is, the volume charge density ρ must be zero.

(b) Is the converse true? That is, in a region of space where there is no charge, must $\mathbf{E}$ be uniform? Explain.

Question 22.15

(a) In a certain region of space, the volume charge density ρ has a uniform positive value. Can $\mathbf{E}$ be uniform in this region? Explain.

(b) Suppose that in this region of uniform positive ρ there is a "bubble" within which $\rho = 0$. Can $\mathbf{E}$ be uniform within this bubble? Explain.

Problem 22.62 A region in space contains a total positive charge Q that is distributed spherically such that the volume charge density $\rho(r)$ is given by

$$\rho(r) = \frac{3\alpha r}{2R} \quad \text{for } r \le \frac{R}{2}, \qquad \rho(r) = \alpha\left[1 - \left(\frac{r}{R}\right)^2\right] \quad \text{for } \frac{R}{2} \le r \le R, \qquad \rho(r) = 0 \quad \text{for } r \ge R.$$

Here α is a positive constant having units of $\mathrm{C\,m^{-3}}$.

(a) Determine α in terms of Q and R.

(b) Using Gauss's law, derive an expression for the magnitude of the electric field as a function of r. Do this separately for all three regions. Express your answers in terms of Q.

(c) What fraction of the total charge is contained within the region $R/2 \le r \le R$?

(d) What is the magnitude of $\mathbf{E}$ at $r = R/2$?