

A-De Discussion

Question 22.14 In a certain region of space, the electric field 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 **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 **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 **E** be uniform within this bubble? Explain.

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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

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

Here α is a positive constant having units of 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 **E** at r = R/2?

January 22, 2020 2