
[Cheng P.3-22] The polarization in a dielectric cube of side L centered at the origin is given by $\mathbf{P} = P_0(\mathbf{a}_x x + \mathbf{a}_y y + \mathbf{a}_z z)$.

- a Determine the surface and volume bound-charge densities.
- b Show that the total bound charge is zero.

Solution:

(a) $\rho_{p,s} = P_0 \frac{L}{2}$, on all six faces of the cube, $\rho_{p,v} = -\nabla \cdot \mathbf{P} = -3P_0$.

(b) $Q_s = (6L^2)\rho_{p,s} = 3P_0L^2$. $Q_v = (L^3)\rho_{p,v} = -3P_0L^3$.

Answer:

(a) $\rho_{p,s} = P_0 \frac{L}{2}$, on all six faces of the cube, $\rho_{p,v} = -3P_0$.

(b) $Q_s = 3P_0L^2$. $Q_v = -3P_0L^3$.