An insulating sphere of radius \(a\) has a total charge of \(+4Q\) uniformly distributed throughout its volume. Concentrically placed around it is a thin conducting sphere of radius \(b\) which has a total charge on its two surfaces of \(+2Q\).

(a) What is the charge on the outer surface of the thin sphere?

\[ +4Q + Q_{\text{outer}} = 0 \Rightarrow Q_{\text{outer}} = -4Q \]

\[ Q_{\text{inner}} + Q_{\text{outer}} = +2Q \Rightarrow Q_{\text{inner}} = 6Q \]

(Grading: -4p) for wrong charge addition or subtraction

(b) What is the volume charge density \(\rho\) within the inner sphere?

\[ \rho = \frac{+4Q}{\frac{4\pi}{3} a^3} \]

(c) What is the magnitude of the electric field inside the inner sphere?

\[ E(r) \cdot (4\pi r^2) = \frac{\rho}{\varepsilon_0} \frac{4\pi}{3} r^3 \]

\[ \Rightarrow E(r) = \frac{4Q r}{4\pi \varepsilon_0 a^3} \]