An insulating sphere of radius 5 cm is surrounded by a hollow conducting sphere with an inner radius of 20 cm and an outer radius of 25 cm. The insulator and conductor both have a net charge. The electric field $E$ at a distance of 10 cm from the center of the system is found to be 3600 N/C radially inward, while the field at a point 50 cm from the center of the system is found to be 200 N/C radially outward. (a) What is the charge of the insulating sphere? (b) What is the net charge on the conducting sphere? (c) What is the charge on the inner surface of the conducting sphere? (d) What is the charge on the outer surface of the conducting sphere?
Solutions:

(a) At $r = 10$ cm we are told $E = -3600$ N/C. From the Gauss Law,

$$E4\pi r^2 = Q/\varepsilon_0,$$
so $Q = 4\pi r^2 \varepsilon_0 E,$
giving $-4 \times 10^{-9}$ C.

(b) At $r = 50$ cm the Gauss Law gives $E4\pi r^2 = (Q_c + Q)/\varepsilon_0,$ which gives, solving for $Q_c$, the result $9.5 \times 10^{-9}$ C.

(c) For $20$ cm $< r < 25$ cm we are in the conductor so $E = 0$ so $Q_{in} = 0,$ so the charge on the inner surface must be $Q' = +4 \times 10^{-9}$ C.

(d) We know the total charge on the conductor, and we know the inner surface charge, so the outer surface charge is also known, since it must satisfy $Q_c = Q' + Q'',$ which means $Q'' = 5.5 \times 10^{-9}$ C.