The figure shows a spherical conducting shell with inner and outer radii of \( a \) and \( b \). This shell has a net charge of \(-5Q\). There is also a point charge \(+4Q\) at its center.

(a) What is the charge on the inner surface of the shell?

Choose a Gaussian surface at \( r = a \)

\[
\oint E \cdot d\mathbf{a} = \frac{9\mu}{60}
\]

But \( E = 0 \Rightarrow q_i = 0 \Rightarrow q_{r=a} + 4Q = 0 \)

or \( q_{r=a} = -4Q \)

(b) What is the charge on the outer surface of the shell?

Total charge is \(-5Q = q_{r=a} + q_{r=b} \)

\[ q_{r=b} = -5Q - q_{r=a} = -Q \]

(c) At a position \( r \) outside the shell, what is the magnitude and direction (indicate with an arrow on the figure) of the electric field?

\[
\oint E \cdot d\mathbf{a} = \frac{9\mu}{60} = \frac{(+4Q - 5Q)}{60}
\]

Therefore

\[ E(r) = \frac{-Q}{4\pi \epsilon_0 r^2} \]

(d) In the vacuum just inside the shell \( (r = a) \), what is the magnitude and direction (indicate with an arrow on the figure) of the electric field?

\[
\oint E \cdot d\mathbf{a} = \frac{9\mu}{60} = \frac{+4Q}{60}
\]

\[ E(r) = \frac{1}{4\pi \epsilon_0} \frac{4Q}{r^2} \]