1. Five point charges $q$ and four Gaussian surfaces $S$ are shown.

   a. What is the total electric flux through surface $S_1$?

   Zero, since there is no charge enclosed by the surface.

   b. What is the total electric flux through surface $S_4$?

   \[ \Phi_E = \frac{q_{\text{in}}}{\varepsilon_0} = \frac{2q}{\varepsilon_0} \]

2. A solid ball of radius $r_b$ has a uniform charge density $\rho$.

   a. What is the magnitude of the electric field $E(r)$ at a distance $r > r_b$ from the center of the ball?

   \[ \Phi_E = \oint E \cdot d\vec{A} = \int E dA = EA = E \pi r^2 \]

   \[ \Phi_E = \frac{q_{\text{in}}}{\varepsilon_0} = \frac{4/3 \pi r_b^3 \rho}{\varepsilon_0} \]
\[ E 4\pi r^2 = \frac{4/3\pi r_b^3 \rho}{\varepsilon_0} \]

\[ E = \frac{\frac{1}{3\varepsilon_0}}{r^2} \]

c. What is the magnitude of the electric field \( E(r) \) at a distance \( r<r_b \) from the center of the ball?

\[ \Phi_E = \oint E \cdot d\mathbf{A} = \int EdA = E \int dA = EA = E 4\pi r^2 \]

\[ \Phi_E = \frac{q_{in}}{\varepsilon_0} = \frac{4/3\pi r^3 \rho}{\varepsilon_0} \]

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

\[ E = \frac{\rho}{3\varepsilon_0 r} \]