Consider an electrostatic situation. A point charge $Q_1 > 0$ is located at the center of a hollow thick spherical shell (made of an insulating material) that has an inner radius of $R_2$ and an outer radius of $R_3$. Naturally, the charge on the shell’s inner surface is $-Q_1$, and the charge on the shell’s outer surface is $Q_2 > 0$. Let $S$ (dashed circular line) be a concentric spherical surface (Gaussian surface) with a radius $R_1$.

Find $E_1$, the magnitude of the radial electric field vector at the surface of the Gaussian surface $S$, which is a distance $R_1$ from the center of the spherical conducting shell.

\[ A) \quad \vec{E} = \frac{1}{4 \pi \epsilon_0} \frac{Q_1}{R_1^2} \]

\[ B) \quad \vec{E} = \frac{1}{4 \pi \epsilon_0} \frac{Q_2}{R_1^2} \]

\[ C) \quad \vec{E} = \frac{1}{4 \pi \epsilon_0} \frac{Q_1 + Q_2}{R_1^2} \]

Since the charge distribution is spherically symmetric, $||\vec{E}||$ must be the same everywhere on $S$. And by symmetry $\vec{E}$ must be directed radially, either outward or inward. However there is a charge enclosed in the Gaussian surface, therefore $\Phi_S = \oint_S \vec{E} \cdot \vec{A} = \frac{Q_1 - Q_1 + Q_2}{\epsilon_0}$, or specifically $\vec{E} = \frac{1}{4 \pi \epsilon_0} \frac{Q_2}{R_1^2}$.

Answer B.

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