ICEs: Gauss' Law

4) A circular insulating disk is uniformly charged to 5.00 μC and has area 0.140 m².

(a) Find the approximate electric field strength 1.00 mm above the disk (not near an edge).

\[
\begin{align*}
\text{Gaussian surface: } & \Phi = \oint E \cdot dA = \int E dA \\
\text{so } & \Phi = E \int dA = E(2A) = \frac{q}{\epsilon_0} = \frac{Q}{\epsilon_0}
\end{align*}
\]

Then:

\[
E = \frac{Q}{2 \epsilon_0 A} = \frac{5.00 \times 10^{-12} \text{ C}}{2 \times 8.85 \times 10^{-12} \text{ C/m}^2 \times 0.140 \text{ m}^2} = 2.02 \times 10^6 \text{ N/C}
\]

(b) Find the approximate electric field strength 10.0 m from the disk.

For \( y = 10.0 \text{ m} \Rightarrow y >> \Gamma \Rightarrow \text{disk looks like a point charge} \)

\[
E = \frac{kQ}{y^2} = \frac{9.99 \times 10^9 \text{ N m}^2 \text{ C}^{-2}}{(10.0 \text{ m})^2} = 4.50 \times 10^6 \text{ N/C}
\]

(c) How would your answers to (a) and (b) change if the disk were a conductor?

\( E \) remains the same in both cases \( \Rightarrow \) the charge simply moves to the surfaces

(\( Q_{\text{conductor}} = \frac{1}{2} Q_{\text{insulator}} \Rightarrow \) but \( Q \) (and \( q_m \)) remain the same since we have 2 surfaces)