7. A surface element of area \( dA = 4.8 \times 10^{-6} \text{ m}^2 \) has normal \( \mathbf{n} \) along \((-3, 1, 4)\). For this element, \( \mathbf{E} = (250, 180, -80) \text{ V/m} \).
   a. (5 pts) Find \( \mathbf{n} \).
   \[
   \mathbf{n} = \frac{(-3, 1, 4)}{\sqrt{9 + 1 + 16}} = \frac{(-3, 1, 4)}{5.10} = (-0.588, 0.196, 0.784)
   \]
   c. (5 pts) Find the flux \( d\Phi_E \) through \( dA \).
   \[
   \begin{align*}
   d\Phi_E &= \mathbf{E} \cdot \mathbf{n} dA \\
   &= (-147 + 353 - 62.7) \text{ V} \cdot 4.8 \times 10^{-6} \text{ m}^2 \\
   &= -175.4 \text{ V} \cdot 4.8 \times 10^{-6} \text{ m}^2 \\
   &= -8.37 \times 10^{-5} \text{ V} \cdot \text{m}.
   \end{align*}
   \]
   d. (5 pts) Find how much charge \( dQ \) will produce this \( d\Phi_E \).
   \[
   d\Phi_E = 4\pi k dQ, \quad dQ = \frac{4\pi k}{4\pi k} d\Phi_E = -7.41 \times 10^{-6} \text{ C}.
   \]

8. The figure gives the cross-section of a conductor that is infinitely long perpendicular to the page.
   a. (5 pts) Sketch the field lines.
   \[
   \begin{align*}
   \text{gap} &\to \text{c} \rightleftharpoons \text{a} \leftleftharpoons \text{b} \rightleftharpoons \text{gap} \\
   5 \text{ V} &\to \text{c} \rightleftharpoons \text{a} \leftleftharpoons \text{b} \rightleftharpoons 15 \text{ V}
   \end{align*}
   \]
   b. (5 pts) At which of the labeled points is the field the largest? the smallest?
   \[
   \text{c}, \quad \text{a}
   \]

9. A charge \( Q \) at the origin is surrounded by two concentric spherical conducting shells. The one at radius \( b \) has charge \(-3Q\) and that at radius \( 2b \) has charge \( 4Q \).
   a. (5 pts) In terms of \( Q \) and \( b \), find the charge per unit area on the shell at \( r = b \).
   \[
   \nabla = -\frac{3Q}{4\pi b^2}
   \]
   b. (5 pts) In terms of \( Q \) and \( b \), and using Gauss’s Law and symmetry, find the magnitude and direction of the field for \( b < r < 2b \).
   \[
   \begin{align*}
   \nabla &\cdot \mathbf{E}_r = \frac{kQ_{\text{enc}}}{r^2}, \quad \text{where} \quad Q_{\text{enc}} = Q - 3Q = -2Q. \\
   \text{So} \quad \mathbf{E}_r &= -\frac{kQ}{r^2} \quad \text{radially inward}
   \end{align*}
   \]
   c. (5 pts) Repeat for \( r > 2b \).
   \[
   \begin{align*}
   \nabla &\cdot \mathbf{E}_r = \frac{kQ_{\text{enc}}}{r^2}, \quad \text{where} \quad Q_{\text{enc}} = Q - 3Q + 4Q = 2Q. \\
   \text{So} \quad \mathbf{E}_r &= \frac{kQ}{r^2} \quad \text{radially outward}
   \end{align*}
   \]