

7. A surface element of area $dA = 3.2 \times 10^{-6} \text{ m}^2$ has normal \hat{n} along $(3, -1, 2)$. For this element, $\vec{E} = (230, -180, -50) \text{ V/m}$.

Pink

- a. (5 pts) Find \hat{n} .

$$\hat{n} = \frac{(3, -1, 2)}{\sqrt{9+1+4}} = \frac{(3, -1, 2)}{3.74} = (0.802, -0.267, 0.535)$$

- c. (5 pts) Find the flux $d\Phi_E$ through dA .

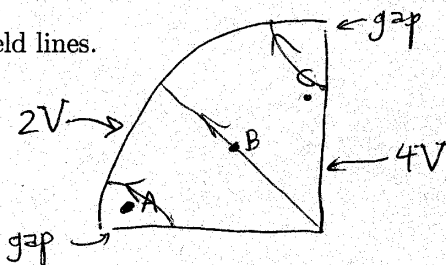
$$d\Phi_E = \vec{E} \cdot \hat{n} dA = (206 \frac{\text{V}}{\text{m}}) (3.2 \times 10^{-6} \text{ m}^2) = 6.59 \times 10^{-4} \text{ V-m}$$

- d. (5 pts) Find how much charge dQ_S will produce this $d\Phi_E$.

$$d\Phi_E = \frac{1}{4\pi\epsilon_0} dQ, \quad dQ = \frac{d\Phi_E}{4\pi\epsilon_0} = 5.83 \times 10^{-15} \text{ C}$$

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.

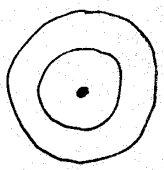


- b. (5 pts) At which of the labeled points is the field the largest? the smallest?

A B

9. A charge $-2Q$ at the origin is surrounded by two concentric spherical conducting shells. The one at radius a has charge $3Q$ and that at radius $2a$ has charge $-4Q$.

- a. (5 pts) In terms of Q and a , find the charge per unit area on the shell at $r = a$.



$$\sigma = \frac{3Q}{4\pi a^2}$$

- b. (5 pts) In terms of Q and a , and using Gauss's Law and symmetry, find the magnitude and direction of the field for $a < r < 2a$.

Use $E_r = \frac{k Q_{enc}}{r^2}$, where $Q_{enc} = -2Q + 3Q = Q$

so $E_r = \frac{kQ}{r^2}$ radially outward

- c. (5 pts) Repeat for $r > 2a$.

Use $E_r = \frac{k Q_{enc}}{r^2}$, where $Q_{enc} = -2Q + 3Q - 4Q = -3Q$

so $E_r = -\frac{3kQ}{r^2}$ radially inward