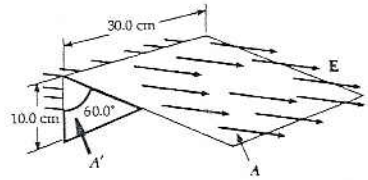
**24.5** (a) $A' = (10.0 \text{ cm})(30.0 \text{ cm})$




$A' = 300 \text{ cm}^2 = 0.0300 \text{ m}^2$

$\Phi_{E,A'} = EA' \cos\theta$

$\Phi_{E,A'} = (7.80 \times 10^4)(0.0300)\cos 180°$

$\Phi_{E,A'} = \boxed{-2.34 \text{ kN}\cdot\text{m}^2/\text{C}}$

(b) $\Phi_{E,A} = EA\cos\theta = (7.80 \times 10^4)(A)\cos 60.0°$

$A = (30.0 \text{ cm})(w) = (30.0 \text{ cm})\left(\dfrac{10.0 \text{ cm}}{\cos 60.0°}\right) = 600 \text{ cm}^2 = 0.0600 \text{ m}^2$

$\Phi_{E,A} = (7.80 \times 10^4)(0.0600)\cos 60° = \boxed{+2.34 \text{ kN}\cdot\text{m}^2/\text{C}}$

(c) The bottom and the two triangular sides all lie *parallel* to **E**, so $\Phi_E = 0$ for each of these. Thus,

$\Phi_{E,\text{ total}} = -2.34 \text{ kN}\cdot\text{m}^2/\text{C} + 2.34 \text{ kN}\cdot\text{m}^2/\text{C} + 0 + 0 + 0 = \boxed{0}$

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**24.16** (a) $\Phi_{E,\text{ shell}} = \dfrac{q_{\text{in}}}{\epsilon_0} = \dfrac{12.0 \times 10^{-6}}{8.85 \times 10^{-12}} = 1.36 \times 10^6 \text{ N}\cdot\text{m}^2/\text{C} = \boxed{1.36 \text{ MN}\cdot\text{m}^2/\text{C}}$

(b) $\Phi_{E,\text{ half shell}} = \frac{1}{2}(1.36 \times 10^6 \text{ N}\cdot\text{m}^2/\text{C}) = 6.78 \times 10^5 \text{ N}\cdot\text{m}^2/\text{C} = \boxed{678 \text{ kN}\cdot\text{m}^2/\text{C}}$

(c) $\boxed{\text{No,}}$ the same number of field lines will pass through each surface, no matter how the radius changes.

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**24.22** $\Phi_{E,\text{ hole}} = \mathbf{E}\cdot\mathbf{A}_{\text{hole}} = \left(\dfrac{k_e Q}{R^2}\right)(\pi r^2) = \left(\dfrac{(8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2)(10.0 \times 10^{-6} \text{ C})}{(0.100 \text{ m})^2}\right)\pi(1.00 \times 10^{-3} \text{ m})^2$

$\Phi_{E,\text{ hole}} = \boxed{28.2 \text{ N}\cdot\text{m}^2/\text{C}}$

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***24.28** (a) $E = \dfrac{2k_e\lambda}{r}$

$3.60 \times 10^4 = \dfrac{2(8.99 \times 10^9)(Q/2.40)}{(0.190)}$

$Q = +9.13 \times 10^{-7} \text{ C} = \boxed{+913 \text{ nC}}$

(b) $\boxed{E = 0}$

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**24.45** (a) Inside surface: consider a cylindrical surface within the metal. Since $E$ inside the conducting shell is zero, the total charge inside the gaussian surface must be zero, so the inside charge/length $= -\lambda$.

$0 = \lambda\ell + q_{\text{in}} \Rightarrow \dfrac{q_{\text{in}}}{\ell} = \boxed{-\lambda}$

Outside surface: The total charge on the metal cylinder is $2\lambda\ell = q_{in} + q_{out}$.

$q_{out} = 2\lambda\ell + \lambda\ell$

so the outside charge/length $= \boxed{3\lambda}$

(b) $E = \dfrac{2k_e(3\lambda)}{r} = \dfrac{6k_e\lambda}{r} = \boxed{\dfrac{3\lambda}{2\pi\epsilon_0 r}}$