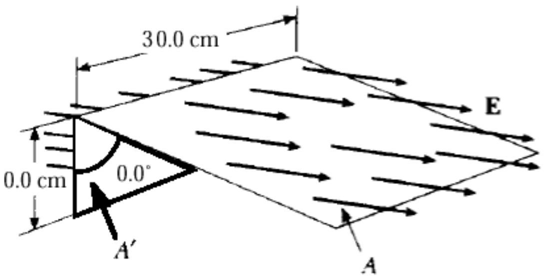
PHYS 232:Lecture Supplement 4

24.4



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

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

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

$\Phi_{E,\,A'} = \left(7.80\times10^4\right)(0.0300)\cos 180°$

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

(b) $\Phi_{E,\,A} = EA\cos\theta = \left(7.80\times10^4\right)(A)\cos 60.0°$

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

$\Phi_{E,\,A} = \left(7.80\times10^4\right)(0.0600)\cos 60° = \boxed{+2.34\ \text{kN}\cdot\text{m}^2/\text{C}}$

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

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

24.55 (a) $q_{\text{in}} = +3Q - Q = \boxed{+2Q}$

(b) The charge distribution is spherically symmetric and $q_{\text{in}} > 0$. Thus, the field is directed $\boxed{\text{radially outward}}$.

(c) $E = \dfrac{k_e q_{\text{in}}}{r^2} = \boxed{\dfrac{2k_e Q}{r^2}}$ for $r \geq c$

(d) Since all points within this region are located inside conducting material, $\boxed{E = 0}$ for $b < r < c$.

(e) $\Phi_E = \int \mathbf{E} \cdot d\mathbf{A} = 0 \Rightarrow q_{\text{in}} = \text{e}_0 \Phi_E = \boxed{0}$

(f) $q_{\text{in}} = \boxed{+3Q}$

(g) $E = \dfrac{k_e q_{\text{in}}}{r^2} = \boxed{\dfrac{3k_e Q}{r^2}}$ (radially outward) for $a \leq r < b$

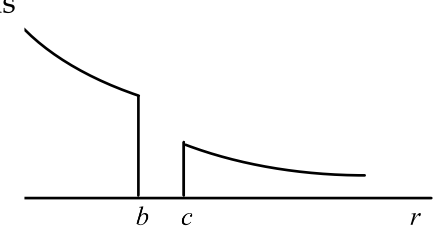
(h) $q_{\text{in}} = \rho V = \left(\dfrac{+3Q}{\frac{4}{3}\pi a^3}\right)\left(\dfrac{4}{3}\pi r^3\right) = \boxed{+3Q\dfrac{r^3}{a^3}}$

(i) $E = \dfrac{k_e q_{\text{in}}}{r^2} = \dfrac{k_e}{r^2}\left(+3Q\dfrac{r^3}{a^3}\right) = \boxed{3k_e Q\dfrac{r}{a^3}}$ (radially outward) for $0 \leq r \leq a$

(j) From part (d), $E = 0$ for $b < r < c$. Thus, for a spherical gaussian surface with $b < r < c$, $q_{\text{in}} = +3Q + q_{\text{inner}} = 0$ where q_{inner} is the charge on the inner surface of the conducting shell. This yields $q_{\text{inner}} = \boxed{-3Q}$

(k) Since the total charge on the conducting shell is $q_{\text{net}} = q_{\text{outer}} + q_{\text{inner}} = -Q$, we have

$$q_{\text{outer}} = -Q - q_{\text{inner}} = -Q - (-3Q) = \boxed{+2Q}$$



(l) See page A.38 of the text book