P24.1 (a) $\Phi_E = EA\cos\theta = (3.50\times10^3)(0.350\times0.700)\cos 0° = \boxed{858\ \text{N}\cdot\text{m}^2/\text{C}}$

(b) $\theta = 90.0°$ $\boxed{\Phi_E = 0}$

(c) $\Phi_E = (3.50\times10^3)(0.350\times0.700)\cos 40.0° = \boxed{657\ \text{N}\cdot\text{m}^2/\text{C}}$

P24.4 (a)
$A' = (10.0\ \text{cm})(30.0\ \text{cm})$

$A' = 300\ \text{cm}^2 = 0.030\,0\ \text{m}^2$

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

$\Phi_{E,\,A'} = (7.80\times10^4)(0.030\,0)\cos 180°$

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

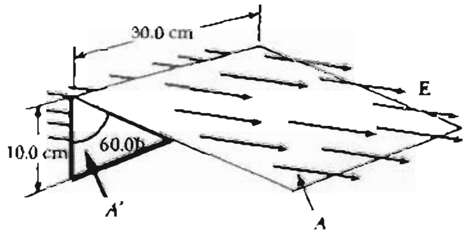

FIG. P24.4

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

$A = (30.0\ \text{cm})(w) = (30.0\ \text{cm})\left(\dfrac{10.0\ \text{cm}}{\cos 60.0°}\right) = 600\ \text{cm}^2 = 0.060\,0\ \text{m}^2$

$\Phi_{E,\,A} = (7.80\times10^4)(0.060\,0)\cos 60.0° = \boxed{+2.34\ \text{kN}\cdot\text{m}^2/\text{C}}$

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

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

P24.10 (a) $E = \dfrac{k_e Q}{r^2}$: $8.90\times10^2 = \dfrac{(8.99\times10^9)Q}{(0.750)^2}$

But Q is negative since **E** points inward. $Q = -5.56\times10^{-8}\ \text{C} = \boxed{-55.6\ \text{nC}}$

(b) The $\boxed{\text{negative}}$ charge has a $\boxed{\text{spherically symmetric}}$ charge distribution.

P24.11 $\Phi_E = \dfrac{q_{in}}{\epsilon_0}$

Through S_1 $\Phi_E = \dfrac{-2Q+Q}{\epsilon_0} = \boxed{-\dfrac{Q}{\epsilon_0}}$

Through S_2 $\Phi_E = \dfrac{+Q-Q}{\epsilon_0} = \boxed{0}$

Through S_3 $\Phi_E = \dfrac{-2Q+Q-Q}{\epsilon_0} = \boxed{-\dfrac{2Q}{\epsilon_0}}$

Through S_4 $\Phi_E = \boxed{0}$

P24.19 If $R \le d$, the sphere encloses no charge and $\Phi_E = \frac{q_{in}}{\epsilon_0} = \boxed{0}$.

If $R > d$, the length of line falling within the sphere is $2\sqrt{R^2 - d^2}$

so $\Phi_E = \boxed{\frac{2\lambda\sqrt{R^2 - d^2}}{\epsilon_0}}$.

P24.23 The charge distributed through the nucleus creates a field at the surface equal to that of a point charge at its center: $E = \frac{k_e q}{r^2}$

$$E = \frac{\left(8.99 \times 10^9 \text{ Nm}^2/\text{C}^2\right)\left(82 \times 1.60 \times 10^{-19} \text{ C}\right)}{\left[(208)^{1/3} 1.20 \times 10^{-15} \text{ m}\right]^2}$$

$E = \boxed{2.33 \times 10^{21} \text{ N/C}}$ away from the nucleus

P24.28 $\sigma = \left(8.60 \times 10^{-6} \text{ C/cm}^2\right)\left(\frac{100 \text{ cm}}{\text{m}}\right)^2 = 8.60 \times 10^{-2} \text{ C/m}^2$

$$E = \frac{\sigma}{2 \epsilon_0} = \frac{8.60 \times 10^{-2}}{2\left(8.85 \times 10^{-12}\right)} = \boxed{4.86 \times 10^9 \text{ N/C away from the wall}}$$

The field is essentially uniform as long as the distance from the center of the wall to the field point is much less than the dimensions of the wall.

*P24.34 The charge density is determined by $Q = \frac{4}{3}\pi a^3 \rho$ $\qquad \rho = \frac{3Q}{4\pi a^3}$

(a) The flux is that created by the enclosed charge within radius r:

$$\Phi_E = \frac{q_{in}}{\epsilon_0} = \frac{4\pi r^3 \rho}{3\epsilon_0} = \frac{4\pi r^3 3Q}{3\epsilon_0 4\pi a^3} = \boxed{\frac{Qr^3}{\epsilon_0 a^3}}$$

(b) $\Phi_E = \boxed{\frac{Q}{\epsilon_0}}$. Note that the answers to parts (a) and (b) agree at $r = a$.

(c)

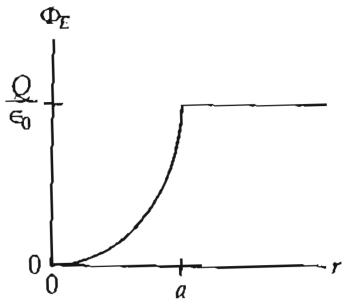

FIG. P24.34(c)

P24.35 (a) $E = \frac{2k_e\lambda}{r} = \frac{2(8.99\times10^9\ \text{N}\cdot\text{m}^2/\text{C}^2)[(2.00\times10^{-6}\ \text{C})/7.00\ \text{m}]}{0.100\ \text{m}}$

$E = \boxed{51.4\ \text{kN/C, radially outward}}$

(b) $\Phi_E = EA\cos\theta = E(2\pi r\ell)\cos 0°$

$\Phi_E = (5.14\times10^4\ \text{N/C})2\pi(0.100\ \text{m})(0.020\,0\ \text{m})(1.00) = \boxed{646\ \text{N}\cdot\text{m}^2/\text{C}}$