Q24.7 Faraday's visualization of electric field lines lends insight to this question. Consider a section of a vertical sheet carrying charge +1 coulomb. It has $\frac{1}{\epsilon_0}$ field lines pointing out from it horizontally to the right and left, all uniformly spaced. The lines have the same uniform spacing close to the sheet and far away, showing that the field has the same value at all distances.

Q24.9 Inject some charge at arbitrary places within a conducting object. Every bit of the charge repels every other bit, so each bit runs away as far as it can, stopping only when it reaches the outer surface of the conductor.

Q24.10 If the person is uncharged, the electric field inside the sphere is zero. The interior wall of the shell carries no charge. The person is not harmed by touching this wall. If the person carries a (small) charge q, the electric field inside the sphere is no longer zero. Charge $-q$ is induced on the inner wall of the sphere. The person will get a (small) shock when touching the sphere, as all the charge on his body jumps to the metal.

Q24.13 Gauss's law predicts, as described in section 24.4, that excess charge on a conductor will reside on the surface of the conductor. If a car is left charged by a lightning strike, then that charge will remain on the outside of the car, not harming the occupants. It turns out that during the lightning strike, the current also remains on the outside of the conductor. Note that it is not necessarily safe to be in a fiberglass car or a convertible during a thunderstorm.

P24.24 (a) $E = \frac{k_e Qr}{a^3} = \boxed{0}$

(b) $E = \frac{k_e Qr}{a^3} = \frac{(8.99 \times 10^9)(26.0 \times 10^{-6})(0.100)}{(0.400)^3} = \boxed{365\ \text{kN/C}}$

(c) $E = \frac{k_e Q}{r^2} = \frac{(8.99 \times 10^9)(26.0 \times 10^{-6})}{(0.400)^2} = \boxed{1.46\ \text{MN/C}}$

(d) $E = \frac{k_e Q}{r^2} = \frac{(8.99 \times 10^9)(26.0 \times 10^{-6})}{(0.600)^2} = \boxed{649\ \text{kN/C}}$

The direction for each electric field is $\boxed{\text{radially outward}}$.

P24.28 $\sigma = \left(8.60\times10^{-6}\ \text{C/cm}^2\right)\left(\frac{100\ \text{cm}}{\text{m}}\right)^2 = 8.60\times10^{-2}\ \text{C/m}^2$

$$E = \frac{\sigma}{2\,\epsilon_0} = \frac{8.60\times10^{-2}}{2\left(8.85\times10^{-12}\right)} = \boxed{4.86\times10^{9}\ \text{N/C away from the wall}}$$

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

P24.29 If ρ is positive, the field must be radially outward. Choose as the gaussian surface a cylinder of length L and radius r, contained inside the charged rod. Its volume is $\pi r^2 L$ and it encloses charge $\rho\pi r^2 L$. Because the charge distribution is long, no electric flux passes through the circular end caps; $\mathbf{E}\cdot d\mathbf{A} = EdA\cos 90.0° = 0$. The curved surface has $\mathbf{E}\cdot d\mathbf{A} = EdA\cos 0°$, and E must be the same strength everywhere over the curved surface.

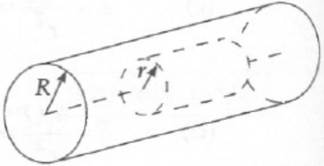

FIG. P24.29

Gauss's law, $\oint \mathbf{E}\cdot d\mathbf{A} = \frac{q}{\epsilon_0}$, becomes $E \int_{\substack{\text{Curved}\\\text{Surface}}} dA = \frac{\rho\pi r^2 L}{\epsilon_0}$.

Now the lateral surface area of the cylinder is $2\pi rL$:

$E(2\pi r)L = \frac{\rho\pi r^2 L}{\epsilon_0}$. Thus, $\mathbf{E} = \boxed{\frac{\rho r}{2\,\epsilon_0}\ \text{radially away from the cylinder axis}}$.

*P24.30 ...