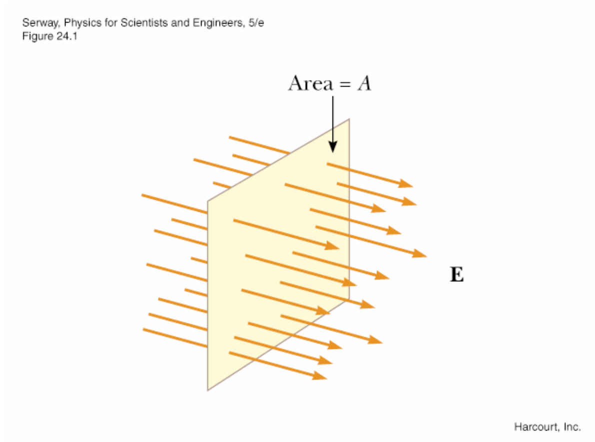
Electric Flux

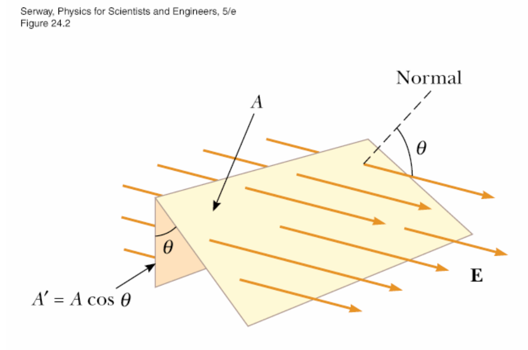
Proportional to the number of electric field lines penetrating a surface.

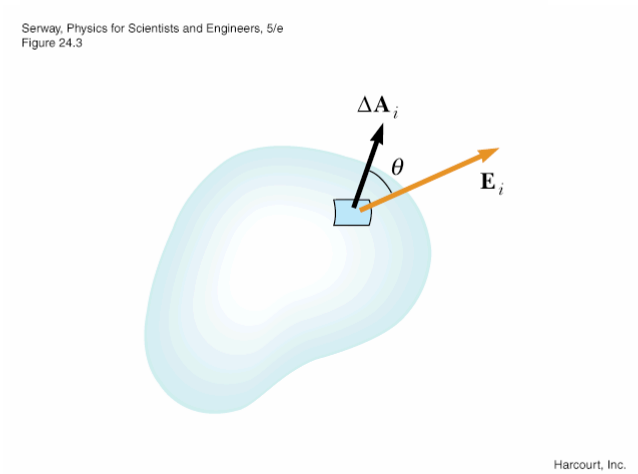


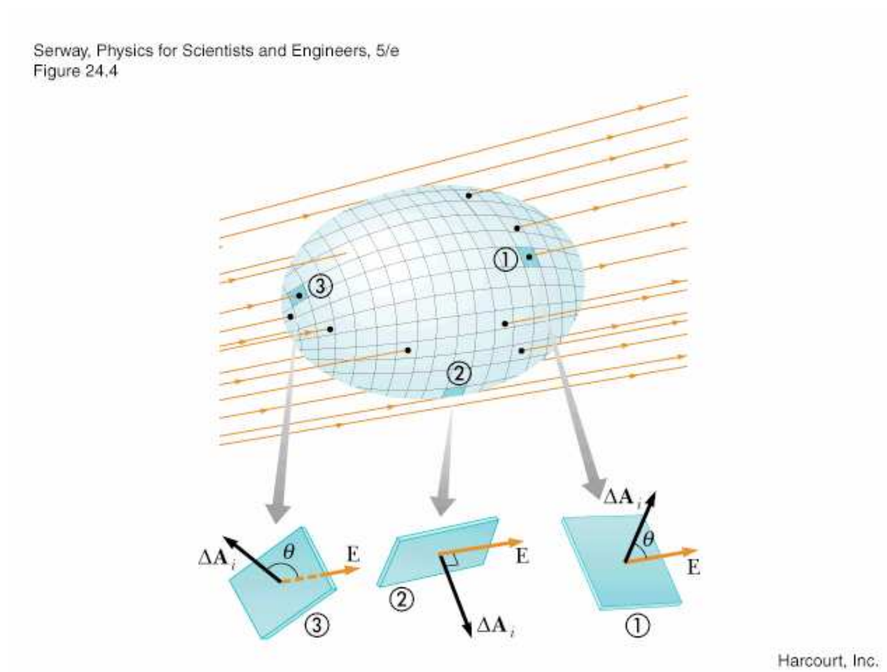
$$\Phi_E = EA\cos\theta$$

$$\Phi_E = \mathbf{E} \cdot \mathbf{A}$$

$$\Phi_E = \oint \mathbf{E} \cdot d\mathbf{A}$$







Gauss's Law

$$\mathbf{E} \cdot \Delta \mathbf{A} = E \Delta A$$

$$\Phi_E = \oint \mathbf{E} \cdot d\mathbf{A} = \oint E\, dA = E \oint dA$$

$$k_e = \frac{1}{4\pi\epsilon_0} \qquad \Phi_E = \frac{q}{\epsilon_0}$$

The net flux through any closed surface surrounding a point charge q is given by q/ϵ_0.

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Figure 24.6

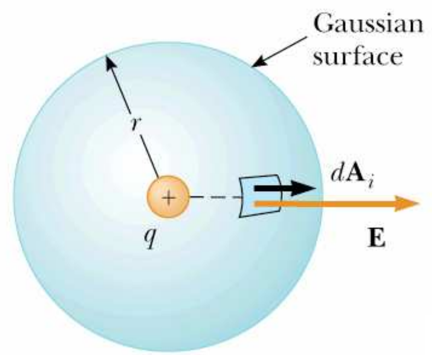

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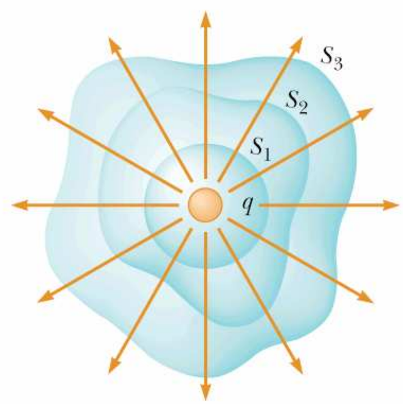
Figure 24.7



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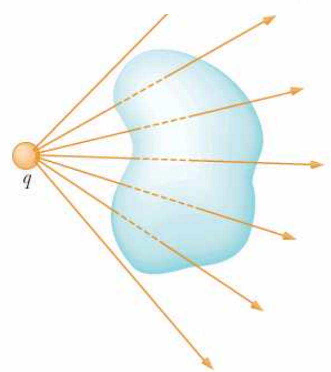

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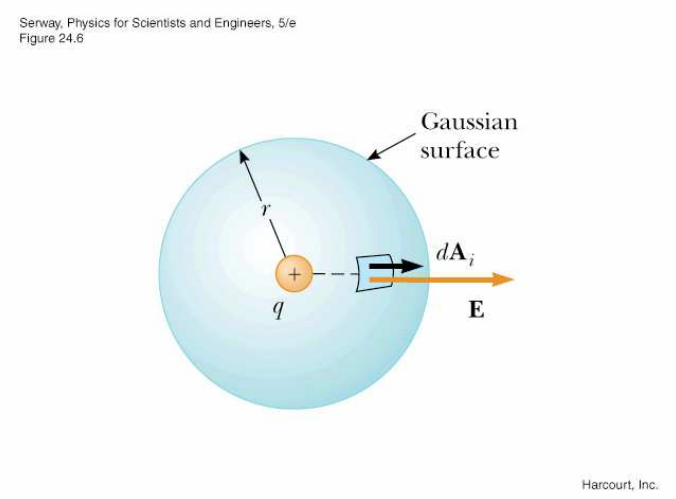
Gauss's Law

$$\Phi_E = \oint \mathbf{E} \cdot d\mathbf{A} = \frac{q_{in}}{\epsilon_0}$$

Example 24.3:
What happens to the total flux through The surface if:

a. The charge is tripled
b. The radius of the sphere is doubled
c. The surface is changed to a cube
d. The charge is moved to a another location inside the surface

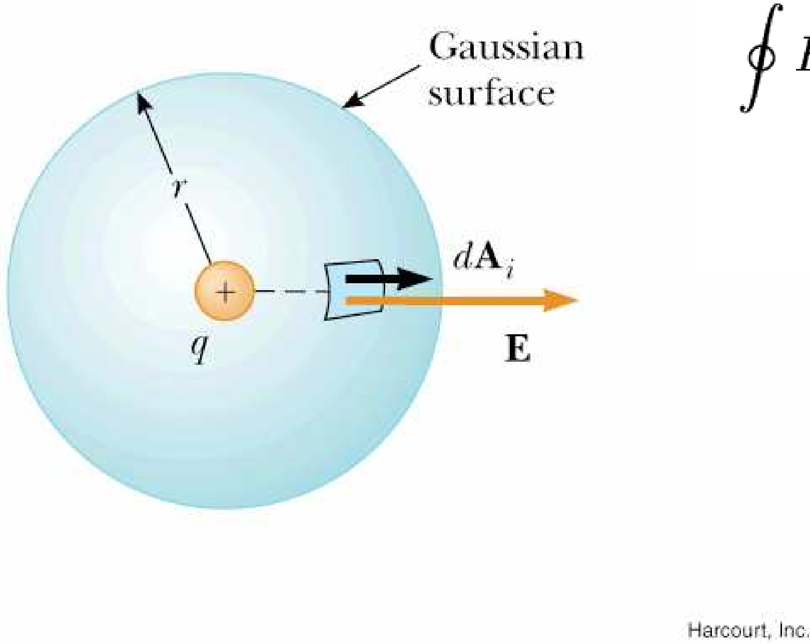


Application of Gauss's Law

Determine a surface such that:

1.Value of the electric field is constant over the surface
2. The dot product between **E** and d**A** can be expressed as a simple algebraic product because **E** and d**A** are parallel
3. The dot product is zero because **E** and d**A** are perpendicular
4. The field is zero over the surface.

Example 24.4: Electric field due to a point charge

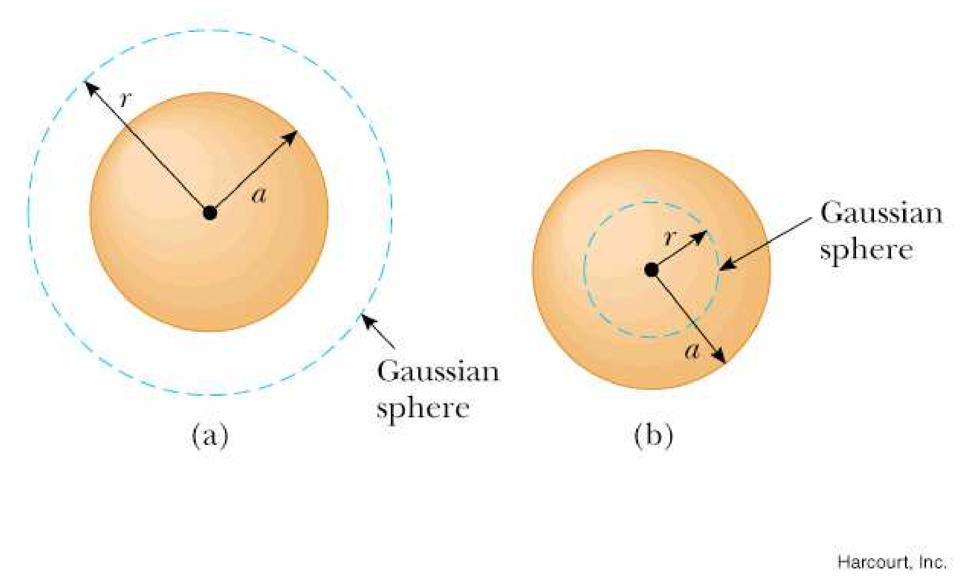


$$\oint E\, dA = E \oint dA = E(4\pi r^2) = \frac{q_{in}}{\epsilon_0}$$

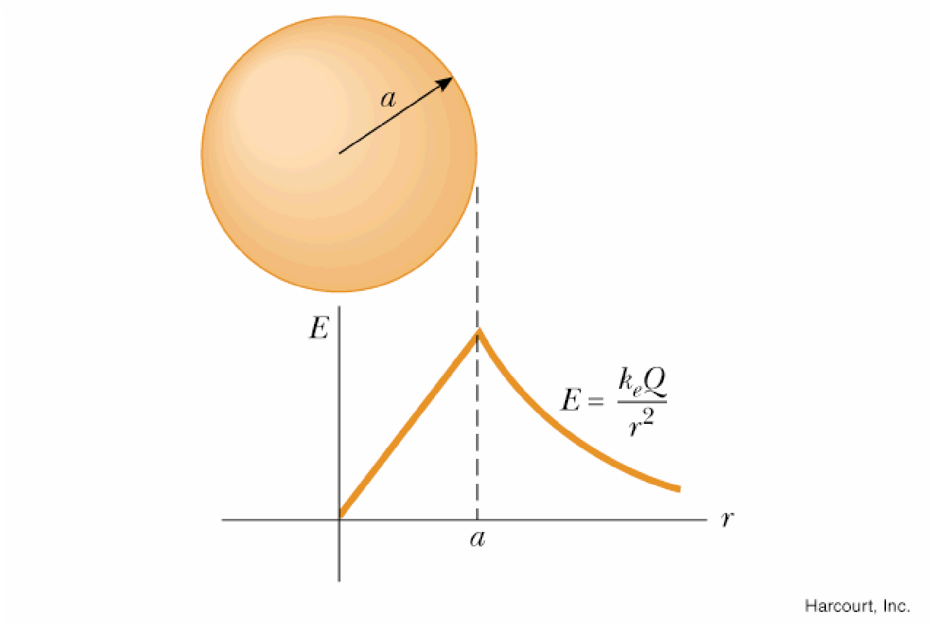
$$E = \frac{q}{4\pi\epsilon_0 r^2} = k_e \frac{q}{r^2}$$

Example 24.5: An insulating solid sphere of radius a carries a total charge Q. calculate:

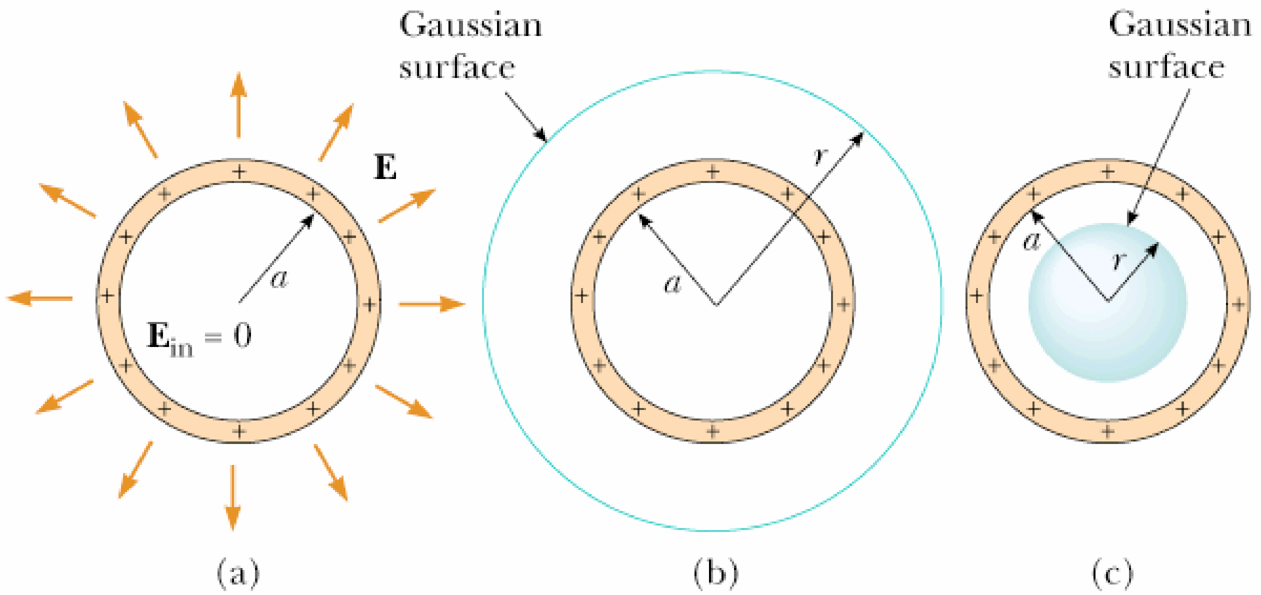
a. The magnitude of the electric filed at a point outside the sphere
b. The magnitude of the electric filed at a point inside the sphere



$$q_{in} = \rho V' = \rho(\frac{4}{3}\pi r^3)$$



Example 24.6: The electric field due to a thin spherical shell



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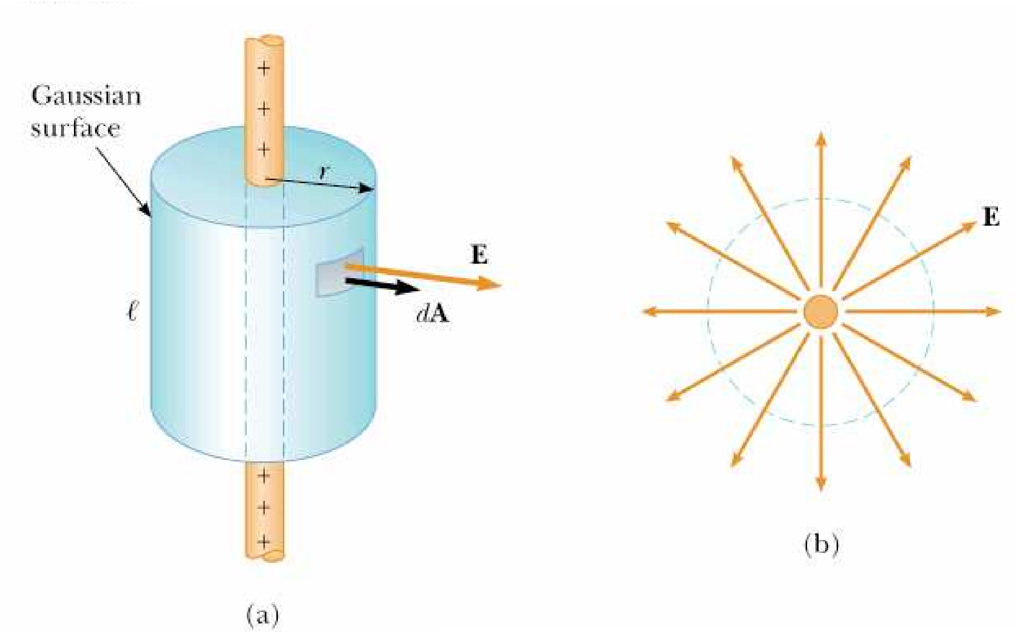
Example 24.7: Find the electric field a distance r from a line of positive charge of infinite length and constant linear charge density λ



$$\Phi_E = \oint \mathbf{E} \cdot d\mathbf{A} = \oint E \, dA = \frac{q_{in}}{\epsilon_0} = \frac{\lambda l}{\epsilon_0}$$

Example 24.8: Find the electric field due to a non-conducting , infinite plane of positive charge with uniform surface charge density σ

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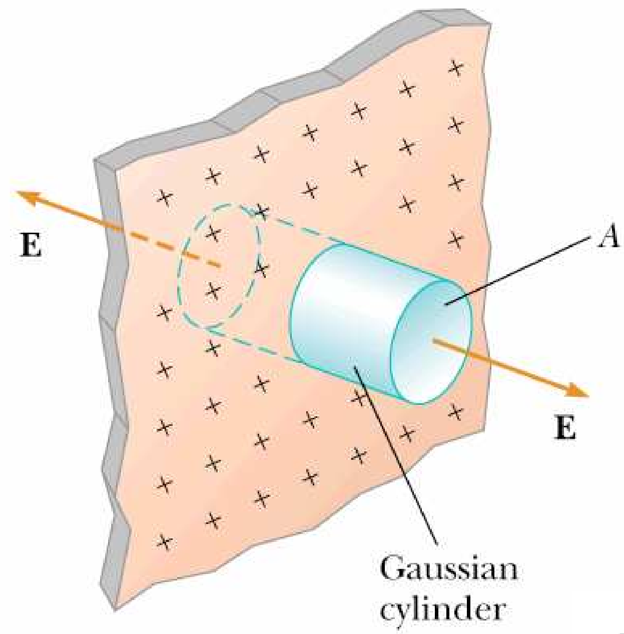
Figure 24.15



$$\Phi_E = 2\oint \mathbf{E}\cdot d\mathbf{A} = 2\oint E\,dA = \frac{q_{in}}{\epsilon_0} = \frac{\sigma A}{\epsilon_0}$$

Conductors in Electrostatic equilibrium

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Figure 24.16

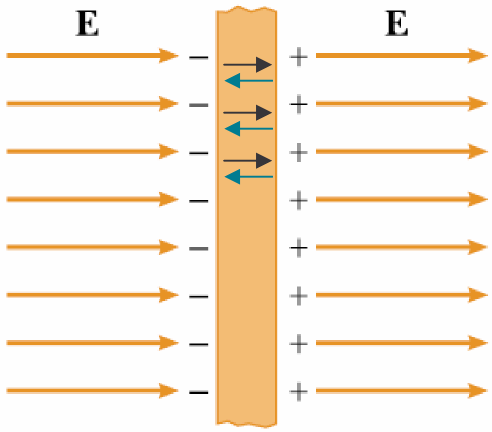

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Figure 24.17

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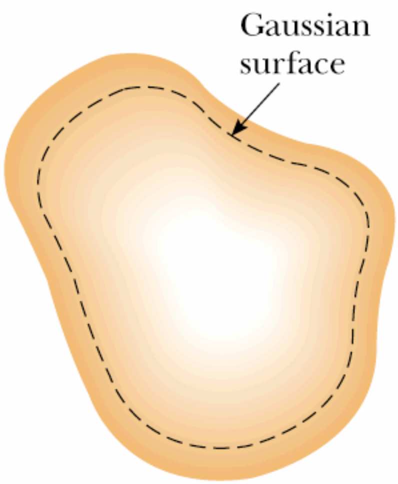

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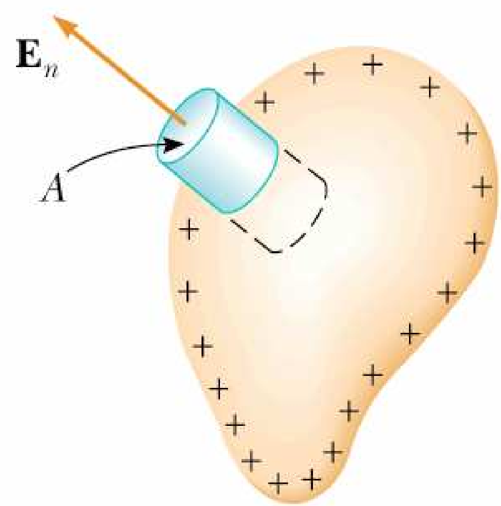
Figure 24.18



$$\Phi_E = \oint \mathbf{E} \cdot d\mathbf{A} = \oint E \; dA = \frac{q_{in}}{\epsilon_0} = \frac{\sigma A}{\epsilon_0}$$