PHYSICS II

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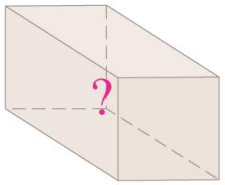
Gauss's Law

- The movement of electrons can be shocking.
- If you look at the girl's hair (figure to the right), you'll see the electrons coating each individual hair fiber and then repelling each other.

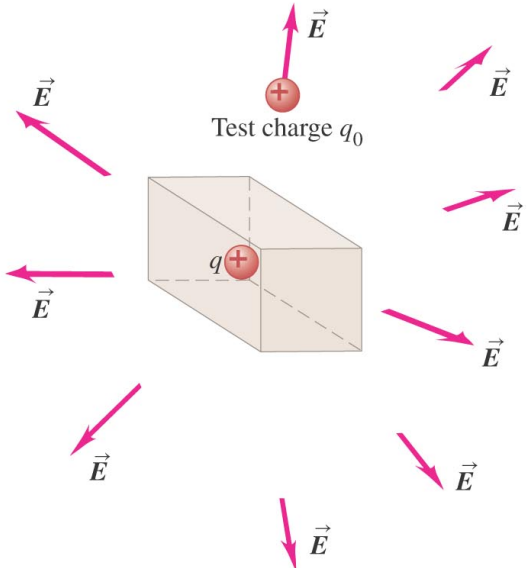
Flux as the flow out of an imagined box

- If we construct a boundary around a charge or charges, we can think of the flow coming out from the charge like water through a screen surrounding a sprinkler.

(a) A box containing an unknown amount of charge

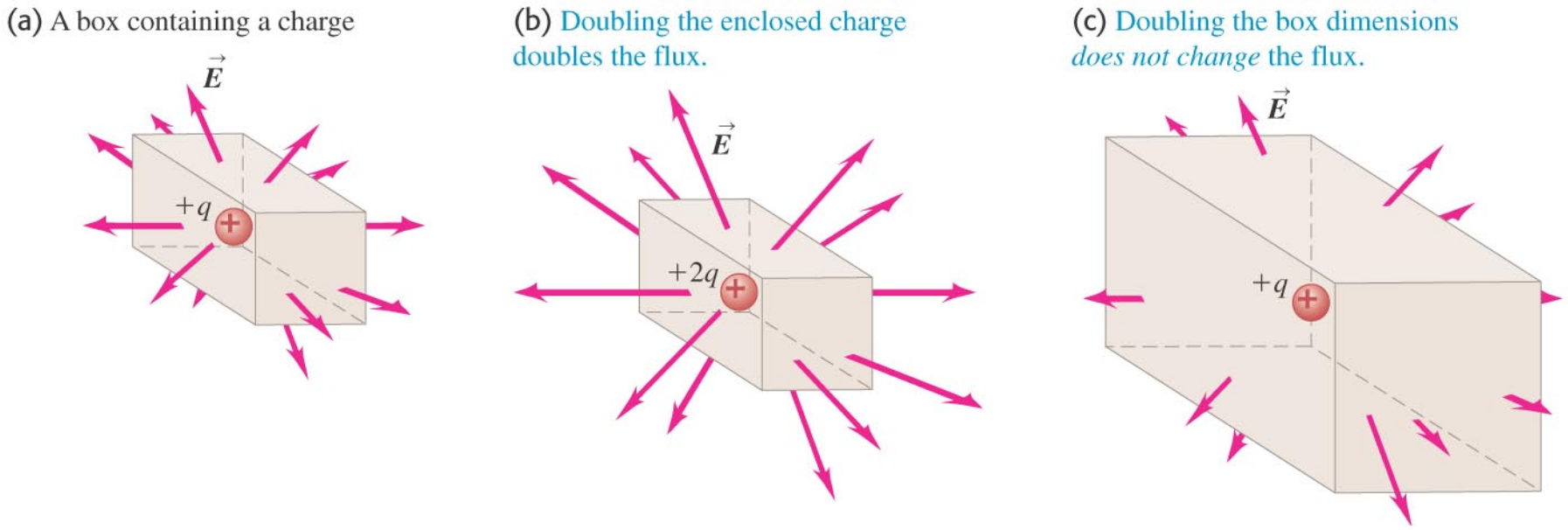


(b) Using a test charge outside the box to probe the amount of charge inside the box



What happens as we change the conditions?

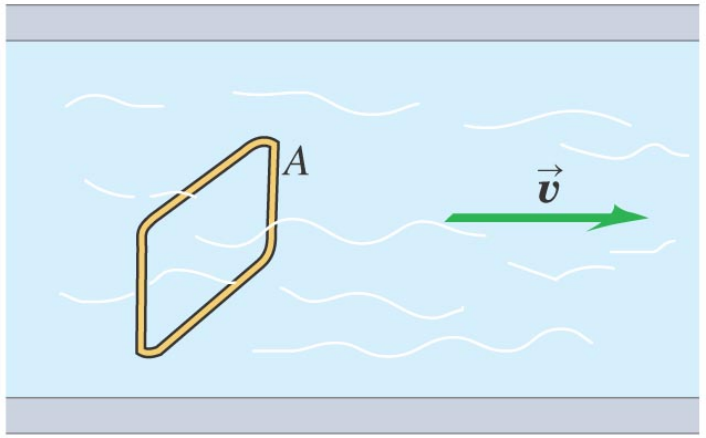
– Consider +1 versus +2 or a box with double the containment dimension.



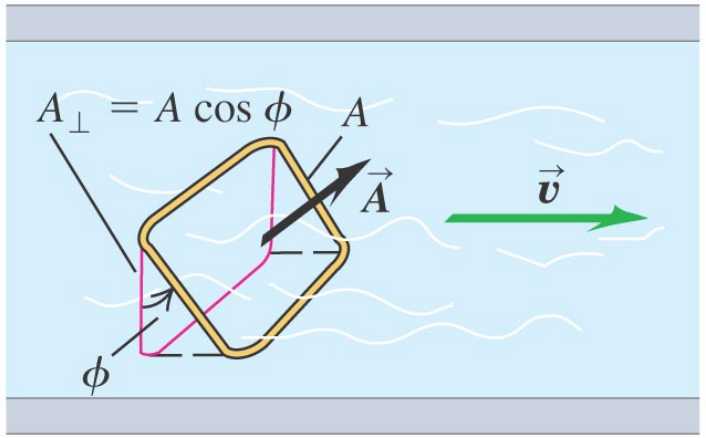
A measurement of flux will be sensitive to measurement

- If we considered flux through a rectangle, the flux will change as the rectangle changes orientation to the flow.

(a) A wire rectangle in a fluid

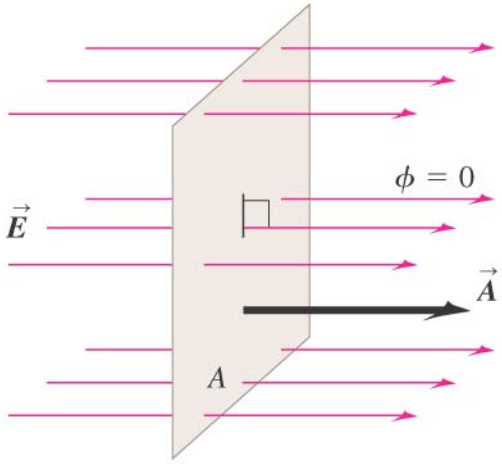


(b) The wire rectangle tilted by an angle ϕ

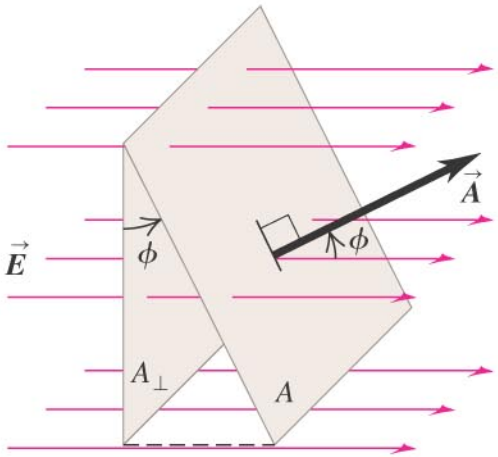


Flux in a uniform field

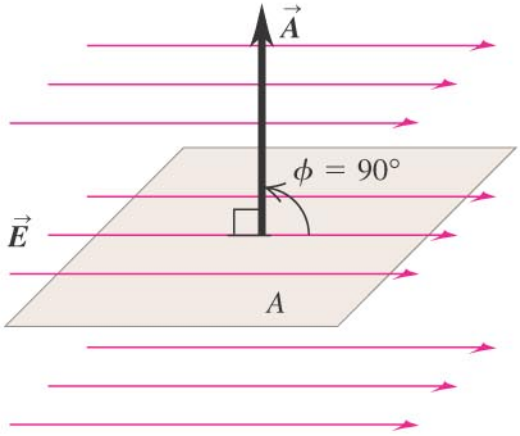
(a) Surface is face-on to electric field:
- $\vec{E}$ and $\vec{A}$ are parallel (the angle between $\vec{E}$ and $\vec{A}$ is $\phi = 0$).
- The flux $\Phi_E = \vec{E} \cdot \vec{A} = EA$.



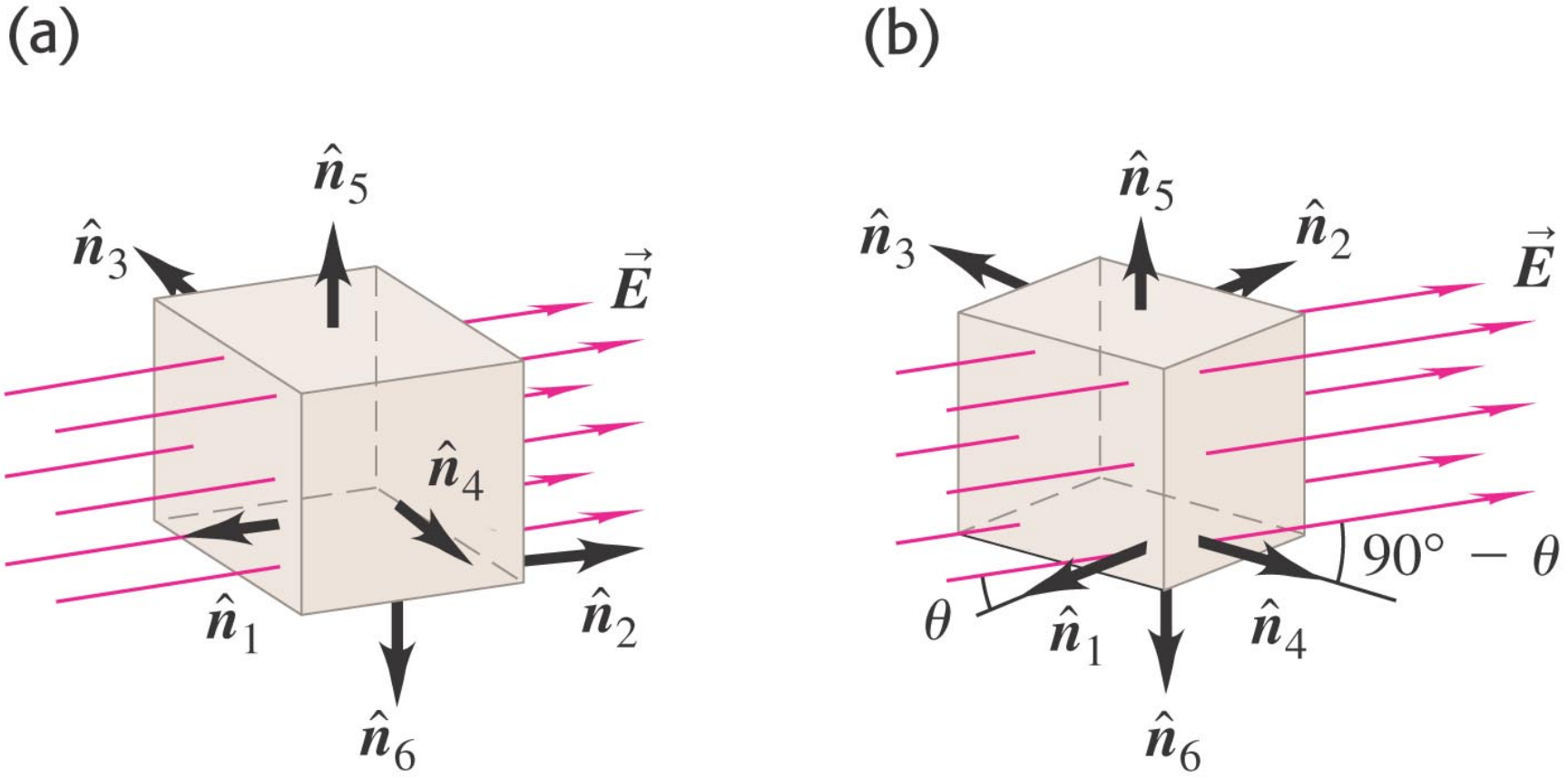
(b) Surface is tilted from a face-on orientation by an angle ϕ:
- The angle between $\vec{E}$ and $\vec{A}$ is ϕ.
- The flux $\Phi_E = \vec{E} \cdot \vec{A} = EA \cos \phi$.



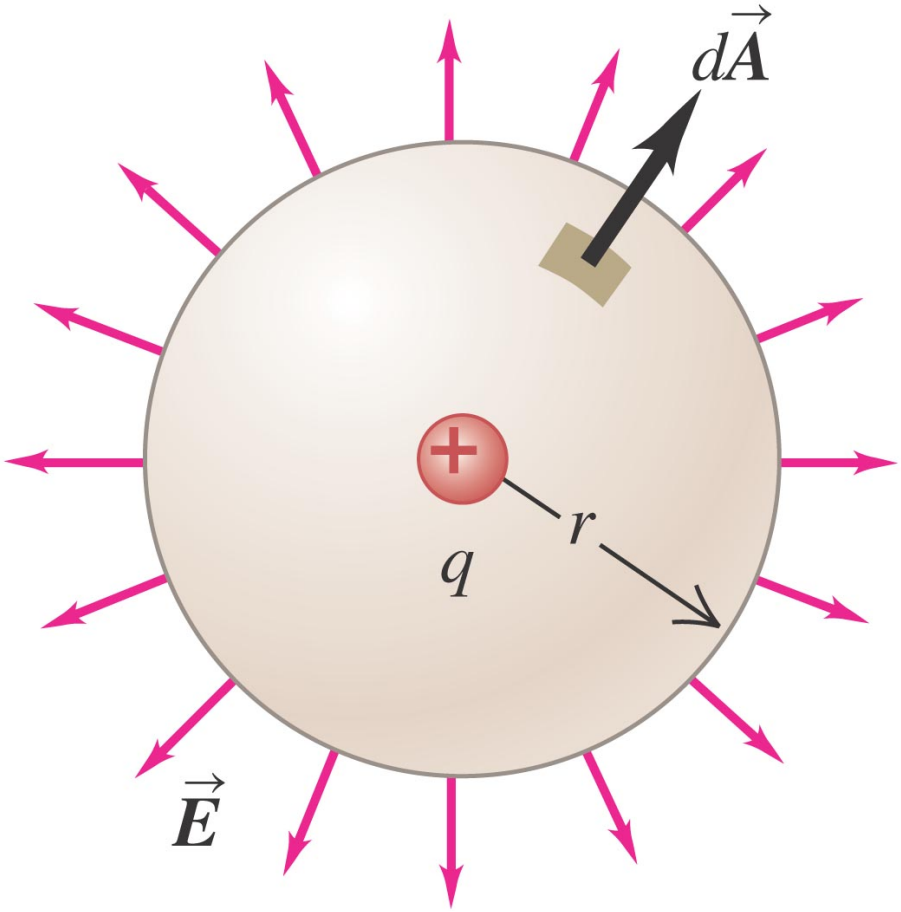
(c) Surface is edge-on to electric field:
- $\vec{E}$ and $\vec{A}$ are perpendicular (the angle between $\vec{E}$ and $\vec{A}$ is $\phi = 90°$).
- The flux $\Phi_E = \vec{E} \cdot \vec{A} = EA \cos 90° = 0$.



The field is not uniform for the cube



The field is not uniform for the sphere

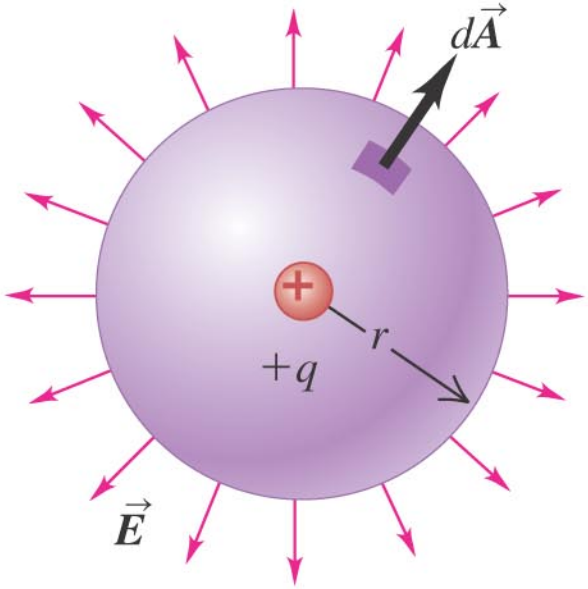


Gausss Law

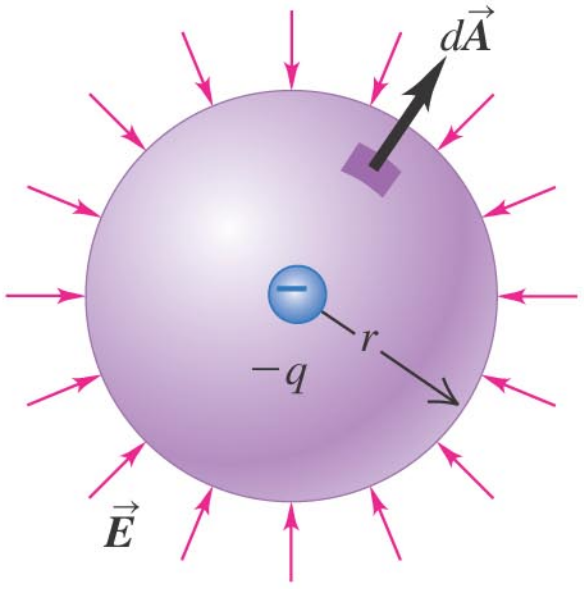
- The expression is an alternative to Coulomb's Law.
- The nifty thing about being a scientist in Gauss's day is that you got to leave your name on clever work.

Effect of changing the sign of the charge

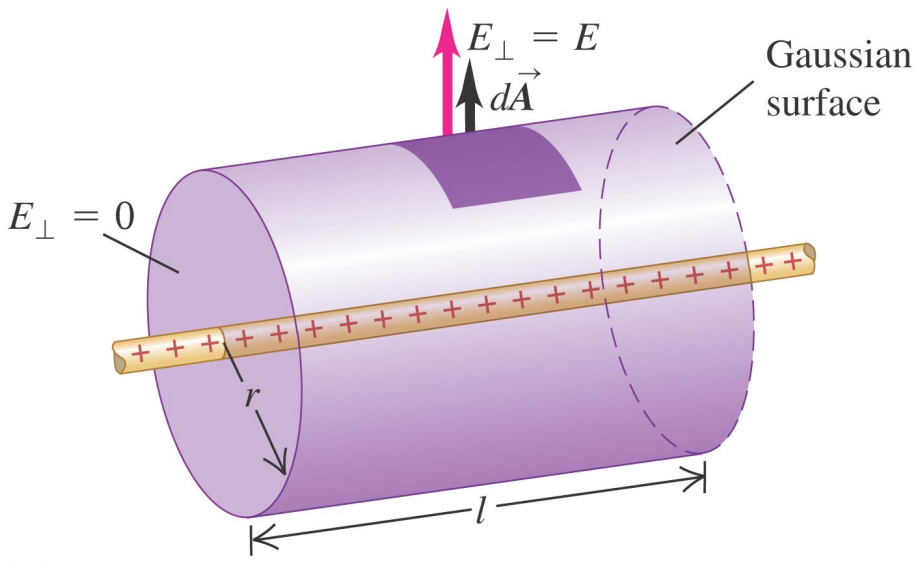
(a) Gaussian surface around positive charge: positive (outward) flux

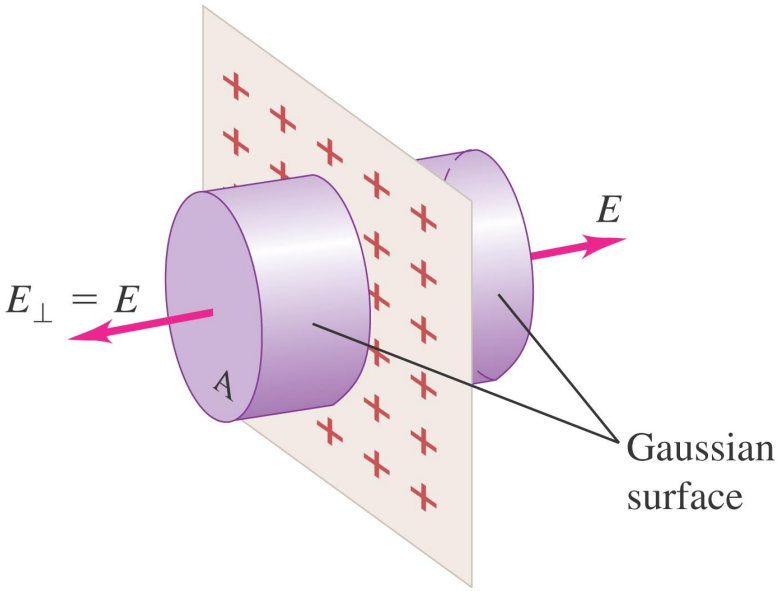


(b) Gaussian surface around negative charge: negative (inward) flux



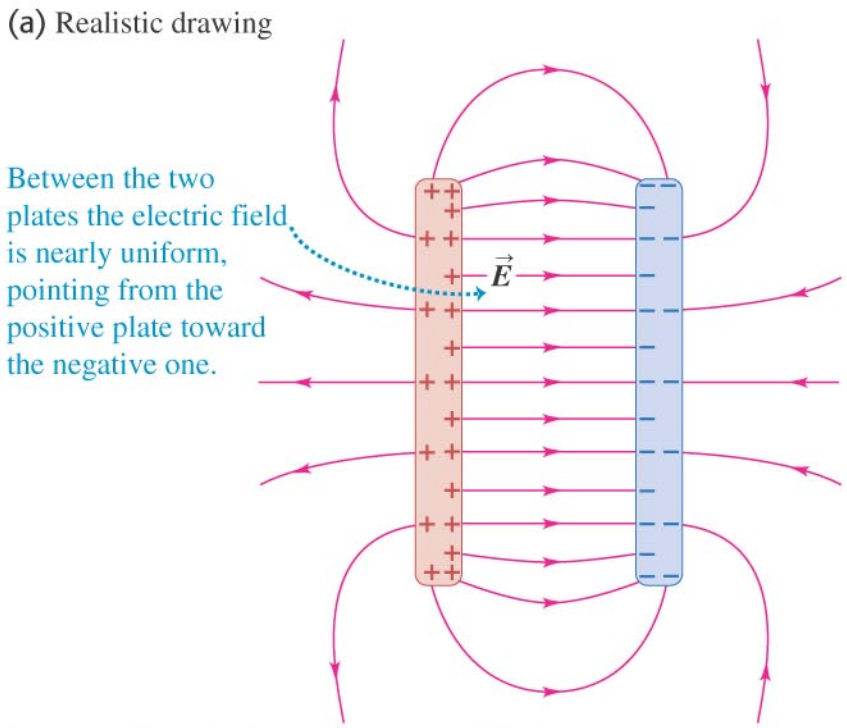
The field of a line or plane of charge

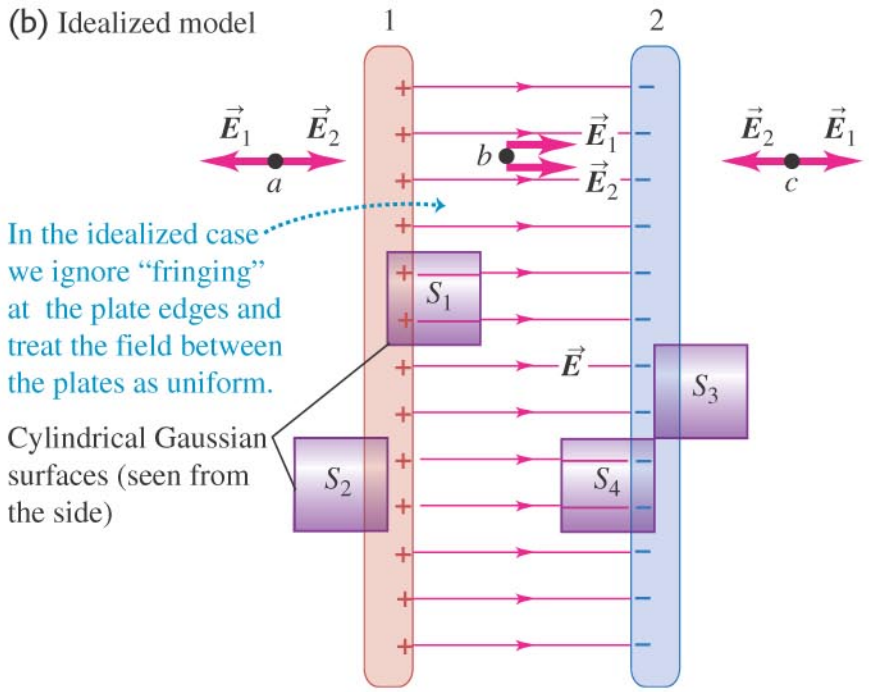




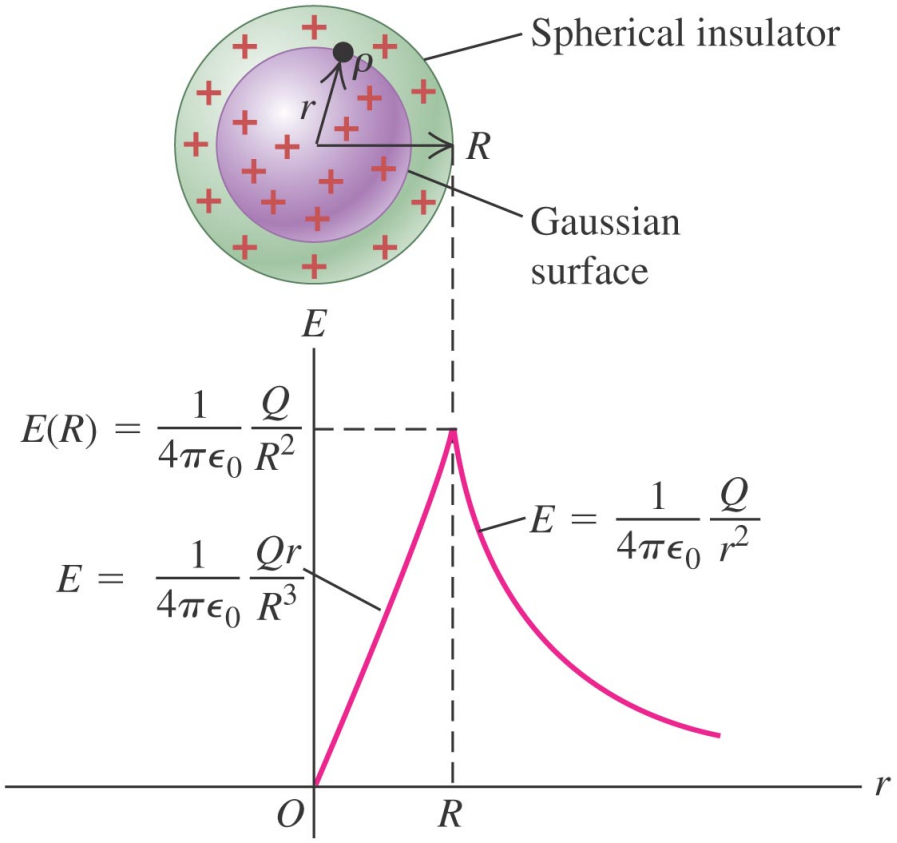
A field between parallel plates of opposing charge

– The capacitor is the actual device.





The field of a uniformly charged sphere



The van de Graaff generator