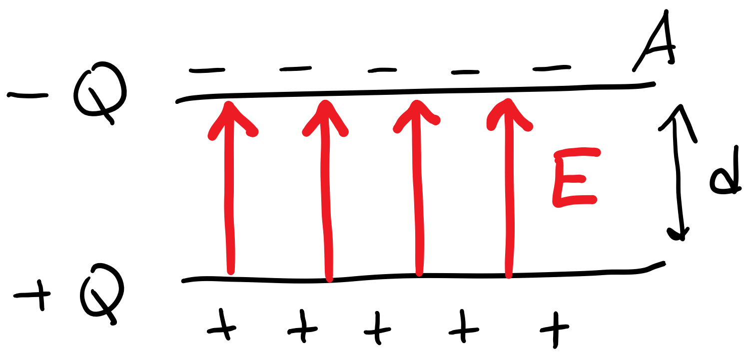
Lecture 4: Electric field ctd

- Uniform field
- Field lines
- Conductors in electric fields
- Forces and torques
- Cathode ray tube

Uniform electric field

Large parallel plates (size >> separation) of area A



Horizontal components cancel,
only vertical components remain
Field inside parallel plate capacitor
is constant
A area of plate,
Q charge on one plate
Q/A =σ surface charge density

$$\vec{E} = \frac{Q}{\varepsilon_o A}, \text{ from + to −}$$

$$\varepsilon_o = \frac{1}{4\pi k} = 8.85 \times 10^{-12} \frac{C^2}{Nm^2}$$

Permittivity constant

Electric field lines

Imaginary lines drawn so that

- Tangent on field line is in direction of electric field
- Field lines closer together where field is larger
- Field lines cannot cross
- Field lines start at positive charge and end at negative charge

Discuss textbook images

Conductors in electric fields – electrostatic equilibrium

Electrostatic equilibrium: charges not moving.
If there were an electric field inside the conductor,
it would exert a force on mobile charges, they would move

In electrostatic equilibrium: $\vec{E} = 0$ inside a conductor

If the conductor has a net charge, the charges are located at the surface.

The electric field at the surface is perpendicular to the surface.
If there were a tangential component, charges would move.

Discuss textbook figures.

Forces and torques on charges in electric field

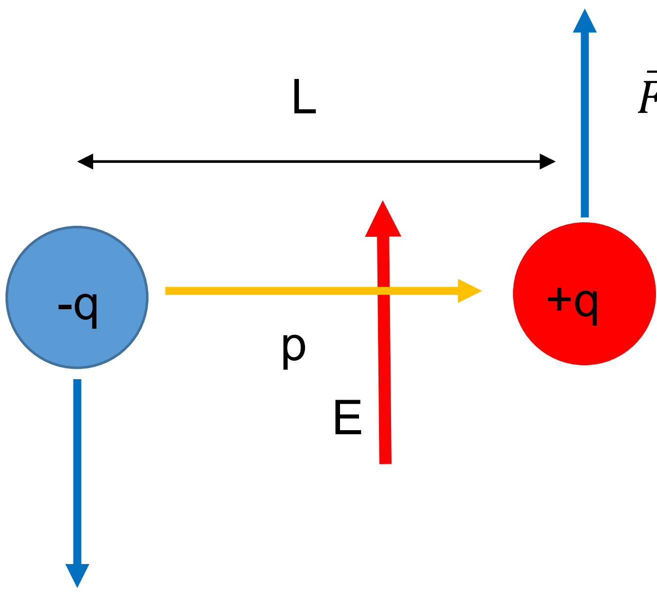
$$\vec{F} = q\vec{E}$$

Force on charge q that is placed in an electric field caused by other charges

If q is positive: $\vec{F}$ points in the same direction as $\vec{E}$

If q is negative: $\vec{F}$ points in the opposite direction of $\vec{E}$

Example: Dipole in uniform field



$$\vec{F}_+ = +q\vec{E}$$

$$\vec{F}_- = -q\vec{E}$$

$$\vec{F}_{net} = \vec{F}_- + \vec{F}_+$$

$$\vec{F}_{net} = 0$$

$$\tau = rF_\perp$$

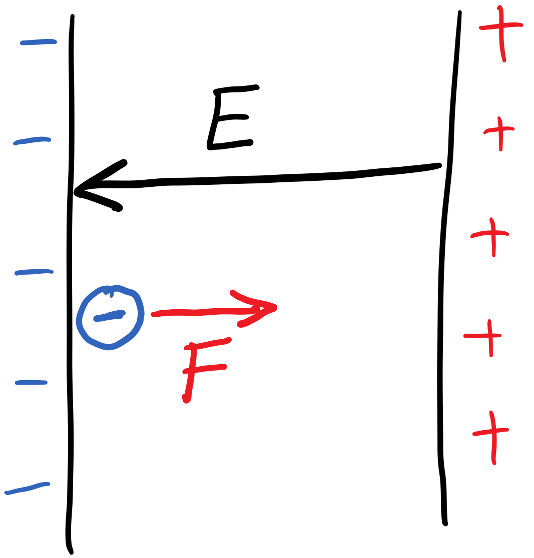
$$r = \frac{L}{2}$$

$$\tau_{net} = |F_-|\frac{L}{2} + |F_+|\frac{L}{2}$$

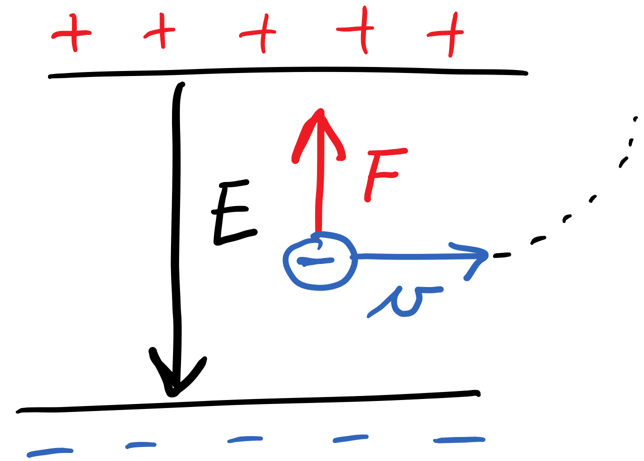
$$\tau_{net} = qEL$$

Dipole moment $\vec{p}$ wants to align with field

Cathode ray tube



electron emitted accelerated towards positive electrode



electrons deflected