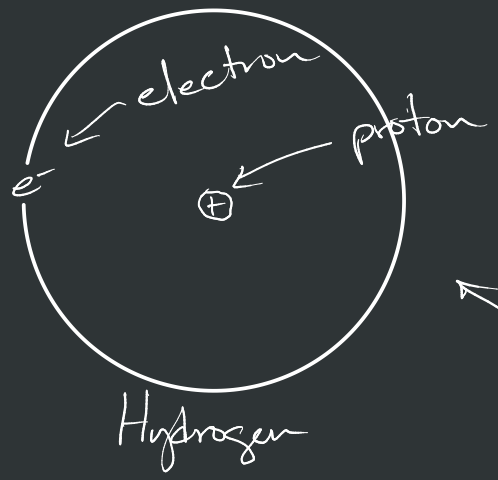
Chapter 16 - Electrostatics

After this you can:
- discuss the property of charge as the origin of the electric field and the electric force
- discuss the quantity of charge

charge
- fundamental property of matter (like mass!)
- causes an electric force field → compare to gravitational field.
  field strength → $g = 9.8 \frac{N}{kg}$
- comes in two types (positive and negative)
  - charges of the same type repel each other
  - charges of the opposite type attract each other

this refers to the direction of the force that results from their electric fields

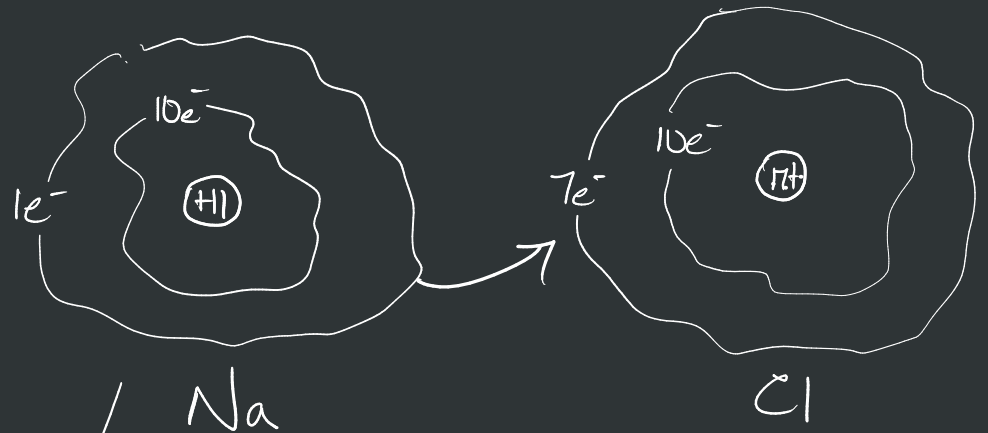
Microscopic vs Macroscopic view of charged matter



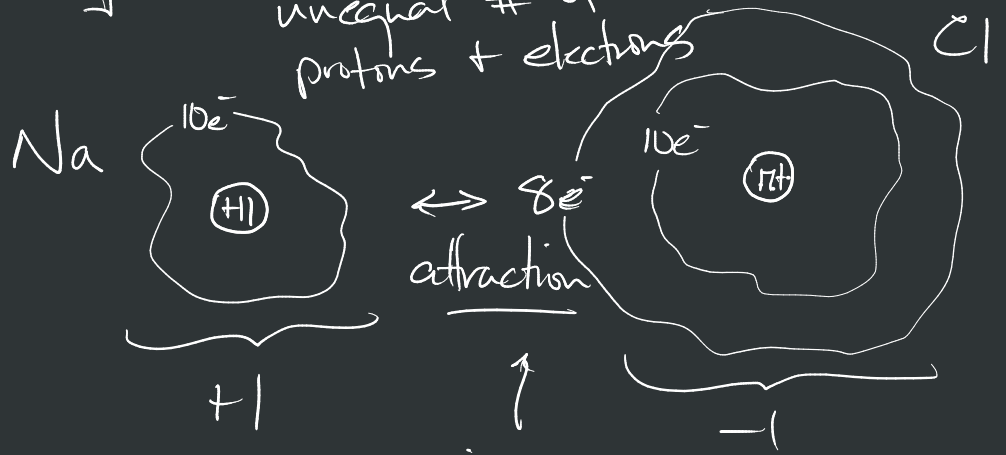
neutral atoms
same # of proton + electrons

net charge = 0

$q_+ + q_- = q_{NET}$



ion — atom with an unequal # of protons + electrons



ionic bonding

elementary charge → proton + electron

So how do we count charges?

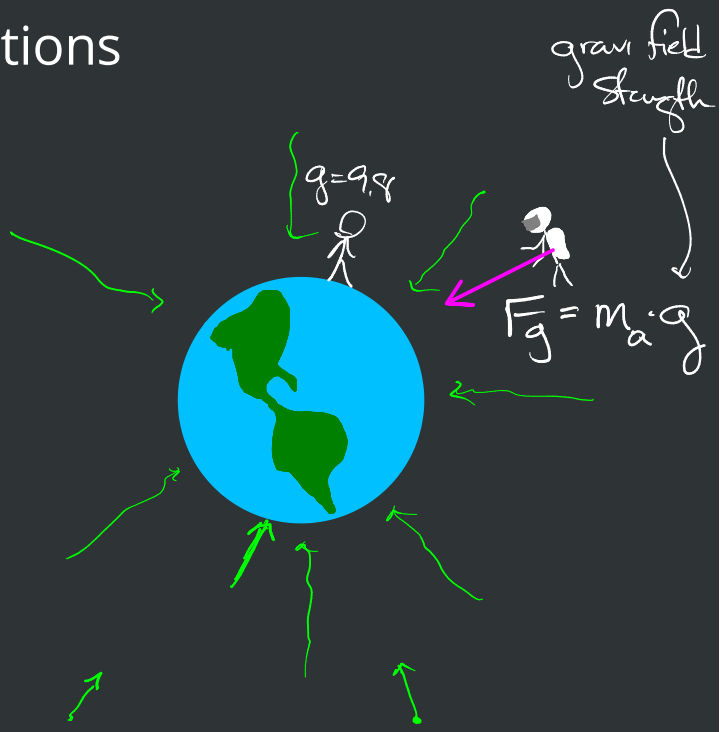
$$1 \text{ Coulomb} = 6.242 \cdot 10^{18} e$$

- $\mu C = 10^{-6} C$
- $nC = 10^{-9} C$

After this you can:

- discuss the meaning of electric field and its use
- calculate the electric field for a few special charge distributions

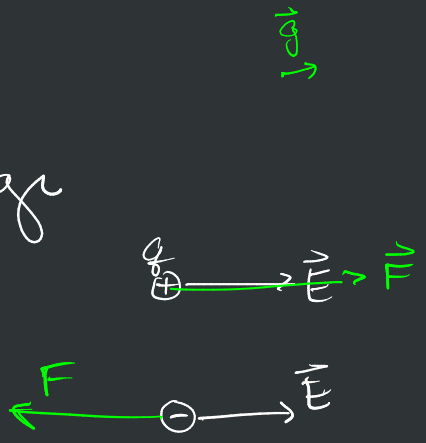
want to know about the force on a charged particle } electric field at the location of the charge } charge distribution that is causing the electric field



So what is the electric field?

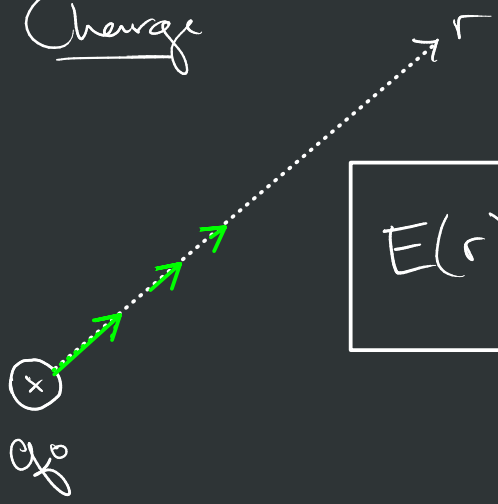
- force per unit of charge

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



- vector field
  - field points away from ⊕ charges
  - field points towards ⊖ charges

Point Charge



$$E(r) = k \frac{|q_0|}{r^2}$$

- q_0: source charge
- r: radial distance from the source charge
- k: Coulomb constant

$$k = 9 \cdot 10^9 \ [?]$$

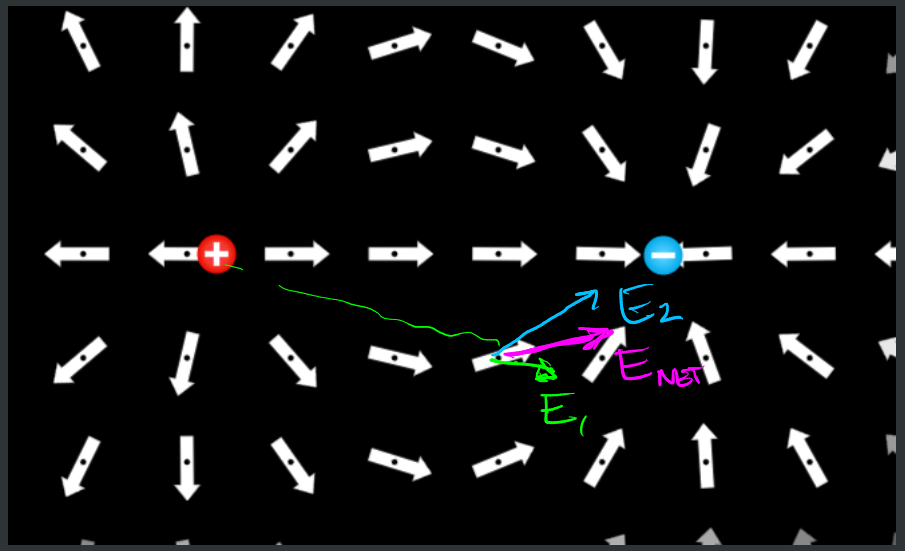
$$k = \frac{1}{4\pi\epsilon_0}$$

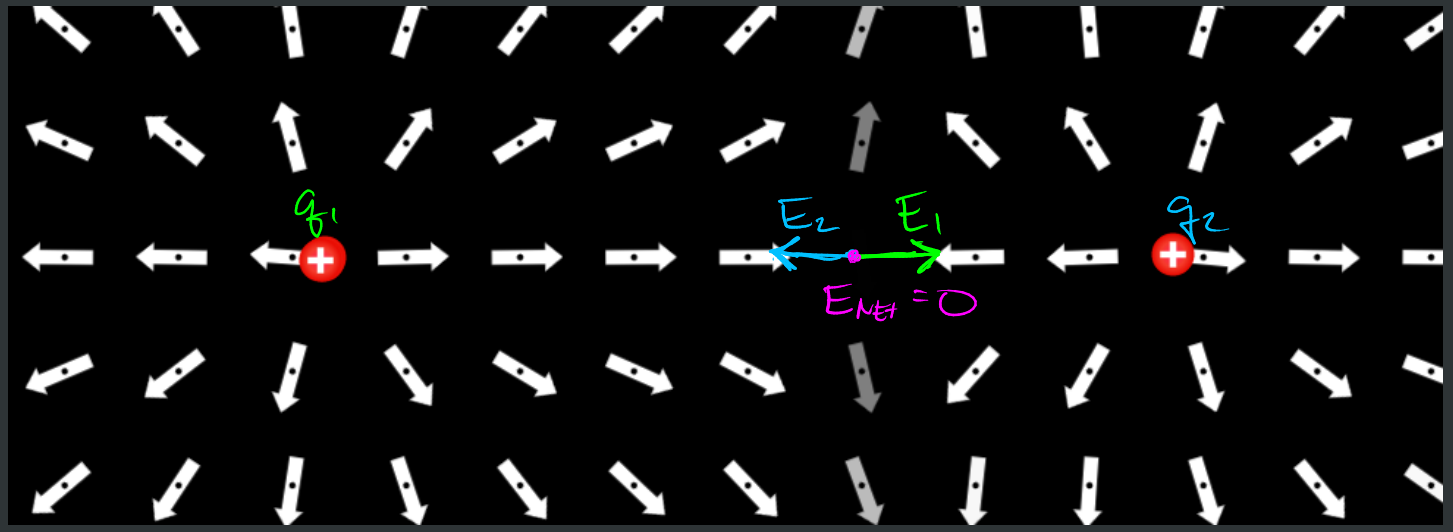
- ϵ_0: permittivity of vacuum

$$\epsilon_0 = 8.85 \cdot 10^{-12} \ [?]$$

Multiple point charge

$$\vec{E}_{NET} = \vec{E}_1 + \vec{E}_2$$

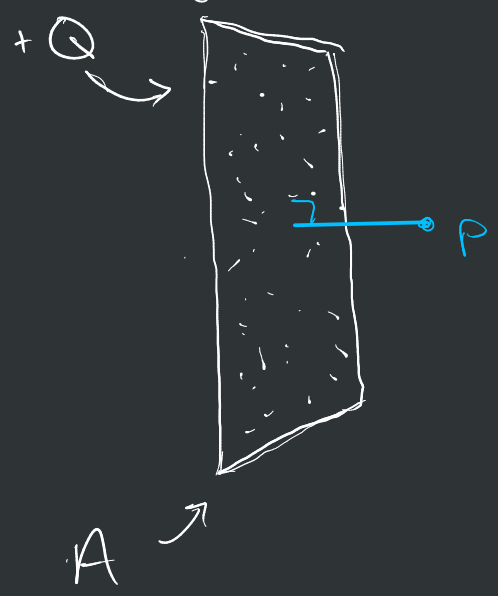




Sheet of charge

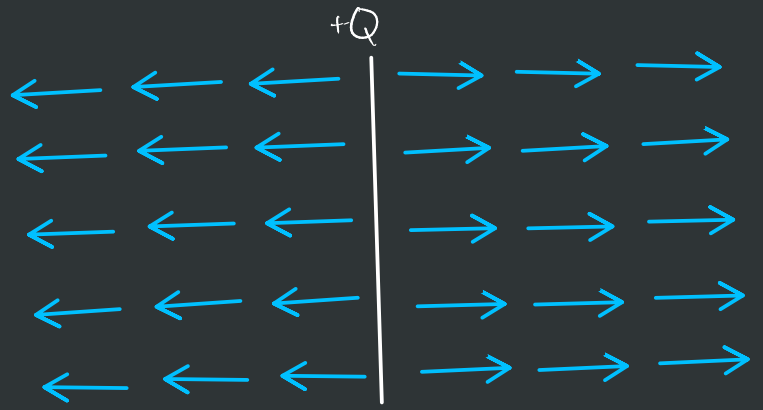
"infinite" → large

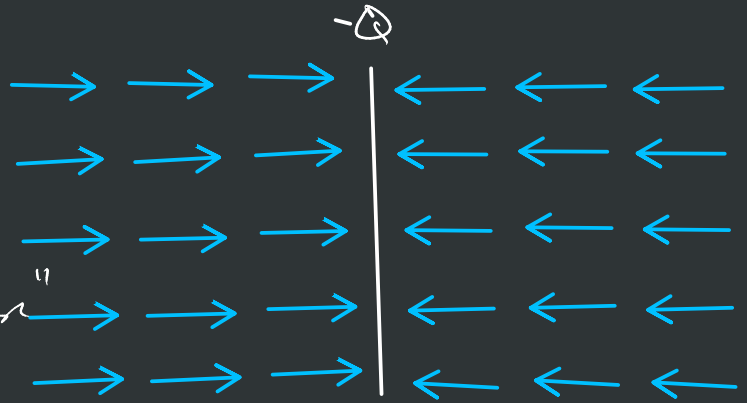
net charge

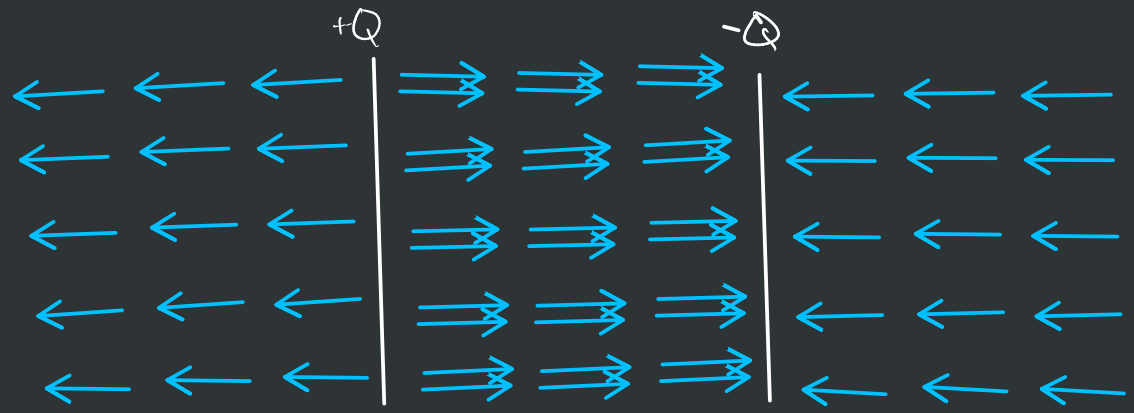


$$E = \frac{|Q|}{2\epsilon_0 A}$$

↑ does not depend on distance from the sheet, as long as we are "close"






+Q
-Q

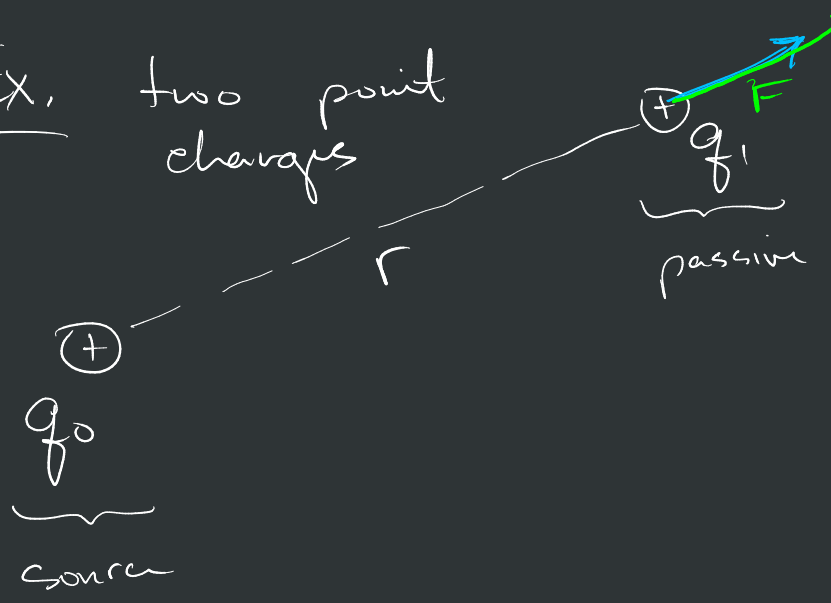
After this you can

- use the electric field created by a source (active) to find the force on a charge (passive) within that field

$$\vec{F} = q_1 \vec{E} \longrightarrow |F| = |q_1||E|$$

q_1: charge being acted on by the electric field produced by other charges.

Ex. two point charges



$$E = \frac{k|q_0|}{r^2}$$

$$F_1 = |q_1|E$$

$$\boxed{|F_1| = \frac{k|q_0||q_1|}{r^2}}$$ ← force between two points charge

Coulomb's Law