Lecture 1: Course introduction Coulomb's Law

- Semester preview
- Force between charged particles

Charge

There are two kinds of charge: positive and negative.

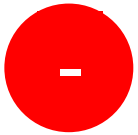
- Like charges repel
- Unlike charges attract
- Charge can be transferred upon contact
- Charge can not be created or destroyed, i.e. is conserved

- Convention: glass rubbed with silk=positive, anything that is attracted to it=negative

Atom:

Nucleus: positively charged protons, uncharged neutrons

Negatively charged electrons, can move



Elementary charge: $e = 1.6 \times 10^{-19}$ C

The charge of an electron is $-e = -1.6 \times 10^{-19}$ Coulombs.

The charge of a proton is $+e = +1.6 \times 10^{-19}$ Coulombs.

Charges can only occur in integer multiples of e.

Insulators and conductors

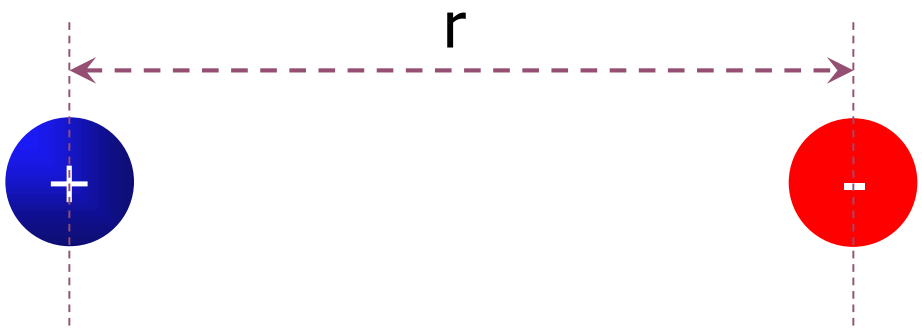
Insulator: Charges remain immobile

Conductor: mobile electrons → current

Force between charges:

Coulomb's Law

$$F = k\frac{|\, q_1 q_2 \,|}{r^2}$$



Unlike charges attract
Like charges repel

$k = 9 \times 10^9\ N \cdot m^2/C^2$

Compare: Force of gravity $F = G\frac{m_1 m_2}{r^2}$

Multiple charges

$$F = k\frac{|\, q_1 q_2 \,|}{r^2}$$

k = 9 x 10^9 N•m^2/C^2

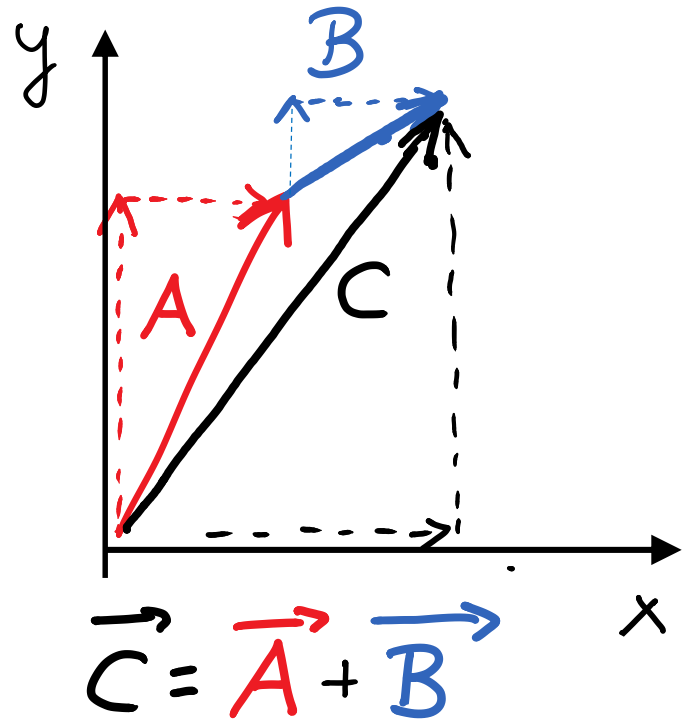
Each charge exerts a force on each other charge
Net force: sum of all the forces

$$\vec{F}_{net} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 \ldots..$$

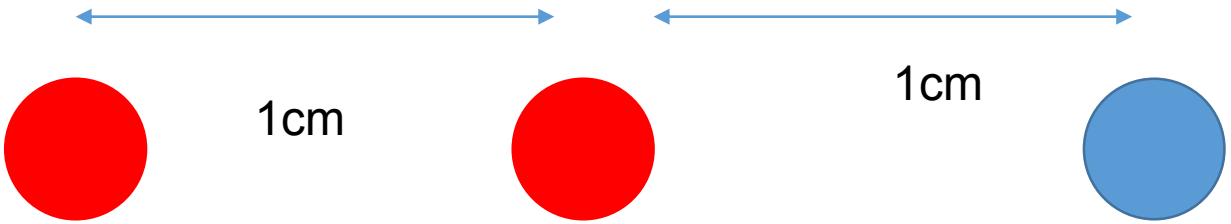
Forces are **vectors**, have magnitude and direction
Vector addition: in components

Vector addition in components

$$C_x = A_x + B_x$$
$$C_y = A_y + B_y$$



Example



q_1=+1nC

q_2=+2nC

q_3=−2nC

Net force on q_2?