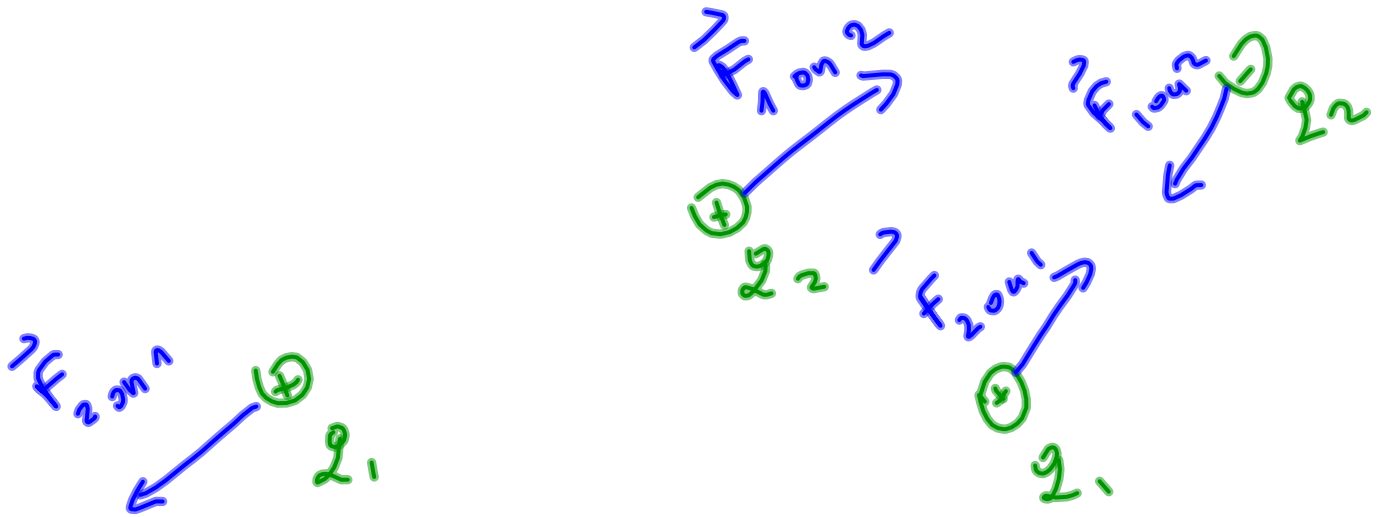
Electric charges & forces

1. Frictional forces such as rubbing add or remove a charge from an object. That process is called charging.

2. There are only 2 kinds of charge (positive & negative)

3. 2 like charges exert repulsive forces on each other. 2 opposite charges attract each other.



4. There are 2 types of classes of materials - conductors
- insulators

Conductors are materials through or along which charge easily moves unlike the insulators. Both can be charged, the difference is in mobility.

Note - earth is a giant conductor

Grounding - any object that is physically connected to the earth through a conductor is said to be grounded

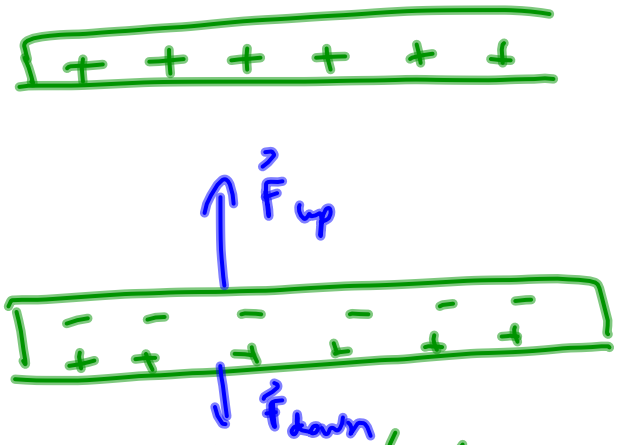
- we ground to protect build-up of any charge on the objects

Charge q [sometimes Q]

[C]

Charge polorization

- slight separation of positive & negative charges in a neutral object



1) charged rod polarizes neutral metal

2) upward force is exerted on excess of electrons at the top surface

3) electric force decreases with distance $F_{up} > F_{down}$

There is a net force called polarization force on the neutral metal that attracts it to positive rod.

Polarized atom is electric dipole.

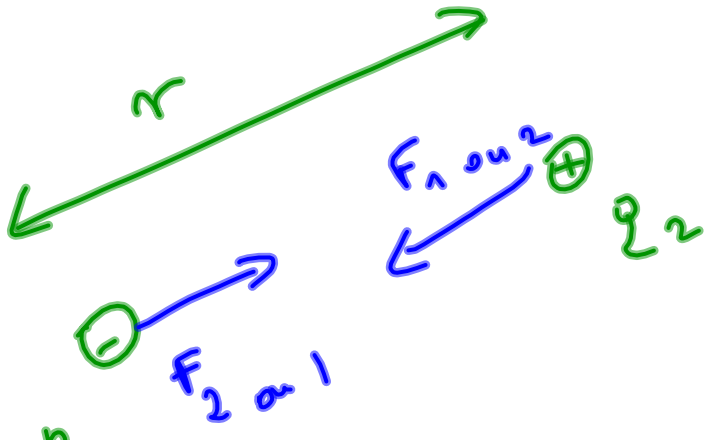
Coulomb's law

- 18th century
- the force law that describes the electric force

If 2 charged particles having charges q_1 & q_2 are a distance r apart, the particles exert forces on each other of magnitude

$$F_{1 \text{ on } 2} = F_{2 \text{ on } 1} = k \frac{|q_1||q_2|}{r^2}$$

where k is called electostatic constant



fundamental unit of charge e has been measured:

$$e = 1.6 \cdot 10^{-19} \text{ C}$$ [C] Coulomb

1 C ~ net charge of $6.25 \cdot 10^{18}$ protons

$$F = k\frac{q_1 q_2}{r^2} \qquad F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$$

$$k = \frac{r^2 F}{q_1 q_2} \left[\frac{Nm^2}{c^2}\right]$$

$$k = 8.99 \cdot 10^9 \frac{Nm^2}{c^2}$$ measured

$$\varepsilon_0 = \frac{1}{4\pi k} = 8.85 \cdot 10^{-12}\ c^2/Nm^2$$

1. Coulomb's law applies only to point charges. Point charge is an idealized material object with Q, but no size (it has m). 2 charged objects are approximated to be point charges if they are much smaller than the separation between them.

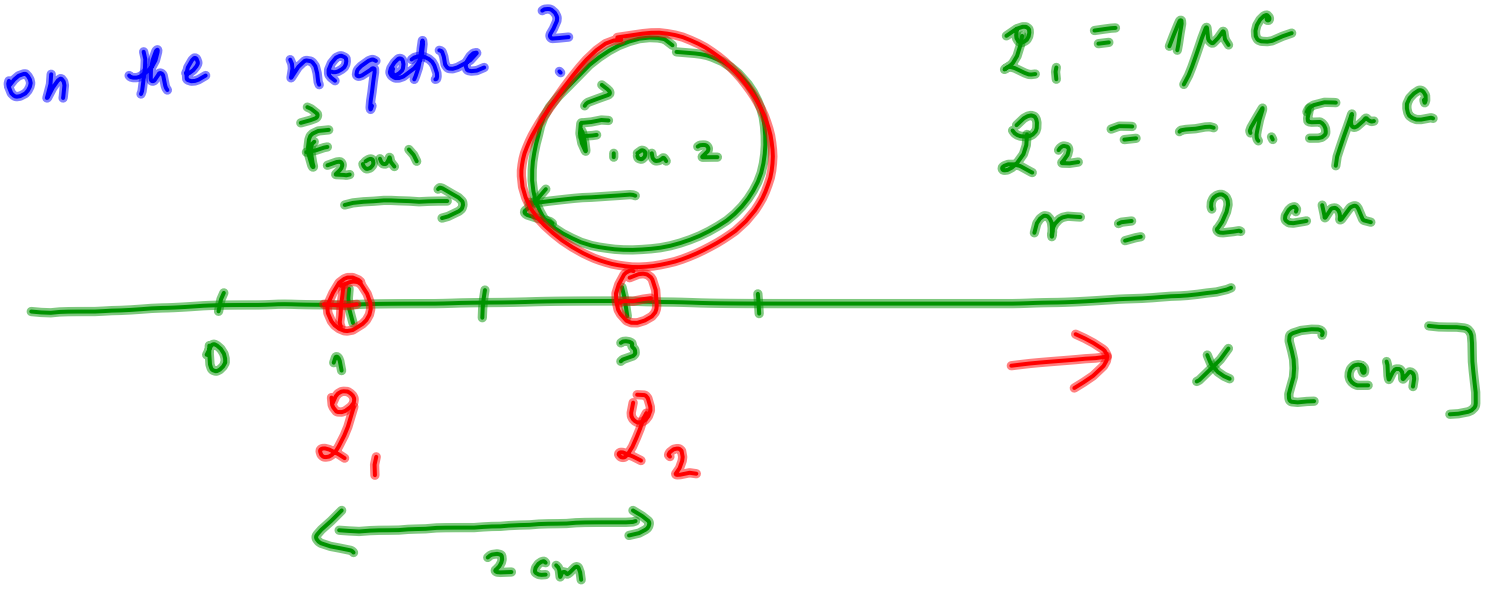
2. Electric fields like other forces can be superimposed:

$$\vec{F}_{net} = \vec{F}_{1 \text{ on } j} + \vec{F}_{2 \text{ on } j} + \vec{F}_{3 \text{ on } j} + \dots$$

Problem solving - identify point charges
- PICTURE (charges, force vectors, distances, angles)
- what are we looking for
- solve
- CHECK UNITS

A $1\,\mu C$ charge is at 1 cm and a $-1.5\,\mu C$ charge is at $x = 3$ cm.

What force does the positive charge exert on the negative?



$\vec{F}_{(12)} = ?$

ion 2

$$|\vec{F}_{12}| = k \frac{|q_1||q_2|}{r^2} = 34\ N$$

$$\vec{F}_{12} = -34\ N$$