Coulomb's law

- the force law that describes the electric force

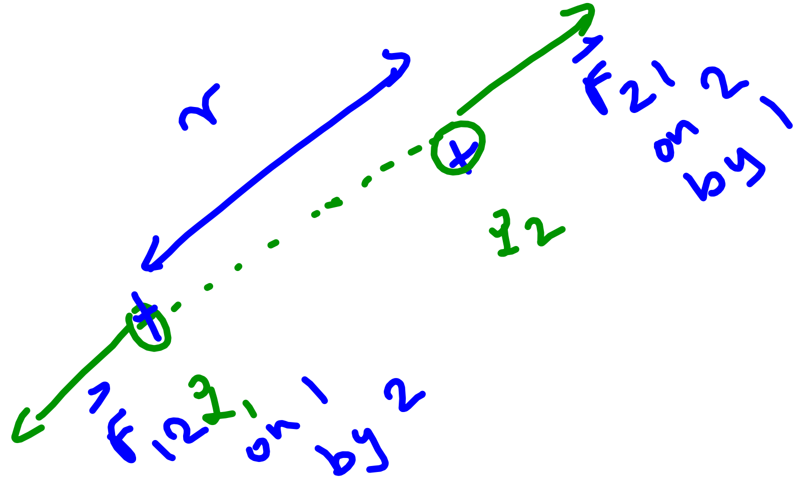
If 2 charged particles having charges q_1 & q_2 are a distance r apart, the particles exert forces on each other of magnitude:

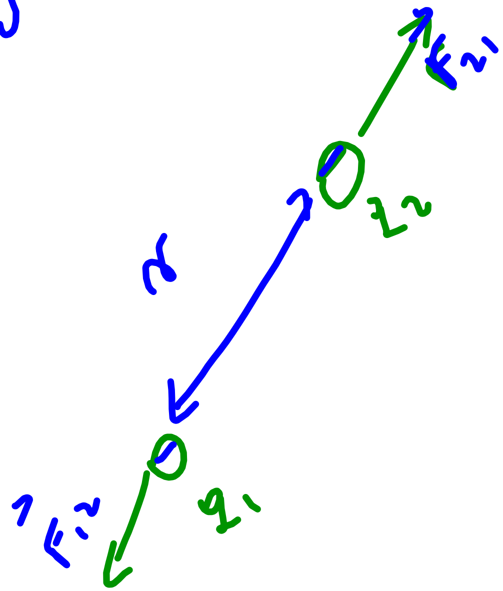
$$F_{12} = F_{21} = k \frac{|q_1||q_2|}{r^2}$$

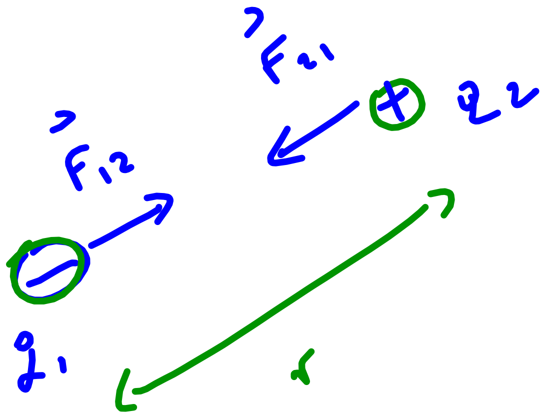
k cte

Forces are action/reaction pair, equal in magnitude & opposite in direction.

The forces are directed along the line joining 2 particles.







charge q [C]

Coulomb

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

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

$$F_{12} = k \frac{|q_1||q_2|}{r^2}$$

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

permittivity of free space

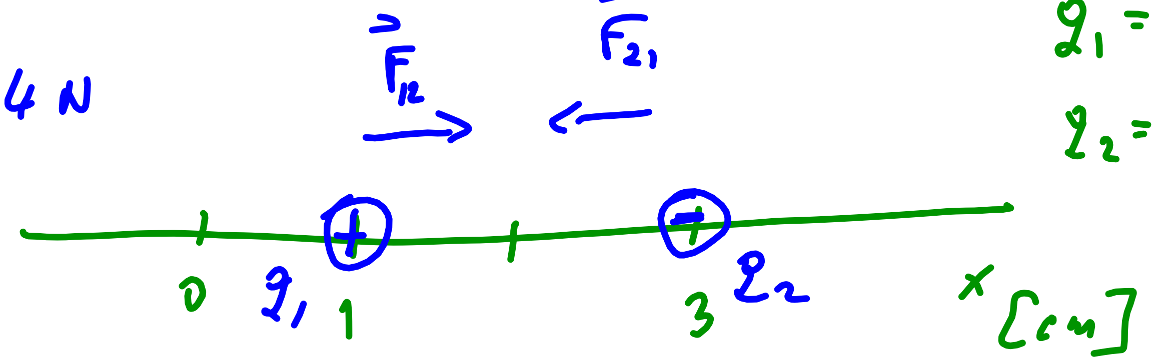
Coulomb's law applies only to point charges.
Point charge is an idealized material object with q & m, but we neglect its size. 2 charged objects are said to be point charges if they are much smaller than the separation between them.

Electric forces, like other forces can be superimposed:

$$\vec{F}_{net} = \vec{F}_{1\,on\,j} + \vec{F}_{2\,on\,j} + \ldots$$

A $1\,\mu C$ charge is at 1 cm & a $-1.5\,\mu C$ charge is at $x = 3$ cm. What force does the positive charge exert on the negative one?

$\vec{F}_{21} = -34\,N$



$q_1 = 1 \cdot 10^{-6}\,C$

$q_2 = -1.5 \cdot 10^{-6}\,\mu C$

$r = 2\,cm = 2 \cdot 10^{-2}\,m$

$\vec{F}_{21} = \,?$

$$|\vec{F}_{21}| = \frac{1}{4\pi\varepsilon_0} \frac{|q_1||q_2|}{r^2} = 34\,N$$