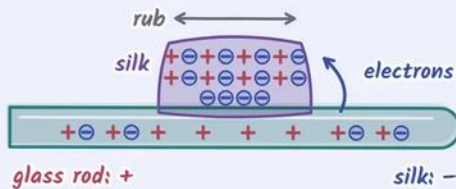




Electric charge, the basics *

- charging by friction transfers electrons: the gainer turns -, the loser +, **equal and opposite**
- charge is additive: total is the algebraic sum, sign included, **unlike mass it can be negative**
- charge is quantized: $q = \pm ne$, $e = 1.6 \times 10^{-19} \text{ C}$ the elementary charge
- not obvious daily since e is tiny: even $1 \mu\text{C}$ needs about 6×10^{12} electrons
- charge is conserved: **never created or destroyed, only transferred**

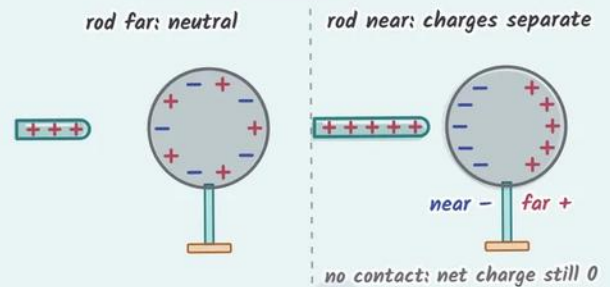


total charge 0: conserved
charge comes in whole electrons: $q = ne$

rubbing moves electrons from glass to silk: glass +, silk -, the total stays 0

Charging by induction

- conductors let charge move (metals, earth, body); insulators hold it (glass, plastic)
- induction: a charged rod nearby shifts free electrons, **near side opposite, far side similar**
- rod near, earth it, remove the earth, then the rod: a charge **opposite to the rod's** stays



bring a charged rod near: the free electrons shift, near side opposite, far side the same; nothing touched, net charge still 0

learn these Coulomb's law

scalar form, in vacuum

$$F = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2}$$

Coulomb's constant

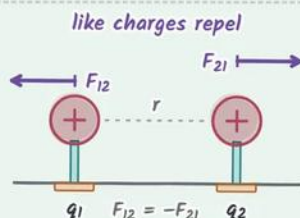
$$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ N m}^2 \text{C}^{-2}$$

vector form, force on q_2 due to q_1

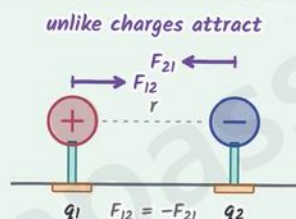
$$\mathbf{F}_{21} = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r_{21}^2} \hat{\mathbf{r}}_{21}$$

in a medium of relative permittivity ϵ_r

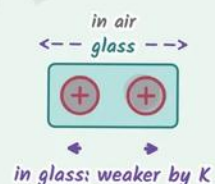
$$\mathbf{F}_{med} = \frac{1}{4\pi\epsilon_0 \epsilon_r} \frac{q_1 q_2}{r^2}$$



like charges repel: F_{12} and F_{21} equal and opposite



unlike charges attract, along the line joining them



the same pair in glass: each force weaker by K

$F_{21} = -F_{12}$, an action-reaction pair along the line joining the charges: a **central force**; a medium always weakens it, $\epsilon_r > 1$