Summary for

Why Does Amber Attract Wood Shavings? — Charges & Coulomb's Law

ETYMOLOGY

- *Charge* ($\rightarrow$) Latin *carricare* = "to load".
- *Electron* ($\rightarrow$) Greek *elektron* (amber).
- Naming of positive/negative charges is arbitrary (Benjamin Franklin).
- Coulomb = SI unit of charge, named after Charles-Augustin de Coulomb.

PHYSICS

- It is not clear why the elementary charge e has its value, nor why charge must exist.
- Coulomb's law: $F = k\,\frac{q_1 q_2}{r^2}$. Here, F: force; q_1, q_2: charges; r: distance between charges; k: proportionality constant.
- Force is a vector. **Magnitude**: strength of the force. **Direction**: direction in which the particle feels the force. For two point charges, the direction is radial.
- **Charge symmetry**: the flip $q \rightarrow -q$ sending particles to antiparticles leaves the laws of physics invariant.
- Rubbing amber with cloth transfers electrons from the cloth to the amber.
- Why rub? Why amber? Why direction of transfer? — unanswered but fundamental open questions.
- Neutral objects (wood shavings) can still be attracted $\rightarrow$ due to **induced charge separation**.
- External electric field shifts charges inside the neutral object $\rightarrow$ positives pulled closer, negatives pushed away.

Particle	Charge (e)
Electron (e^-)	-1
Electron neutrino (ν_e)	0
Muon (μ^-)	-1
Muon neutrino (ν_μ)	0
Tau (τ^-)	-1
Tau neutrino (ν_τ)	0
Up quark (u)	$+\frac{2}{3}$
Down quark (d)	$-\frac{1}{3}$
Charm quark (c)	$+\frac{2}{3}$
Strange quark (s)	$-\frac{1}{3}$
Top quark (t)	$+\frac{2}{3}$
Bottom quark (b)	$-\frac{1}{3}$
Photon (γ)	0
Gluon (g)	0
Z boson (Z^0)	0
W^+ (W^+)	$+1$
W^- (W^-)	-1
Higgs (H^0)	0
Proton	$+1$
Neutron	0

TOOLBOX

- Use different coordinates for different purposes: Cartesian (x, y) or polar (r, ϕ), usually chosen by the symmetry of the problem.
- Repetitive asking of ”why”: N-times to be answered within physics, N+1 and we are discussing philosophy.