

Basic Properties of Electric Charge

The three rules every charge obeys

Additivity

Conservation

Quantisation

1. Additivity of Charges

Charges add up like real numbers.

Electric charge is a scalar quantity. If a system contains multiple point charges, the total charge is simply the algebraic sum of all individual charges. Proper signs (+ and -) must be used.

System Total Calculation

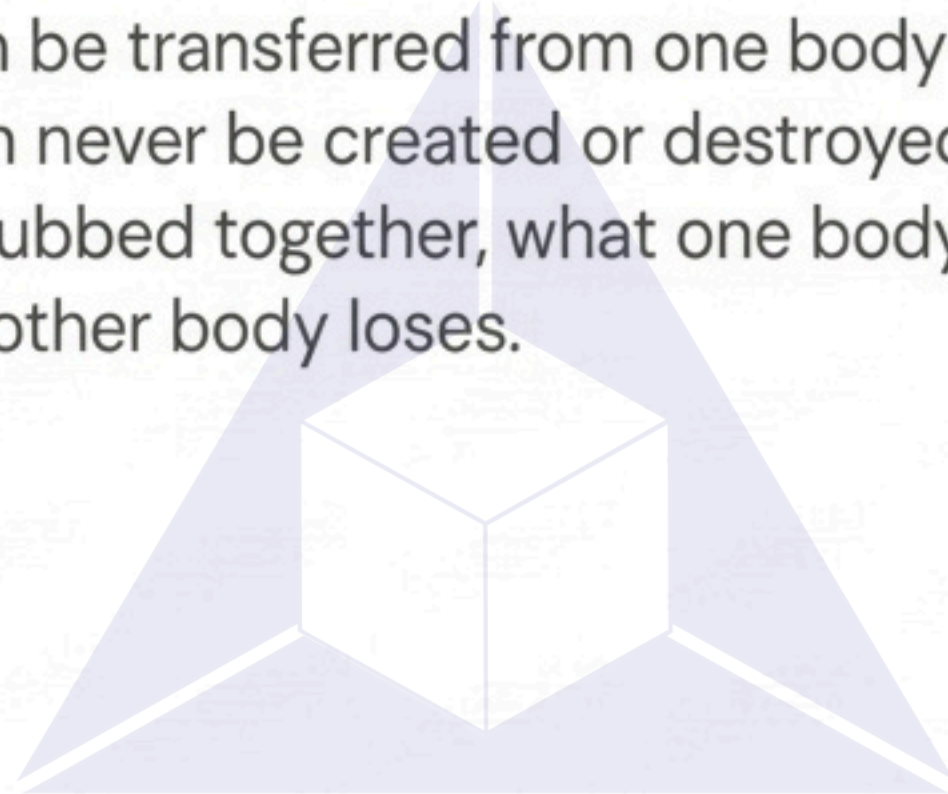

$$+2q + (-3q) + +4q + (-5q) = -2q$$

Magnitude adds algebraically,
taking polarity into account.

2. Conservation of Charge

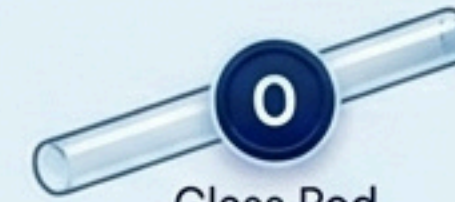
Total charge of an isolated system is constant.

Charges can be transferred from one body to another, but they can never be created or destroyed. When bodies are rubbed together, what one body gains in charge, the other body loses.



Friction Transfer Flow

Step 1: Before Rubbing



Glass Rod



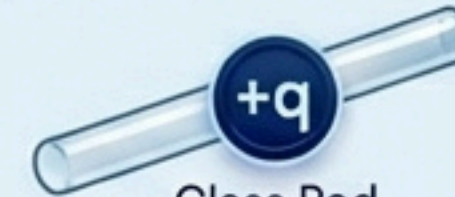
Silk Cloth

System Net Charge = 0

Step 2: The Transfer



Step 3: After Rubbing



Glass Rod



Silk Cloth

System Net Charge = (+q) + (-q) = 0



Charge is redistributed, but the isolated system total remains conserved.



You've Learned the Theory. Let's Test Them Now.

$$E=mc^2$$



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3. Quantisation of Charge

All observable free charges are integral multiples of a basic unit of charge (e). You cannot have a fraction of an electron.

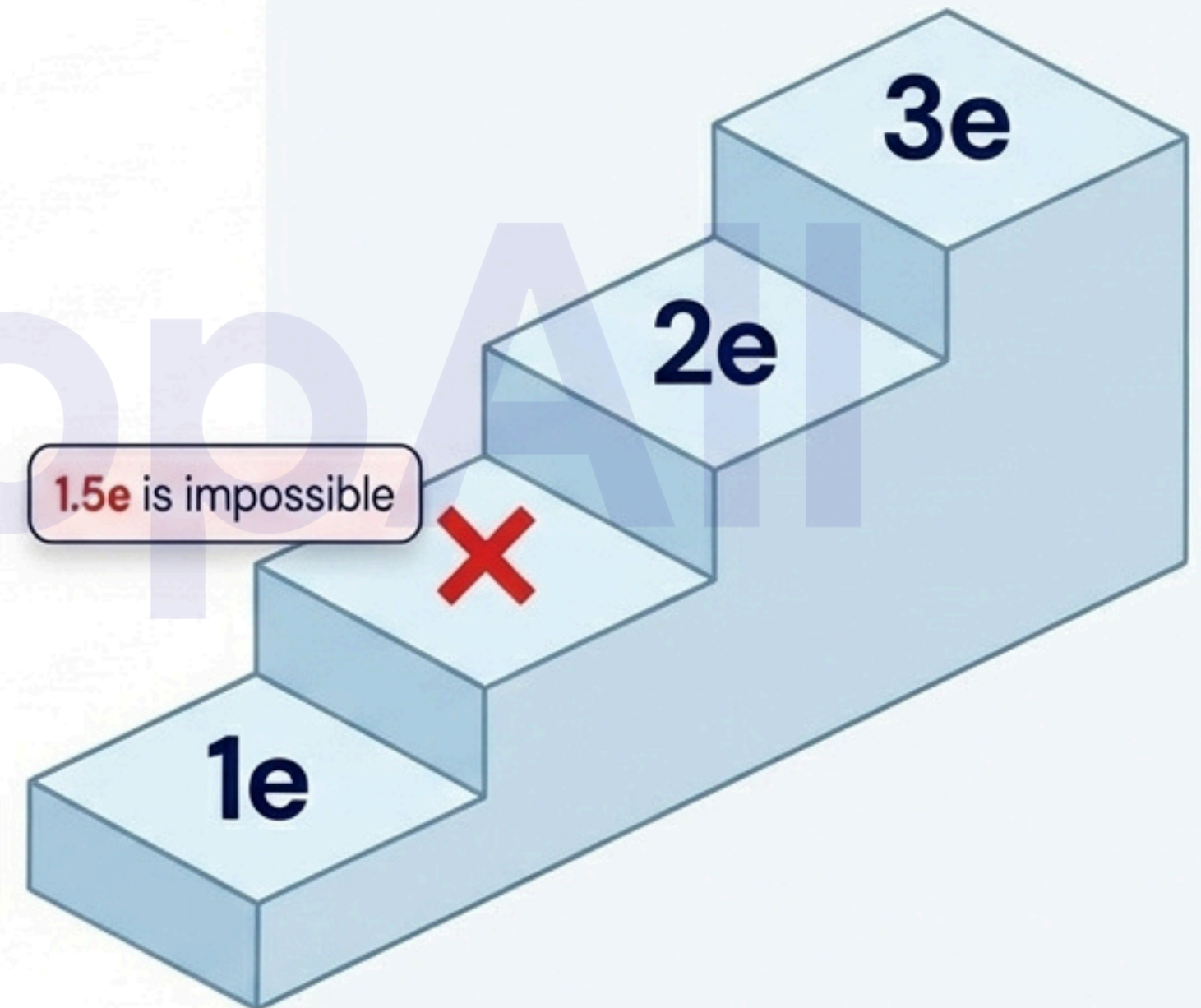
Formula Card

$$q = ne$$

q = Total Charge

n = Integer ($\pm 1, \pm 2, \pm 3 \dots$)

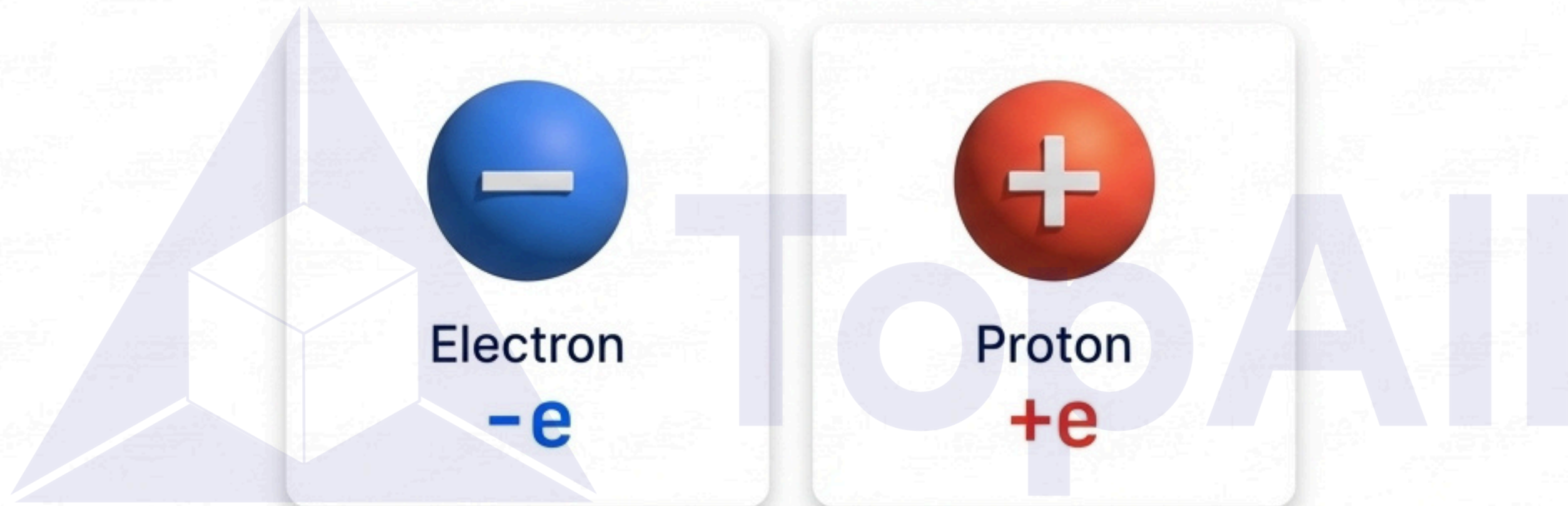
e = Elementary Charge



Note: At macroscopic levels (e.g., $1 \mu\text{C}$), the step size ' e ' is so small that charge appears continuous, like viewing a dotted line from far away.

The Basic Units of Charge

Protons and electrons are the fundamental charge carriers.
By convention, electrons are negative and protons are positive.



The Elementary Charge (e)

$$e = 1.602 \times 10^{-19} \text{ C}$$

It takes $\approx 6 \times 10^{18}$ electrons
to make just -1 C of charge!

Exam Traps & Misconceptions



TRAP: If it's a scalar, it's not conserved.

False. Mass is a scalar but is not always conserved (e.g., relativistic physics).

Charge is both a scalar (no direction) AND strictly conserved in an isolated system.



TRAP: Friction creates static electricity.

False. Friction does not create charge; it only transfers existing electrons from one material to another. The net charge of the two objects combined remains exactly zero.

Summary & Practice

- ✓ **Additivity:** Net charge is the algebraic sum of all charges ($q_1 + q_2 + \dots$).
- ✓ **Conservation:** Total charge of an isolated system cannot change.
- ✓ **Quantisation:** Charge exists only in discrete lumps ($q = ne$).

Q1. How many electrons are in -1 C of charge?

Use $q = ne$ where $q = -1$ and $e = -1.6 \times 10^{-19}$ C.

$$n = 6.25 \times 10^{18} \text{ electrons.}$$

Q2. Can a body have a charge of 0.8×10^{-19} C?

No. $n = q/e = 0.5$. Since n is not an integer, this violates quantisation.

NEXT CHAPTER → Coulomb's Law and Forces Between Multiple Charges



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