



First suggested by Faraday's laws of electrolysis.
Experimentally proven by Millikan's oil drop experiment (1912).

A decorative graphic consisting of a series of blue dots of varying sizes, followed by a thick blue horizontal line that extends to the right edge of the slide.

Quantisation of Charge

The discrete nature of electricity: why charge is grainy, not a continuous fluid.

The Universal Rule of Charge Transfer



$$q = ne$$

q = Total charge on a body.

n = Any integer ($\pm 1, \pm 2, \pm 3 \dots$).

e = The basic unit of charge.



Caution / Exam Trap: n cannot be a fraction or a decimal. A body cannot gain or lose 1.5 electrons. Charge always transfers in exact, whole steps.

The Elementary Charge (e)

The smallest independent charge that can exist freely in nature.

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

Electron



Charge: $-e$

Proton



Charge: $+e$

Synthesis Chip

If a body has n_1 electrons and n_2 protons, its net charge is exactly $(n_2 - n_1)e$.



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$$E=mc^2$$



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The Enormity of 1 Coulomb

Why everyday electrostatics relies on micro-units.

1C

$1\text{ C} \approx 6 \times 10^{18}$ electrons
(A staggering, astronomically large number)

Definition: 1 Coulomb is the charge flowing through a wire in 1 second if the current is 1 Ampere.

Practical Electrostatics Uses Smaller Prefixes:

- $1\text{ }\mu\text{C}$ (microcoulomb) = 10^{-6} C
- 1 mC (millicoulomb) = 10^{-3} C

The Illusion of Scale: Micro vs. Macro

Why the 'graininess' of charge vanishes in everyday physics.

Microscopic Scale



Scale: Charges are in tens or hundreds of e .

Reality: Quantisation is highly visible and mathematically critical. The discrete "lumps" matter.

Macroscopic Scale



Scale: Charges are in μC (containing $\sim 10^{13}$ electrons).

Reality: The step size of $1e$ is infinitely small compared to the total charge. Quantisation has no practical consequence and is ignored.

Visual Analogy Callout

Like a dotted line viewed from far away, millions of discrete points blur into a continuous line.

Review & Application

Key Takeaways

1. All free charges in the universe are integral multiples of e ($q = ne$).
2. Charge is discrete and 'grainy', not a continuous fluid.
3. At macroscopic scales (e.g., μC), the step size e is so small that quantisation is practically ignored and charge appears continuous.

Check Your Understanding

Is a charge of $4.8 \times 10^{-19} \text{ C}$ possible in nature? What about $4.0 \times 10^{-19} \text{ C}$?

Answer Key

$$4.8 \times 10^{-19} \text{ C} \div 1.6 \times 10^{-19} \text{ C} = 3 \text{ (Integer} \rightarrow \text{Possible)}$$

$$4.0 \times 10^{-19} \text{ C} \div 1.6 \times 10^{-19} \text{ C} = 2.5 \text{ (Fraction} \rightarrow \text{Impossible)}$$



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