ELECTRICITY DAY 1: CHARGE, CONSERVATION & QUANTIZATION

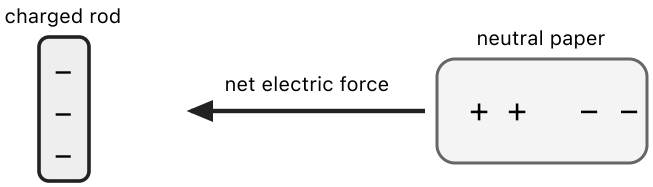
CED 10.1 · Skill 3.B · FRQ: QQT · target: charge is transferred, not created or used up

PREDICT BEFORE OBSERVING

A rubbed plastic rod approaches neutral paper bits. Circle one before the rod moves: the paper is **attracted / repelled / ignored**.

Observation source: rod and paper; projected PhET *Balloons and Static Electricity* as a partial substitute using the same polarization mechanism; or the printed arrangement below.

PRINTED FALLBACK - DECIDE BEFORE ADDING FORCE ARROWS



TWO KINDS OF CHARGE

- Like signs repel; unlike signs attract.
- Ordinary matter contains positive protons and negative electrons.
- In solid objects, protons remain bound in nuclei. Charging usually transfers electrons.
- Neutral means the positive and negative totals are equal. It does not mean charged particles are absent.

QUICK A neutral plastic strip gains electrons. State the strip's final sign and the sign of the object that supplied those electrons.

CHARGE COMES IN PACKETS

The magnitude of charge is an integer multiple of the elementary charge.

$$q = ne \qquad e = 1.60 \times 10^{-19}\text{C}$$

Use the sign to describe whether electrons are missing $(+q)$ or in excess $(-q)$. The count n is nonnegative.

WE DO A conductor has $q = -1.60\text{nC}$. Find the number of excess electrons. Carry the coulomb units through the division.

YOU DO A neutral sphere loses 3.00×10^{10} electrons. Find its final charge in nanocoulombs and state its sign.

Unit checkpoint: $1\text{nC} = 10^{-9}\text{C}$. A particle count has no unit after C/C cancels.

CONSERVATION OF CHARGE

For an isolated system, the algebraic sum of all charges remains constant.

$$q_{\text{total,before}} = q_{\text{total,after}}$$

When identical conducting spheres touch, electrons move until the spheres reach the same potential. Identical spheres then carry equal charge.

WE DO Identical spheres carry $+6.5\text{nC}$ and -1.5nC. They touch and separate. Find the charge on each sphere.

YOU DO Identical spheres carry -5.5nC and $+2.5\text{nC}$. They touch and separate. Find the final charge on each and identify the direction electrons moved during contact.

Representation habit: write a signed charge ledger before using an equation. The total should be visible before and after.

PRACTICE

1. A conductor has charge $+2.40\text{nC}$. How many electrons are missing?

2. An object has 4.50×10^{10} excess electrons. Find its charge in nC.

3. An isolated three-object system begins at $+5.5\text{nC}$, -2.5nC, and 0. After electrons transfer internally, one object reads $+1.0\text{nC}$ and another reads -4.0nC. Find the third charge.

4. Identical spheres at $+7.5\text{nC}$ and -3.5nC touch and separate. Find the final charge on each.

5. Identical spheres at -6.5nC and $+1.5\text{nC}$ touch and separate. Find the final charge and excess-electron count on each sphere.