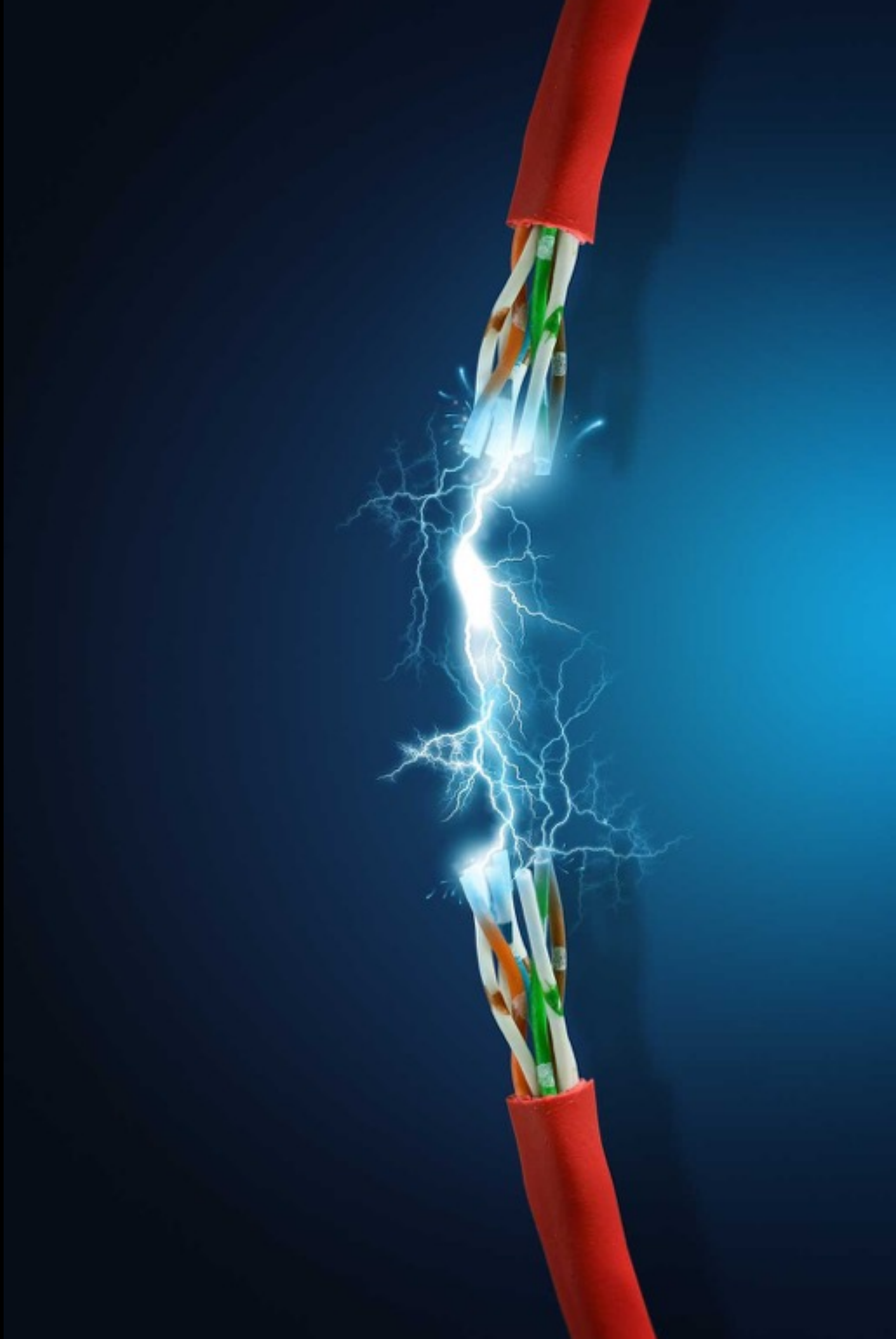
ELECTRICITY

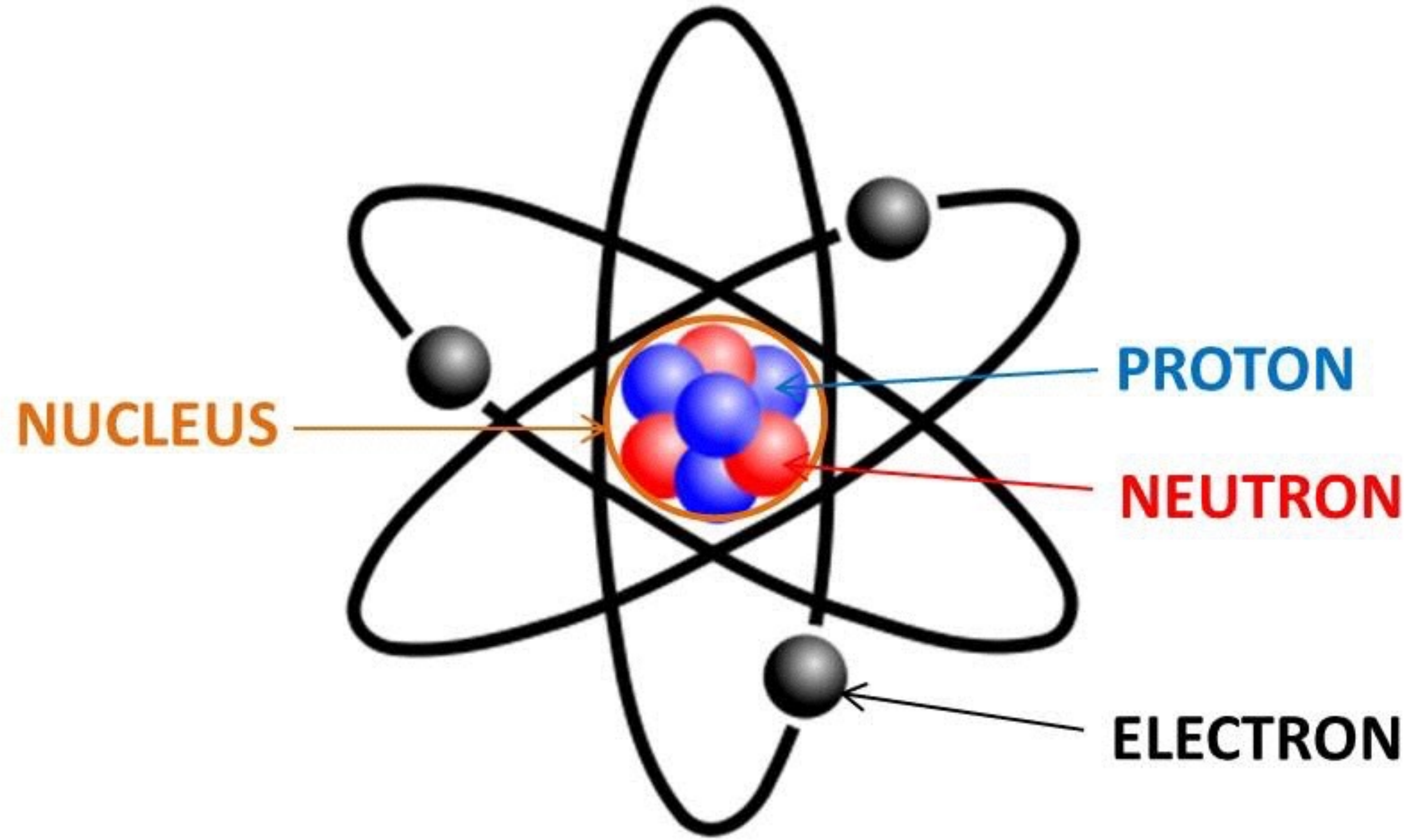
- Electric forces include:
  - the forces between atoms and molecules holding them together
  - the forces involved in metabolic processes in our bodies
  - elastic forces
  - normal forces
  - other contact forces



STATIC ELECTRICITY

- The word *electricity* comes from the Greek word *elektron*, meaning "amber"
- The ancients discovered that if you rub an amber rod with a piece of cloth, the amber attracts small pieces of leaves or dust
  - Today, we called this "amber effect" ***static electricity***

THE STRUCTURE OF AN ATOM

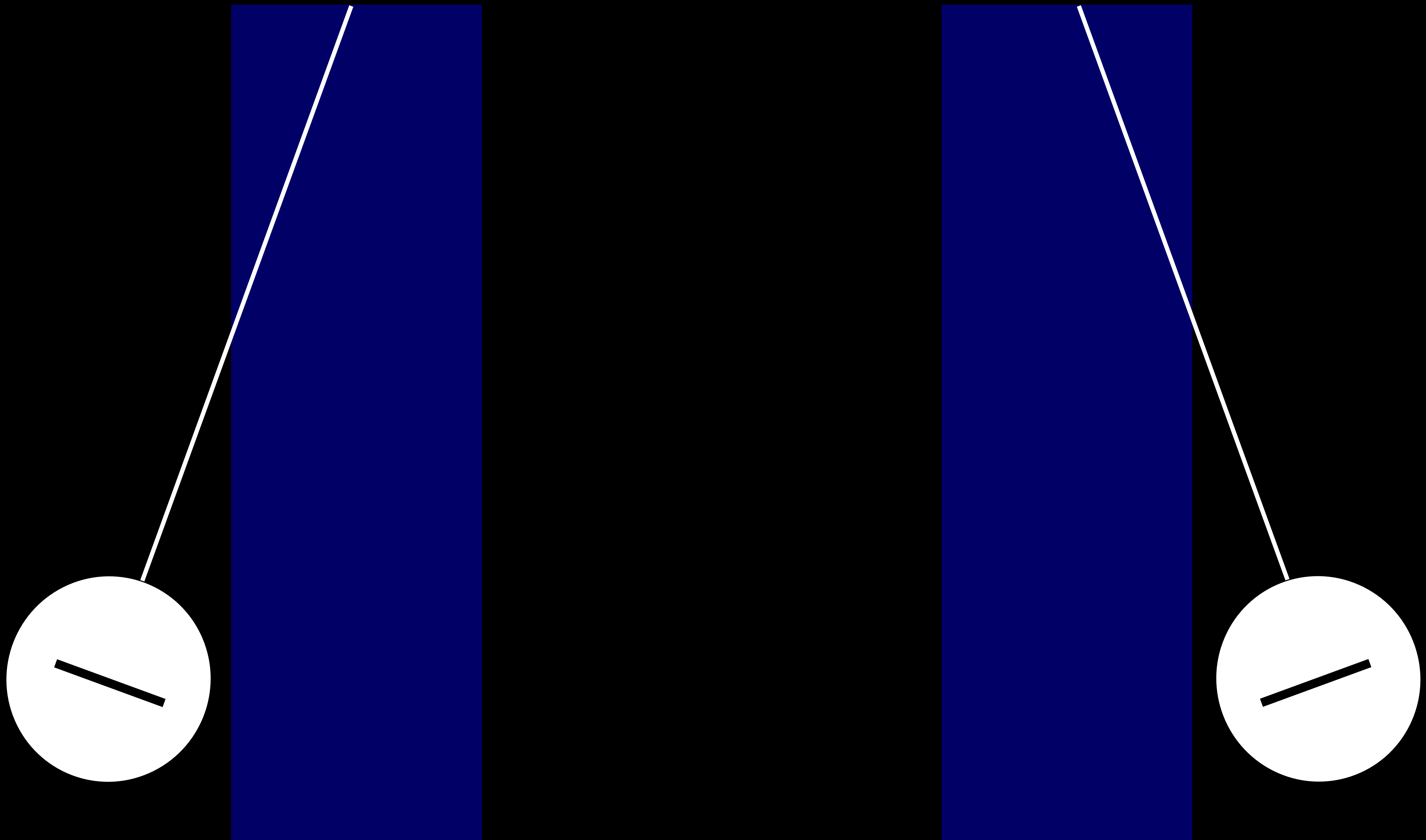


CHARGE

- Protons and electrons have an attribute called ***charge***
    - Protons have *positive* charge
    - Electrons have *negative* charge
    - Neutrons have *no* charge
- Charge is measured in ***Coulombs*** (**C**)

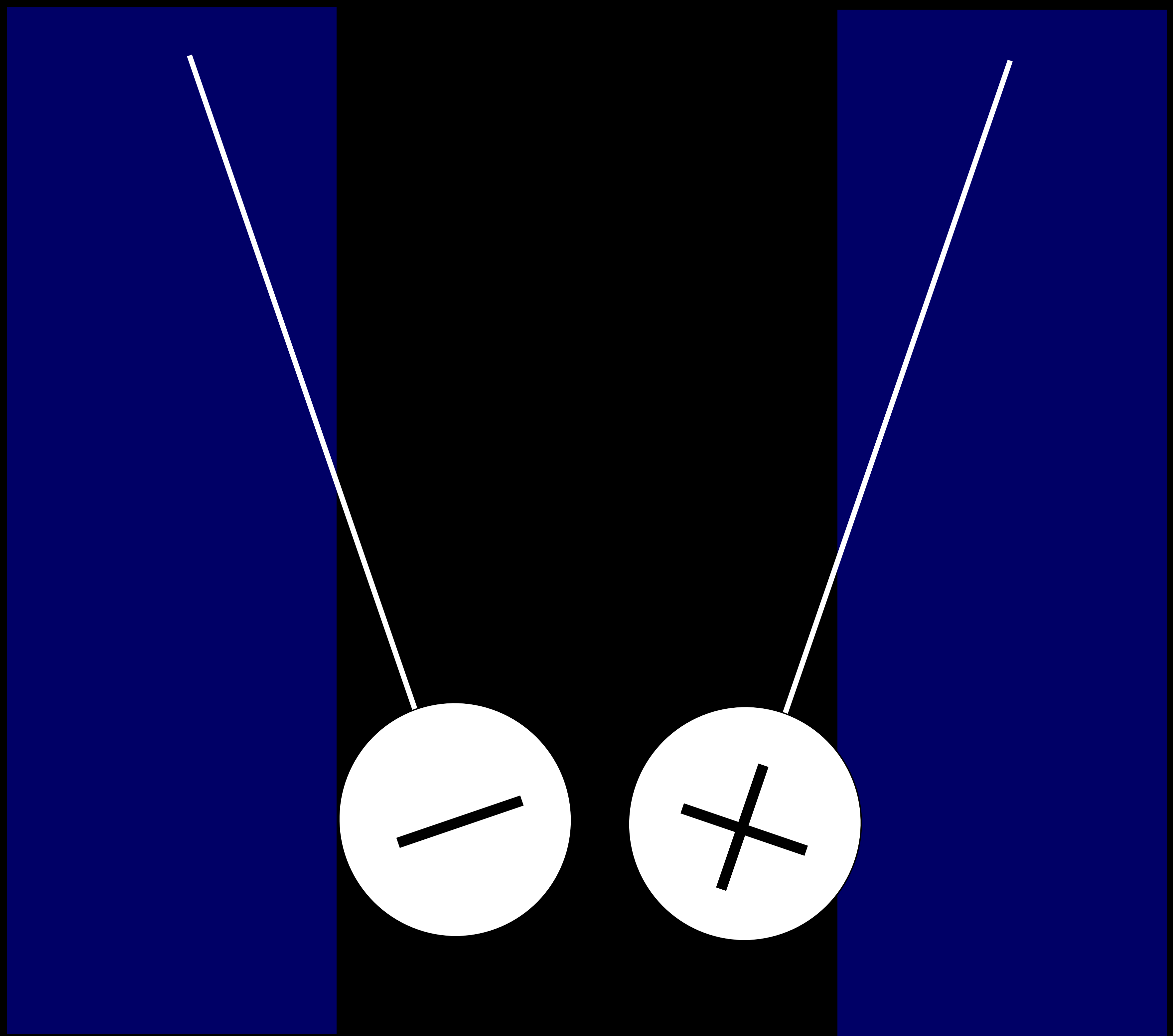
CHARGE

LIKE CHARGES REPEL



CHARGE

OPPOSITE CHARGES ATTRACT

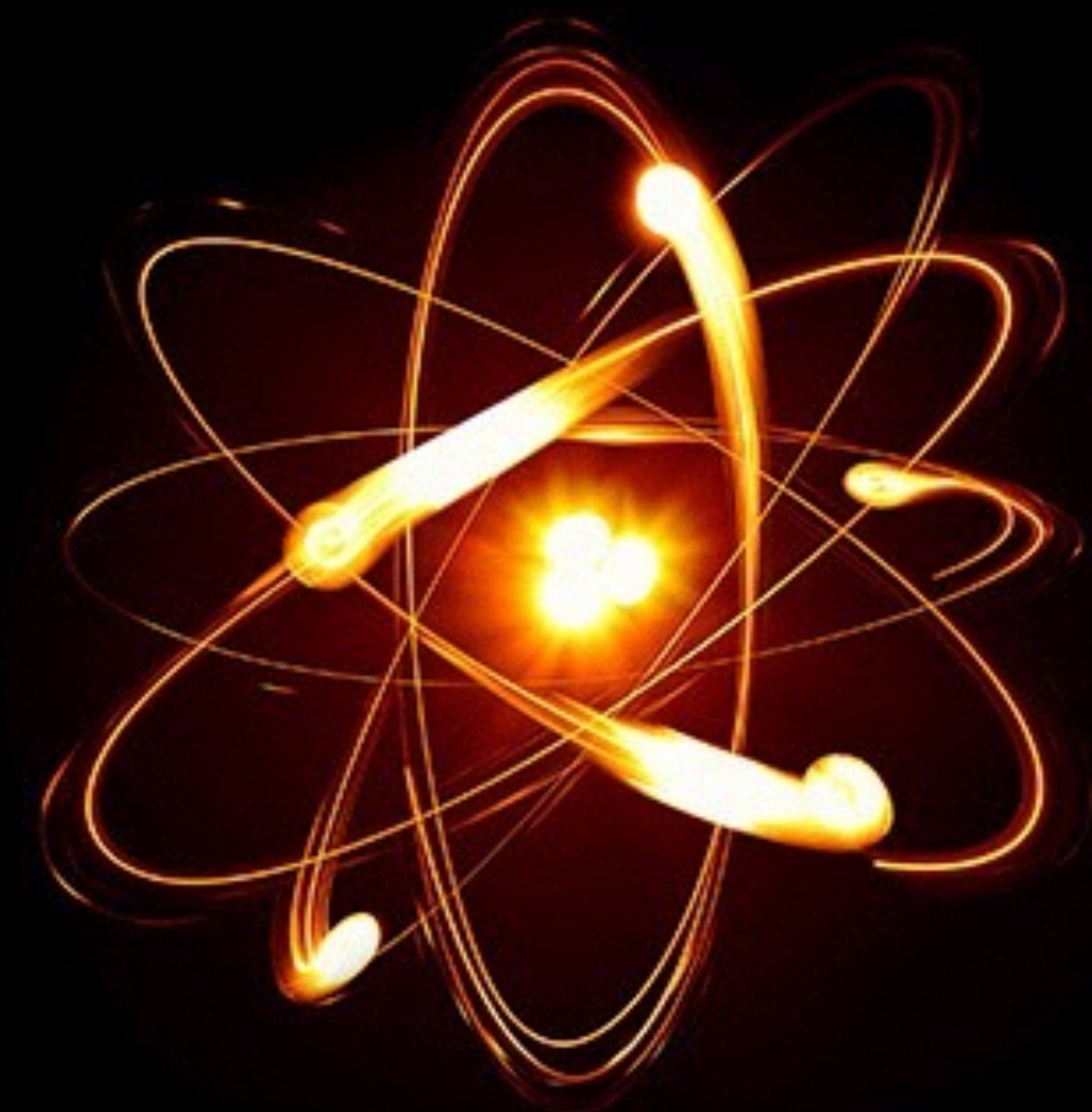


QUANTIZATION OF CHARGE

- $e^- = -1.6\times10^{-19}$ C (charge on an electron)
- $p^+ = +1.6\times10^{-19}$ C (charge on a proton)
- ***Quantization of Charge*** means that how much charge you can have is restricted to discrete quantities
  - A charged object will *always* have a charge that is an integer multiple of the charge on an electron (or proton)

QUANTIZATION OF CHARGE

- $Q = ne$
- Q = total charge
- n = (number protons) - (number of electrons)
- $e = 1.6 \times 10^{-19}$ C
- e is called the ***elementary charge***
  - Indivisible — you will never find a smaller charge in nature



PARTICLE	RELATIVE MASS	RELATIVE CHARGE	CHARGE (C)	MASS (KG)
PROTONS	1	+1	$+1.6 \times 10^{-19}$	1.67×10^{-27}
NEUTRONS	1	0	0	1.67×10^{-27}
ELECTRONS	0.0005	-1	-1.6×10^{-19}	9.11×10^{-31}

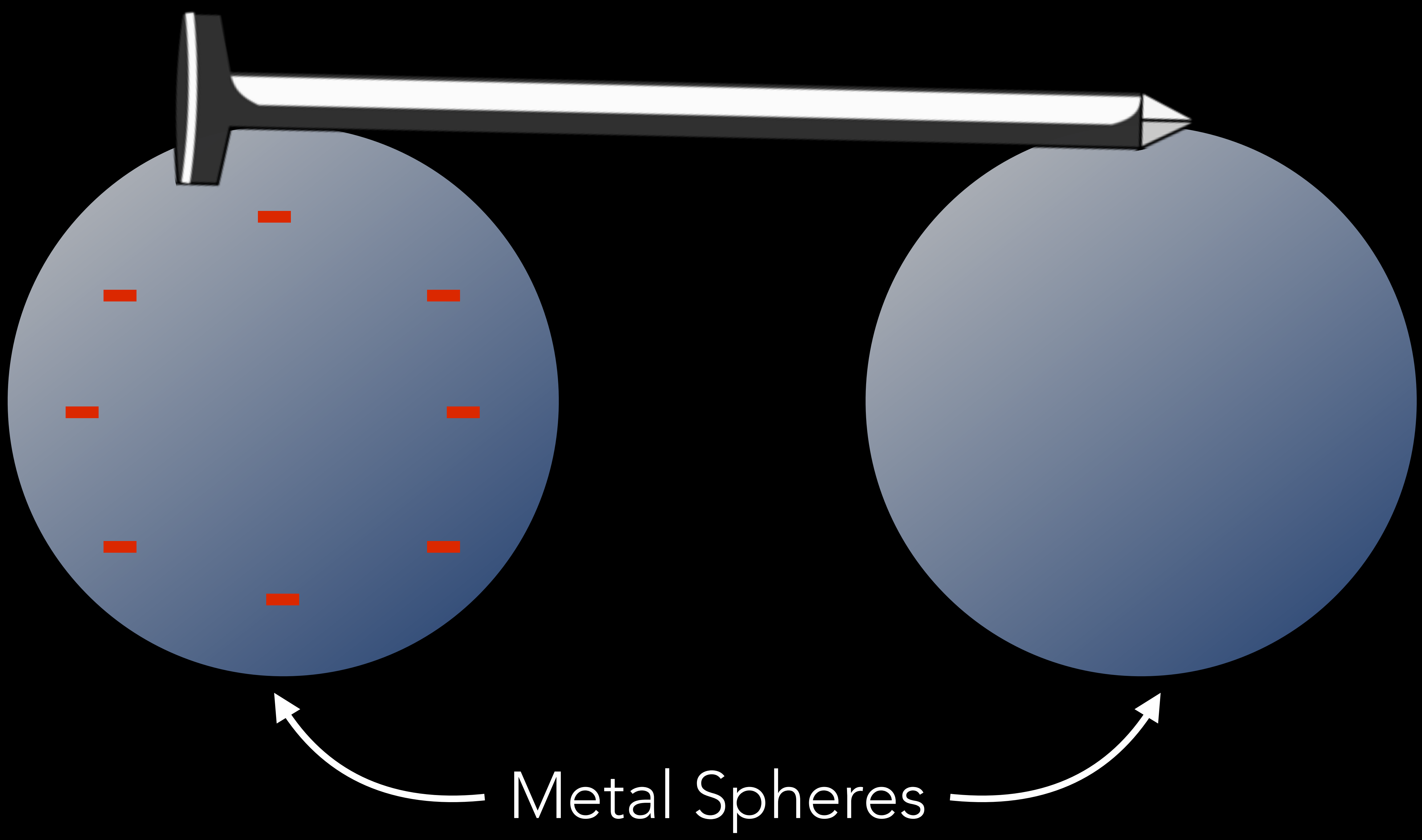
CHARGE AND EVERYDAY OBJECTS

	AMOUNT OF CHARGE
Charges in static electricity from rubbing materials together	~ microcoulombs
Charges traveling through a lightning bolt	15 - 350 C
Charge that travels through a typical alkaline AA battery from being fully charged to discharged	about 5000 C

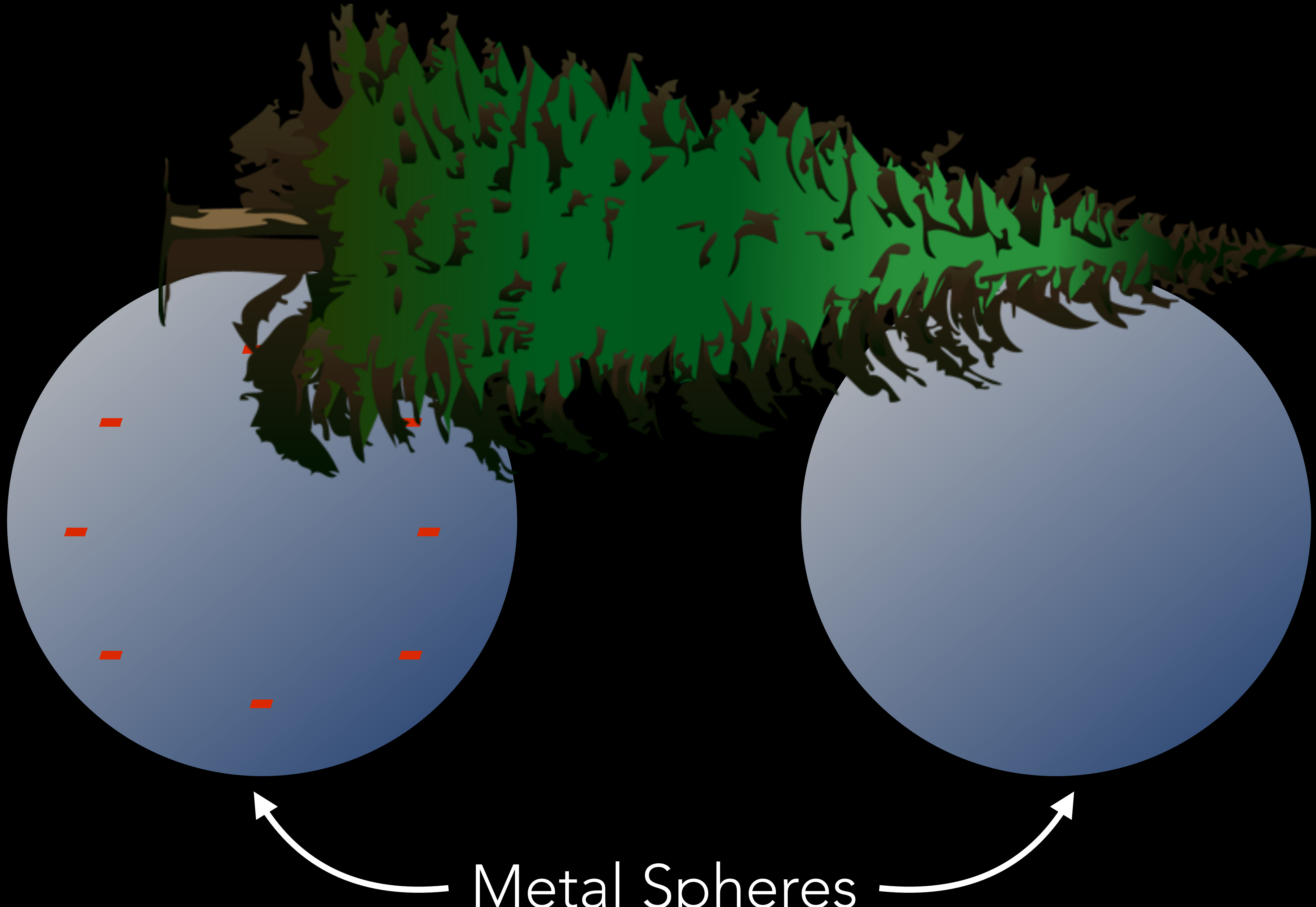
THE LAW OF CONSERVATION OF ELECTRIC CHARGE

- **Electric charge cannot be created or destroyed. The net amount of electric charged produced in any process is *always* zero.**
    - If one object or region of space acquires a positive charge, then an equal amount of negative charge will be found in neighboring areas or objects.

INSULATORS & CONDUCTORS



INSULATORS & CONDUCTORS



INSULATORS & CONDUCTORS

- Materials like the iron nail are said to be ***conductors*** of electricity (typically metals)
- Materials like wood or rubber are *nonconductors* or ***insulators***
- Nearly all natural materials fall into one or the other of these two distinct categories
    - A few (like silicon, germanium, and carbon) fall into an intermediate (but distinct) category known as ***semiconductors***

HOW TO MOVE CHARGES

- There are three basic ways to move charges between and/or within objects

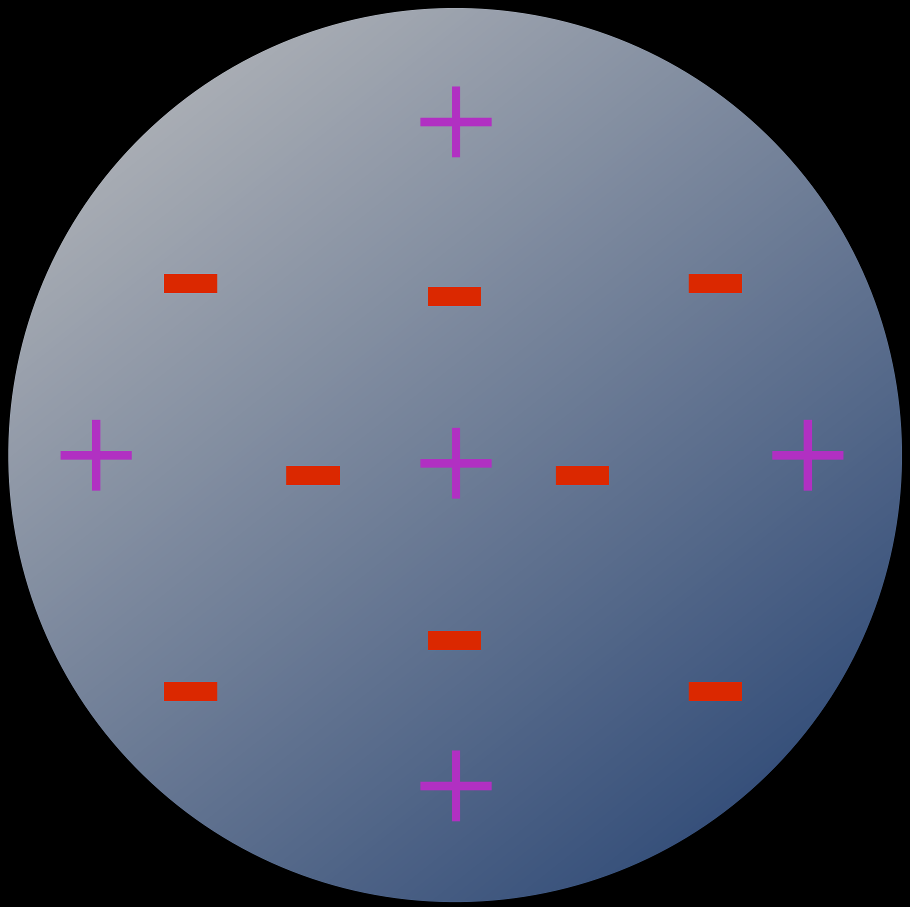
  1. Conduction

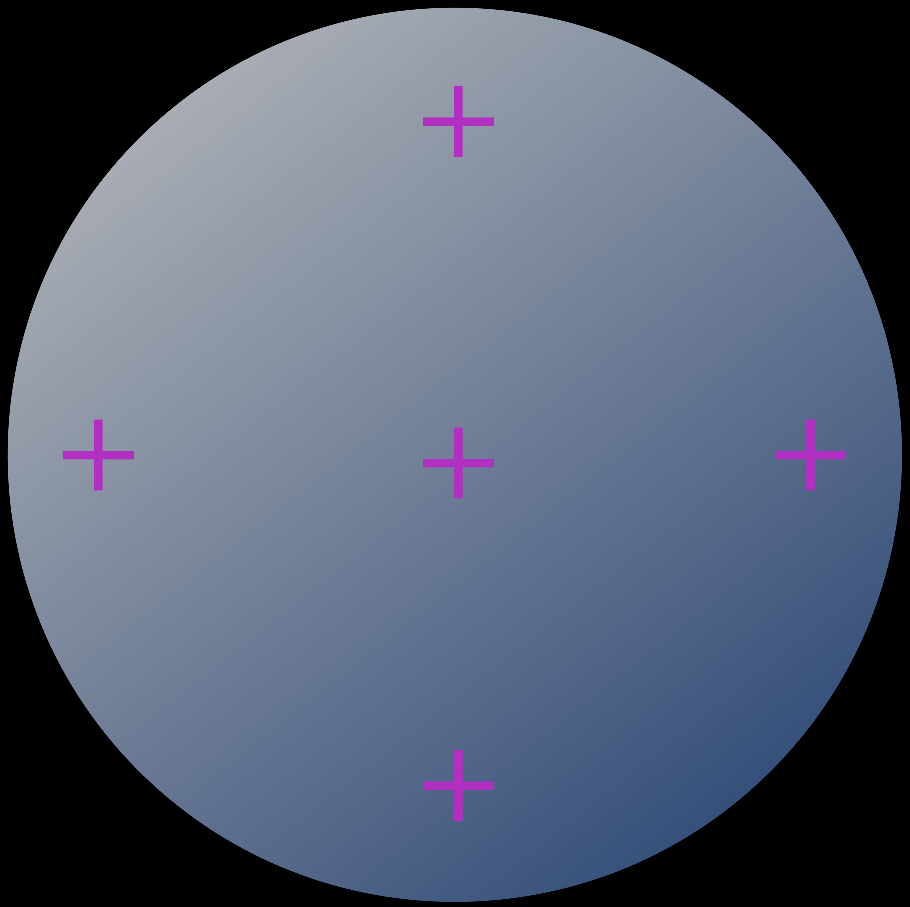
  2. Induction

  3. Friction

HOW TO MOVE CHARGES

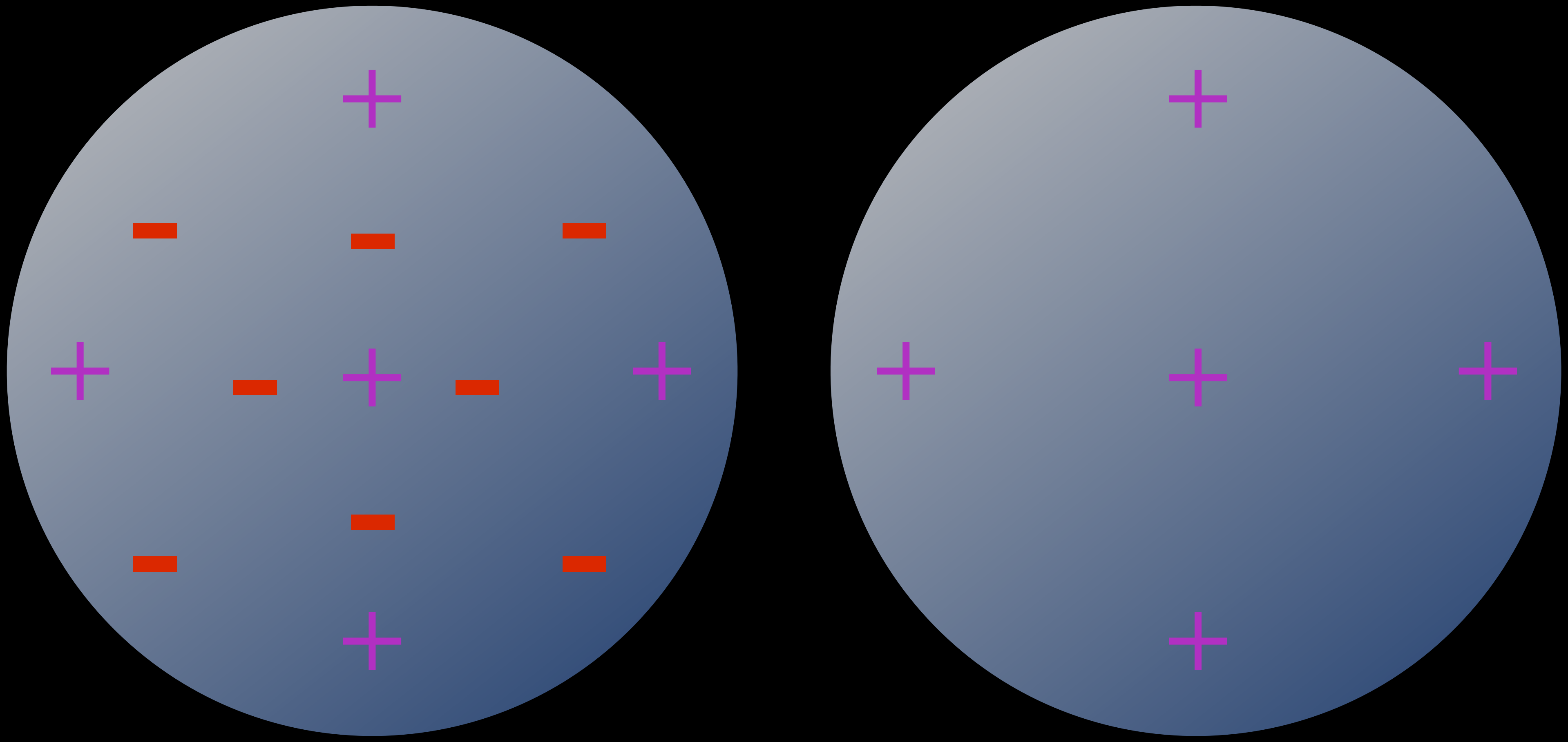
- ***Conduction*** is where charges move between objects when they *<u>touch</u>*





HOW TO MOVE CHARGES

- ***Induction*** is *separation of charge* within an object because of the close approach of another charged object but *without touching*

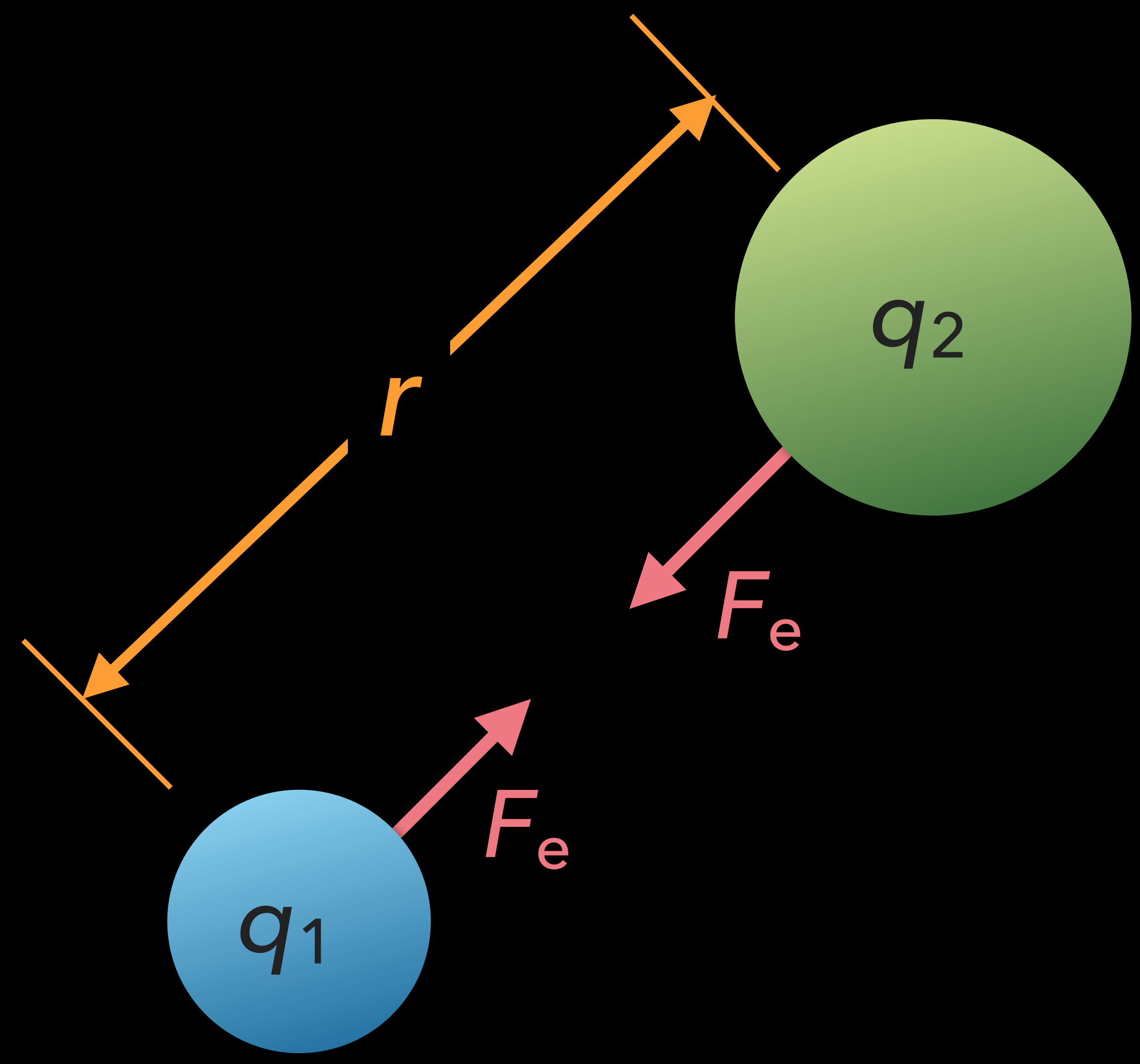


HOW TO MOVE CHARGE

- Charging by ***friction*** is where electrons are physically stripped from one material and transferred to another

FORMALIZING ELECTRIC FORCE

- The electric force between two objects depends on 3 quantities
    - How big is the first charge: q_1
    - How big is the second charge: q_2
    - How far apart are they: r



COULOMB'S LAW

- $F_e = \frac{kq_1q_2}{r^2}$ Inverse square law!
  - $k = 9.0\times10^9\ \mathrm{Nm^2/C^2}$
- If F_e is positive, the force is *repulsive*
- If F_e is negative, the force is *attractive*

EXAMPLE 1

- Determine the electric force on an electron in a hydrogen atom from the proton if they are separated by an average distance of $r = 0.53 \times 10^{-10}$ m
  - *Ans.* $F_e = -8.2 \times 10^{-8}$ *N*