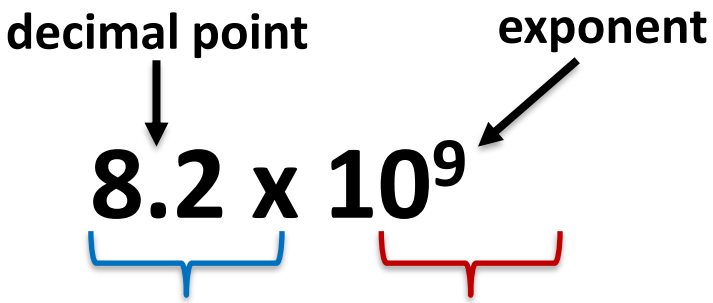
Scientific Notation

- **Scientific notation** (also referred to as *"standard form"* or *"standard index form"*) is a way of writing numbers that are too big or too small to be conveniently written in decimal form.

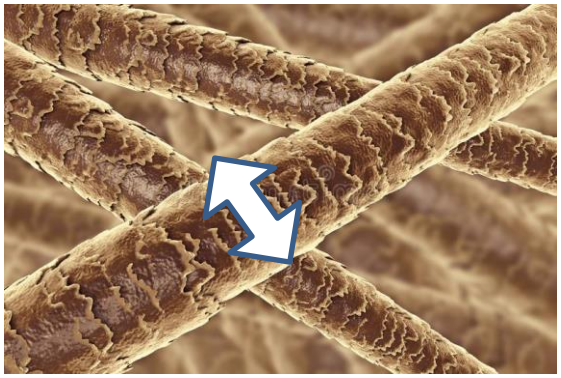
World Population in 2025



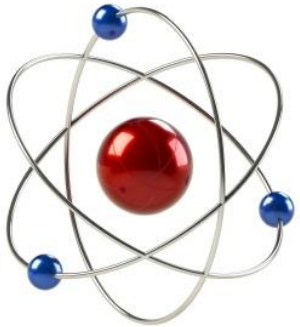
- **large positive (+) exponent** represents **very large** number
- **large negative (-) exponent** represents **very small** number

Atoms are extremely small!

A human hair is (approximately) how many atoms thick?



HUMAN HAIR ~ 100 µm



ATOM ~ 100 pm

10^{-6} m/10^{-12} m =

=1,000,000

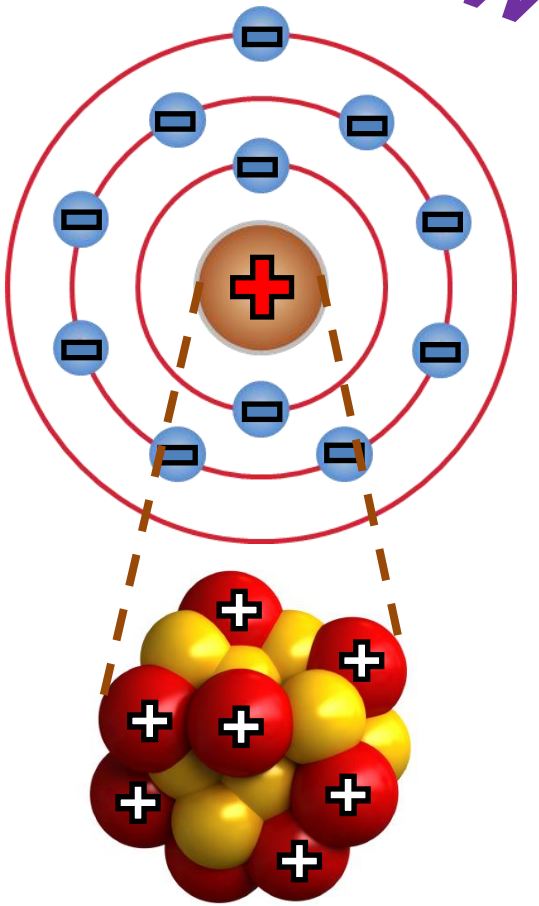
or

1 million!

Atomic Structure

REVIEW

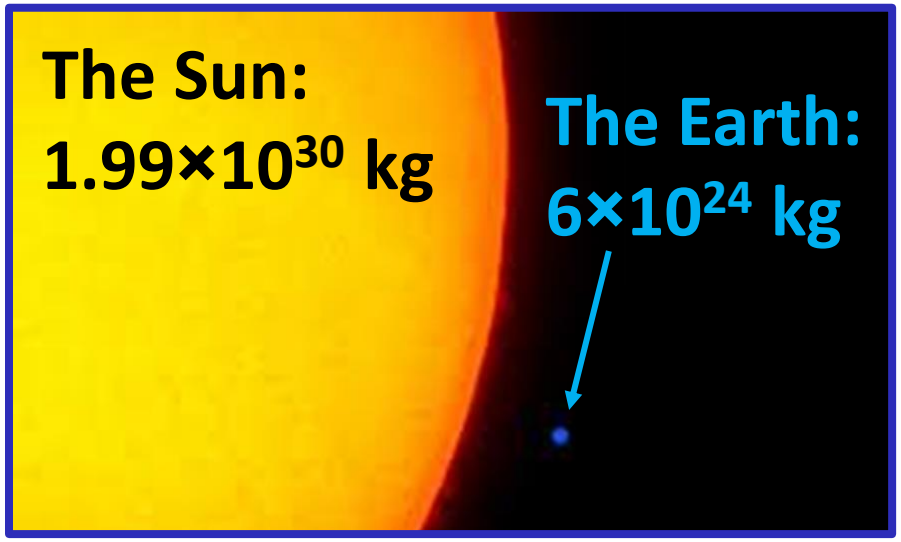
- **All atoms have:**
  - a positively charged nucleus
  - and negatively charged electrons moving around within atomic orbitals
- **Atomic nucleus consists of:**
  - positively charged protons (# of protons = # of electrons)
  - and neutrons that have no electric charge
- **The # of protons (*atomic number*) defines the "kind of atom", or the identity of a chemical element.**

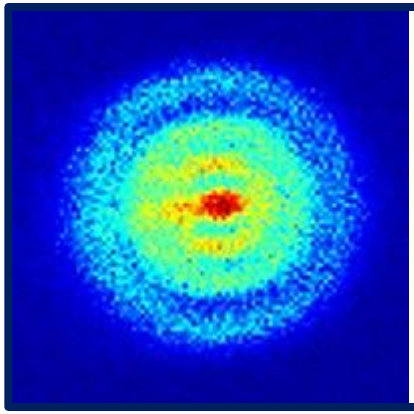


Atom ~10^{-10}m
Nucleus ~10^{-14}m
Proton/Neutron ~10^{-15}m
Electron <10^{-18}m

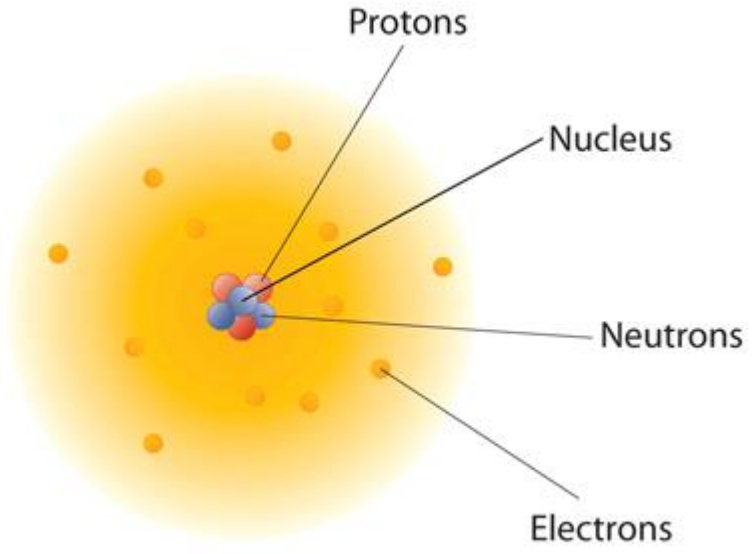
Mass is the **amount of material** in an object

- **SI unit of mass is kg**





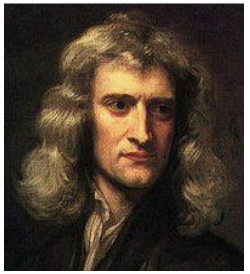
The mass of a smallest atom, Hydrogen, is 1.67×10^{-27} kg



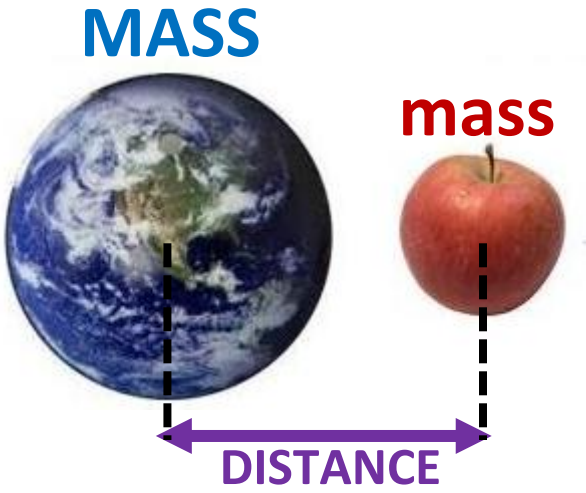
- Since **all atoms making up any object are composed of protons, neutrons and electrons**, mass is essentially defined by the

total amount of all those particles in an object.

Gravity aka **gravitation**



is the universal **force of attraction** that acts **between any two or more objects that have mass**



$$\text{GRAVITY} = G \cdot \frac{\text{MASS} \cdot \text{mass}}{(\text{DISTANCE})^2}$$

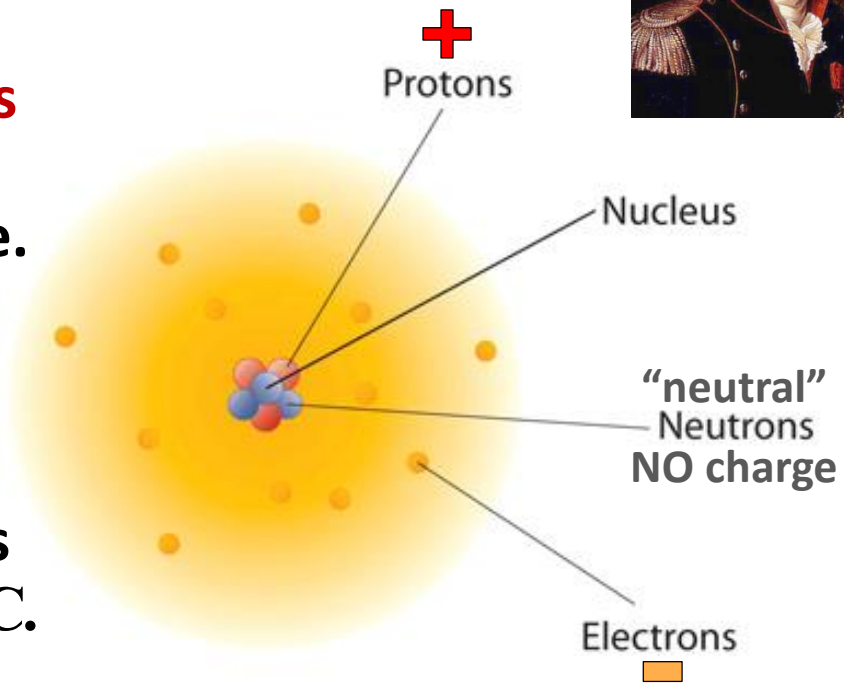
$$6.67 \times 10^{-11}\ \text{Nm}^2/\text{Kg}^2$$

"gravitation constant"

- **Gravity is generally a "weak" force…but massive objects create strong gravitational pull!**
- **Gravity has infinite range…but very distant objects experience very little mutual attraction!**

Charge, + or −, is the basic property of matter that gives rise to all electrical and magnetic forces and interactions.

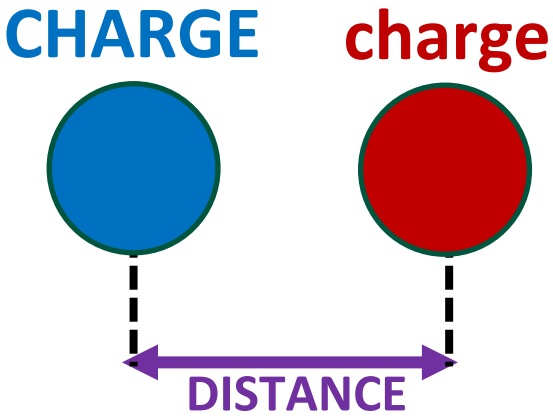
- In atoms, electrons carry the negative (-) charge, and protons carry the positive (+) charge; neutrons have NO (zero) charge.
- SI unit of charge is Coulomb.
- The charge of a single electron, known as *elementary charge*, is equal to *negative* 1.602×10^{-19} C.



- The charge of a single proton is the same but *positive*.
- Matter is usually *charge-neutral*, meaning the positive and negative charges balance out on large scale.

Electromagnetism

is an interaction that occurs between particles that have electric charge

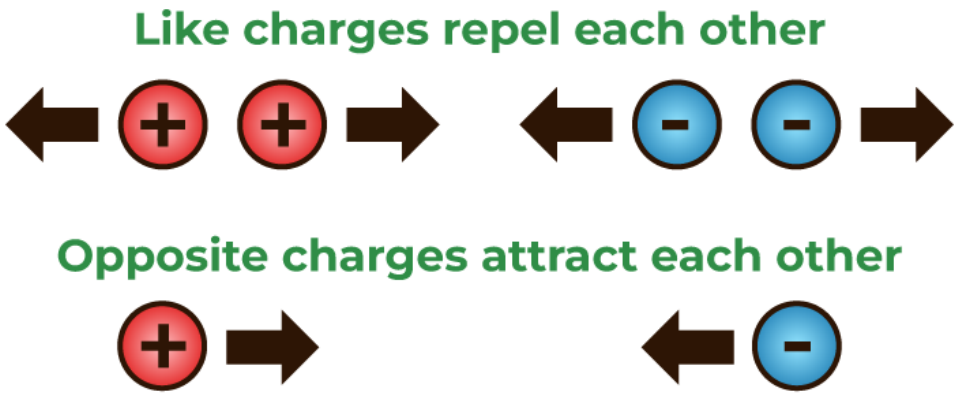


$$\text{ELECTRIC FORCE} = k \cdot \frac{\text{CHARGE} \cdot \text{charge}}{(\text{DISTANCE})^2}$$

$k = 8.99 \cdot 10^9\ N \cdot m^2/C^2$

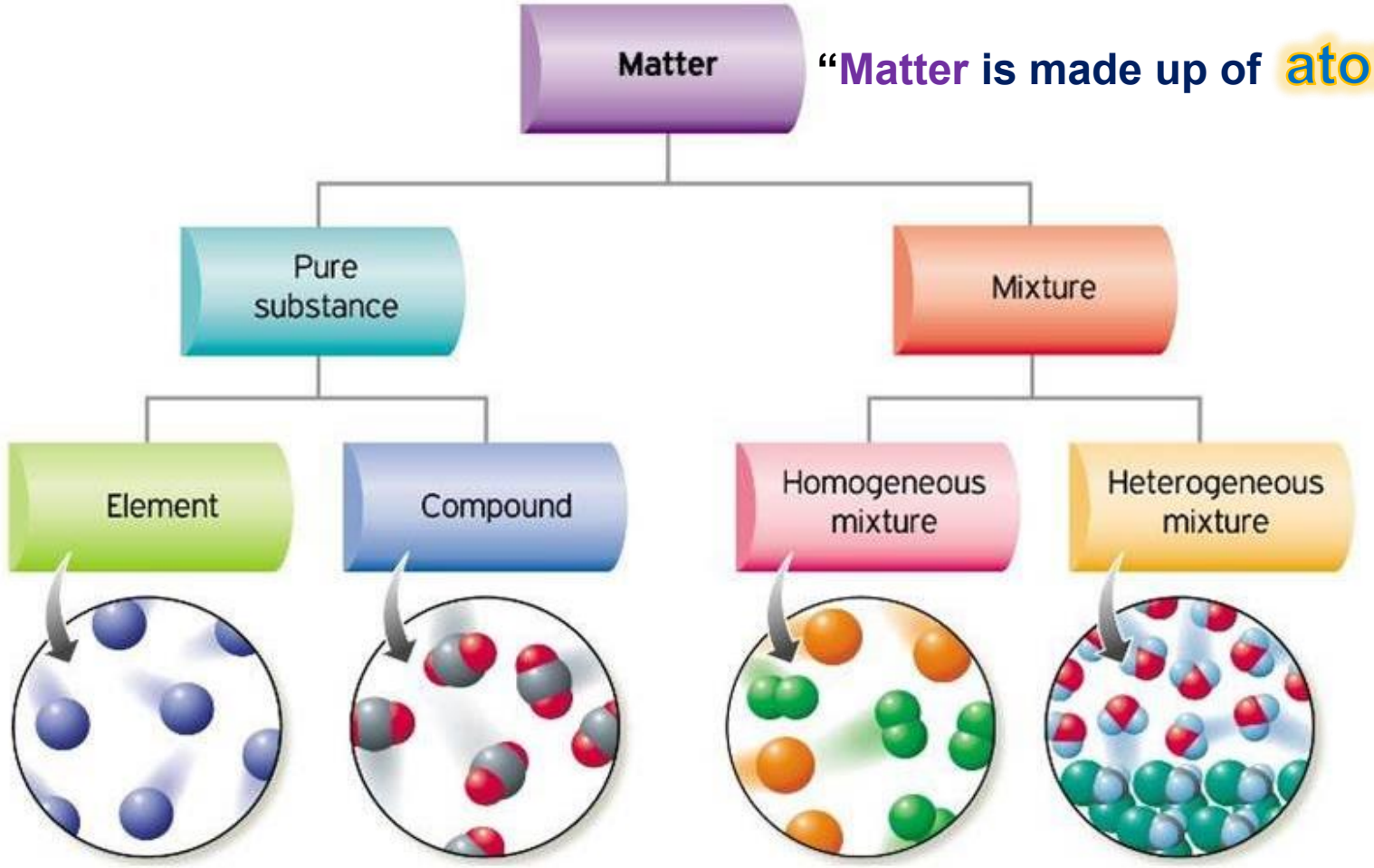
"electrostatic force constant"

A "strong" force at the atomic level… responsible for binding atoms into molecules and molecules into liquids and solids!



Classification of Substances

REVIEW



"Matter is made up of atoms"

"Single kind"

States of Matter

REVIEW