

LET US REVIEW...

Properties of Matter

Mass and Charge

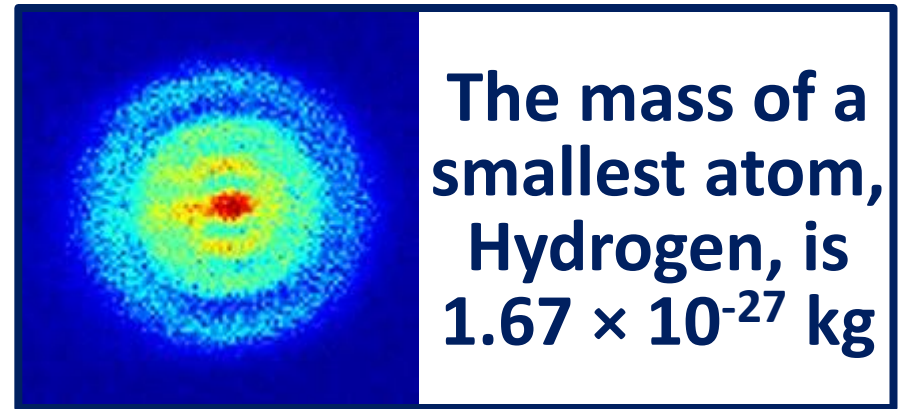
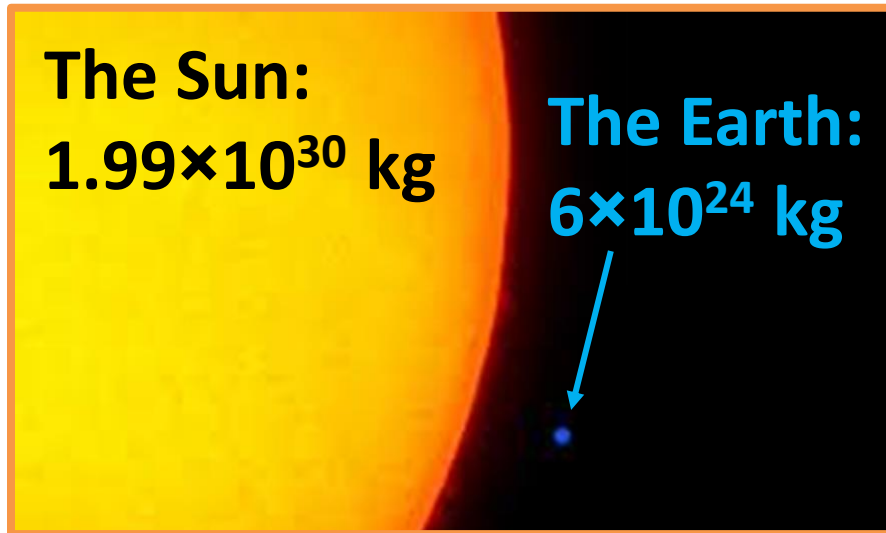
Gravity

Electromagnetism

Nuclear force

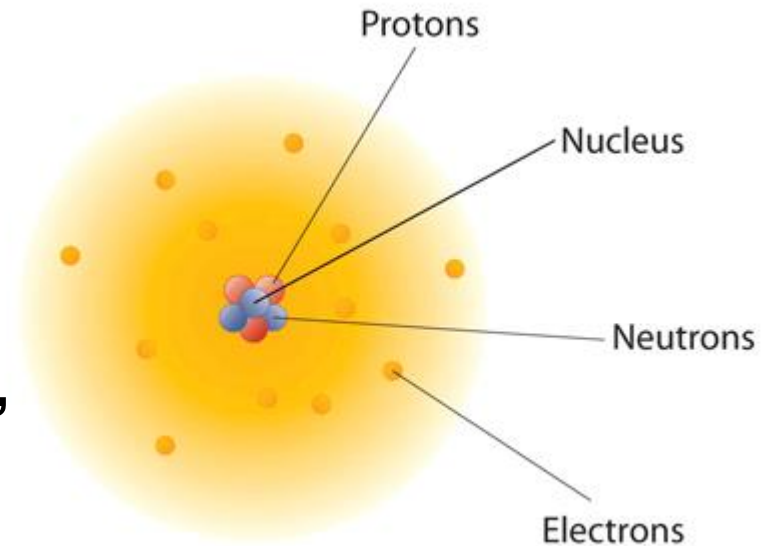
Mass is the **amount of material** in an object

- SI unit of mass is **kg**

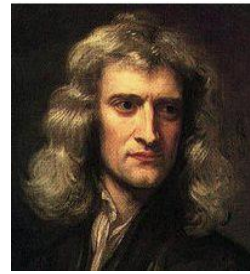


- Since all atoms making up any object are composed of protons, neutrons and electrons, mass is essentially defined by the

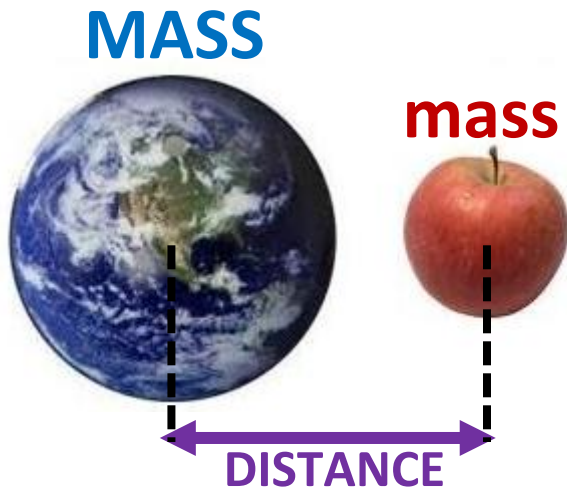
total amount of all those particles in an object.



Gravity aka gravitation



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



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

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



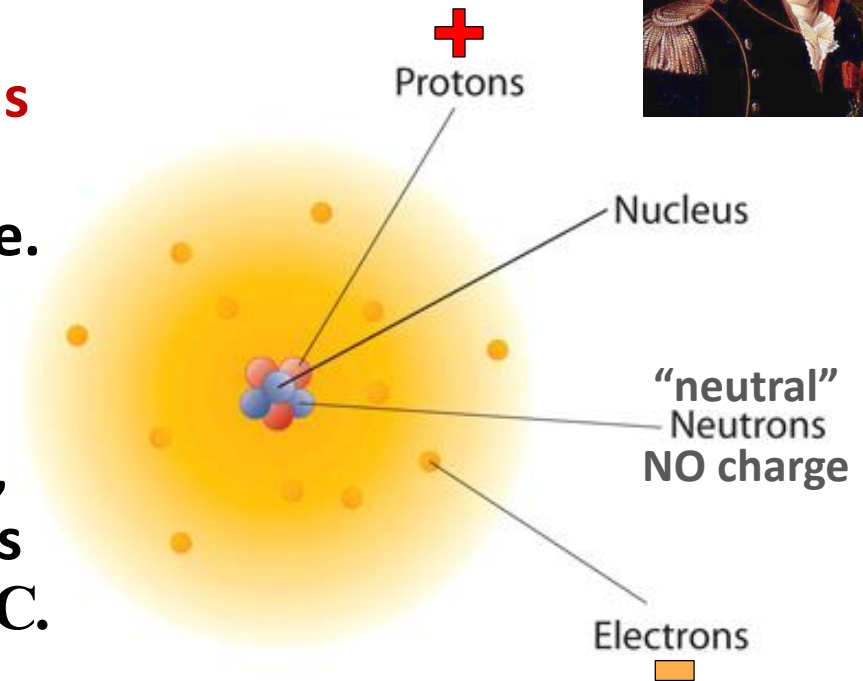
- In atoms, **electrons** carry the **negative** (-) charge, and **protons** carry the **positive** (+) charge; neutrons have NO (zero) charge.

- 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**.

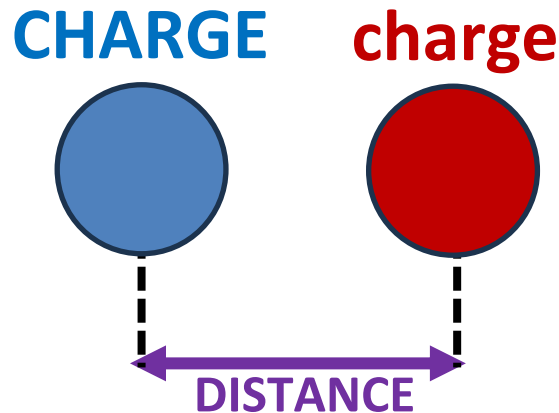
- The charge of a single proton is the same but *positive*.

- Matter is usually *charge-neutral*, meaning the positive and negative charges balance out on large scale.



Electromagnetism

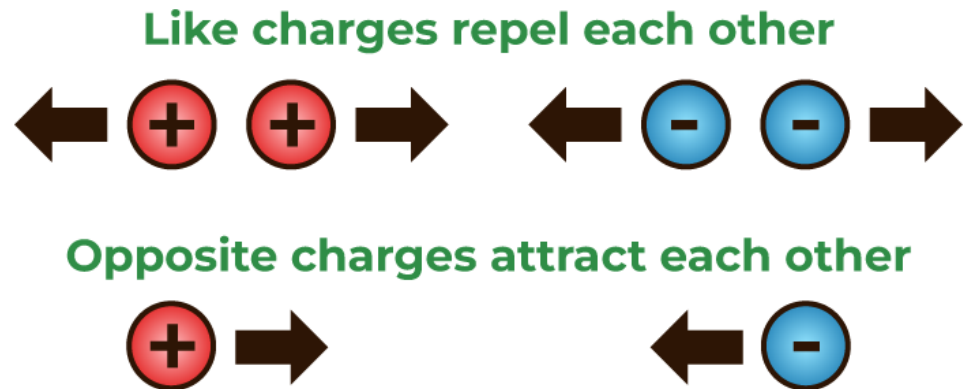
is an interaction that occurs between particles that have electric charge



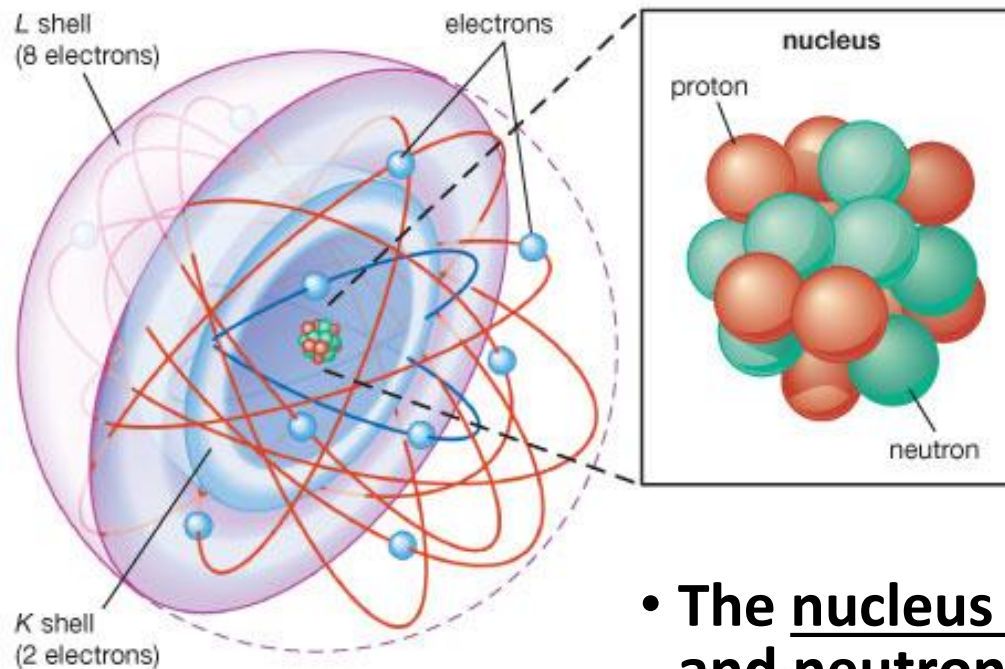
$$\text{ELECTRIC FORCE} = k \cdot \frac{\text{CHARGE} \cdot \text{charge}}{(\text{DISTANCE})^2}$$

$8.99 \cdot 10^9 \text{ N} \cdot \text{m}^2 / \text{C}^2$
“electrostatic force constant”

A “strong” force at the atomic level...
responsible for binding atoms into molecules and molecules into liquids and solids!



What Holds an Atom Together?



- The electrons are kept in orbit around the nucleus due to an electromagnetic field of attraction between the positive (+) charge of the protons and the negative (-) charge of the electrons.

- The nucleus of protons and neutrons is kept together by the nuclear (strong) force, which *opposes and overcomes the electromagnetic repulsion when particles are very close to each other (~1 fm!)*.