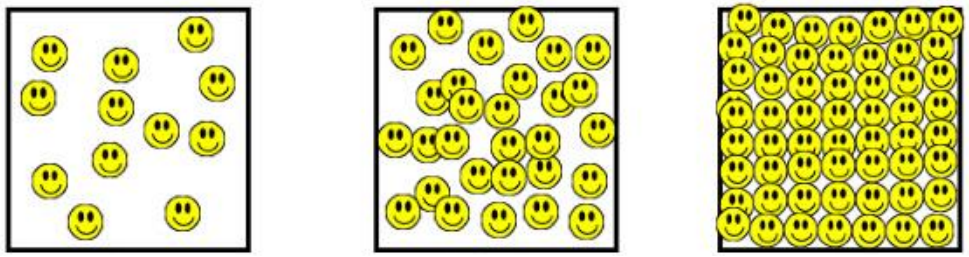
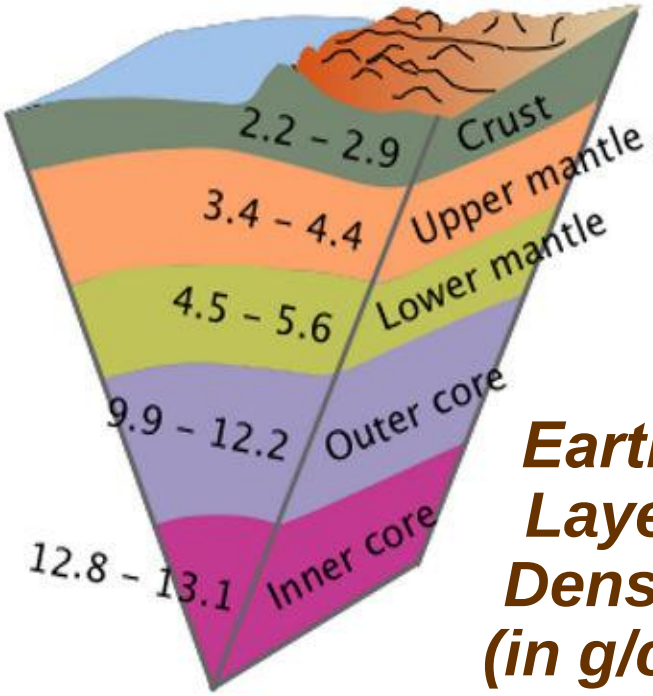
Density

- **Density is a measure of <u>how much matter (particles!) is contained in a unit of volume</u>:**

  - **density = $\frac{\text{mass}}{\text{volume}}$**
  - **SI unit is kg/m^3**

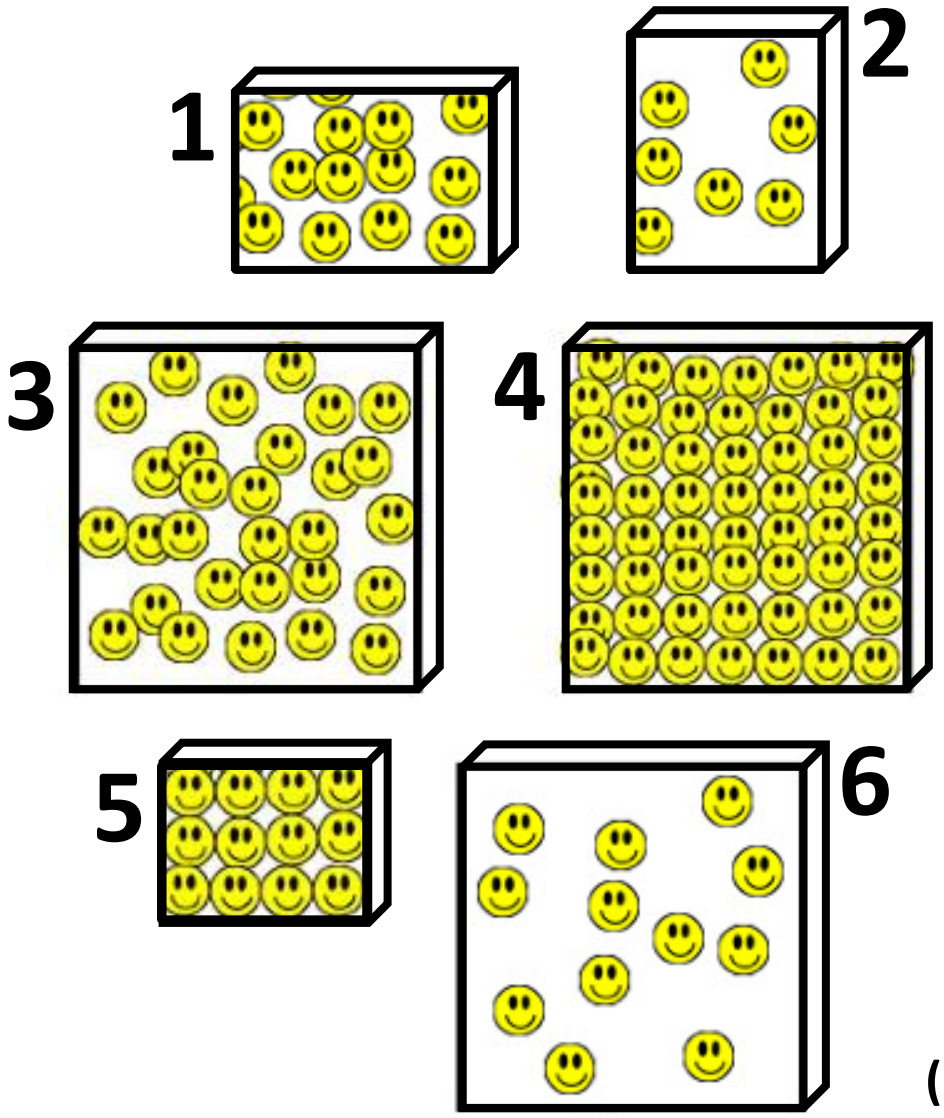




Earth's Layers Density (in g/cm^3)

- **The density of a material varies with temperature and pressure** (this variation is typically small for solids and liquids but much greater for gases).
  - **In general, lowering the temperature results in density increase**
  - **Increasing the pressure also results in density increase**

Which of the following objects…

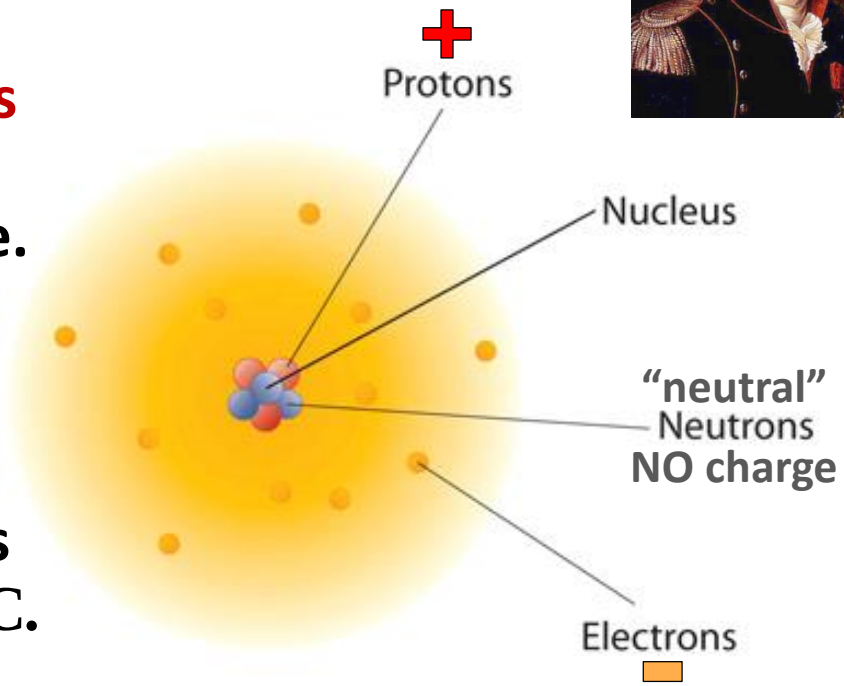


- …have the same volume?
- …have the same density?
- …have different mass?
- …have different volume?
- …have the same mass?
- …have different density?

(note: all “atoms” here are the same; all objects have the same thickness)

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

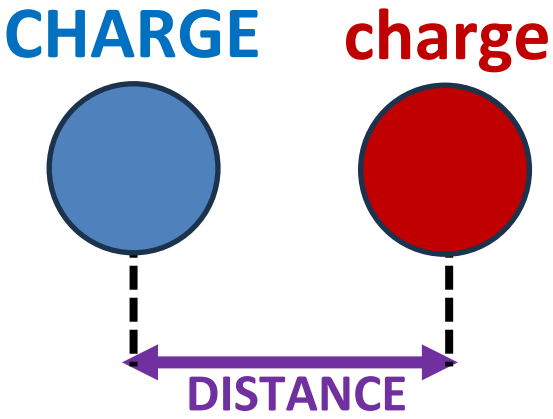
- In atoms, electrons carry the negative (-) charge, and protons carry the positive (+) charge; neutrons have NO (zero) charge.
- SI unit of charge is Coulomb.
- The charge of a single electron, known as *elementary charge*, is equal to *negative* 1.602×10^{-19} C.



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

Electromagnetism

is an interaction that occurs between particles that have electric charge

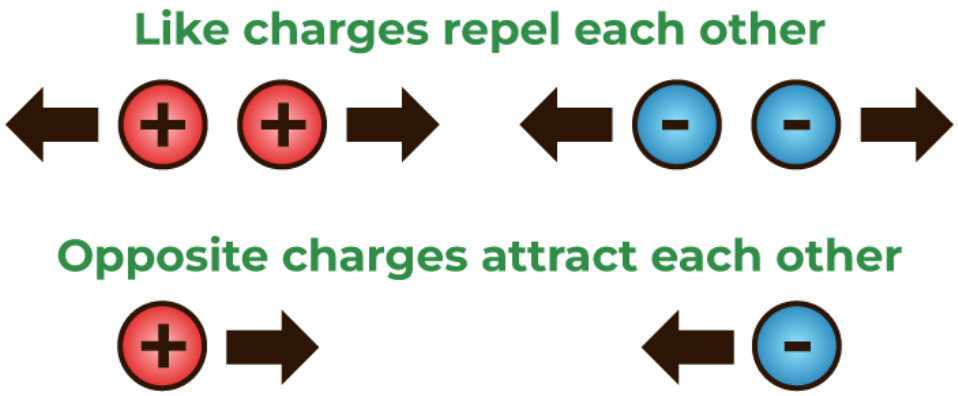


$$\text{ELECTRIC FORCE} = k \cdot \frac{\text{CHARGE} \cdot \text{charge}}{(\text{DISTANCE})^2}$$

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

"electrostatic force constant"

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



States of Matter

- **Matter can exist in several different *forms*, or *states of aggregation*.**

- **Matter commonly exists in four fundamental states:**
  - Solid
  - Liquid
  - Gas
  - Plasma

- **The different states of matter are based upon distance between particles (atoms and/or molecules), particle arrangement, and energy of particles.**