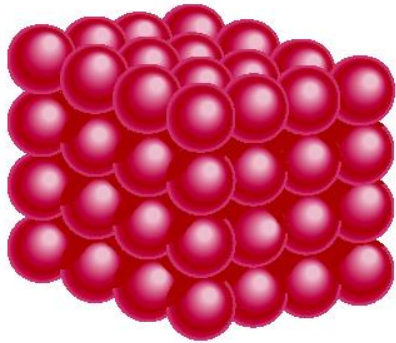
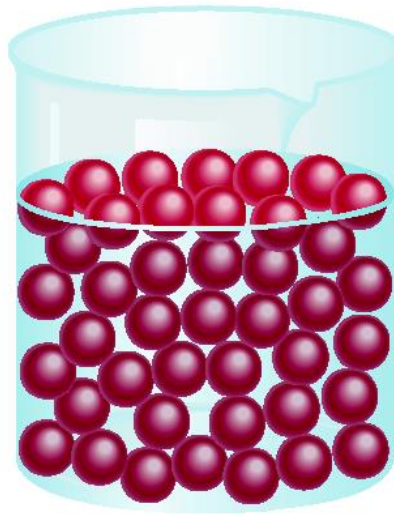


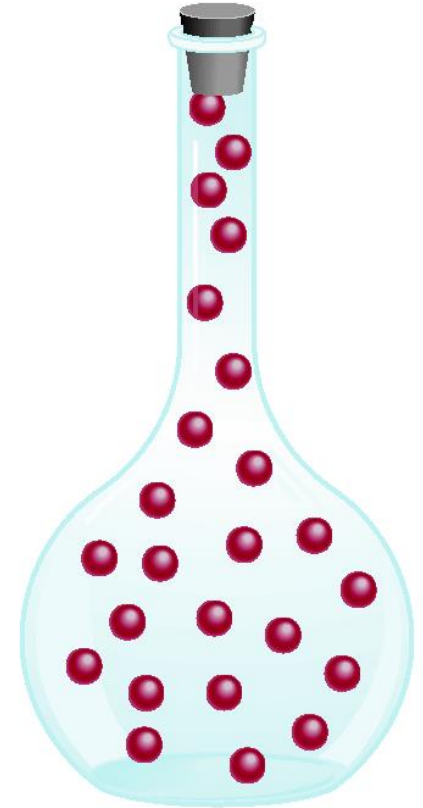
A Comparison: The Three States of Matter



Solid



Liquid



Gas

Example: ICE → WATER → WATER VAPOR

Temperature

- Ordinary matter is made of particles - atoms or molecules.

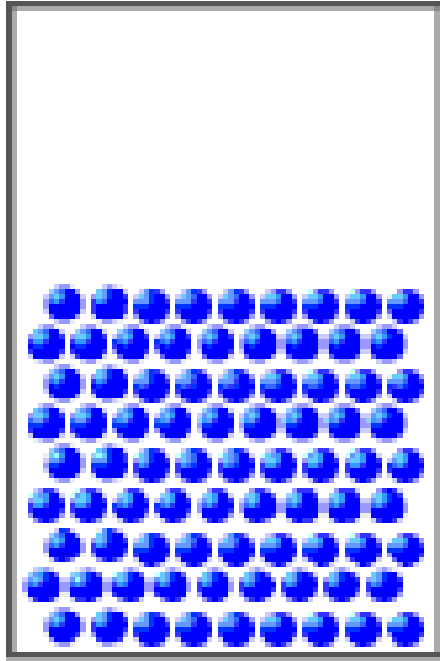


- **Particles of matter are in constant motion** (*vibrating in place in solids, sliding past each other in liquids, flying around freely in gases*), **but they don't all move at the same speed and in the same direction all the time.**
- **Temperature is a measure of the average energy associated with random motion of the particles of a substance.**
- The higher the temperature of an object, the faster on average its particles move.

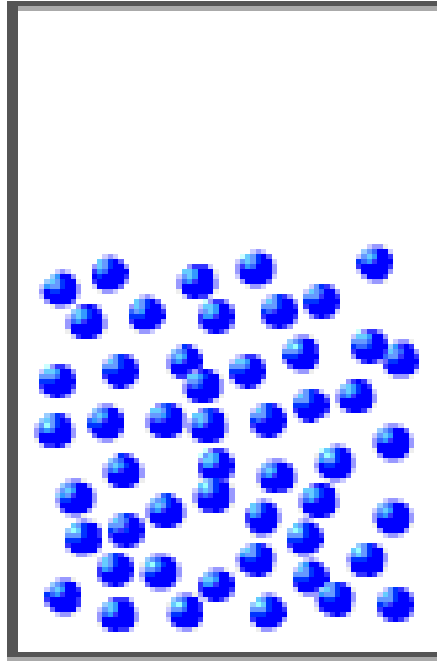
Flame:
1000-1500°C



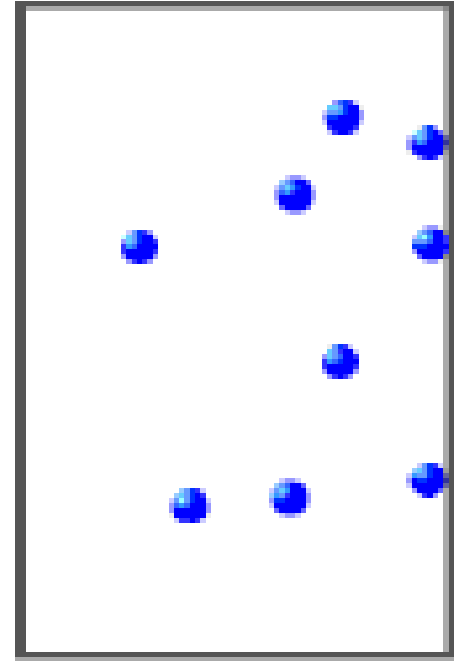
A Comparison: The Three States of Matter



Solid



Liquid



Gas

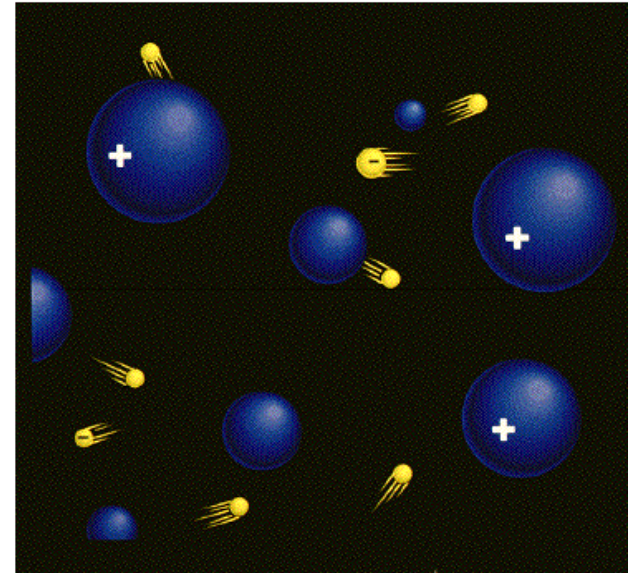
Example: ICE \longrightarrow WATER \longrightarrow WATER VAPOR

But what happens if you raise the temperature to super-high levels... between 1000°C and 1,000,000,000°C ?

Will everything just be a gas?

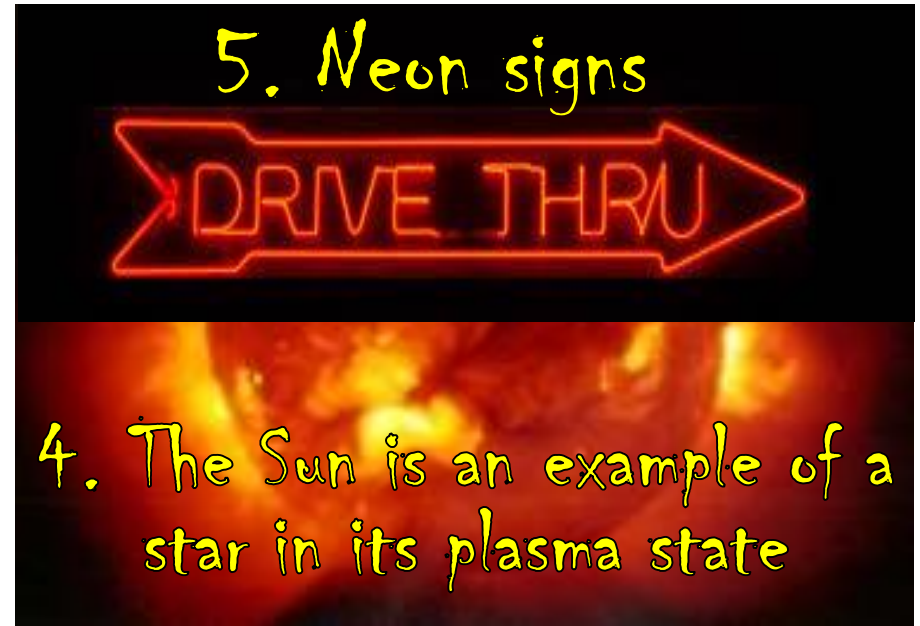
PLASMA

- A plasma is an **ionized gas**: positively charged nuclei swim in a "sea" of freely-moving dissociated electrons.
- A plasma is a very good **conductor of electricity**: it produces and responds to magnetic fields.
- Plasmas, like gases, have an **indefinite shape** and an **indefinite volume**.
- A gas is usually converted to a plasma in one of the following two ways:
 - from a **huge voltage** difference between two points
 - by exposing gas to **extremely high temperatures** that cause electrons to leave the atoms



Plasma is a common state of matter!

Some places where plasmas are found...



4. The Sun is an example of a star in its plasma state

Everyday Properties of Matter

We can observe the following about ordinary matter:

- How it **looks** (Shiny, Dull, Color, etc.)
- How it **feels** (Hard, Soft, Rough, Smooth, etc.)
- How it **smells** (Sweet, Sharp, Terrible, No Smell, etc.)
- How it **sounds** (Loud, Soft, Echo, No Sound, etc.)
- What it **does** (Stretch, Break, Magnetize, Ignite etc.)

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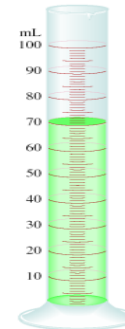
- Anything **else**?
- How it **moves**
- How it **changes**

Physical Properties of Matter

We can describe physical properties of matter in terms of physical quantities and laws.

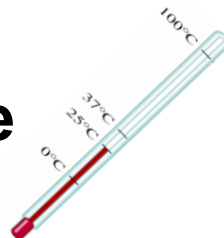
- An extensive property **depends upon how much matter is being considered:**

- mass
- volume
- electrical charge



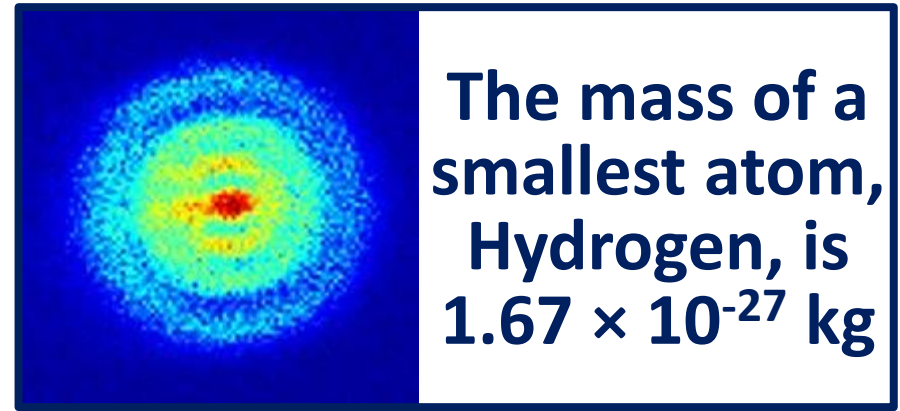
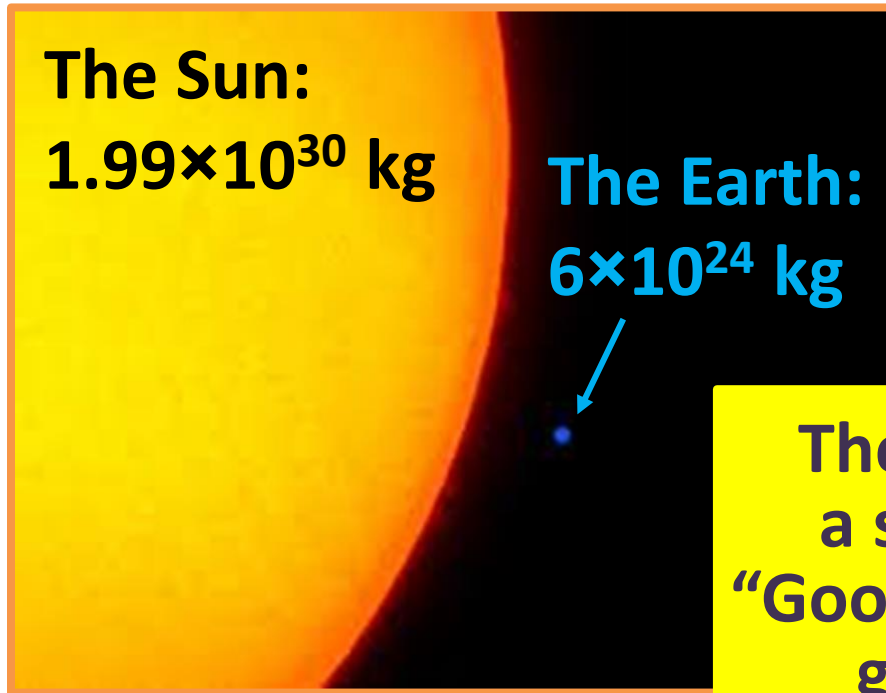
- An intensive property **does not depend upon how much matter is being considered:**

- density
- temperature
- color
- elasticity
- metallicity
- solubility etc...



Mass

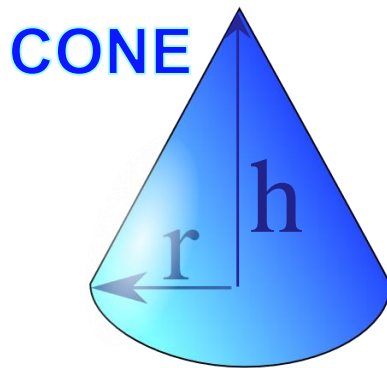
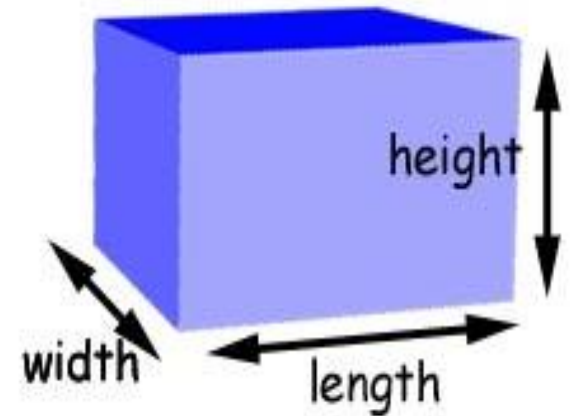
- **Mass** is the **amount of material** in an object (**doesn't change**).
- Don't confuse with **weight**, a measure of how strongly gravity is pulling on an object (**decreases** as elevation increases).



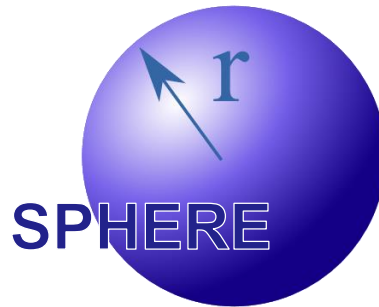
- SI unit of mass is **kg**

Volume

- **Volume** is the amount of three-dimensional space that a substance or shape occupies or contains.
- SI unit of volume is m^3
- $V_{\text{rectangular prism}} = \text{length} \times \text{width} \times \text{height}$

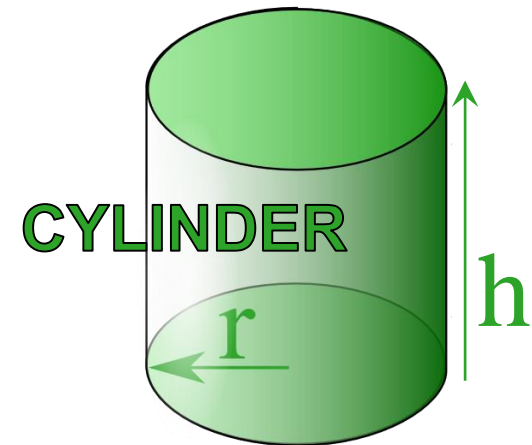


$$\left(\frac{1}{3}\right)\pi r^2 h$$



SPHERE

$$\left(\frac{4}{3}\right)\pi r^3$$



CYLINDER

$$\pi r^2 h$$

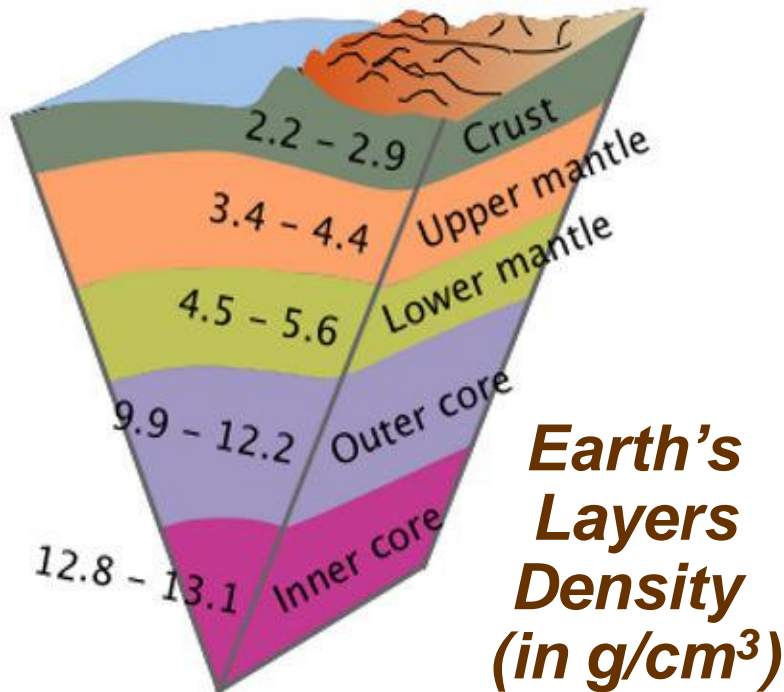
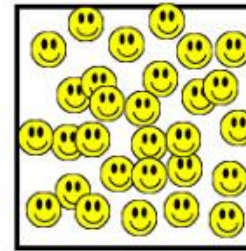
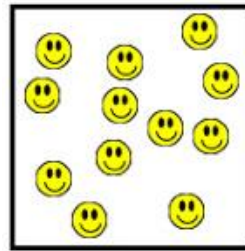
Where r = radius, h = height, and π = 3.14

Density

- **Density** is a measure of how much matter is contained in a unit of volume:

➤ $\text{density} = \frac{\text{mass}}{\text{volume}}$

➤ SI unit is kg/m^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**