

**How many states of matter  
can you find in each picture?**



# 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** (Bounce, Stretch, Break, Magnetize etc.)

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- Anything **else**?

- How it **moves**

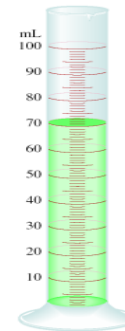
- How it **changes**

# 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 vs Weight

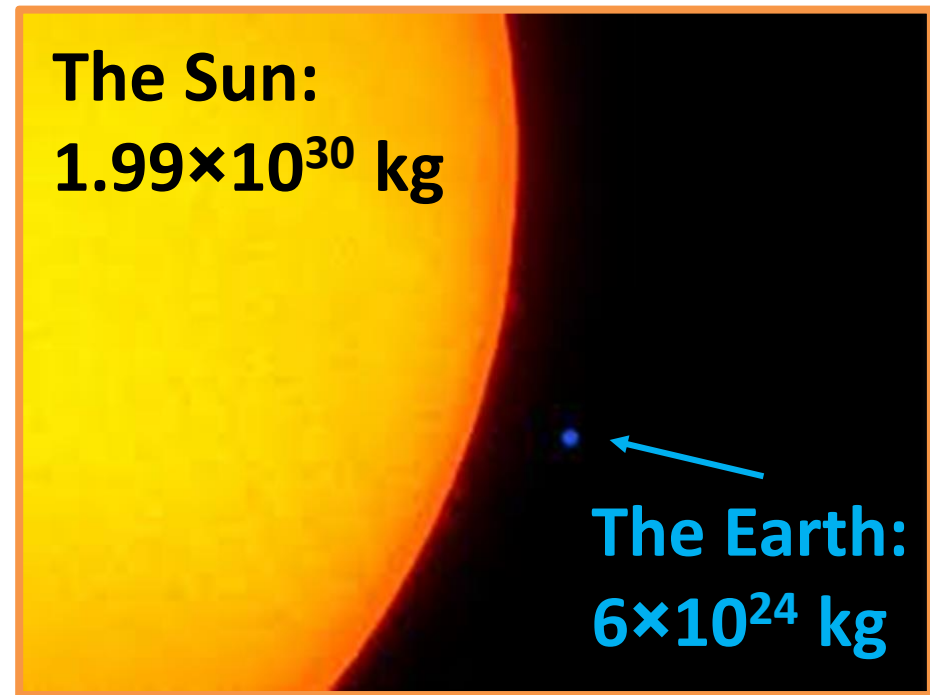
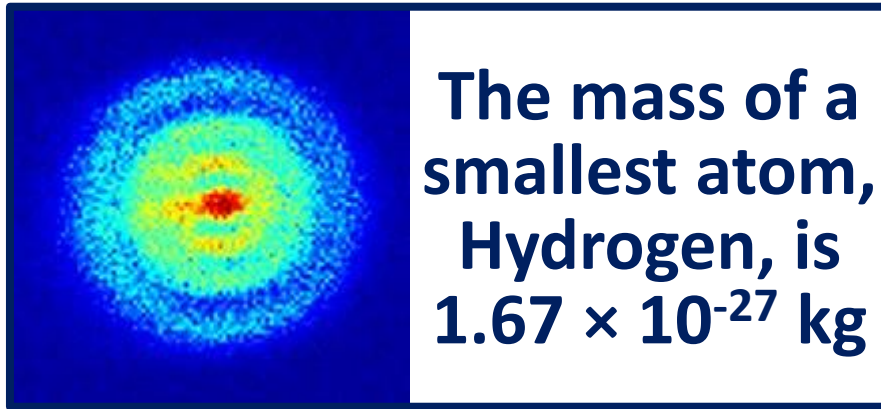
- **Mass** is the amount of material in an object (doesn't change).
- **Weight** is a measure of how strongly gravity is pulling on an object (decreases as elevation increases).
- Note: on the Earth's surface, terms “weight” and “mass” are used interchangeably since we use a **weighing scale** to determine mass.



- Example: **What is the weight of a Martian on Mars and Moon if it weighs 50 kg on Earth?**
  - Gravity on Moon is 0.16 of Earth gravity while gravity on Mars is 0.38 of Earth gravity.
  - Answer: this Martian weighs 8.3 kg on Moon and 18.8 kg on Mars (the numbers shown by the scale), but **his/her mass is still 50 kg!!!**



# Examples



The mass of a blue whale heart can reach 450 kg

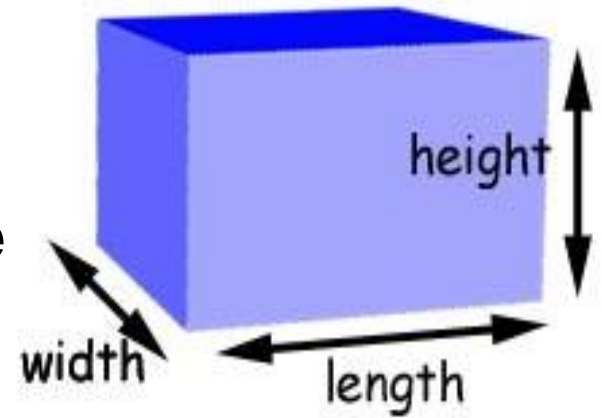


# Volume

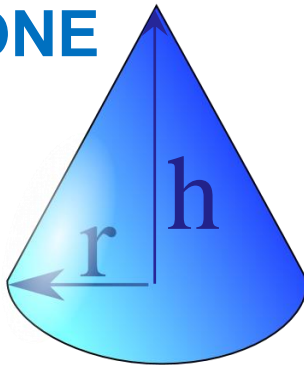
- **Volume** is the amount of three-dimensional space that a substance or shape occupies or contains:

➤ SI unit is  $\text{m}^3$

➤  $V_{\text{rectangular prism}} = \text{length} \times \text{width} \times \text{height}$

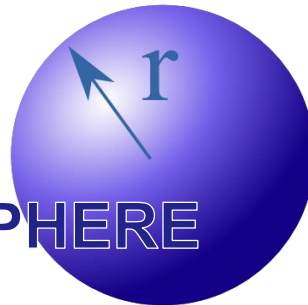


**CONE**



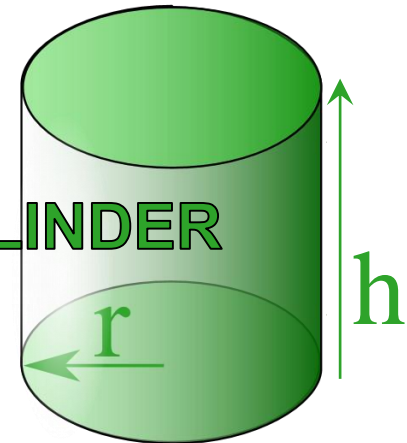
$$\left(\frac{1}{3}\right)\pi r^2 h$$

**SPHERE**



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

**CYLINDER**



$$\pi r^2 h$$

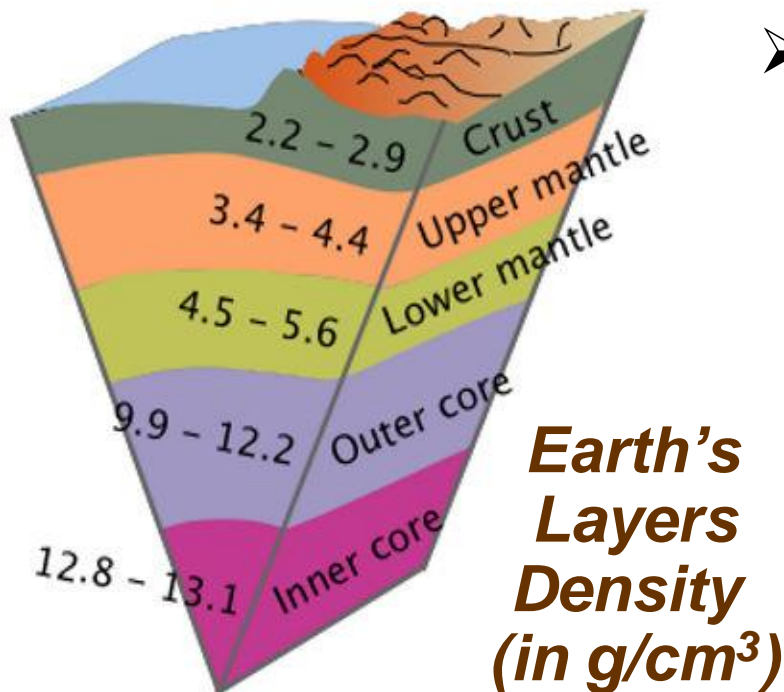
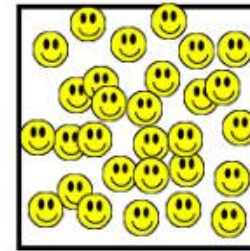
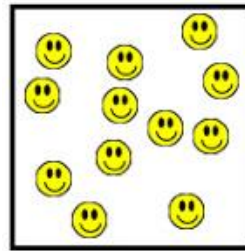
Where  $r$  = radius,  $h$  = height, and  $\pi = 3.14$

# 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<sup>3</sup>**



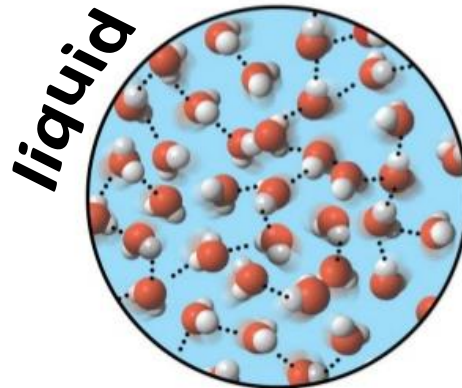
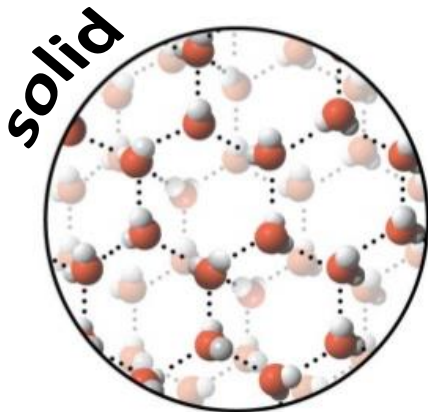
- The density of a material varies with temperature and pressure (this variation is typically small for solids and liquids but much greater for gases).
- In general, lowering the temperature results in density increase
- Increasing the pressure also results in density increase

# Understanding Water Density

↓ temperature = ↑ density  
therefore **colder water sinks...**

If colder water is more dense than warmer water, and the denser goes under the less dense, **how come ice cubes float?**

Aren't they **colder water** on top of **warmer water**?



**ANSWER:** Water is the only substance that gets denser as it cools down until it is close to 4°C... it then becomes less dense and only then freezes!



# Fun with Liquids

Have you ever heard the phrase "oil and water don't mix"?



The term  
**“miscibility”**  
describes how well  
two substances  
mix. “Immiscible”  
liquids do not mix.  
When combined  
together, they form  
**layers.**

**WHY?**