



DEVIL PHYSICS
THE BADDEST CLASS ON CAMPUS
AP PHYSICS

LSN 10-1: PHASES OF MATTER

**LSN 10-2: DENSITY AND SPECIFIC
GRAVITY**

Introductory Video: Chemical Properties - Density

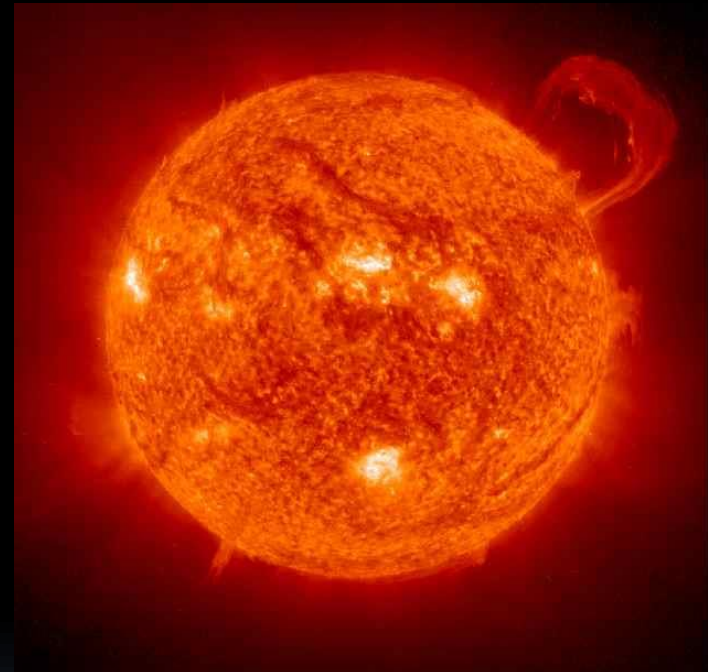


Objectives:

- Name the four states of matter.
- Describe the characteristics that differentiate the four states of matter.
- Define density.
- Solve problems involving density.
- Define specific gravity.
- Determine the specific gravity of a given substance.

Phases (States) of Matter:

- Solid
- Liquid
- Gas
- Plasma

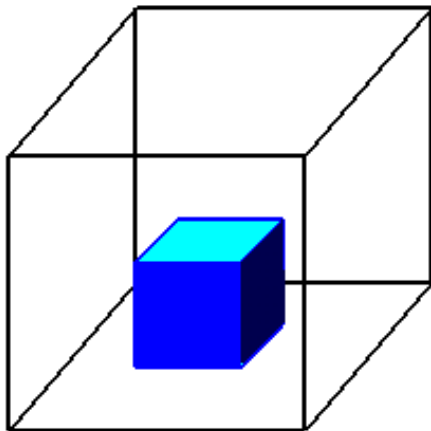


What characteristics differentiate these four?



States of Matter

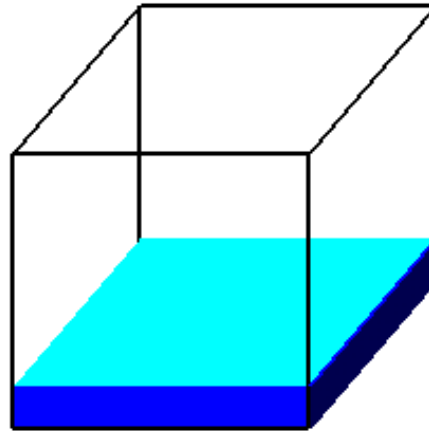
Glenn
Research
Center



Solid

Holds Shape

Fixed Volume

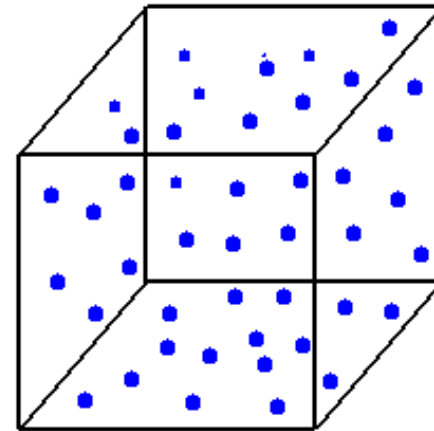


Liquid

Shape of Container

Free Surface

Fixed Volume

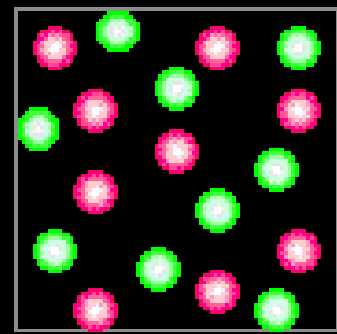
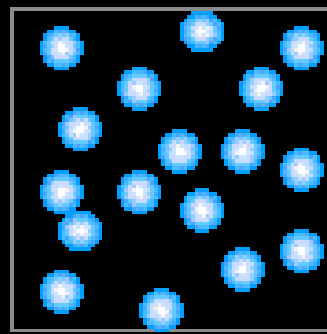
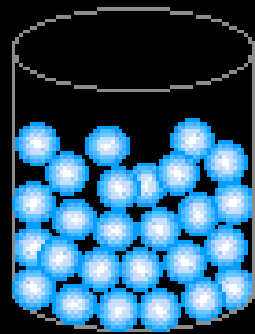
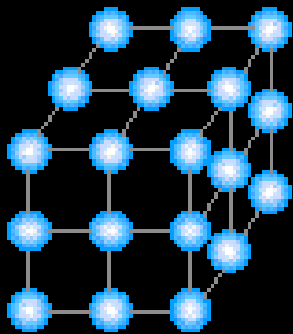


Gas

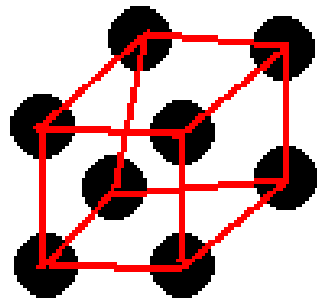
Shape of Container

Volume of Container

States of Matter

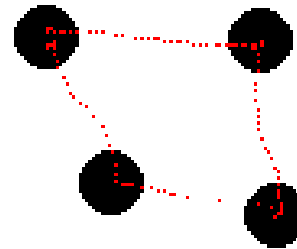


Solid



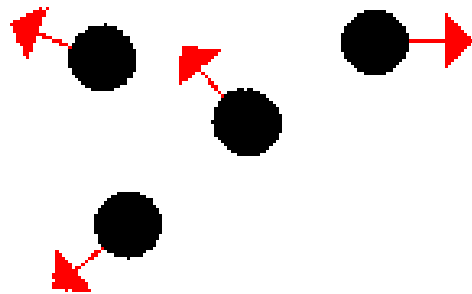
strong bonds

Liquid



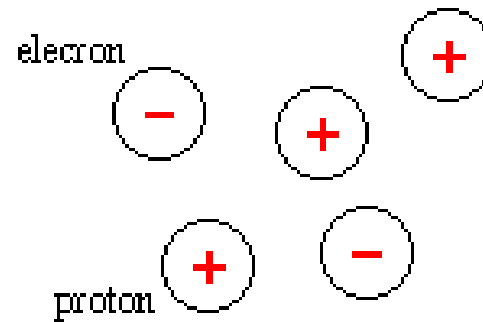
weak bonds

Gas



no bonds

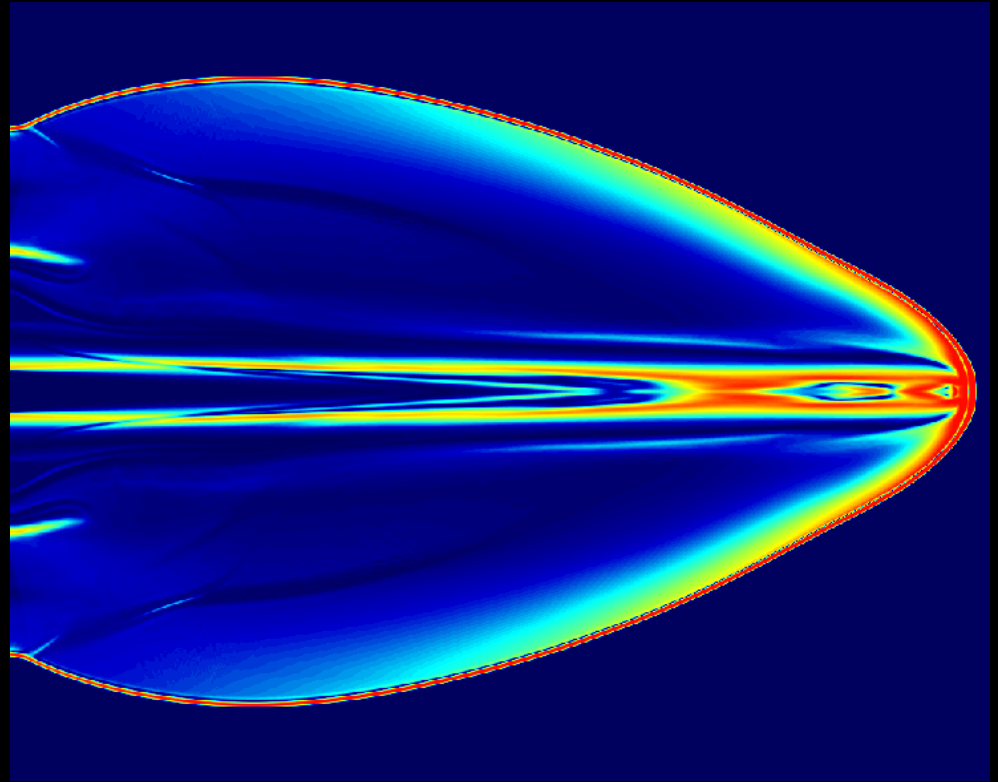
Plasma



ionization

Fluids

- Liquid
- Gas



What properties do they have in common?

Density (ρ)

- Mass per unit volume

$$\rho = \frac{m}{V}$$

- A characteristic property of any pure substance
- SI unit is kg/m³
 - 1 kg/m³ = 1x10⁻³ g/cm³
 - 1x10³ kg/m³ = 1 g/cm³

Density (ρ)

$$\rho = \frac{m}{V}$$

- SI unit is kg/m³
 - 1 kg = 1000 (1x10³) g
 - 1 m³ = 1m x 1m x 1m
 - = 100cm x 100cm x 100cm
 - = 1000000 (1x 10⁶) cm³
 - 1kg/m³ = (1x10³) g / (1x 10⁶) cm³
 - 1kg/m³ = 1x10⁻³ g / cm³
 - 1kg/m³ = 0.001 g / cm³
- 1 ml of water = 1 g = 1 cm³ of water

Density (ρ)

Table 10-1

- Water = $1 \times 10^3 \text{ kg/m}^3$
- Ice = $0.917 \times 10^3 \text{ kg/m}^3$
- Steam = 0.598 kg/m^3

$$\rho = \frac{m}{V}$$

TABLE 10-1
Densities of Substances[†]

Substance	Density, ρ (kg/m ³)
<i>Solids</i>	
Aluminum	2.70×10^3
Iron and steel	7.8×10^3
Copper	8.9×10^3
Lead	11.3×10^3
Gold	19.3×10^3
Concrete	2.3×10^3
Granite	2.7×10^3
Wood (typical)	$0.3\text{--}0.9 \times 10^3$
Glass, common	$2.4\text{--}2.8 \times 10^3$
Ice	0.917×10^3
Bone	$1.7\text{--}2.0 \times 10^3$
<i>Liquids</i>	
Water (4° C)	1.00×10^3
Blood, plasma	1.03×10^3
Blood, whole	1.05×10^3
Sea water	1.025×10^3
Mercury	13.6×10^3
Alcohol, ethyl	0.79×10^3
Gasoline	0.68×10^3
<i>Gases</i>	
Air	1.29
Helium	0.179
Carbon dioxide	1.98
Water (steam) (100° C)	0.598

[†]Densities are given at 0°C and 1 atm pressure unless otherwise specified.

Density (ρ)

Table 10-1

- Specifies a temperature and pressure
- Negligible effect on solids and liquids, more pronounced with gases

$$\rho = \frac{m}{V}$$

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Density (ρ)

- Example: A certain material has a mass of 11,700kg and a volume of 1.5m³. What is the material?

$$\rho = \frac{m}{V}$$

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Density (ρ)

- **Example:** A certain material has a mass of **11,700kg** and a volume of **1.5m³**. What is the material?
- **$\rho = m/v = (11,700\text{kg})/(1.5\text{m}^3)$**
- **$\rho = 7.8 \times 10^3 \text{ kg/m}^3$**
- **The object is iron or steel**

$$\rho = \frac{m}{V}$$

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Specific Gravity

- Ratio of the density of a substance to that of water at 4.0°C (1000 kg/m³)

$$SG = \frac{\rho_{object}}{\rho_{water}}$$

- Once the density is found in kg/m³, you can simply divide it by 1000 (10³)
- Since it is a ratio of like units, SG is unitless

Specific Gravity

$$SG = \frac{\rho_{object}}{\rho_{water}}$$

- Example: What is the specific gravity of gold?

Specific Gravity

$$SG = \frac{\rho_{object}}{\rho_{water}}$$

- Example: What is the specific gravity of gold?
- $\rho_{gold} = 19.3 \times 10^3 \text{ kg/m}^3$
- $SG = (\rho_{object}) / (\rho_{water})$
- $SG = (\rho_{gold}) / (\rho_{water})$
- $SG = (19.3 \times 10^3 \text{ kg/m}^3) / (1 \times 10^3 \text{ kg/m}^3)$
- $SG = 19.3$

Sample Problems

- How much volume would 100kg of aluminum occupy?
 - $m = 100\text{kg}$
 - $\rho = ?$

Sample Problems

- How much volume would 100kg of aluminum occupy?
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 - $\rho = m/V$
 - $V = m/\rho$
 - $\rho_{AL} = ?$

Sample Problems

- How much volume would 100kg of aluminum occupy?
 - $m = 100\text{kg}$
 - $\rho = m/V$
 - $V = m/\rho$
 - $\rho_{\text{AL}} = 2.7 \times 10^3 \text{ kg/m}^3$
 - $V = (100\text{kg}) / (2.7 \times 10^3 \text{ kg/m}^3)$
 - $V = ?$

Sample Problems

- How much volume would 100kg of aluminum occupy?
 - $m = 100\text{kg}$
 - $\rho = m/V$
 - $V = m/\rho$
 - $\rho_{\text{AL}} = 2.7 \times 10^3 \text{ kg/m}^3$
 - $V = (100\text{kg}) / (2.7 \times 10^3 \text{ kg/m}^3)$
 - $V = 0.037 \text{ m}^3$ or $3.7 \times 10^{-2} \text{ m}^3$

Sample Problems

- How much volume would 100kg of aluminum occupy?
 - $m = 100\text{kg}$
 - $V = 0.037\text{ m}^3$ or $3.7 \times 10^{-2}\text{ m}^3$
 - ***How many cm^3 ?***

Sample Problems

- How much volume would 100kg of aluminum occupy?
 - $m = 100\text{kg}$
 - $V = 0.037\text{ m}^3$ or $3.7 \times 10^{-2}\text{ m}^3$
 - ***How many cm^3 ?***
 - $V = 3.7 \times 10^{-2}\text{ m}^3 \times 10^6\text{ cm}^3 / 1\text{ m}^3$
 - $V = 3.7 \times 10^4\text{ cm}^3$

Sample Problems

- What is the mass of 3m^3 of gold?
 - $V = 3\text{m}^3$
 - $\rho = ?$

Sample Problems

- What is the mass of 3m^3 of gold?
 - $V = 3\text{m}^3$
 - $\rho = m/V$
 - $m = ?$

Sample Problems

- What is the mass of 3m^3 of gold?
 - $V = 3\text{m}^3$
 - $\rho = m/V$
 - $m = \rho V$
 - $\rho_{\text{Au}} = ?$

Sample Problems

- What is the mass of 3m^3 of gold?
 - $V = 3\text{m}^3$
 - $\rho = m/V$
 - $m = \rho V$
 - $\rho_{\text{Au}} = 19.3 \times 10^3 \text{ kg/m}^3$
 - $m = (19.3 \times 10^3 \text{ kg/m}^3) \times (3\text{m}^3)$
 - $m = ?$

Sample Problems

- What is the mass of 3m^3 of gold?
 - $V = 3\text{m}^3$
 - $\rho = m/V$
 - $m = \rho V$
 - $\rho_{\text{Au}} = 19.3 \times 10^3 \text{ kg/m}^3$
 - $m = (19.3 \times 10^3 \text{ kg/m}^3) \times (3\text{m}^3)$
 - $m = 5.79 \times 10^4 \text{ kg}$

Summary:

- What are the four states of matter?

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- What are the four states of matter?
- How do the four states of matter differ from one another?

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Summary:

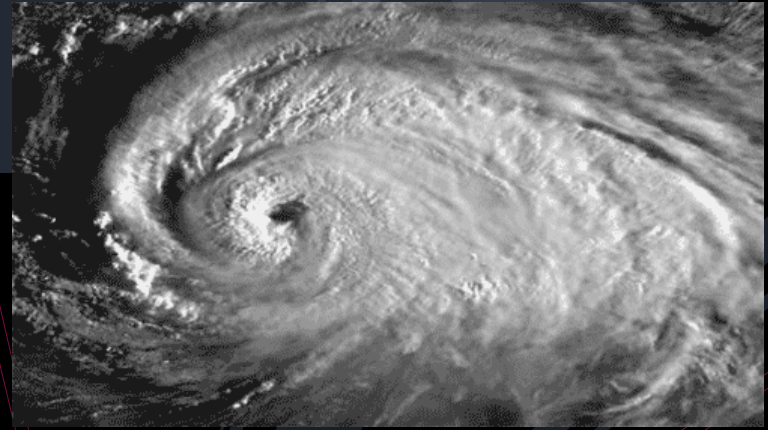
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- How do the four states of matter differ from one another?
- What is density?
- How do you solve problems involving density?
- What is specific gravity?
- How can you determine the specific gravity of a given substance?



QUESTIONS?

Homework

#1-6



Summary Video: [Hydroelectric](#)

