

## Characteristics of liquids at rest

منتدى روضة العلوم الطبيعية

### Density ( $\rho$ ): -

Some materials are heavy while others are light.

### Example :-

•Gold and Platinum are heavy metals, Mercury and Glycerine are heavy liquids while Carbon dioxide is a heavy gas. Hydrogen is a light gas.

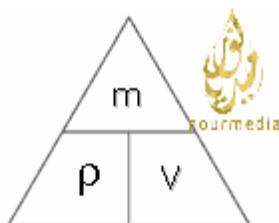
∴ CO<sub>2</sub> is denser than H<sub>2</sub>, and the density of CO<sub>2</sub> is greater than that of H<sub>2</sub>.

### Definition: -

Density is mass per unit volume at certain temperature.

### Law :-

$$\rho = \frac{\text{mass (m)}}{\text{volume(V)}}$$



### Unit :-

Kg / m<sup>3</sup> Or gm / cm<sup>3</sup> Or gm / liter

### •The dimension formula (D . F)

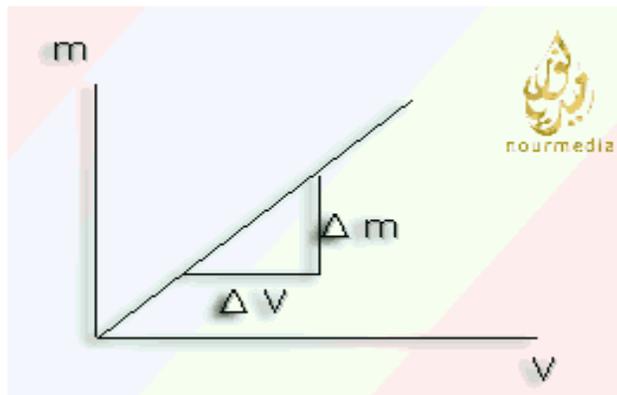
$$D . F \longrightarrow ML^{-3}$$

Density is a scalar quantity with no direction

### •Density is a physical property that depends on :

1- Material.

- 2- Temperature.
- 3- Purity.



- Density is the proportionality constant for the relation between mass and volume.
- Density is the slope for the graphical relation between mass and volume.

Note: -

$$\begin{aligned} \text{Kg} &= 10^3 \text{ gm} \\ \text{m}^3 &= 10^6 \text{ cm}^3 \end{aligned}$$

$$\begin{aligned} \text{Kg} / \text{m}^3 &= \frac{10^3 \text{ gm}}{10^6 \text{ cm}^3} \\ \text{Kg} / \text{m}^3 &= 10^{-3} \text{ gm} / \text{cm}^3 \\ \text{gm} / \text{cm}^3 &= 10^3 \text{ Kg} / \text{m}^3 \\ \text{gm} / \text{cm}^3 &> \text{Kg} / \text{m}^3 \end{aligned}$$

## Examples

### (Conversion of units of volume and mass)

1- Prove that  $\text{Kg} / \text{m}^3 = \text{gm} / \text{liter}$

#### Solution

$$\frac{\text{kg}}{\text{m}^3} = \frac{1000\text{gm}}{1000\text{liter}} = \text{gm} / \text{liter}$$

**2- A rectangular block made of Copper, with dimensions 10, 5, 2 cm and mass 889 gm. Find its density in Kg/m<sup>3</sup>**

**Solution**

$$r = \frac{m}{v}$$

$$= \frac{889 \times 10^{-3} \text{Kg}}{10 \times 5 \times 2 \times 10^{-6} \text{m}^3} = 8890 \text{ kg /m}^3$$

**3- A golden Cube has density of 19300 Kg/ m<sup>3</sup> and mass of 10.5 gm find the length of its side.**

**Solution**

$$\text{Volume} = \frac{m}{\rho}$$

$$V = \frac{10.5 \times 10^{-3}}{19300} = 544.04 \times 10^{-9} \text{ m}^3$$

$$V = 5.4404 \times 10^{-3} \text{ cm}^3$$

$$V = L^3$$

$$\sqrt[3]{5.44 \times 10^{-3}} = \sqrt[3]{L^3}$$

$$L = 0.1758775 \text{ cm}$$

**4- The radius of a lead sphere is 7cm and its density is 11400 Kg / m<sup>3</sup>. Find its mass.**

**Solution**

$$\text{Mass} = V \times r$$

$$m = r \frac{4}{3} \rho r^3$$

$$m = 11400 \times \frac{4}{3} \times \frac{22}{7} \times (0.07)^3$$

$$m = 16.379 \text{ Kg}$$

**5- A hollow cylindrical container, of inner radius 7 cm and height 10 cm, is filled completely with water whose density is  $1000 \text{ kg / m}^3$ . find the mass of water and the mass of kerosene that filled the same container if the density of kerosene is  $820 \text{ Kg / m}^3$**

### **Solution**

$$r = 7 \text{ cm} = 0.07 \text{ m}$$

$$h = 10 \text{ cm} = 0.1 \text{ m}$$

$$V = \pi r^2 h$$

$$= \frac{22}{7} \times (0.07)^2 \times 10 \times 10^{-2}$$

$$= 1.539 \times 10^{-3} \text{ m}^3$$

$$m_{\text{H}_2\text{O}} = V \times 10^3 \times 1.539 \times 10^{-3}$$
$$= 1.539 \text{ Kg}$$

$$m_{\text{kerosene}} = \rho_k V$$
$$= 820 \times 1.539 \times 10^{-3}$$
$$= 1.26198 \text{ Kg}$$

### **Note : -**

Equal volumes from different materials have different masses.

### **Relative density or the specific gravity**

### **Definition : -**

It is the ratio between the density of a substance to that of water at the same temperature.

Or

The ratio between the mass of a certain volume of a substance to that of water at the same volume of water at same and temperature.

**Law: -**

$$R . D = \frac{\text{Density of substance}}{\text{Density of water}} \quad \text{at the same temp.}$$

$$= \frac{\text{Mass of substance}}{\text{Mass of water}} \quad \text{having same volume and temp}$$

$$\text{Where } R . D = \frac{\rho_{\text{sub}}}{\rho_{\text{H}_2\text{O}}} = \frac{m_{\text{sub}}}{m_{\text{H}_2\text{O}}} \quad \text{having the same volume and temp.}$$

**Unit: -**

Has no unit because it is a ratio between two similar quantities.

$$D . F \longrightarrow M^0 L^0$$

It is a scalar quantity

What is meant by: -

1- R . D of AL = 2.7 ?

**Answer**

The ratio between the density of Al to that of water is 2.7 at same temp.

Or :-

It means that the density of Al equals 2.7 times that of water at same temp.

2- The density of gold equals 19300 Kg / m<sup>3</sup>?

**Answer**

19300 Kg is the mass per unit volume (1 m<sup>3</sup>) of gold at certain temp.

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