

## FlexiPrep

### Density of Water, Some Properties of Water, Definition of Density of Water (For CBSE, ICSE, IAS, NET, NRA 2022)

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#### Density of Water

- Water is a tasteless, transparent, odorless, and colorless chemical substance, which is the main constituent of this planet's lakes, oceans, streams, and the fluids of most living organisms.
- Density is the mass per unit volume of a substance.

#### Some Properties of Water

<b>Density:</b>	997 kg/ m <sup>3</sup>
<b>Formula:</b>	H <sub>2</sub> O
<b>Molar Mass:</b>	18.01528 g/mol
<b>Boiling Point:</b>	100°C
<b>Melting Point:</b>	0°C
<i>Some Properties of Water</i>	

#### Definition of Density of Water

- The density of a material is defined as its mass per unit volume. It's a measurement of how tightly matter is packed together.
- It is of a substance can be explained as the relationship between the mass of the substance and volume it takes up.
- *Definition:* It is the weight of the water per its unit volume, which depends on the temperature of the water.

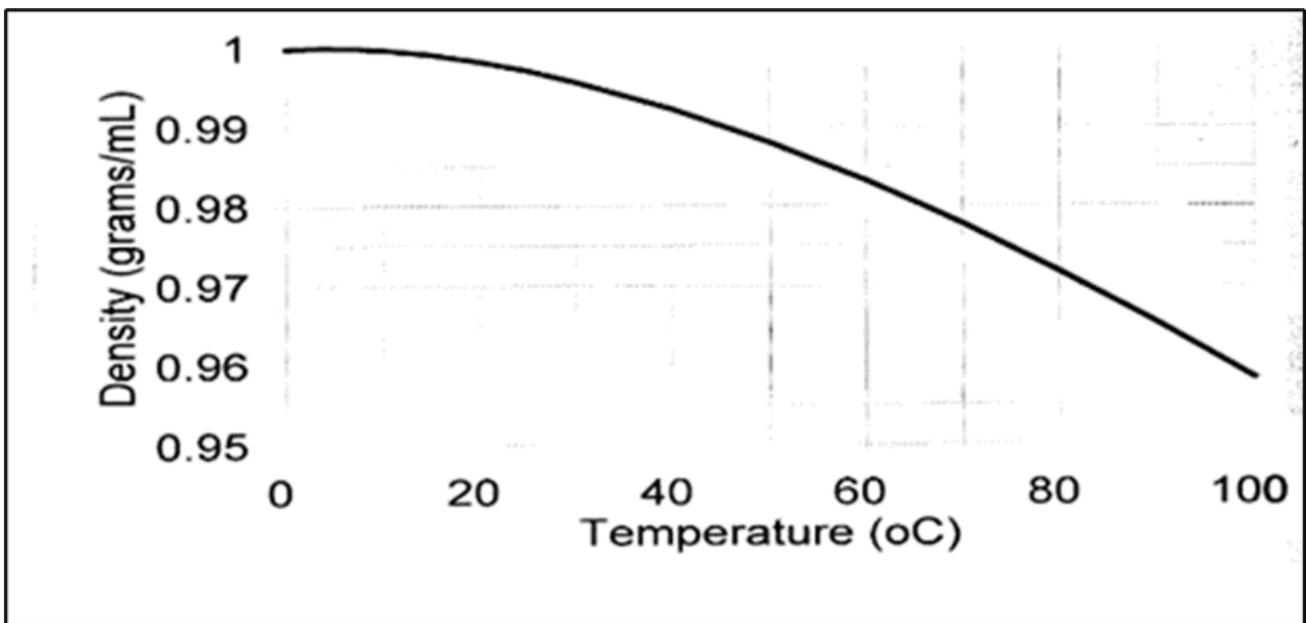
#### Factors Affecting Water Density

- There are so many factors which can affect the density of a substance.
- Some factors which affect the density of water is given as below.
  - The density of water is approximately around about **1 gram/cubic centimeter** (1 g/ cm<sup>3</sup> ).
  - It is temperature-dependent, but this relation is said to be non- linear and it is uni modal in nature rather than monotonic.
  - When it is cooled from the room temperature, the liquid water tends to become increasingly dense, as with another kind of substances, but approximately at about 4°C , pure water is said to reach its maximum density.
  - As it gets cooled further, it tends to expand and becomes less dense. This kind of unusual negative thermal expansion is related to strong, intermolecular forces, orientation-dependent, or interactions and it is observed in the form of molten silica.

#### Density vs Temperature

- Water does not have an absolute density as its density varies with temperature.
- It has a higher density in the liquid state than the solid.
- Check the Density VS Temperature Graph given below to understand how density changes with temperature.

#### Density vs Temperature Graph



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### Expression of Density

Density is the ratio of the mass to the volume of a substance:

$$\rho = \frac{m}{V} [1]$$

where  $\rho$  = density, units typically  $\left[ \frac{g}{cm^3} \right]$  or  $\left[ \frac{lb}{ft^3} \right]$

m = mass, units typically [g] or [lb]

V = volume, units typically  $[cm^3]$  or  $[ft^3]$

Pure water has its highest density 1000 kg/  $m^3$  or 1.940 slug/  $ft^3$  at temperature  $4^\circ C (= 39.2^\circ F)$ .

Specific weight is the ratio of the weight to the volume of a substance:

$$\gamma = \frac{m \times g}{V} = \rho \times g [2]$$

where  $\gamma$  = specific weight, units typically  $\left[ \frac{N}{m^3} \right]$  or  $\left[ \frac{lbf}{ft^3} \right]$

m = mass, units typically [g] or [lb]

$g$  = acceleration due to gravity, units typically  $\left[\frac{m}{s^2}\right]$  and value on Earth usually given as

$9.80665 \frac{m}{s^2}$  or  $32.17405 \frac{ft}{s^2}$   $V$  = volume, units typically  $[cm^3]$  or  $[ft^3]$

$\rho$  = density, units typically  $\left[\frac{g}{cm^3}\right]$  or  $\left[\frac{lb}{ft^3}\right]$

### Density of Water at Various Temperature Scales

The water density varies for different temperature. The density (in  $kg/m^3$ ) of water for different temperature scale (ranging from  $100^\circ C$  to  $-30^\circ C$ ) is given in the table below.

#### Different Temperature Scale

Temperature	Density in $kg/m^3$
$100^\circ C$	958.4
$80^\circ C$	971.8
$60^\circ C$	983.2
$40^\circ C$	992.2
$30^\circ C$	995.65
$25^\circ C$	997.04
$22^\circ C$	997.77
$20^\circ C$	998.2
$15^\circ C$	999.1
$10^\circ C$	999.70
$4^\circ C$	998.97
$0^\circ C$	999.83
$-10^\circ C$	998.12
$-20^\circ C$	993.547
$-30^\circ C$	983.854

*Different Temperature Scale*

#### Density of Several Liquids with Different Specific Gravities

Material	Density ( $gram/cm^3$ )
Rubbing Alcohol	0.79
Lamp Oil	0.8
Baby Oil	0.83
Water	1.0
Milk	1.03
Liquid Soap	1.06
Corn Syrup	1.33
Maple Syrup	1.37

Honey	1.42
<i>Density of Several Liquids with Different Specific Gravities</i>	

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