# Properties of Fluids

### 1.4.1 Density

The density of a substance is the quantity of matter contained in a unit volume of the substance. It can be expressed in three different ways.

#### 1.4.1.1 Mass Density

Mass Density, $\rho$, is defined as the mass of substance per unit volume.

Units: Kilograms per cubic metre, $kg/m^3$ (or $kg\,m^{-3}$)

Dimensions: $ML^{-3}$

Typical values:

Water = 1000 $kg\,m^{-3}$, Mercury = 13546 $kg\,m^{-3}$ Air = 1.23 $kg\,m^{-3}$, Paraffin Oil = 800 $kg\,m^{-3}$.

(at pressure =$1.013\times10^{-5}$ $N\,m^{-2}$ and Temperature = 288.15 K.)

# Specific Weight

Specific Weight $\omega$, (sometimes γ, and sometimes known as *specific gravity*) is defined as the weight per unit volume.

*or*

The force exerted by gravity, g, upon a unit volume of the substance.

The Relationship between g and $\omega$ can be determined by Newton's 2nd Law, since

$$\text{weight per unit volume} = \text{mass per unit volume} \times g$$

$$\omega = \rho g$$

Units: Newton's per cubic metre, $N/m^3$ (or $N\,m^{-3}$)

Dimensions: $ML^{-2}T^{-2}$.

Typical values:

Water =9814 $N\,m^{-3}$, Mercury = 132943 $N\,m^{-3}$, Air =12.07 $N\,m^{-3}$, Paraffin Oil =7851 $N\,m^{-3}$

#### 1.4.1.3 Relative Density

Relative Density, $\sigma$, is defined as the ratio of mass density of a substance to some standard mass density.

For solids and liquids this standard mass density is the maximum mass density for water (which occurs at 4°c) at atmospheric pressure.

$$\sigma = \frac{\sigma_{substance}}{\sigma_{H_2O(at\,4^\circ c)}}$$

Units: None, since a ratio is a pure number.

Dimensions: 1.

Typical values: Water = 1, Mercury = 13.5, Paraffin Oil =0.8.