# Properties of Matter

Elasticity is the property of a body to recover its original configuration (shape and size) when you remove the deforming forces.

Plastic bodies do not show a tendency to recover to their original configuration when you remove the deforming forces. Plasticity is the property of a body to lose its property of elasticity and acquire a permanent deformation on the removal of deforming force.

**Stress:**

It is the ratio of the internal force F, produced when the substance is deformed, to the area A over which this force acts. In equilibrium, this force is equal in magnitude to the externally applied force. In other words,

The SI Unit of stress is newton per square meter ($Nm^{-2}$).In CGS units, stress is measured in dyne-$cm^{-2}$. Dimensional formula of stress is $ML^{-1}T^{-2}$

Types of Stress

- Normal stress: It is the restoring force per unit area perpendicular to the surface of the body. It is of two types: tensile and compressive stress.
- (Tangential stress: When the elastic restoring force or deforming force acts parallel to the surface area, the stress is called tangential stress.

## Strain:

It is the ratio of the change in size or shape to the original size or shape. It has no dimensions, it is just a number.

Longitudinal strain: If the deforming force produces a change in length alone, the strain produced in the body is called longitudinal strain or tensile strain.

Volumetric strain: If the deforming force produces a change in volume alone, the strain produced in the body is called volumetric strain.

Shear strain: The angle tilt caused in the body due to tangential stress expressed is called shear strain.

The maximum stress to which the body can regain its original status on the removal of the deforming force is called the elastic limit.

Hooke's law states that, within elastic limits, the ratio of stress to the corresponding strain produced is a constant. This constant is called the modulus of elasticity.

Modulus of elasticity of any material is the ratio of stress applied to the material to strain in the material. It is obtained from Hooke's law. Depending upon the type of stress being applied and the resulting strain there are three types of modulus of elasticity, they are:

1. Young's Modulus: It is defined as- the ratio of longitudinal stress to longitudinal strain, is denoted by Y.

2. Bulk Modulus: It is defined as- the ratio of volumetric stress (or volume stress) to normal strain, and is denoted by B.

3.Shear Modulus: It is defined as- the ratio of shear stress to shear strain, and is denoted by $\eta$.

Pressure is defined as the physical force exerted on an object.The force applied is perpendicular to the surface of objects per unit area. The basic formula for pressure is F/A (Force per unit area). Unit of pressure is Pascals (Pa). Types of Pressures are Absolute, Atmospheric, Differential, and Gauge Pressure.

The amount of force exerted (thrust) on a surface per unit area is defined as **'Pressure'**. It can also be defined as the ratio of the force to the area (over which the force is acting).

The SI unit is **'pascals (Pa)'.** 1 Pa = $1N/m^2$

## Types of Pressure

- Atmospheric Pressure
- Absolute Pressure
- Differential Pressure
- Gauge Pressure

# Atmospheric Pressure

The earth's atmospheric air is surrounded by a layer of gases and so this air surrounding the earth exerts a pressure known as the **'atmospheric pressure'**. Its value at sea level is 101325 Pa.

It is measured using a mercury barometer (hence atmospheric pressure is also known as barometric pressure), indicating the height of a column of mercury which exactly balances the weight of the column of atmosphere over the barometer. It can be expressed in several different systems of units such as millimeters (or inches) of mercury, pounds per square inch (psi), dynes per square centimeter, millibars (mb), standard atmospheres, or kilopascals.

The atmospheric pressure decreases near Earth's surface, with height at a rate of about 3.5 millibars for every 30 meters (100 feet).

1. **Absolute pressure**: The pressure of having no matter or a complete vacuum inside a place is called absolute pressure.
2. **Differential pressure**: A measurement of the elevation of a fluid in a device is called differential pressure.
3. **Atmospheric pressure**: The weight of the air above a surface exerts a force per unit area against a surface is called atmospheric pressure.
4. **Gauge pressure**: The pressure as calculated in relation to the atmospheric pressure is called gauge pressure.

The surface tension of a liquid is mainly a force that mainly acts to reduce the surface area of a liquid. The directed contracting force which attracts the molecules at the surface of a liquid towards the interior of the liquid is surface tension. The surface tension of liquids depends on the composition of the vapour phase. The surface tension of liquids have many important roles in daily life and also various industrial processes.

## Applications of Surface Tension

Surface tension has a huge role in daily life, health and many industrial processes. There are so many techniques that have been developed to modify surface tension.

1. Daily life Example:

a) Small insects such as the water strider can walk on the surface of the water because their weight is very less so they can't penetrate the water.

b) Disinfectants are mainly the solution of low surface tension so that when we use them in the field they can float on the water and spread out on the cells to destroy them.

c) Soaps and detergents also work on the basis of surface tension. They lower the surface tension of the water so that the soaps and detergents easily soak into the pores and holes.

d) The water bubbles are round because the surface tension of water provides the tension to form the bubble with the water and the surface tension minimizes the bubble into spherical shapes.

e) A small needle can be floated on the surface of the water.

2. Role of surface tension on human health:

Surface tension changes in biological phenomena can determine various diseases in the human body.

3. Industrial applications:

Surface tension is an important factor in industrial processes. In all the industrial plants the R&D departments use the surface tension phenomena to improve the quality of the products. Many operations are used to improve the quality of the product such as detergent formulations. By the use of detergent formulations, we can improve the cleaning properties with more biological surfactants at a lower temperature.

4. Surface tension is also important for characterization for food, pharmaceutical and packaging products.

## Viscosity Definition

**The definition of viscosity is as follows:**

Viscosity is a measure of a fluid's resistance to flow.
The SI unit of viscosity is poiseiulle (PI). Its other units are newton-second per square metre (N s $m^{-2}$) or pascal-second (Pa s.) The dimensional formula of viscosity is [$ML^{-1}T^{-1}$].

The viscosity of liquids decreases rapidly with an increase in temperature, and the viscosity of gases increases with an increase in temperature. Thus, upon heating, liquids flow more easily, whereas gases flow more slowly. Also, viscosity does not change as the amount of matter changes, therefore it is an intensive property.