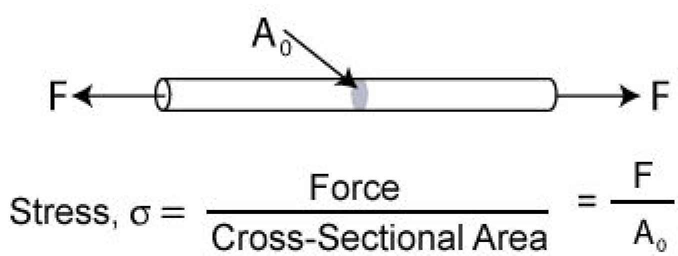
# Mechanical Properties

## 1. Stress

When the deforming force is applied to an object. The object deforms. In order to bring the object back to the original shape and size, there will be an opposing force generated inside the object.

This restoring force will be equal in magnitude and opposite in direction to the applied deforming force. The measure of this restoring force generated per unit area of the material is called stress.




Thus, Stress is defined as “The restoring force per unit area of the material”. It is a tensor quantity. Denoted by Greek letter $\sigma$. Measured using Pascal or $N/m^2$. Mathematically expressed as –

$$\sigma = FA$$

Where,

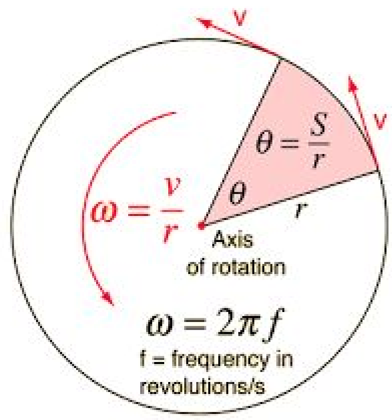
F is the restoring force measured in Newton or N.

A is the area of cross-section measured in $m^2$.

$\sigma$ is the stress measured using $N/m^2$ or Pa.

## 2. Angular Velocity

In physics, angular velocity refers to how fast an object rotates or revolves relative to another point, i.e. how fast the angular position or orientation of an object changes with time.




In general, angular velocity is measured in angle per unit time, e.g. radians per second (angle replacing distance from linear velocity with time in common). The SI unit of angular velocity is expressed as radians per second with the radian having a dimensionless value of unity, and thus the SI units of angular velocity are oftentimes listed as simply 1/s or $s^{-1}$.

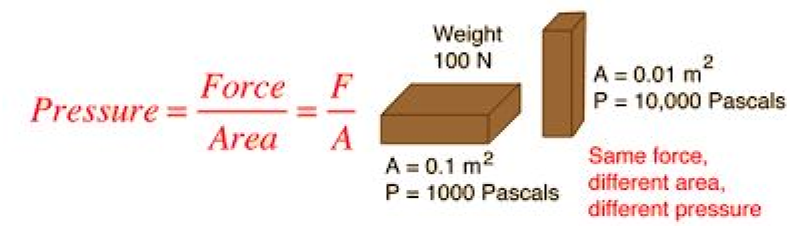
## 3. Viscosity

The viscosity of a fluid is a measure of its resistance to deformation at a given rate. For liquids, it corresponds to the informal concept of "thickness": for example, syrup has a higher viscosity than water.

The SI unit of dynamic viscosity is the newton-second per square meter ($N\cdot s/m^2$), also frequently expressed in the equivalent forms pascal-second (Pa·s) and kilogram per meter per second ($kg{\cdot}m^{-1}{\cdot}s^{-1}$). The CGS unit is the poise (P, or $g{\cdot}cm^{-1}{\cdot}s^{-1}$ = 0.1 Pa·s), named after Jean Léonard Marie Poiseuille. It is commonly expressed, particularly in ASTM standards, as centipoise (cP), because centipoise is equal to the SI millipascal seconds (mPa·s).

## 4. Pressure

Pressure is the force applied perpendicular to the surface of an object per unit area over which that force is distributed. Gauge pressure (also spelled gage pressure) is the pressure relative to the ambient pressure.




Various units are used to express pressure. Some of these derive from a unit of force divided by a unit of area; the SI unit of pressure, the pascal (Pa), for example, is one newton per square metre ($N/m^2$); similarly, the pound-force per square inch (psi) is the traditional unit of pressure in the imperial and US customary systems. Pressure may also be expressed in terms of standard atmospheric pressure; the atmosphere (atm) is equal to this pressure, and the torr is defined as 1/760 of this. Manometric units such as the centimetre of water, millimetre of mercury, and inch of mercury are used to express pressures in terms of the height of column of a particular fluid in a manometer.

## 5. Izod test value & Charpy test value

Both Charpy and Izod impact testing are popular methods of determining impact strength, or toughness, of a material. In other words, these tests measure the total amount of energy that a material is able to absorb. This energy absorption is directly related to the brittleness of the material. Brittle materials, such as ceramics or glass, tend to have lower absorption rates than ductile materials like copper or aluminum.

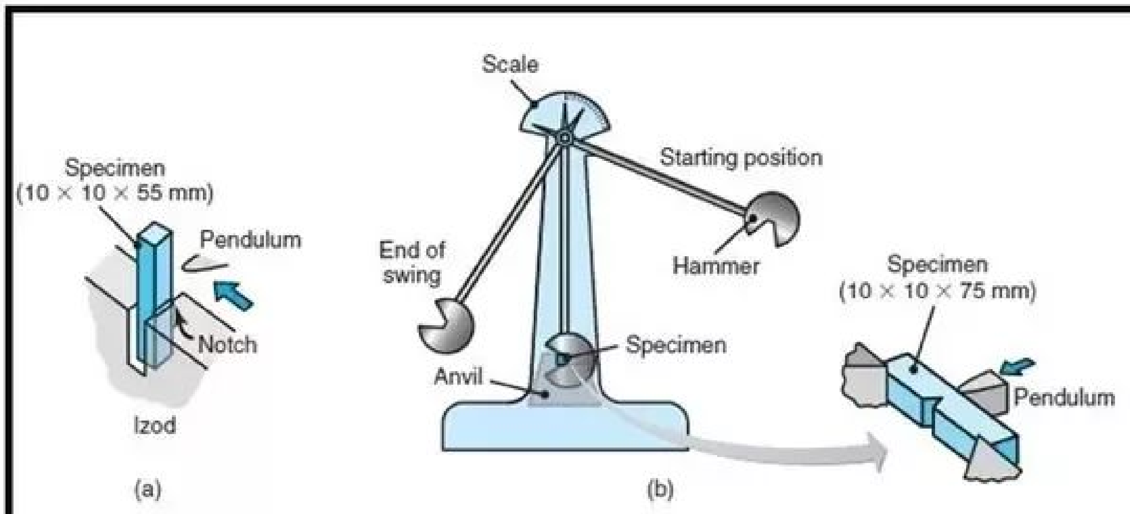
Understanding a material's energy absorption properties is critical, as it predicts how much plastic deformation the material will be able to withstand before catastrophic failure. It is also important to understand the similarities and differences between these two common impact test methods.

## Charpy Impact Testing

The Charpy impact test was developed by S.B. Russell and Georges Charpy at the turn of the 20th century. It remains to this day one of the most popular impact testing methods due to the relative ease of creating samples and obtaining results. The test apparatus consists of a weighted pendulum, which is dropped from a specified height to make contact with the specimen. The energy transferred to the material can be inferred by comparing the difference in the height of the pendulum before and after the fracture.

A Charpy test specimen, which is placed horizontally into the machine, is typically a 55 x 10 x 10mm (2.165" x 0.394" x 0.394") bar with a notch machined into one of the faces. This notch, which can be either V-shaped or U-shaped, is placed facing away from the pendulum and helps to concentrate the stress and encourage fracture. Testing can be performed at both ambient and reduced temperatures, sometimes as low as -425F.

Charpy impact testing is most commonly performed to ASTM E23, ASTM A370, ISO 148, or EN 10045-1. While the test is most commonly performed on metals, there are also a number of standards that exist for plastics and polymers, including ASTM D6110 and ISO 179.




Impact test specimens: (a) Charpy; (b) Izod.

## Izod Impact Testing

The Izod impact test was named for English engineer Edwin Gilbert Izod, who first described the test method in 1903. The test apparatus and specimen design are very similar to Charpy impact, with some notable differences, including the orientation of the specimen, which is clamped into the apparatus vertically with the notch facing toward the pendulum. The pendulum then impacts the sample at a specified area above the notch.

One of the main differences from Charpy impact is that Izod impact testing can be performed on either plastic or metallic specimens. Plastic samples are typically a 64 x 12.7 x 3.2 mm bar with a machined V-shaped notch. Metallic samples are typically round 127 x 11.43 mm bar with 1 or 3 machined V-shaped notch(es).

Common Izod impact test methods include ASTM D256, ASTM E23, and ISO 180.