Class XI: Physics
Chapter 9, Mechanical Properties of Solids

Points to remember

Key Learning:

1. Stress is the restoring force per unit area and strain is the fractional change in dimension.
2. Types of stresses (a) tensile stress — longitudinal stress (b) shearing stress, and (c) hydraulic stress.
3. Hooke's law states that the extension is proportional to the force or tension in a wire if the proportional limit is not exceeded. The constant of proportionality is called modulus of elasticity.
4. Three elastic moduli *viz.,* Young's modulus, shear modulus and bulk modulus are used to describe the elastic behaviour of objects as they respond to deforming forces that act on them.
5. Strain is fractional deformation.
6. Elastic deformations, stress is proportional to strain. The proportionality constant is called the elastic modulus.

$$\frac{Stress}{Strain} = Elastic \text{ modulus}$$

7. Elastomers, a new class of solid, do not obey Hooke's law.
8. Tensile stress = force per unit area = F/A
9. Tensile strain is extension per unit length = *e/l.*
10. Shearing stress is possible only in solids.
11. In elastic behaviour, metal returns to original length after load is removed. In this situation the energy is then recovered.
12. In plastic behaviour, metal permanently strained after load is removed. In this case the energy transferred to heat after elastic limit exceeded.

Top Formulae:

1. Normal stress, S = F / a; where a = πr^2
2. Longitudinal strain = $\frac{\Delta \ell}{\ell}$
3. $Young's$ modulus $Y = \frac{\text{tensile stress}}{\text{tensile strain}} = \frac{F/A}{\Delta L/L_0} = \frac{F}{A}\frac{L_0}{\Delta L}$
4. Breaking force = breaking stress x area of cross section
5. Volumetric strain = $\frac{\Delta V}{V}$
6. $Bulk$ modulus, $B = \frac{Bulk\ \text{stress}}{Bulk\ \text{strain}} = -\frac{\Delta p}{\Delta V/V_0} = -\frac{\Delta p V_0}{\Delta V}$
7. Shearing strain = $\frac{\Delta L}{L} = \theta$
8. $Shear$ modulus, $S = \frac{\text{Shear stress}}{\text{Shear strain}} = \frac{F/A}{x/h} = \frac{F}{A}\frac{h}{x}$
9. Modulus of rigidity, G = $\frac{F}{a\theta}$
10. Elastic potential energy of a stretched wire

=(1/2) x stress x strain x volume