

Mechanical Properties of Solids — Assignment 1

Class 11 Physics · Topic-wise question bank covering every concept of the chapter · Narayan Gurukul Academy

Instructions: (1) Attempt all questions. This worksheet walks through every concept of the chapter, topic by topic.
 (2) The interactive MCQ version of these questions (with instant answer reveal) is available on the notes page.
 (3) Universal values: $g = 10 \text{ m/s}^2$ unless stated. Give answers with correct SI units.

Elasticity, Stress and Strain

MCQ Questions (choose the correct option)

- The property by which a body regains its original shape on removal of the deforming force is called —
 (A) elasticity
 (B) plasticity
 (C) viscosity
 (D) ductility
- The SI unit of stress is —
 (A) N m^{-2} (pascal)
 (B) N m
 (C) J
 (D) W
- Longitudinal strain is defined as —
 (A) change in length divided by original length
 (B) change in length times original length
 (C) force per unit area
 (D) stress per unit strain
- Which of the following is a dimensionless quantity? —
 (A) Strain
 (B) Stress
 (C) Young's modulus
 (D) Force

1 Mark Questions

- Define elasticity.
- Define stress and state its SI unit.
- Define longitudinal strain.

2 Mark Questions

- Distinguish between stress and strain.
- Define longitudinal, shearing and volumetric strain with their expressions.
- A wire of length 2 m stretches by 2 mm under load. Find the longitudinal strain.

3 Mark Questions

- Define elasticity, stress and strain, and explain how a stretched wire regains its length when the load is removed.
- A steel wire of diameter 1 mm and length 2 m is stretched by a force of 50 N. If Young's modulus of steel is $2 \times 10^{11} \text{ N m}^{-2}$, find the increase in its length.

Hooke's Law and the Stress–Strain Curve

MCQ Questions (choose the correct option)

- Hooke's law states that, within the elastic limit, —
 - stress is proportional to strain
 - strain is inversely proportional to stress
 - stress equals strain
 - stress varies quadratically with strain
- The ratio of stress to strain is called the —
 - modulus of elasticity
 - elastic limit
 - yield strength
 - plasticity
- The material that fractures with very little plastic deformation is called —
 - brittle
 - ductile
 - elastic
 - malleable
- The slope of the linear portion of the stress–strain curve gives —
 - the modulus of elasticity
 - the yield stress
 - the ultimate stress
 - the strain energy

1 Mark Questions

- State Hooke's law.
- Define the modulus of elasticity.
- Distinguish between a ductile and a brittle material.

2 Mark Questions

- Explain the stress–strain curve for a ductile material and identify the elastic limit and yield point.
- A material obeys Hooke's law up to a stress of $2 \times 10^8 \text{ N m}^{-2}$. Which region of the curve corresponds to this?
- Give one example each of a ductile and a brittle material.

3 Mark Questions

- Draw and explain the stress–strain curve for a metallic wire, marking the proportional limit, elastic limit, yield point and breaking point.
- A wire of length 4 m and area 10^{-6} m^2 stretches by 1 mm under a load of 20 kg. Assuming Hooke's law applies, find the stress and strain, and the Young's modulus of the wire.

The Three Moduli of Elasticity

MCQ Questions (choose the correct option)

- Young's modulus is the ratio of —
 - longitudinal stress to longitudinal strain

- (B) shearing stress to shearing strain
 - (C) volumetric stress to volumetric strain
 - (D) force to area
2. The bulk modulus of a material is the ratio of —
- (A) volumetric stress to volumetric strain
 - (B) longitudinal stress to longitudinal strain
 - (C) stress to volume
 - (D) strain to stress
3. The compressibility of a material is the reciprocal of its —
- (A) bulk modulus
 - (B) Young's modulus
 - (C) shear modulus
 - (D) elastic limit
4. Among solids, liquids and gases, the highest bulk modulus is possessed by —
- (A) solids
 - (B) liquids
 - (C) gases
 - (D) the same for all

1 Mark Questions

1. Define Young's modulus.
2. Define the bulk modulus of a material.
3. What is compressibility?

2 Mark Questions

1. A wire of length 2 m and area 10^{-6} m^2 is stretched by 1 mm under a load of 5 kg. Find its Young's modulus. ($g = 10 \text{ m/s}^2$.)
2. Distinguish between rigidity modulus and bulk modulus.
3. Why do gases have a much smaller bulk modulus than solids?

3 Mark Questions

1. Define the three elastic moduli — Young's, shearing and bulk — and give an expression and an application for each.
2. A uniform pressure of $2 \times 10^6 \text{ N m}^{-2}$ is applied to a solid of bulk modulus 10^{10} N m^{-2} . Find the fractional change in its volume.

Poisson's Ratio

MCQ Questions (choose the correct option)

1. Poisson's ratio is the ratio of —
 - (A) lateral strain to longitudinal strain
 - (B) longitudinal strain to lateral strain
 - (C) stress to strain
 - (D) volume strain to linear strain
2. For a material that is nearly incompressible, Poisson's ratio is close to —
 - (A) 0.5

- (B) 0
(C) 1
(D) 0.25
3. Poisson's ratio has —
(A) no unit
(B) the unit of strain
(C) the unit N m^{-2}
(D) the unit metre
4. When a wire is stretched, its diameter —
(A) decreases
(B) increases
(C) remains the same
(D) first increases then decreases

1 Mark Questions

1. Define Poisson's ratio.
2. State the typical range of Poisson's ratio for most materials.
3. What is the physical effect of lateral contraction in a stretched wire?

2 Mark Questions

1. A wire of diameter 1 mm is stretched so that its longitudinal strain is 2×10^{-3} . If Poisson's ratio is 0.3, find the change in its diameter.
2. Explain why rubber has a Poisson's ratio near 0.5 while steel is near 0.3.
3. Define lateral and longitudinal strain, and write the expression for Poisson's ratio.

3 Mark Questions

1. Define Poisson's ratio and show that it is dimensionless. State the significance of the two limiting values 0 and 0.5.
2. A wire of length 3 m and diameter 1 mm is stretched by 3 mm. If Poisson's ratio is 0.25, find the decrease in its diameter.

Elastic Potential Energy and Applications

MCQ Questions (choose the correct option)

1. The elastic potential energy stored per unit volume in a stretched wire is —
(A) $\frac{1}{2} \times \text{stress} \times \text{strain}$
(B) $\text{stress} \times \text{strain}$
(C) $\frac{1}{2} \times \text{stress} / \text{strain}$
(D) $\text{stress} / \text{strain}$
2. The elastic energy stored in a stretched spring of spring constant k and extension x is —
(A) $\frac{1}{2}kx^2$
(B) kx^2
(C) $\frac{1}{2}kx$
(D) kx
3. The ratio of breaking stress to working stress is called the —
(A) factor of safety

- (B) yield strength
 - (C) modulus of rigidity
 - (D) elastic limit
4. Ropes, belts and crane cables primarily rely on the material's —
- (A) tensile strength and Young's modulus
 - (B) bulk modulus
 - (C) Poisson's ratio
 - (D) thermal conductivity

1 Mark Questions

1. Write the expression for the elastic potential energy per unit volume of a stretched wire.
2. Define the factor of safety in structural design.
3. Give one practical application of elastic behaviour.

2 Mark Questions

1. A steel wire of Young's modulus $2 \times 10^{11} \text{ N m}^{-2}$ is stretched to a strain of 10^{-3} . Find the energy stored per unit volume.
2. Explain why crane cables are made of steel with a high Young's modulus rather than a low one.
3. A spring of spring constant 200 N m^{-1} is stretched by 5 cm. Find the elastic energy stored in it.

3 Mark Questions

1. Derive an expression for the elastic potential energy stored per unit volume in a stretched wire in terms of Young's modulus and strain.
2. Discuss the practical applications of elastic behaviour in the design of beams, columns and crane cables, and explain the role of the factor of safety.