Mechanical Properties of Solids

Class 11 Physics · 24 NEET MCQs with answers & explanations

Mechanical Properties of Solids covers stress, strain, Young's modulus, bulk modulus, shear modulus, Poisson's ratio and the stress-strain curve. NEET tests elastic moduli calculations, stress-strain graph interpretation and Hooke's law application. Questions are mostly numerical and formula-based.

Key Elasticity Concepts

Concept	Key Fact
Stress	Force per unit area (F/A); units: Pa or N/m²
Strain	Fractional change: ΔL/L (longitudinal), ΔV/V (volumetric), tanθ (shear)
Young's modulus (Y)	Y = stress/strain = (F/A)/(ΔL/L); for longitudinal deformation
Bulk modulus (B)	B = −V(ΔP/ΔV); resistance to uniform compression
Hooke's law	Stress ∝ strain (within elastic limit); F = kx for springs
Stress-strain curve	Proportional limit → elastic limit → yield point → ultimate strength → fracture

Questions

Q1. Which property enables a material to regain its original shape and size after the deforming force is removed, provided the elastic limit is not exceeded?

(A) Elasticity
(B) Plasticity
(C) Brittleness
(D) Ductility

Q2. According to NCERT, the deformation produced in a body depends primarily on:

(A) Nature of force only
(B) Both the applied force and the nature of the material
(C) Only the dimensions of the body
(D) Only the temperature

Q3. Which statement correctly distinguishes elastic and plastic behaviour?

(A) Elastic bodies never deform
(B) Plastic bodies completely recover their shape
(C) Elastic deformation is recoverable whereas plastic deformation is permanent
(D) Plastic deformation occurs only in liquids

Q4. Longitudinal strain is defined as:

(A) Change in area divided by original area
(B) Change in volume divided by original volume
(C) Change in length divided by original length
(D) Original length divided by change in length

Q5. A wire of original length 2 m elongates by 2 mm under a load. The longitudinal strain produced is:

(A) 1×10^{-3}
(B) 1×10^{-2}
(C) 2×10^{-3}
(D) 5×10^{-4}

Q6. When a wire is stretched, its length increases while its lateral dimensions decrease. Which of the following correctly explains the sign relationship between longitudinal and lateral strain?

(A) Lateral strain is opposite in sign to longitudinal strain because stretching increases length but decreases lateral dimensions
(B) Lateral strain has the same sign as longitudinal strain since both result from the same applied force
(C) Lateral strain is zero when longitudinal strain is non-zero
(D) Lateral strain and longitudinal strain are equal in magnitude and opposite in sign for all materials

Q7. A wire of length 2 m extends by 1 mm under a tensile stress of 1×10^8 Pa. The Young's modulus of the material is:

(A) 2×10^{11} Pa
(B) 1×10^{11} Pa
(C) 2×10^{10} Pa
(D) 1×10^8 Pa

Q8. Which material is most suitable for manufacturing machine tools that must undergo minimum deformation under load?

(A) Rubber
(B) Steel
(C) Wood
(D) Plastic

Q9. For the same applied stress, a material with a higher Young's modulus experiences less strain. Which of the following correctly explains this?

(A) From Y = stress/strain, for constant stress, strain = stress/Y — so strain decreases as Y increases
(B) A higher Young's modulus means the material has a lower elastic limit, reducing the strain produced
(C) A higher Young's modulus increases the cross-sectional area, distributing the stress over more material
(D) Young's modulus and strain are directly proportional, so higher Y produces higher strain

Q10. A wire of length 2 m extends by 2 mm under a tensile stress of 2×10^8 Pa. The Young's modulus of the material is:

(A) 1×10^{11} Pa
(B) 4×10^{11} Pa
(C) 2×10^{11} Pa
(D) 1×10^8 Pa

Q11. A material is stressed beyond its proportional limit but has not yet reached its elastic limit. Which of the following correctly describes this region?

(A) Hooke's law no longer holds, but the material still recovers completely after unloading
(B) Hooke's law holds and the material recovers completely
(C) The material undergoes permanent deformation
(D) The material has reached its breaking point

Q12. A wire has Young's modulus 2×10^{11} Pa. If the strain produced is 5×10^{-4}, the stress developed is:

(A) 1×10^{8} Pa
(B) 1×10^{7} Pa
(C) 2×10^{8} Pa
(D) 2×10^{15} Pa

Q13. A steel wire and a copper wire have identical length and cross-sectional area. They are subjected to the same tensile force. Which quantity is the same for both wires?

(A) Strain
(B) Stress
(C) Extension
(D) Young's modulus

Q14. A wire has Young's modulus 2×10^{11} Pa. If the stress applied is 4×10^{8} Pa, the strain produced is:

(A) 4×10^{-3}
(B) 5×10^{2}
(C) 2×10^{-3}
(D) 8×10^{-3}

Q15. Which of the following correctly states why Young's modulus — and not the amount of extension — is the proper measure of elasticity?

(A) A material that returns to its original shape with a smaller deformation for the same stress has greater elasticity
(B) A material that stretches more for the same stress is more elastic
(C) Elasticity is determined by the density of the material
(D) A material with zero extension is perfectly rigid and has infinite elasticity

Q16. The initial straight-line portion of the stress–strain curve represents:

(A) Hooke's law region where stress ∝ strain and slope = Young's modulus
(B) Plastic region where permanent deformation occurs
(C) Fracture region where the material breaks
(D) Necking region where cross-section reduces rapidly

Q17. The point on the stress–strain curve beyond which stress is no longer proportional to strain is called the:

(A) Elastic limit
(B) Proportional limit
(C) Yield point
(D) Breaking point

Q18. All of the following correctly describe the linear (OA) region of the stress–strain curve EXCEPT:

(A) Stress is directly proportional to strain throughout this region
(B) The slope of this region equals Young's modulus of the material
(C) Permanent deformation begins to accumulate in this region
(D) A material in this region will completely recover its original shape on unloading

Q19. According to NCERT, which of the following statements is correct regarding elasticity?

(A) Steel is more elastic than rubber
(B) Rubber is more elastic than steel
(C) Both steel and rubber are equally elastic
(D) Elasticity depends on cross-sectional area, not material

Q20. Which quantity is represented by the slope of the initial straight-line portion of the stress-strain graph?

(A) Elastic limit
(B) Young's modulus
(C) Strain at proportional limit
(D) Bulk modulus

Q21. A material is stressed beyond its proportional limit but is still within its elastic limit. Which of the following correctly describes this situation?

(A) The material will fully recover its original dimensions after unloading
(B) The material will undergo permanent deformation after unloading
(C) Hooke's law remains valid throughout this region
(D) The material has crossed its fracture point

Q22. Why is steel generally preferred over aluminium for constructing bridges and building frameworks?

(A) Steel has lower density
(B) Steel has a higher Young's modulus
(C) Steel has a lower melting point
(D) Steel is more compressible

Q23. A crane cable is designed with a large cross-sectional area primarily to:

(A) Reduce stress and extension under heavy loads
(B) Increase its density
(C) Reduce its length
(D) Increase thermal conductivity

Q24. A suspension bridge cable should operate well below its elastic limit because:

(A) It should permanently elongate under traffic load
(B) It should have maximum plastic deformation
(C) It must return to its original length after load is removed
(D) It should reduce its Young's modulus over time

Answer key

1-A	**2-B**	**3-C**	**4-C**	**5-A**	**6-A**	**7-A**	**8-B**
9-A	**10-C**	**11-A**	**12-A**	**13-B**	**14-C**	**15-A**	**16-A**

17-B	18-C	19-A	20-B	21-A	22-B	23-A	24-C

Answers with explanations

Q1 — Answer: (A) Elasticity
Elasticity is the property by which a body regains its original configuration after removal of deforming force. Plasticity causes permanent deformation, so Option B is wrong.

Q2 — Answer: (B) Both the applied force and the nature of the material
Deformation depends on both the applied force and the elastic properties of the material. Options A, C, D are each incomplete and exclude essential contributing factors.

Q3 — Answer: (C) Elastic deformation is recoverable whereas plastic deformation is permanent
Elastic deformation disappears fully after force removal; plastic deformation persists. Option B is the opposite of the correct definition of plasticity.

Q4 — Answer: (C) Change in length divided by original length
Longitudinal strain = $\Delta L/L_0$ — ratio of change in length to original length, always dimensionless. Option D is the reciprocal, the most common error. Option A defines area strain; Option B defines volumetric strain.

Q5 — Answer: (A) 1×10^{-3}
Strain = $\Delta L/L = (2 \times 10^{-3}) / 2 = 1 \times 10^{-3}$. Option C ($2 \times 10^{-3}$) traps students who correctly convert mm to m but forget to divide by L. Option B (10^{-2}) arises from a decimal-place error in unit conversion.

Q6 — Answer: (A) Lateral strain is opposite in sign to longitudinal strain because stretching increases length but decreases lateral dimensions
Stretching gives positive longitudinal strain and negative lateral strain — always opposite in sign. Option D is the NEET-style trap: magnitudes are equal only for a specific Poisson's ratio of 0.5; in general they differ. Option B wrongly equates signs.

Q7 — Answer: (A) 2×10^{11} Pa
Strain = $\Delta L/L = 10^{-3}/2 = 5 \times 10^{-4}$. Y = stress/strain = $10^8/5 \times 10^{-4} = 2 \times 10^{11}$ Pa. Option B arises from using ΔL directly as strain without dividing by L. Option D confuses Young's modulus with the applied stress value.

Q8 — Answer: (B) Steel
Minimum deformation requires maximum stiffness — the largest Young's modulus. Steel has $Y \approx 2 \times 10^{11}$ Pa, far greater than rubber ($\sim 10^6$ Pa), wood ($\sim 10^{10}$ Pa), or plastic ($\sim 10^9$ Pa).

Q9 — Answer: (A) From Y = stress/strain, for constant stress, strain = stress/Y — so strain decreases as Y increases
From Y = stress/strain, rearranging gives strain = stress/Y. For fixed stress, strain is inversely proportional to Y. Option D is the classic direct-proportionality inversion error students make.

Q10 — Answer: (C) 2×10^{11} Pa
Strain = $\Delta L/L = (2 \times 10^{-3})/2 = 10^{-3}$. Y = Stress/Strain = $(2 \times 10^8)/(10^{-3}) = 2 \times 10^{11}$ Pa. Option D is the trap — copying stress directly without dividing by strain.

Q11 — Answer: (A) Hooke's law no longer holds, but the material still recovers completely after unloading
The proportional limit marks the end of Hooke's law. Between the proportional limit and elastic limit, stress is no longer proportional to strain, but full recovery still occurs. Permanent deformation only begins beyond the elastic limit.

Q12 — Answer: (A) 1×10^{8} Pa
Stress = Y × Strain = $(2\times10^{11})(5\times10^{-4}) = 1\times10^{8}$ Pa. Option B arises from a powers-of-ten error giving 10^{7}. Option C arises from using strain as 10^{-3} instead of 5×10^{-4}. Option D arises from multiplying Y × Y × strain.

Q13 — Answer: (B) Stress
Stress = F/A. Since force and area are identical, stress is the same for both wires. Strain = stress/Y and extension = FL/AY both differ because Y differs between steel and copper.

Q14 — Answer: (C) 2×10^{-3}
Strain = Stress/Y = $(4\times10^{8})/(2\times10^{11}) = 2\times10^{-3}$. Trap A: student uses stress coefficient 4 but skips dividing by Y coefficient 2. Trap D: student multiplies coefficients (4×2=8) instead of dividing.

Q15 — Answer: (A) A material that returns to its original shape with a smaller deformation for the same stress has greater elasticity
Y = stress/strain: for the same stress, smaller strain means larger Y and greater elasticity. Steel extends less than rubber under equal stress, making steel more elastic. Option B reverses the relationship.

Q16 — Answer: (A) Hooke's law region where stress ∝ strain and slope = Young's modulus
In the linear region, stress ∝ strain and the slope equals Young's modulus. All other regions — plastic, necking, fracture — occur at higher stresses well beyond the elastic region.

Q17 — Answer: (B) Proportional limit
The proportional limit is the specific point up to which stress ∝ strain and the graph is linear. Beyond it the curve becomes non-linear even if the material is still elastic. The elastic limit lies at or beyond the proportional limit.

Q18 — Answer: (C) Permanent deformation begins to accumulate in this region
Permanent deformation begins only after the elastic limit is exceeded — which lies beyond the linear region OA. In OA, deformation is completely reversible and Hooke's law holds throughout.

Q19 — Answer: (A) Steel is more elastic than rubber
Young's modulus measures degree of elasticity. Steel has a far larger Young's modulus than rubber and is therefore more elastic in the scientific sense, despite rubber showing larger deformation.

Q20 — Answer: (B) Young's modulus
In the Hooke's law region, Stress = Y × Strain. The slope of the linear portion is Stress/Strain = Young's modulus. Bulk modulus relates to volumetric stress, not this graph's slope.

Q21 — Answer: (A) The material will fully recover its original dimensions after unloading
Elastic limit is the maximum stress for complete recovery. Between proportional limit and elastic limit, Hooke's law fails but recovery is still complete. Permanent deformation only begins beyond the elastic limit.

Q22 — Answer: (B) Steel has a higher Young's modulus
Higher Young's modulus means greater stiffness. Steel deforms less than aluminium under identical load, making it safer for structural use. Density and melting point are not the basis for this choice.

Q23 — Answer: (A) Reduce stress and extension under heavy loads
Stress = F/A. Larger area reduces stress and also reduces extension since ΔL = FL/AY. Density and thermal conductivity are unrelated to the structural purpose of cable thickness.

Q24 — Answer: (C) It must return to its original length after load is removed
Cables experience repeated loading cycles. Operating below the elastic limit ensures complete recovery after unloading and prevents permanent structural deformation.

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