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CLASS 11 PHYSICS · NCERT CHAPTER 8 · IMU CET PRACTICE

Mechanical Properties of Solids

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Questions: 45 MCQs

Each question has exactly one correct option. Attempt all questions first, then check the Answer Key and Solutions at the end.

- 1 Hooke's law states that within the elastic limit,
(A) stress equals strain
(B) strain is independent of stress
(C) stress is inversely proportional to strain
(D) stress is proportional to strain
- 2 The SI unit of stress is
(A) N
(B) N/m^2
(C) dimensionless
(D) N m
- 3 The ratio of stress to strain is called
(A) modulus of elasticity
(B) elastic limit
(C) Poisson's ratio
(D) compressibility
- 4 Young's modulus of a perfectly rigid body is
(A) zero
(B) infinite
(C) unity
(D) between 0 and 1
- 5 A wire of length 2 m and area 1 mm^2 is stretched by a force of 100 N. If $Y = 2 \times 10^{11} \text{ N/m}^2$, the extension is
(A) 10 mm
(B) 1 mm
(C) 0.1 mm
(D) 2 mm
- 6 A wire is stretched by a force F producing extension l . If a wire of the same material with double length and double radius is stretched by the same force, the extension is
(A) $l/2$
(B) $2l$
(C) l
(D) $l/4$
- 7 The bulk modulus of a perfectly incompressible fluid is
(A) negative
(B) infinite
(C) one
(D) zero
- 8 Compressibility is the reciprocal of
(A) Poisson's ratio
(B) bulk modulus
(C) Young's modulus
(D) shear modulus



- 9 Shear modulus is also called
(A) Young's modulus (B) bulk modulus
(C) modulus of rigidity (D) compressibility
- 10 Which property relates lateral strain to longitudinal strain?
(A) Rigidity modulus (B) Bulk modulus
(C) Poisson's ratio (D) Young's modulus
- 11 Strain energy stored per unit volume of a stretched wire is
(A) stress/strain (B) stress $\times$ strain
(C) $2 \times$ stress $\times$ strain (D) $\frac{1}{2} \times$ stress $\times$ strain
- 12 The work done in stretching a wire by force F producing extension l is
(A) Fl^2 (B) Fl
(C) $\frac{1}{2}Fl$ (D) $2Fl$
- 13 Steel is more elastic than rubber because
(A) steel is heavier
(B) rubber has a larger Young's modulus
(C) steel has a larger Young's modulus
(D) steel stretches more for the same stress
- 14 The dimensional formula of Young's modulus is
(A) $[ML^2T^{-2}]$ (B) $[M^0L^0T^0]$
(C) $[MLT^{-2}]$ (D) $[ML^{-1}T^{-2}]$
- 15 The beyond-elastic-limit region where a material deforms permanently is called
(A) plastic region (B) fracture point
(C) elastic region (D) proportional region
- 16 Materials that undergo large plastic deformation before fracture are called
(A) brittle (B) elastomers
(C) ductile (D) rigid
- 17 Rubber-like substances that can be stretched greatly and still regain their shape are called
(A) brittle materials (B) ductile materials
(C) elastomers (D) plastics
- 18 A rod of length L is heated by ΔT and prevented from expanding. The thermal stress developed is (α = linear expansivity)
(A) $Y\Delta T/\alpha$ (B) $Y\alpha\Delta T$
(C) $YL\alpha\Delta T$ (D) $\alpha\Delta T/Y$
- 19 The value of Poisson's ratio theoretically lies between
(A) -2 and 2 (B) 0 and 1
(C) -1 and 0.5 (D) 1 and 2



- 20** A cube is subjected to a uniform pressure on all faces. The relevant modulus is
(A) shear modulus (B) bulk modulus
(C) Young's modulus (D) Poisson's ratio
- 21** A force of 1000 N is applied tangentially on the top face (area 0.01 m^2) of a cube of side 10 cm. The shearing stress is
(A) 10^5 N/m^2 (B) 10^6 N/m^2
(C) 10^3 N/m^2 (D) 10^4 N/m^2
- 22** Two wires of the same material have lengths in ratio 1 : 2 and diameters in ratio 2 : 1. For the same force, the ratio of their extensions is
(A) 1 : 8 (B) 1 : 2
(C) 1 : 4 (D) 2 : 1
- 23** A steel wire of cross-section $2 \times 10^{-6} \text{ m}^2$ supports a load of 40 kg. The stress in the wire is ($g = 10 \text{ m/s}^2$)
(A) $2 \times 10^7 \text{ N/m}^2$ (B) $4 \times 10^8 \text{ N/m}^2$
(C) $2 \times 10^8 \text{ N/m}^2$ (D) $8 \times 10^8 \text{ N/m}^2$
- 24** When a wire is stretched, its strain energy per unit volume is $\frac{1}{2}Y\epsilon^2$. If strain is doubled, energy density becomes
(A) four times (B) unchanged
(C) double (D) half
- 25** Breaking stress of a wire depends on
(A) the material of the wire (B) the load applied
(C) the radius of the wire (D) the length of the wire
- 26** The maximum load a wire can bear is W . If the wire's radius is doubled, the maximum load becomes
(A) $2W$ (B) $W/2$
(C) $4W$ (D) W
- 27** The maximum load a wire can bear is W . If the wire is cut to half its length, the maximum load becomes
(A) W (B) $4W$
(C) $2W$ (D) $W/2$
- 28** The bulk modulus of water is $2.2 \times 10^9 \text{ N/m}^2$. The pressure needed to decrease its volume by 1% is
(A) $2.2 \times 10^7 \text{ N/m}^2$ (B) $2.2 \times 10^5 \text{ N/m}^2$
(C) $2.2 \times 10^9 \text{ N/m}^2$ (D) $2.2 \times 10^{11} \text{ N/m}^2$
- 29** Which of the following has the maximum Young's modulus?
(A) Glass (B) Rubber
(C) Copper (D) Steel
- 30** Liquids and gases possess only
(A) all three moduli (B) Young's modulus
(C) shear modulus (D) bulk modulus



- 31** The stress–strain graph of a material is linear up to
(A) the breaking point (B) the yield point
(C) the proportional limit (D) the ultimate stress point
- 32** Strain is defined as
(A) change in dimension / original dimension
(B) original dimension / change in dimension
(C) force × area
(D) force / area
- 33** A wire elongates by 4 mm when a load is hung from it. If the load is passed over a pulley and both ends of the wire carry the same load, the elongation is
(A) zero (B) 8 mm
(C) 4 mm (D) 2 mm
- 34** The Young's modulus of a wire depends on
(A) the material only (B) applied load
(C) cross-sectional area (D) length of the wire
- 35** A wire of length L and radius r is stretched by a force F . The elastic potential energy stored is
(A) $FL/(\pi r^2 Y)$ (B) $F^2 L/(\pi r^2 Y)$
(C) $F L^2/(2\pi r^2 Y)$ (D) $F^2 L/(2\pi r^2 Y)$
- 36** Cranes use thick steel ropes made of many thin wires rather than a single solid rod because
(A) it decreases the breaking stress
(B) it reduces the weight to zero
(C) thin wires have larger Young's modulus
(D) it gives flexibility and strength while being easy to handle
- 37** The elastic behaviour of materials is important in designing beams. The depression of a beam is minimised by using
(A) a material of low Young's modulus
(B) an I-shaped cross-section (large depth)
(C) a beam of very small depth
(D) a long beam
- 38** The fractional change in volume per unit pressure is
(A) bulk modulus (B) strain energy
(C) rigidity (D) compressibility
- 39** A rubber cord is stretched by 25% of its length. The longitudinal strain is
(A) 25 (B) 0.25
(C) 0.025 (D) 2.5
- 40** For a material with Poisson's ratio 0.5, the material is
(A) highly compressible
(B) incompressible (volume unchanged on stretching)
(C) brittle
(D) perfectly rigid

- 41 The extension of a wire under a load is 1 mm. If the load is doubled (within elastic limit), the extension becomes
- (A) 0.5 mm (B) 4 mm
(C) 1 mm (D) 2 mm
-
- 42 A metal rod of Young's modulus 2×10^{11} Pa undergoes a strain of 0.05%. The energy stored per unit volume is
- (A) 5×10^4 J/m³ (B) 1×10^4 J/m³
(C) 2.5×10^5 J/m³ (D) 2.5×10^4 J/m³
-
- 43 A material that breaks soon after the elastic limit with little plastic region is
- (A) brittle (B) elastomer
(C) malleable (D) ductile
-
- 44 The restoring force per unit area in a deformed body is called
- (A) modulus (B) pressure only
(C) strain (D) stress
-
- 45 The ratio of shearing stress to shearing strain is the
- (A) bulk modulus (B) modulus of rigidity
(C) Poisson's ratio (D) Young's modulus
-



Answer Key

1	2	3	4	5	6	7	8	9	10
D	B	A	B	B	A	B	B	C	C
11	12	13	14	15	16	17	18	19	20
D	C	C	D	A	C	C	B	C	B
21	22	23	24	25	26	27	28	29	30
A	A	C	A	A	C	A	A	D	D
31	32	33	34	35	36	37	38	39	40
C	A	C	A	D	D	B	D	B	B
41	42	43	44	45					
D	D	A	D	B					

Hints & Solutions

- (D) Within the proportional limit, stress = modulus $\times$ strain.
- (B) Stress = force/area $\rightarrow$ N/m² (pascal).
- (A) Modulus of elasticity = stress/strain.
- (B) A perfectly rigid body has zero strain for any stress, so $Y = \text{stress}/0 \rightarrow \infty$.
- (B) $\Delta L = FL/(AY) = 100 \times 2/(10^{-6} \times 2 \times 10^{11}) = 10^{-3} \text{ m} = 1 \text{ mm}$.
- (A) $\Delta L \propto L/r^2 \rightarrow (2)/(4) = 1/2 \rightarrow 1/2$.
- (B) No volume change under any pressure $\rightarrow B = \Delta P/(\Delta V/V) \rightarrow \infty$.
- (B) $K = 1/B$.
- (C) Shear modulus (G or η) is the modulus of rigidity.
- (C) $\sigma = -(\text{lateral strain})/(\text{longitudinal strain})$.
- (D) $u = \frac{1}{2} \sigma \epsilon$.
- (C) Force increases linearly from 0 to F, so $W = \frac{1}{2}FL$.
- (C) For the same stress, steel produces less strain, i.e., higher Y — that is the meaning of "more elastic".
- (D) $Y = \text{stress}/\text{strain} \rightarrow$ same as pressure, [ML⁻¹T⁻²].
- (A) In the plastic region the body does not regain its original shape on removal of load.
- (C) Ductile materials (e.g., copper) can be drawn into wires due to large plastic range.
- (C) Elastomers (e.g., rubber, aorta tissue) show large elastic strains.
- (B) Strain prevented = $\alpha\Delta T \rightarrow \text{stress} = Y\alpha\Delta T$ (independent of length).
- (C) Theoretical limits are $-1 < \sigma < 0.5$; practically $0 < \sigma < 0.5$.
- (B) Uniform hydraulic stress causes a volume change, characterised by the bulk modulus.
- (A) Shear stress = $F/A = 1000/0.01 = 10^5 \text{ N/m}^2$.
- (A) $\Delta L \propto L/d^2 \rightarrow (1/4) : (2/1) = 1 : 8$.
- (C) Stress = $400/(2 \times 10^{-6}) = 2 \times 10^8 \text{ N/m}^2$.



24. (A) $u \propto \epsilon^2 \rightarrow 4$ times.
25. (A) Breaking stress is a material property; breaking load depends on area.
26. (C) Breaking load = breaking stress $\times \pi r^2 \propto r^2 \rightarrow 4W$.
27. (A) Breaking load depends on area and material, not length.
28. (A) $\Delta P = B \times (\Delta V/V) = 2.2 \times 10^9 \times 0.01 = 2.2 \times 10^7 \text{ N/m}^2$.
29. (D) Steel ($\sim 2 \times 10^{11} \text{ Pa}$) has a higher Y than copper ($\sim 1.1 \times 10^{11}$), glass ($\sim 0.7 \times 10^{11}$) and rubber.
30. (D) Fluids cannot sustain tensile or shear stress in static conditions, so only bulk modulus applies.
31. (C) Hooke's law (linear relation) holds up to the proportional limit.
32. (A) Strain is the fractional change in a dimension and is dimensionless.
33. (C) The tension in the wire is still equal to the load (W), so the elongation remains 4 mm.
34. (A) Y is a property of the material, independent of dimensions and load (within elastic limit).
35. (D) $U = \frac{1}{2} F \Delta L$ with $\Delta L = FL/(\pi r^2 Y) \rightarrow U = F^2 L/(2\pi r^2 Y)$.
36. (D) A rope of many thin wires is flexible, easy to manufacture and strong for the same cross-section.
37. (B) Sag $\delta \propto WL^3/(Ybd^3)$; increasing depth d reduces sag. I-beams provide large depth with less material.
38. (D) $K = -(1/V)(\Delta V/\Delta P)$.
39. (B) Strain = $\Delta L/L = 0.25$.
40. (B) $\sigma = 0.5$ corresponds to no change in volume under longitudinal stress.
41. (D) $\Delta L \propto F \rightarrow 2 \text{ mm}$.
42. (D) $u = \frac{1}{2} Y \epsilon^2 = \frac{1}{2} \times 2 \times 10^{11} \times (5 \times 10^{-4})^2 = 10^{11} \times 25 \times 10^{-8} = 2.5 \times 10^4 \text{ J/m}^3$.
43. (A) Brittle materials (e.g., glass, cast iron) fracture with little plastic deformation.
44. (D) Stress = internal restoring force per unit area.
45. (B) $G = (F/A)/\theta$.

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