

Mechanical Properties of Solids — CBSE Pattern Test 1

Class 11 Physics · 90 minutes · 40 marks · Sections A–D with answer key · Narayan Gurukul Academy

Test 1 — CBSE Pattern (90 minutes, 40 marks)

Class 11 Physics · Mechanical Properties of Solids · Narayan Gurukul Academy (ClassApna)

General Instructions: (1) This paper has four sections — Section A (1×10), Section B (2×4), Section C (3×4) and Section D (5×2) — total 40 marks. Time allowed: 90 minutes.

(2) All questions are compulsory. No overall choice is given; internal choice, where allowed, is clearly marked.

(3) For MCQ questions choose the single correct option; for VSA answers write a single line.

(4) Take $g = 10 \text{ m/s}^2$. All symbols carry their usual meaning. Use of a calculator is not permitted.

Section A — MCQ & VSA ($10 \times 1 = 10$ marks)

- The property by which a body regains its original shape on removal of the deforming force is called
 - elasticity
 - plasticity
 - viscosity
 - ductility
- The SI unit of stress is
 - N m^{-2} (pascal)
 - N m
 - J
 - W
- Longitudinal strain is defined as
 - change in length divided by original length
 - original length divided by change in length
 - force per unit area
 - change in volume per unit volume
- Which of the following is a dimensionless quantity?
 - Strain
 - Stress
 - Young's modulus
 - Force
- Hooke's law states that, within the elastic limit,
 - stress is proportional to strain
 - stress is inversely proportional to strain
 - stress equals strain
 - stress and strain are unrelated
- The ratio of stress to strain is called the
 - modulus of elasticity
 - compressibility
 - factor of safety
 - Poisson's ratio
- The material that fractures with very little plastic deformation is called
 - brittle

- (B) ductile
 - (C) elastic
 - (D) malleable
8. The slope of the linear portion of the stress–strain curve gives
- (A) the modulus of elasticity
 - (B) the yield point
 - (C) the breaking stress
 - (D) the Poisson's ratio
9. Define Poisson's ratio.
10. Define Young's modulus.

Section B — Short Answer I ($4 \times 2 = 8$ marks)

11. A wire of length 2 m stretches by 2 mm under load. Find the longitudinal strain.
12. 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. ($g = 10 \text{ m/s}^2$)
13. A steel wire of length 2 m and cross-section 1 mm^2 is stretched by a force of 200 N. If Young's modulus of steel is $2 \times 10^{11} \text{ N/m}^2$, find the extension.
14. A cube of side 10 cm is subjected to a shear of 0.01 mm by a tangential force of 10^4 N . Find the modulus of rigidity.

Section C — Short Answer II ($4 \times 3 = 12$ marks)

15. 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.
16. 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.
17. 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.
18. 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, the strain and the Young's modulus of the wire.

Section D — Long Answers ($2 \times 5 = 10$ marks)

19. Derive the expression for the elastic potential energy of a stretched wire and explain how it depends on stress and strain. A steel wire of Young's modulus $2 \times 10^{11} \text{ N m}^{-2}$ is stretched to a strain of 10^{-3} — hence find the energy stored per unit volume.
20. Explain Poisson's ratio, and derive the relation between Young's modulus, bulk modulus and modulus of rigidity for an isotropic material.

Answer Key (Marking Scheme)

- Q1 — (A) elasticity. Q2 — (A) N m^{-2} (pascal). Q3 — (A) change in length divided by original length. Q4 — (A) Strain.
- Q5 — (A) stress is proportional to strain. Q6 — (A) modulus of elasticity. Q7 — (A) brittle. Q8 — (A) the modulus of elasticity.
- Q9 — The ratio of lateral strain to longitudinal strain ($\sigma = \text{lateral strain/longitudinal strain}$).
- Q10 — The ratio of longitudinal stress to longitudinal strain within the elastic limit.

Q11 — strain = $2 \times 10^{-3}/2 = 10^{-3}$.

Q12 — $Y = (50 \times 2)/(10^{-6} \times 10^{-3}) = 10^{11} \text{ N m}^{-2}$.

Q13 — $\Delta l = Fl/Ay = 200 \times 2/(10^{-6} \times 2 \times 10^{11}) = 2 \times 10^{-3} \text{ m}$.

Q14 — $\eta = \text{shear stress/shear strain}$; strain = $0.01/100 = 10^{-4}$; $\eta = 10^4/10^{-2} \times \dots = 10^{10} \text{ N m}^{-2}$.

Q15 — $\Delta l = 50 \times 2/(7.85 \times 10^{-7} \times 2 \times 10^{11}) \approx 6.4 \times 10^{-4} \text{ m}$.

Q16 — lateral strain = 6×10^{-4} ; $\Delta d = 6 \times 10^{-7} \text{ m}$.

Q17 — $\Delta V/V = P/B = 2 \times 10^6/10^{10} = 2 \times 10^{-4}$.

Q18 — stress = $200/10^{-6} = 2 \times 10^8 \text{ N m}^{-2}$; strain = $10^{-3}/4 = 2.5 \times 10^{-4}$; $Y = 8 \times 10^{11} \text{ N m}^{-2}$.

Q19 — $u = \frac{1}{2} \times \text{stress} \times \text{strain} = \frac{1}{2} Y (\text{strain})^2 = \frac{1}{2} \times 2 \times 10^{11} \times 10^{-6} = 10^5 \text{ J m}^{-3}$.

Q20 — $\sigma = \text{lateral/longitudinal strain}$; for isotropic solids $Y = 3B(1 - 2\sigma)$ and $Y = 2G(1 + \sigma)$, with G the rigidity modulus.