

STUDYNEST | CLASS 11 PHYSICS QUESTION PAPER 1

Chapter 8: Mechanical Properties of Solids

Maximum Marks: 40 | Suggested time: 60 minutes

Instructions: Answer all questions. Show calculation steps and units. Original practice paper, not an official examination.

Section A 1-mark questions - $8 \times 1 = 8$ marks

1. Define stress. [1]
2. SI unit of Young's modulus? [1]
3. Longitudinal strain? [1]
4. Hooke's law? [1]
5. Modulus for volume change? [1]
6. Is strain dimensionless? [1]
7. Meaning of large Young's modulus? [1]
8. Longitudinal stress? [1]

Section B 2-mark questions - $6 \times 2 = 12$ marks

9. 100 N on $2 \times 10^{-4} \text{ m}^2$: stress? [2]
10. 2 m wire extends 1 mm: strain? [2]
11. Stress= $2 \times 10^7 \text{ Pa}$, strain= 10^{-4} : Y ? [2]
12. 10 cm cube compresses by .1 cm: strain magnitude? [2]
13. $L=1 \text{ m}$, $A=2 \times 10^{-6} \text{ m}^2$, $Y=2 \times 10^{11}$, $F=40 \text{ N}$: extension? [2]
14. Why use steel reinforcement in concrete? [2]

Section C 3-mark questions - $4 \times 3 = 12$ marks

15. Wire $L=2\text{m}$, $A=10^{-6}$, $Y=2 \times 10^{11}$, $F=100\text{N}$: extension? [3]
16. Stress $4 \times 10^7 \text{ Pa}$ at strain 2×10^{-4} . Estimate modulus. [3]
17. $B=1.5 \times 10^9 \text{ Pa}$, volume strain= -2×10^{-4} . Pressure increase? [3]
18. Why does doubling wire length double its extension if F, A, Y fixed? [3]

Section D 4-mark questions - $2 \times 4 = 8$ marks

19. Distinguish proportional and elastic limits. [4]
20. Derive extension and calculate for $F=50 \text{ N}$, $L=1.5\text{m}$, $A=10^{-6}$, $Y=2 \times 10^{11}$. [4]

End of question paper.

FORMULA AND EQUATION REFERENCE

Chapter-specific equations and relations

- Stress $\sigma = F/A$; longitudinal strain $\epsilon = \Delta L/L$ (dimensionless).
 - Young's modulus $Y = (F/A)/(\Delta L/L) = FL/(A \Delta L)$, so $\Delta L = FL/(AY)$.
 - Bulk modulus $B = -\Delta p/(\Delta V/V)$; therefore $\Delta p = -B(\Delta V/V)$.
 - Shear modulus $G = \text{shear stress}/\text{shear strain}$; shear strain approximately x/L for small deformation.
 - Hooke's law: stress proportional to strain within the proportional limit.
 - For a cube, volume strain $= \Delta V/V$; for small uniform linear compression, use the stated volume change directly.
 - Stress and elastic moduli are in Pa (N/m^2); strain has no unit.
- Use equations only when their assumptions apply; keep units consistent.

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STEP-BY-STEP SOLUTIONS

Concept questions are answered directly; numerical problems show the governing equation and substitution.

Question 1

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here: Restoring force per unit area.

Final answer: Restoring force per unit area.

Question 2

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here: Pa.

Final answer: Pa.

Question 3

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here: $\Delta L/L$.

Final answer: $\Delta L/L$.

Question 4

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here: Within proportional limit, stress is proportional to strain.

Final answer: Within proportional limit, stress is proportional to strain.

Question 5

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here: Bulk modulus.

Final answer: Bulk modulus.

Question 6

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here: Yes.

Final answer: Yes.

Question 7

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here: Material is relatively stiff.

Final answer: Material is relatively stiff.

Question 8

Principle / definition: Identify the physical quantity or law asked for, then apply the chapter definition.

Apply it here: F/A .

Final answer: F/A .

Question 9

Working: Use $\sigma = F/A$. Substitute $F = 100 \text{ N}$ and $A = 2 \times 10^{-4} \text{ m}^2$: $\sigma = 100 / (2 \times 10^{-4}) = 5 \times 10^5 \text{ Pa}$.

Final answer: $5 \times 10^5 \text{ Pa}$.

Question 10

Working: Strain = $\Delta L/L$. Convert $1 \text{ mm} = 0.001 \text{ m}$; strain = $0.001/2 = 5 \times 10^{-4}$ (dimensionless).

Final answer: 5×10^{-4} .

Question 11

Working: Young's modulus $Y = \text{stress}/\text{strain} = (2 \times 10^7) / (10^{-4}) = 2 \times 10^{11} \text{ Pa}$.

Final answer: $2 \times 10^{11} \text{ Pa}$.

Question 12

Working: Volume strain magnitude = $|\Delta V|/V = 0.1 \text{ cm} / 10 \text{ cm} = 0.01$. It is dimensionless.

Final answer: 0.01.

Question 13

Working: $\Delta L = FL/(AY) = 40(1) / [(2 \times 10^{-6})(2 \times 10^{11})] = 40 / (4 \times 10^5) = 1 \times 10^{-4} \text{ m}$.

Final answer: $1 \times 10^{-4} \text{ m}$.

Question 14

Working: Concrete is strong under compression but relatively weak under tension. Steel reinforcement carries tensile stress and helps the composite structure resist bending and cracking.

Final answer: Steel carries tensile stress effectively; concrete is strong in compression.

Question 15

Working: $\Delta L = FL/(AY) = 100(2)/[(10^{-6})(2 \times 10^{11})] = 200/(2 \times 10^5) = 1 \times 10^{-3} \text{ m} = 0.001 \text{ m}$.

Final answer: 0.001 m.

Question 16

Working: $Y = \text{stress}/\text{strain} = (4 \times 10^7)/(2 \times 10^{-4}) = 2 \times 10^{11} \text{ Pa}$.

Final answer: $2 \times 10^{11} \text{ Pa}$.

Question 17

Working: $B = -\Delta p/(\Delta V/V)$, so $\Delta p = -B(\Delta V/V) = -(1.5 \times 10^9)(-2 \times 10^{-4}) = 3 \times 10^5 \text{ Pa}$.

Final answer: $3 \times 10^5 \text{ Pa}$.

Question 18

Working: From $Y = FL/(A \Delta L)$, rearrange $\Delta L = FL/(AY)$. If F , A and Y stay fixed, ΔL is directly proportional to L ; doubling L doubles the extension.

Final answer: ΔL proportional to L .

Question 19

Working: The proportional limit is the end of the straight-line stress-strain region where stress is proportional to strain. The elastic limit is the greatest stress after which a material still returns fully to its original dimensions when unloaded; the elastic limit can be beyond the proportional limit.

Final answer: Proportional limit ends linearity; elastic limit is the greatest stress for full recovery after unloading.

Question 20

Working: Start with $Y = FL/(A \Delta L)$, giving $\Delta L = FL/(AY)$. Substitute: $\Delta L = 50(1.5)/[(10^{-6})(2 \times 10^{11})] = 75/(2 \times 10^5) = 3.75 \times 10^{-4} \text{ m}$.

Final answer: $\Delta L = FL/(AY) = 3.75 \times 10^{-4} \text{ m}$.

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