PHYSICS – CLASS XI

Chapter 8 : Mechanical Properties of Solids

PRACTICE PAPER (Chapter-wise Test)

Time : 1½ Hours **Max. Marks : 35**

General Instructions

(a) All questions are compulsory.

(b) There are 17 questions in total. Section A: Q. 1 to 8 carry 1 mark each. Section B: Q. 9 to 12 carry 2 marks each. Section C: Q. 13 to 15 carry 3 marks each. Section D: Q. 16 and 17 carry 5 marks each.

(c) There is no overall choice. An internal choice is given in one 2-mark question (Q. 11), one 3-mark question (Q. 14) and both 5-mark questions (Q. 16, Q. 17). Attempt only one of the given choices.

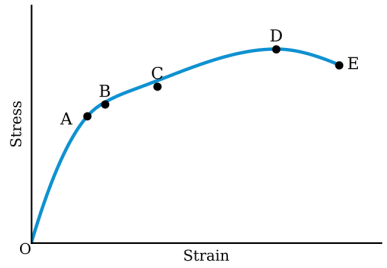
(d) Use of calculators is not permitted. Take $g = 10\ \text{m s}^{-2}$, Young's modulus of steel $Y = 2 \times 10^{11}\ \text{N m}^{-2}$ and the density of water = $1000\ \text{kg m}^{-3}$ unless a different value is given in the question.

(e) Figures are schematic and not drawn to scale. Write the unit with every numerical answer.

SECTION A

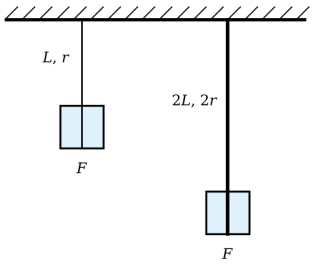
Questions 1 to 8 carry 1 mark each.

1. The figure shows a typical stress–strain curve for a metal. Hooke's law is obeyed (stress ∝ strain) only up to the point **(1)**



(a) A
(b) B
(c) C
(d) D

2. A wire of length L and radius r is stretched by a load F and its extension is ΔL. A second wire of the same material, of length $2L$ and radius $2r$, is stretched by the same load F (figure). Its extension is **(1)**

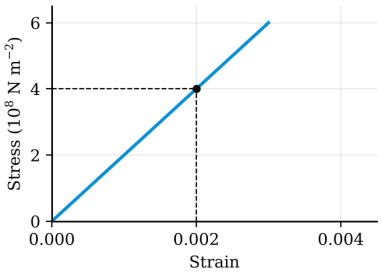


(a) $\Delta L/2$
(b) ΔL
(c) $2\Delta L$
(d) $\Delta L/4$

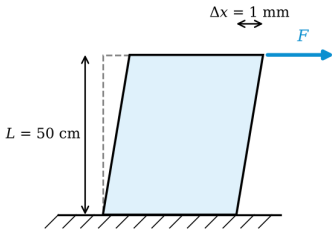
3. The dimensional formula of Young's modulus is **(1)**
(a) $[M\ L^{-1}\ T^{-2}]$
(b) $[M\ L\ T^{-2}]$
(c) $[M\ L^{2}\ T^{-2}]$
(d) $[M^{0}\ L^{0}\ T^{0}]$

4. **Assertion (A):** Steel is more elastic than rubber. **(1)**
Reason (R): For the same stress, steel shows a much smaller strain than rubber.
(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

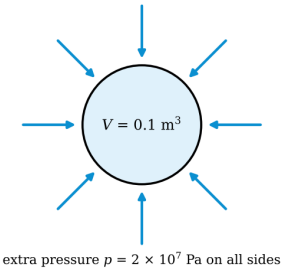
5. The graph shows the stress–strain relation for the elastic region of a wire (figure). Find the Young's modulus of the material of the wire. **(1)**



6. A tangential force F displaces the top face of a block through $\Delta x = 1$ mm relative to its fixed bottom face, which is at a distance $L = 50$ cm from it (figure). Find the shearing strain. **(1)**



7. A solid sphere of volume 0.1 m^3 and bulk modulus 1×10^{11} N m^{-2} is subjected to an extra hydraulic pressure of 2×10^7 N m^{-2} on all sides (figure). Find the decrease in its volume. **(1)**

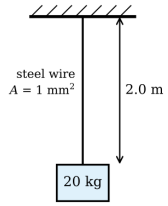


8. A wire is stretched so that the stress in it is 2×10^8 N m^{-2} and the strain is 1×10^{-3}. Find the elastic potential energy stored per unit volume of the wire. **(1)**

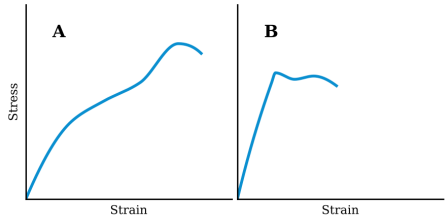
SECTION B

Questions 9 to 12 carry 2 marks each.

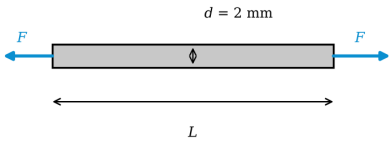
9. A steel wire of length 2.0 m and cross-sectional area 1.0 mm^2 (= 1×10^{-6} m^2) supports a mass of 20 kg (figure). Find (i) the stress in the wire and (ii) the elongation of the wire. **(2)**



10. The stress–strain graphs for two materials A and B are drawn to the same scale (figure). (i) Which material has the greater Young's modulus? (ii) Which is the stronger material? Give a reason in each case. **(2)**



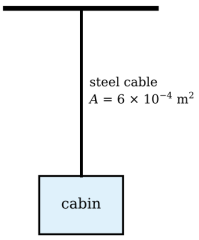
11. A wire of diameter 2 mm is stretched by a force F (figure). Its length increases by 0.1% and its diameter decreases by 0.03%. Find the Poisson's ratio of the material. **(2)**



OR

Write the formula for (i) Young's modulus, (ii) shear modulus and (iii) bulk modulus of a material. State which of these three can be defined for liquids and gases.

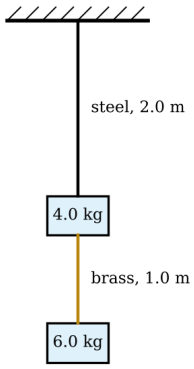
12. A steel cable of cross-sectional area 6×10^{-4} m² is used to hold a lift cabin (figure). The stress in the cable must not exceed 1×10^{8} N m^{-2}. Find the maximum load, in newton and in kilogram, that the cable can support. **(2)**



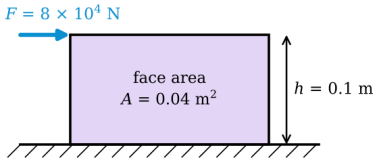
SECTION C

Questions 13 to 15 carry 3 marks each.

13. Two wires, a steel wire of length 2.0 m and a brass wire of length 1.0 m, each of cross-sectional area 2.0 mm² (= 2×10^{-6} m²), are joined end to end and loaded as shown (figure). Take $Y_{steel} = 2 \times 10^{11}$ N m^{-2} and $Y_{brass} = 1 \times 10^{11}$ N m^{-2}. Find (i) the tension in each wire, (ii) the elongation of the steel wire and (iii) the elongation of the brass wire, and hence the total elongation. **(3)**

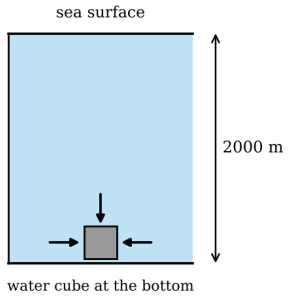


14. A rectangular slab of face area 0.04 m² and thickness h = 0.1 m is fixed at its bottom face to the floor. A tangential force of 8 × 10⁴ N is applied on its top face (figure). The shear modulus of the material is 5 × 10⁹ N m⁻². Find (i) the shearing stress, (ii) the shearing strain and (iii) the displacement of the top face. **(3)**

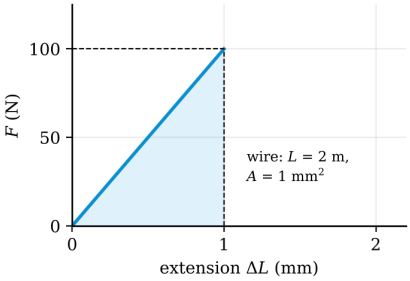


OR

A cube of water of volume 5 m³ is taken to the bottom of an ocean 2000 m deep (figure). The bulk modulus of water is 2.0 × 10⁹ N m⁻². Find (i) the pressure due to the water column at the bottom, (ii) the fractional compression ΔV/V and (iii) the decrease in volume of the cube.



15. The graph shows the variation of the stretching force F with the extension ΔL of a steel wire of length 2 m and cross-sectional area 1 mm² (figure). Find (i) the Young's modulus of the material, (ii) the elastic potential energy stored in the wire at an extension of 1 mm, and (iii) the energy stored per unit volume. **(3)**



SECTION D

Questions 16 and 17 carry 5 marks each.

16. A mass of 2 kg is tied to the end of a steel wire of unstretched length 1.0 m and cross-sectional area 1.0×10^{-6} m², and is whirled in a vertical circle with a constant angular speed of 2 rad s^{-1} (figure). **(5)**

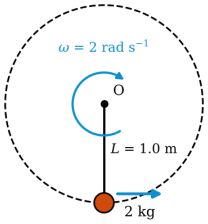
(a) State Hooke's law. (1)

(b) Find the tension in the wire when the mass is at the lowest point of the circle. (1)

(c) Find the stress in the wire at that point. (1)

(d) Find the strain produced. (1)

(e) Find the elongation of the wire. (1)



OR

A rigid horizontal bar of mass 15 kg is supported symmetrically by three vertical wires, each 2.0 m long: a copper wire at each end and an iron wire in the middle (figure). Each wire carries the same tension. Take $Y_{copper} = 1 \times 10^{11}$ N m^{-2} and $Y_{iron} = 2 \times 10^{11}$ N m^{-2}.

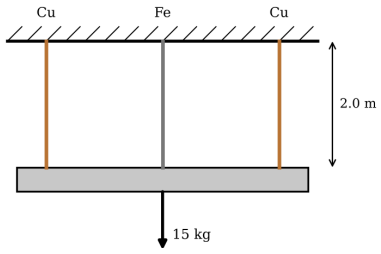
(a) Find the tension in each wire. (1)

(b) Why must the extension of the three wires be equal if the bar remains horizontal? (1)

(c) Express the extension of a wire of diameter d in terms of the tension T, length L and Y. (1)

(d) Find the ratio of the diameter of the copper wire to that of the iron wire. (1)

(e) Find the ratio of the stress in the copper wire to that in the iron wire. (1)



17. A crane has to lift a load of 10 tonnes (10^4 kg) using a steel rope whose yield strength is 2.5×10^8 N m^{-2} (figure). **(5)**

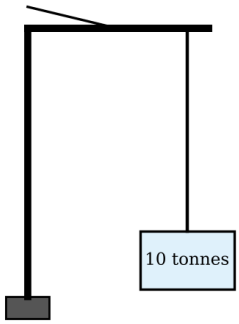
(a) What is meant by yield strength? (1)

(b) Find the minimum cross-sectional area of the rope so that the stress does not exceed the yield strength. (1)

(c) In practice a safety factor of 10 is used. Find the cross-sectional area of the rope then. (1)

(d) The rope is made of thin steel wires, each of cross-sectional area 4×10^{-6} m^2. Find the number of wires required. (1)

(e) Why is the rope made of many thin braided wires rather than a single thick wire? (1)



OR

A bar of length l, breadth b and depth d, supported at its ends and loaded at the centre by a load W, sags by $\delta = Wl^3/(4bd^3Y)$ (figure).

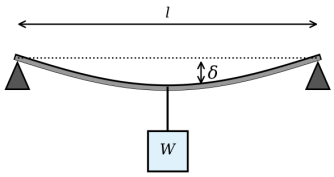
(a) By what factor does δ change if the depth d is doubled? (1)

(b) By what factor does δ change if the breadth b is doubled? (1)

(c) Hence state which is more effective in reducing the bending. (1)

(d) Why may a very deep, thin bar buckle? (1)

(e) Why is the I-shaped cross-section commonly used for beams in bridges? (1)



— END OF QUESTION PAPER —